MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

April 19, 1982

NUCLEAR PRODUCTION DEPARTMENT

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Mr. Denton:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
File 0260/L-814.2
SQRT - Additional Information Supporting Justification for Interim Operation
Reference: AECM-82/128, dated April 5, 1982
AECM-82/173

Mississippi Power & Light Company's (MP&L) letter of April 5, 1982, (AECM-82/128) provided MP&L's justification for interim operation for equipment not qualified to the SQRT criteria.

On April 13, 1982, the NRC Equipment Qualification Branch notified MP&L of their concerns in regard to MP&L's SQRT justification for interim operation. The Equipment Qualification Branch requested MP&L to provide additional information to support the justification of interim operation.

The purpose of this letter is to provide the additional information which has been requested by the Equipment Qualification Branch.

The following additional information is provided:

A. To Equipment Qualification Branch on April 20, 1982

1. Main Steam Isolation Valve
2. RHR Heat Exchanger
3. CRD Solenoid Valve C11-F009
4. Conductivity Cell
5. Air Operated Butterfly Valve (M-257.0/258.0)
6. Safety Relief Valve (M-141.1)

B. To Equipment Qualification Branch on April 21, 1982

1. HPCS Valve Actuator
2. HPCS Diesel Generator
3. Switches
4. Pressure Indicator

B001 S/1 Limited Dist
Add: T. Y. Chang EQB

C. Attachment No. 1

Main Steam Isolation Valve

D. Attachment No. 2

RHR Heat Exchanger

E. Attachment No. 3

CRD Solenoid Valve (C11-F009)

F. Attachment No. 4

Conductivity Cell (E12-N025A, B)

G. Attachment No. 5

Air Operated Butterfly Valves (M-257.0/258.0)

H. Attachment No. 6

Safety Relief Valve (M-141.0)

I. Attachment No. 7

Refurbishment Schedule for HPCS Injection Valve (E22-F004)

If you have any questions or require further information, please contact this office.

Yours truly,

L. F. Dale
Manager of Nuclear Services

RAB/SHH/JDR:lm

Attachments:
1. Main Steam Isolation Valve
2. RHR Heat Exchanger
3. CRD Solenoid Valve (C11-F009)
4 Conductivity Cell (E12-N025A, B)
5. Air Operated Butterfly Valves (M-257.0/258.0)
6. Safety Relief Valve (M-141.1)
7. Refurbishment Schedule for HPCS Injection Valve (E22-F004)

cc: (See Next Page)

cc: Mr. N. L. Stampley (w/o)
Mr. G. B. Taylor (w/o)
Mr. R. B. McGehee (w/o)
Mr. T. B. Conner (w/o)

Mr. Richard C. DeYoung, Director (w/o)
Office of Inspection & Enforcement
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Washington, D.C. 20555

Mr. J. P. O'Reilly, Regional Administrator (w/a)
Office of Inspection & Enforcement
U.S. Nuclear Regulatory Commission
Region II
101 Marietta St., N.W., Suite 3100
Atlanta, Georgia 30303

AE2Q3

ATTACHMENT NO. 1

Main Steam Isolation Valve
B21-F022/F028

GRAND GULF
MAIN STEAM ISOLATION VALVES

MPL# B21-F022
MPL# B21-F028

ADDITIONAL INFORMATION SUPPORTING
JUSTIFICATION FOR INTERIM OPERATION

PREPARED BY: K. KUMAR 4/17/82 U. N. SINHA

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175 CURTNER AVENUE
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APRIL 17, 1982

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ABSTRACT

The following tests and analyses have been performed on the Grand Gulf Main Steam Isolation Valves Upper Structure, or similar Upper Structures:

- Grand Gulf 28" Main Steam Isolation Valve Upper Structure has been compared with a dynamically tested 26" main steam isolation valve Upper Structure and it has been concluded that Grand Gulf Upper Structure is similar to the tested Upper Structure.

- Required Response Spectra have been developed for Grand Gulf at the base of valve cover. These response spectra have been compared with the test response spectra for the tested similar valve upper structure. The TRS envelope the RRS with margin.

- Static Bend tests have been performed on the Grand Gulf Main Steam Isolation Valve which assure valve operability under expected loads.

- A special valve closure analysis demonstrates adequacy of structure during opening/closing of the valve.

It is therefore, concluded that the Grand Gulf Main Steam Isolation Valve Upper Structure is dynamically adequate to meet the expected loadings. Thus, use of this equipment during startup and operation of the Grand Gulf Station is justified until such time as the requalification is complete.

Main Steam Isolation Valves

General Description

The Main Steam Isolation Valve is of a quick closing design for high pressure steam service. It is a Wye pattern type valve complete with actuator and accessory equipment. The valve is actuated with an air cylinder operator (air-to-open, air-and/or spring-to-close). The valves are usually installed in a horizontal main steam line with two valves in series per main steam line, inboard valve located within the drywell and the outboard valve located outside the containment. The valve is designed for steam service. The 28" size has a capacity of 4,120,000# per hour with 06.6 psig maximum calculated pressure drop across the fully open valve. The base material is carbon steel, with a type 17-4PH stainless steel stem and a stellite guide bushing located in the cover. The body seating surface and guide ribs, the disc seating surfaces and the guide surface near the main seat and the cover back-seating surface are all faced with stellite. The body-to-bonnet joint is a bolted type construction with a totally enclosed spiral wound stainless steel, asbestos filled gasket. The bonnet joint is prepared for seal welding, but seal welding would be performed by others at the installation site if required. The stem seal stuffing box is equipped with two sets of packing. A lantern ring is located between the two sets of packing with a leakoff connection to the lantern ring in the form of a socket welded pipe nipple. The body is equipped with provision for a 2" schedule 160 drain nipple located in the inlet end of the valve body. The valve is equipped with position switches to indicate open, closed and 94 percent open positions.

Operational Requirements

NOTE: All part nos. referred to are from dwg. 13561-01-H, Sheet 1 unless otherwise noted.

The valve is to be capable of opening with a 200 psi differential pressure tending to hold the valve closed, utilizing a minimum of 90 psig min. air pressure in the cyclinder actuator. To accomplish this requirement and keep the cylinder size within reasonable limits a cylinder balancing arrangement in the form of a cup whose upper end extends into the valve body bonnet bore is employed. The poppet is equipped with an internal pilot valve seat, and the end of the valve stem acts as the pilot valve poppet. When the valve stem lifts, the pressure in the balancing cylinder area decays, and thereby reduces the differential pressure acting over the main poppet area, thus reducing the operator force required to open the valve.

The valve is required to have an adjustable closing speed of three to ten seconds. This requirement is accomplished by a tandem air and hydraulic cylinder (part no. 37) and 1" flow control valve (part no. 6 sheet 4 of dwg. 13561-01-H) installed in the external manifold mounted on the hydraulic section of the tandem cylinder (part no. 37).

When closing the main steam isolation valve, the oil in the underside of the piston in the hydraulic cylinder must be displaced through the external manifold to the top side of the piston. The rate at which this oil displacement takes place is controlled by the adjustment of the 1" flow control valve (part no. 6 sheet 4 of dwg. 13561-01-H) which in turn controls the rate of valve closure.

Operational Requirements (Continued)

The closing speed control is provided with a minimum flow position to prevent full closure of the flow through the hydraulic cylinder's external piping.

The range of closing speed adjustment (3 to 10 seconds) is accomplished with not less than two full revolutions of the adjustment spindle of the 1" flow control valve (part no. 6 sheet 4 of dwg. 13561-01-H).

Provisions are required to accommodate an increase in fluid pressure due to the increase of ambient temperature from that existing during filling and sealing of the hydraulic system to that existing during emergency conditions. This requirement is satisfied by using a small accumulator (part no. 8 sheet 4 dwg. 13561-01-H) on the hydraulic cylinder external manifold. The accumulator is precharged with nitrogen at 100 psig, and has a design pressure limit of 5000 psig.

The valve is to be capable of opening at the rate of one inch plus or minus one-half inch per second. The opening speed adjustment is accomplished by use of a 1/2" flow control valve (part no. 7 sheet 4 dwg. no. 13561-01-H).

The valve operator is provided with an exercising control feature for stroking the valve from the 100% open position to the 94% open position. This requirement is accomplished by installing a normally open 1 1/4" three-way valve (part no. 2 sheet 4 dwg. no. 13561-01-H) in the line between the connection to the underside of the air cylinder operator and the main four-way air control valve. When the exercising control is energized, the under side of the pneumatic cylinder is vented and the springs (part no. 15 & 16) will force the valve toward the closed position.

NOTE: The isolation valve is equipped with a position switch to indicate when the 94% open position has been reached. If the three-way exercising control is left in the energized position, the main steam isolation valve will go to the fully closed position.

The exercising speed is such that the valve shall be capable of stroking from 100% open to the fully closed position in 45 to 60 seconds. The exercising speed adjustment is accomplished by use of a 1/2" air metering valve (part no. 9 sheet 4 of dwg. no. 13561-01-H) installed in the exhaust port of the three-way exercising valve. The above time for full closing is not intended to imply that the valve is to be exercised to the fully closed position when the plant is in operation.

Operational Description of the Pneumatic System Components (Dwg. 13561-01-H Sheet 4)

The air supply to the pneumatic operating cylinder is controlled by a 1 1/4" four-way pilot operated valve (part no. 1) which depending on its position, applies air pressure to either the top or bottom end of the air cylinder operator while alternately exhausting the opposite end of the cylinder. This 1 1/4" four-way pilot operated valve (part no. 1) in turn is controlled by a three-way normally energized 1/4" dual solenoid operated valve (part no. 4).

Operational Description of the Pneumatic System Components (Continued)

To open the main steam isolation valve, either or both of the solenoids on the three-way main pilot control valve (part no. 4) are energized which feeds air pressure to the piston of the 1 1/4" four-way pilot operated valve (part no. 1) causing it to shift its position. The four-way pilot operated valve (part no. 1) then feeds air pressure to the underside of the air operating cylinder and at the same time exhausts air from the top end of the cylinder and the main steam isolation valve opens. Should either of the solenoids of the three-way main pilot control valve (part no. 4) be de-energized while the other is energized, the air pressure would be maintained in the piston of the 1 1/4" four-way pilot operated valve (part no. 1) and it would maintain its position, thus the main steam isolation valve would remain in the open position.

In the event of loss of system air supply, the air pressure in the piston of the 1 1/4" four-way pilot operated valve (part no. 1) would exhaust out through the three-way solenoid operated valve (part no. 4) to the air supply line. The 1 1/4" four-way pilot operated valve (part no. 1) would shift its position and exhaust the air pressure from the underside of the operating cylinder. The force generated by the closing spring will close the main steam isolation valve, (any air pressure contained in the air storage tank will assist the spring in closing the valve).

To close the main steam isolation valve, both solenoids on the three-way main pilot control valve (part no. 4) are de-energized which exhausts the air pressure from the piston to the 1 1/4" four-way pilot operated valve (part no. 1) causing it to shift its position. The 1 1/4" four-way pilot operated valve (part no. 1) then feeds air pressure to the top side of the air operating cylinder and at the same time exhausts the air from the bottom side of the operating cylinder and the main steam isolation valve closes. It should be noted that in the event no air pressure is available for closing, the closing springs will supply the force to close the main steam isolation valve.

A 1 1/4" normally open three-way pilot operated valve (part no. 2) is installed in the air line between the underside of the air operating cylinder and the main 1 1/4" four-way pilot operated valve (part no. 1). Its purpose is to accomplish the exercising feature.

This 1 1/4" three-way pilot operated exercising valve (part no. 2) in turn is controlled by a three-way normally de-energized solenoid operated valve (part no. 5).

To exercise the main steam isolation valve, the three-way solenoid operated valve (part no. 5) is energized which feeds air pressure to the piston of the 1 1/4" three-way pilot operated valve (part no. 2) causing it to shift its position. The air supply being fed from the main 1 1/4" four-way pilot operated valve (part no. 1) to the underside of the air cylinder is blocked and the air in the cylinder is exhausted to atmosphere through the 1 1/4" three-way pilot operated exercising valve (part no. 2). When the air pressure in the under-side of the air operating cylinder decays to a point where its force can no longer overcome the force generated by the closing springs, the

isolation valve will start to close. A 1/2" metering valve (part no. 9) installed in the exhaust port of the 1 1/4" three-way pilot operating exercising valve (part no. 2) is used to adjust the rate of exercising speed. The exercising speed from 100 percent open to fully closed position, (14 inches of valve stroke), is 45 to 60 seconds. When the three-way solenoid operated valve (part no. 5) is de-energized, it exhausts the air pressure from the piston of the three-way pilot operated exercising valve (part no. 2) causing it to shift its position. The exhaust port is now blocked and the air from the main 1 1/4" four-way pilot operated valve (part no. 1) is fed to the underside of the air cylinder operator and the main steam isolation valve returns to its full open position.

A 1 1/4" two-way pilot operated valve (part no. 3) is installed in a tee in the air line between the underside of the air operating cylinder and the 1 1/4" normally open three-way pilot operated exercising valve (part no. 2). This 1 1/4" two-way pilot operated valve (part no. 3) serves as an additional closing valve in the air control system. The 1 1/4" two-way pilot operated valve (part no. 3) is controlled by the same dual solenoid operated three-way valve (part no. 4) that controls the main 1 1/4" four-way pilot operated valve (part no. 1). When the three-way dual solenoid operated valve (part no. 4) is energized to open the main steam isolation valve, air pressure is also fed to the piston of the 1 1/4" two-way pilot operated valve (part no. 3) which shifts its position. The valve closes, blocking the exhaust port and prevents the air pressure in the line to the underside of the air operating cylinder from exhausting to atmosphere.

When the dual solenoids of the main three-way pilot operated valve (part no. 4) are de-energized to close the main steam isolation valve, the air pressure is exhausted from the piston of the 1 1/4" two-way pilot operated valve (part no. 3) causing it to shift its position. The air in the underside of the air cylinder operator is then exhausted to atmosphere through the open 1 1/4" two-way pilot operated valve (part no. 3) as well as through the main 1 1/4" four-way pilot operated valve (part no. 1).

Hydraulic Speed Control System

The purpose of the hydraulic speed control system is to control the opening and closing speed of the pneumatic cylinder operator on the main steam isolation valve. The sub-plate mounted hydraulic speed control system is connected to the speed control cylinder at the top and bottom ports. By the use of adjustable flow control valves in the sub-plate assembly, the amount of flow from one side of the hydraulic cylinder piston to the other can be regulated. This regulated flow controls the operator cylinder opening and closing speed.

Operational Description of the Hydraulic System Components

Part Nos. From Dwg. 13561-01-H Sheet 4

A 1" closing flow control valve (part no. 6) (adjustable and pressure compensated), is sized so that the time to fully stroke the pneumatic operator is less than 3 seconds when only spring force is applied in the closing direction.

It is also capable of adjusting the closing time to 10 or more seconds when both air pressure and spring loads are applied in closing direction. The range of closing speed adjustment, (3 to 10 seconds) is accomplished with not less than two full revolutions of the adjustment spindle. The closing flow control valve (part no. 6) is equipped with a minimum flow position to prevent its full closure. The minimum flow position is sized so that the time of full pneumatic operator stroke is greater than 10 seconds in order to achieve the adjustable closure range of 3 to 10 seconds. The adjustable spindle of the closing flow control valve (part no. 6) is provided with a positive locking device.

A 1/2" opening flow control valve (part no. 7), (adjustable and pressure compensated), is sized so that the time to fully stroke the pneumatic actuator (retract piston rod from fully extended position), is at a rate of 1 inch, plus or minus 1/2 inch per second. The opening flow control valve (part no. 7) is equipped with a minimum flow position to prevent its full closure. The minimum flow position is sized so that the time of full operator stroke is less than 1/2" per second in order to achieve the adjustable opening range of 1/2" to 1 1/2" per second. The adjustable spindle of the opening flow control valve (part no. 7) is provided with a positive locking device.

The accumulator is included in the hydraulic system in order to accommodate an increase in fluid pressure due to the increase of ambient temperature from that existing during filling and sealing of the hydraulic system to that existing during emergency ambient conditions.

The required response spectra (RRS) used in this evaluation for the Grand Gulf MSIV Upper Structure are based on the following observations:

a) The main steam isolation valve (MSIV) is mounted on the piping which is supported by the main steam guide and the head fitting. The main steam guide, in turn, is mounted on the platform near the drywell wall, and the head fitting is mounted in the shield building wall.

b) The support system and valve body are stiff so that the loads (response spectra) input to the MSIV upper structure can be considered the same as obtained from the building model.

Based on the above observations, it can be shown that in the vicinity of the main steam isolation valves (MSIV), the controlling dynamic loads as determined by the piping dynamic analysis are the combination of safe shutdown earthquake (SSE) plus the safety relief valve blowdown structural load (SRV). Grand Gulf unique enveloped (SSE + SRV) response spectra, hereafter called the required response spectra (RRS), have been developed to compare with the test response spectra (TRS) used on the tests of similar valve upper structures. Based on the comparison of RRS and TRS, the following conclusions can be made:

1. Grand Gulf Project Unique Response Spectra show 2g ZPA loading on the MSIV, whereas the test response spectra used for testing the 24 inch and 26 inch MSIV upper structures used ZPA of 5.5g.

2. Test response spectra used for testing the MSIV upper structures were broad band in comparison with narrow band real input motion to Grand Gulf MSIV. So, it can be seen that TRS provide conservatively higher load than the required load (RRS).

3. The natural frequency of the Grand Gulf Upper Structure is about 13 Hz. The natural frequencies of the tested MSIV Upper Structures were between 10 Hz and 14 Hz. Since the tests were performed from 2 Hz to 40 Hz, excitation of the upper structure at the natural frequency is assured.

4. Comparison of different components of Grand Gulf MSIV Upper Structure and the tested MSIV Upper Structure have been made (Appendix I). The comparison shows that the Grand Gulf MSIV Upper Structure is physically similar to the tested upper structure and generally made out of better material.

Based on the above information, it can be concluded that the TRS used for testing the 24 inch and 26 inch MSIV upper structures envelop the Grand Gulf Unique Required Response Spectra (RRS) (See Fig. 1) and that comparison of these spectra is justified based on similarity of the valve upper structures.

TESTS AND ANALYSES SUPPORTING OPERABILITY OF GRAND GULF MAIN STEAM ISOLATION VALVES

Operability of the Grand Gulf Main Steam Isolation Valve is based on the following information:

1. A Static Bend Test was performed on the Grand Gulf Valve which demonstrated that the valve would close within the required time period of 4.0 ± 1 seconds. The valve was exercised using air and springs, while the valve was being subjected to a static equivalent seismic load. In this test, the stem moved freely without any scratches or binding when a load of 18,550 lbs (approximately 5.6 g) was applied at the spring top plate. On the Grand Gulf valve, the maximum expected dynamic load is approximately 6.6 g's applied at the center of gravity of the upper structure. Calculating moments, the static bend test imposed a moment of approximately 280 in-lbs at the valve body/bonnet centerline. The comparable maximum expected dynamic moment is approximately 263 in-lbs. The static bend test therefore bounds the expected dynamic moment.

2. A special "Closure Analysis" was performed on the Grand Gulf 28" Main Steam Isolation Valves. This analysis was done to assure that the air pressure in the pneumatic cylinder and the springs are more than adequate to open/close the valve under the Grand Gulf specified flow conditions.

3. Upper Structures of two main steam isolation valves similar to the Grand Gulf Main Steam Isolation Valve have been previously tested. The Test Response Spectra of the tested Upper Structures envelope the Required Response Spectra of the Grand Gulf Upper Structure (See Figure 1). Operability of the Upper Structure was demonstrated during and after the seismic test.

Grand Gulf Main Steam Isolation Valves were supplied by Atwood and Morrill Valve Co. using Sheffer/Hiller SA-A039 pneumatic and hydraulic components. These valves remain in open position all the time during normal plant operation and are checked periodically for their closure capability. The Upper Structure of a similar 26" valve was tested and operated successfully during and after the test under simulated seismic loadings. The Test Response Spectra for the similar 26" valve Upper Structure envelopes the Grand Gulf Required Response Spectra. Grand Gulf Main Steam Isolation Valve Upper Structure is very similar to the tested Upper Structure (Refer to Appendix-I for detailed comparison). The Required Response Spectra for Grand Gulf is enveloped by the Test Response Spectra with substantial Margin. (See Figure 1). Based on the similarity of the tested Upper Structure and the Grand Gulf Upper Structure it is anticipated that the Grand Gulf Upper Structure would respond in a similar manner when dynamically tested. It is expected that the relative stress level in the Yoke Rods would be lower due to the use of superior yoke rod material and size which provides additional assurance of Upper Structure's seismic capability. Furthermore, successful "Static Bend Test" and "Closure Analyses" have been performed.

It is, therefore, concluded that the Grand Gulf Upper Structure is dynamically adequate to meet the expected loadings. Thus startup and operation of Grand Gulf Station is justified until such time as requalification is completed.

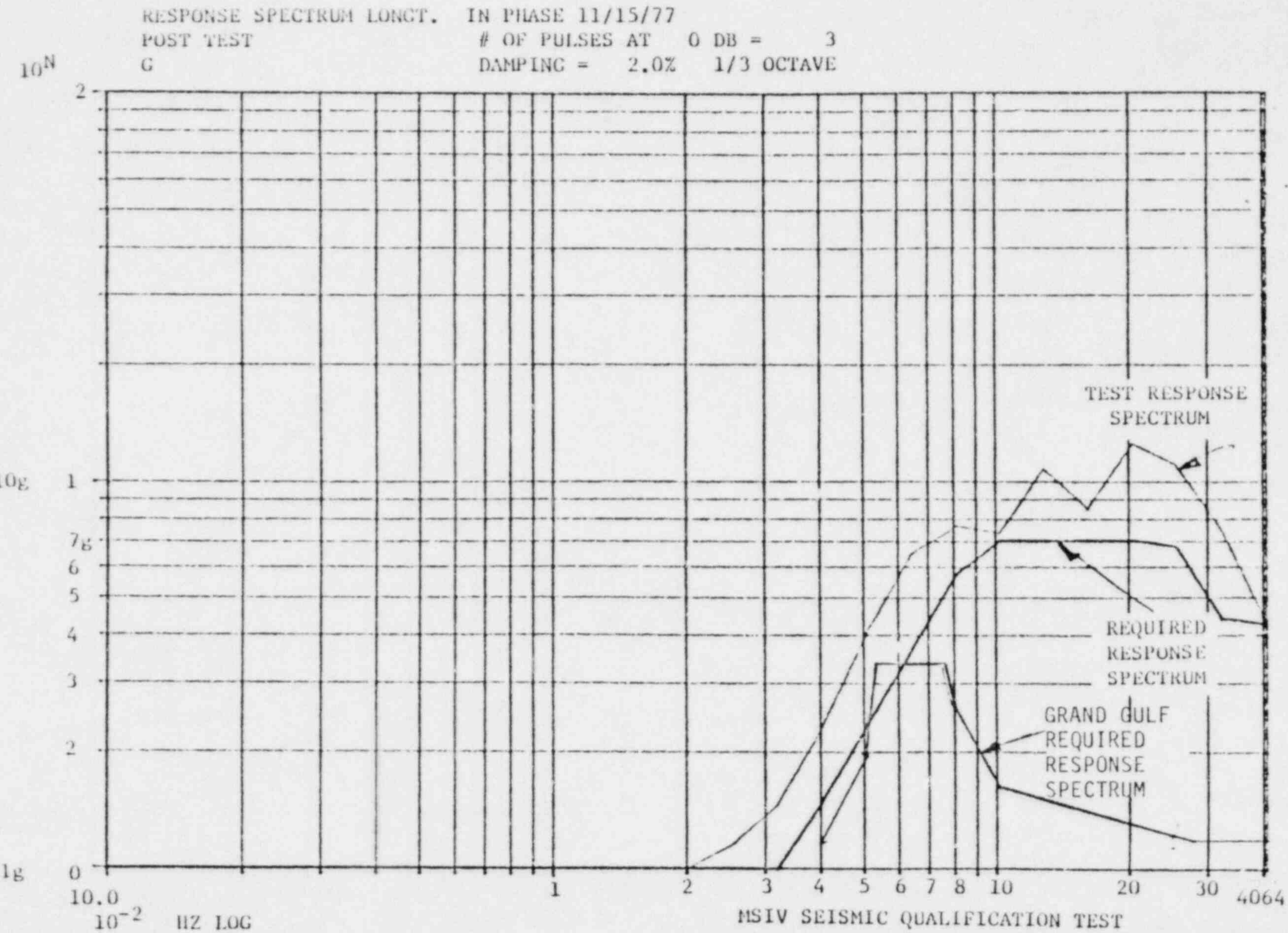


Figure 1 Response Spectrum

Appendix I

PHYSICAL COMPARISON OF GRAND GULF AND THE TESTED UPPER STRUCTURE

APPENDIX I - PHYSICAL COMPARISON OF GRAND GULF AND THE TESTED UPPER STRUCTURE (Actuator Only)

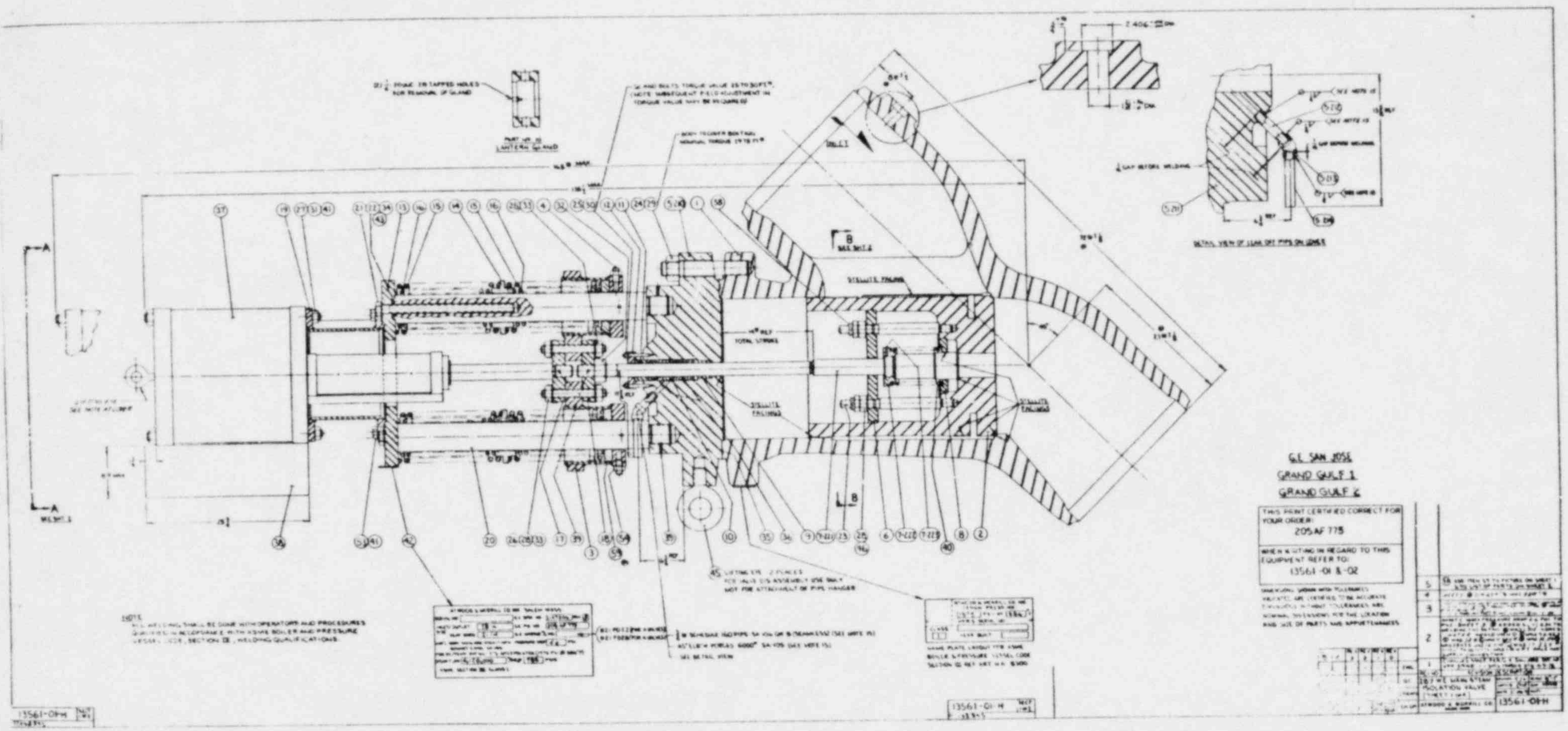
Item Description	Grand Gulf Upper Structure	24" - Tested Upper Structure Report No. NEDE-24122-2
Pneumatic/Hydraulic Component Vendor	Sheffer/Hiller	Sheffer/Hiller
Component Model No.	SA-A039	SA-A012
Dual Solenoid Supplier/Model No.	ASCO/HTX832320	ASCO/HTX832320
Single Solenoid Supplier/Model No.	ASCO/HTX8320A20	ASCO/HTX8320A20
2-Way Valve Supplier/Model No.	Norgren B0004A	Norgren/B-1026B-00-A1 Similar to B0004A
3-Way Valve Supplier/Model No.	Norgren/C0007A	Norgren/C-1037B-00A1 Similar to C0007A
4-Way Valve Supplier/Model No.	Norgren/F013A	Norgren F2227B-00-A1 Similar to F013A
O-Rings	Viton	Viton
Pneumatic Cylinder Height	24 1/8"	27 1/2"
Pneumatic Cylinder Bore Dia.	20"	20"
Piston Diameter	3"	3"
Stroke Length	15"	18"
Operating Pressure	90 - 125 PSI	90 - 125 PSI
Hydraulic Cylinder Bore Dia.	5"	5"
Piston Diameter	3"	3"
Hydraulic Fluid	GE Silicone-SF-1147	Shell Irus - 902

APPENDIX I - PHYSICAL COMPARISON OF GRAND GULF AND THE TESTED UPPER STRUCTURE
(Yoke Components Only)

Item Description	Grand Gulf Upper Structure	26" - Tested Upper Structure Report No. NEDE-24122-1
Valve Vendor	A & M	A & M
Valve Size	28"	26"
Bonnet Cover Plate Dia.	35 5/8"	33 7/8"
Bonnet Cover Plate Thickness	5 5/8"	5 3/8"
Bonnet Cover Plate Material	SA-105	SA-105
Body Bonnet Bot diameter	2¼	2"
Number of Body Bonnet bolts	18	20
Yoke Rod Material	AISI - 4140	AISI - 1018
Yoke Rod Diameter	4.5"	3"
Yoke Rod Length	37 3/4"	34 1/4"
Tested Yoke Rod Stress	-	20,000 PSI
Yoke Rod Yield Stress	103,000 PSI	48000 PSI
Outside Springs		
Spring Wire Diameter	25/32"	23/32"
Spring Coil Outside Diameter	7 3/4"	6 1/4"
Boxed load (Valve Closed)	1412 lbs	1150 lbs
Boxed load (Valve Open	2524 lbs	2346 lbs
Inside Springs		
Spring Wire Diameter	9/16"	17/32"
Spring Coil Outside Diameter	6"	4 5/8"
Boxed load (Valve Closed)	712 lbs	618 lbs
Boxed load (Valve Open)	1220 lbs	1260 lbs
General		
Overall Upper Structure Height	Approx. 90"	Approx. 85.50"
Overall Upper Structure C.G.	39.56"	33.81"
Overall Upper Structure Weight including cover.	5860 lbs	4597 lbs
Stem Travel Nominal	14"	13"
Limit Switches	NAMCO EA-740	NAMCO EA-740
Stem Diameter	2"	2"

Appendix II

VALVE ASSEMBLY DRAWINGS


G.E. SAN JOSE
GRAND GULF 1
GRAND GULF 2
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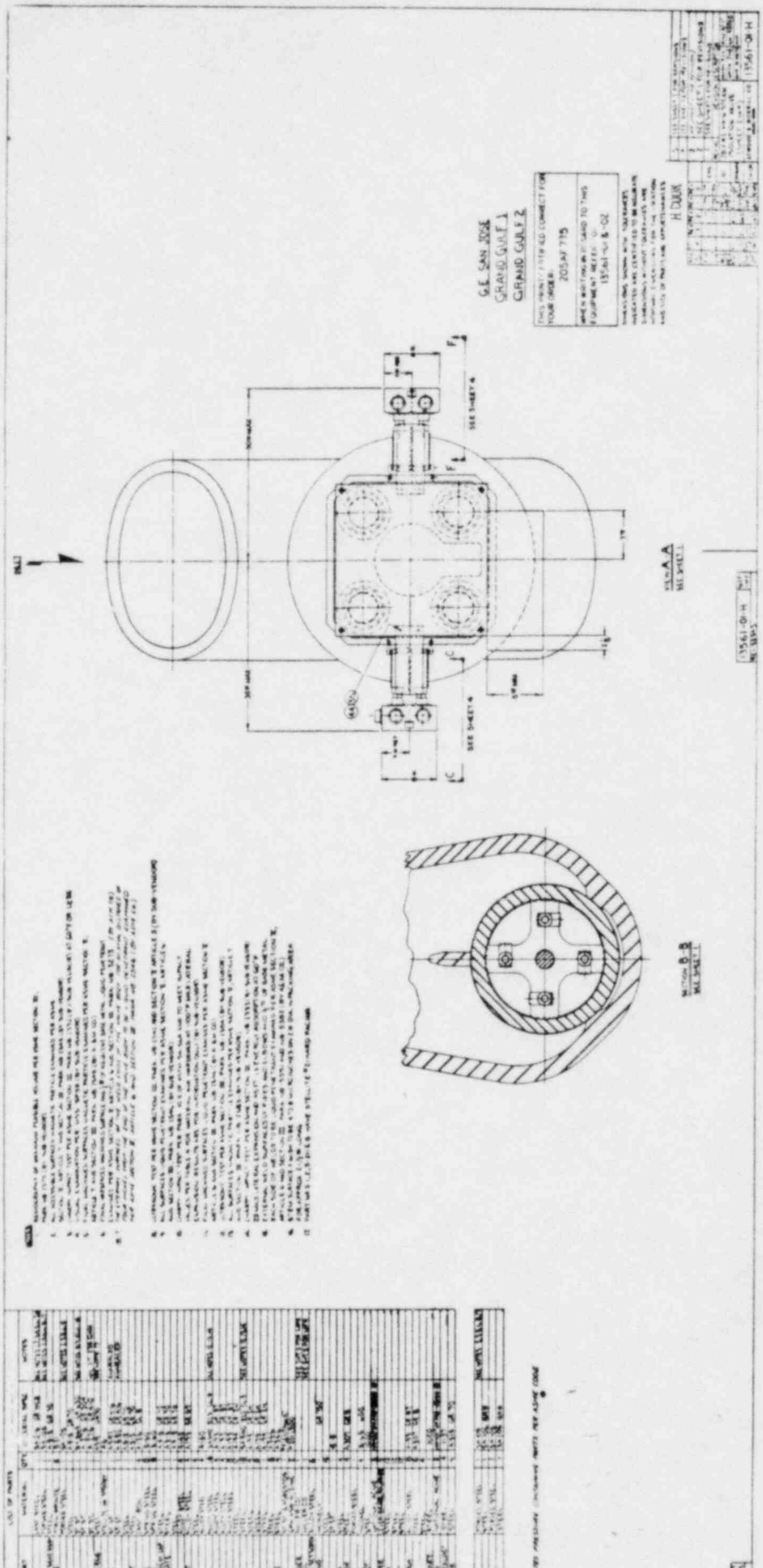
205AF775
WHEN WRITING IN REGARD TO THIS EQUIPMENT REFER TO:
13561-01 & -02
13561-01-H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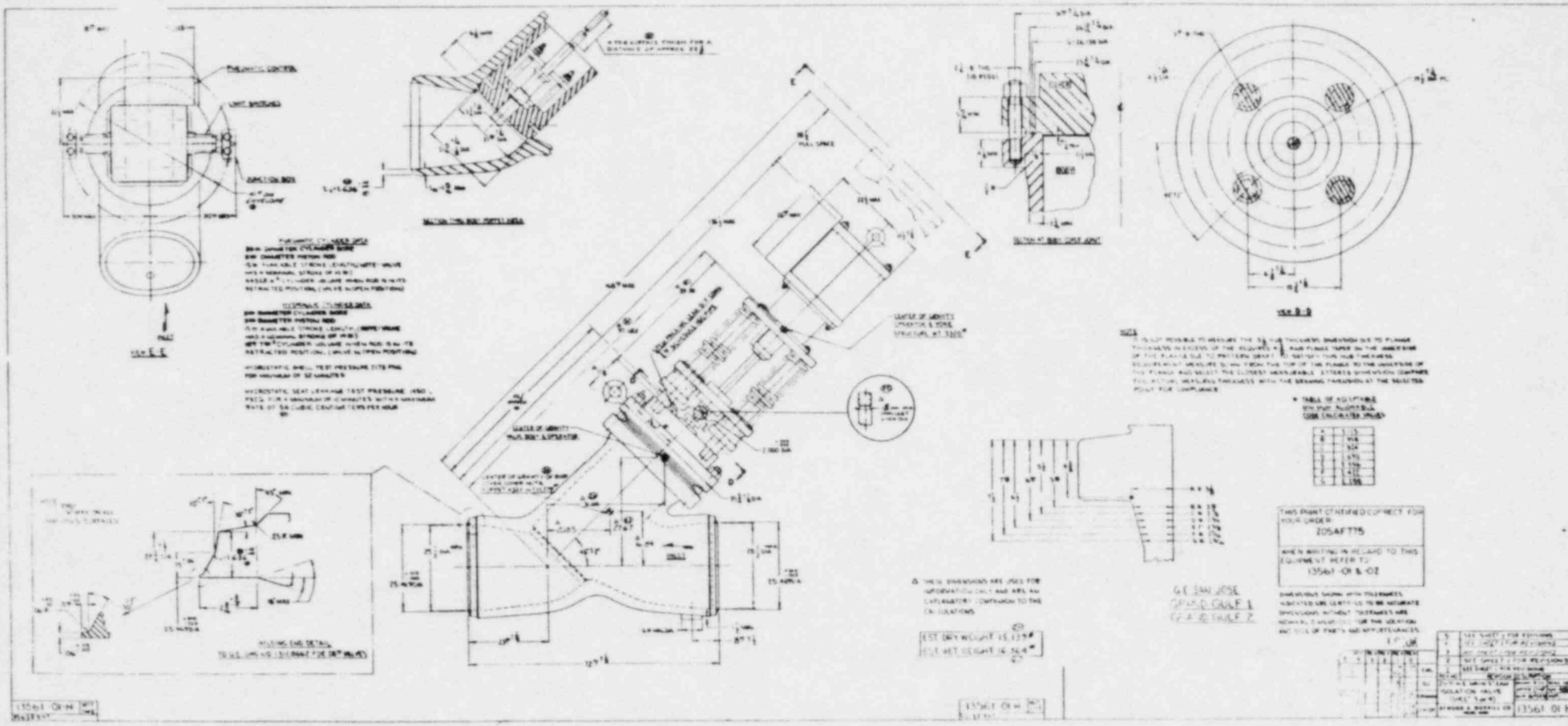
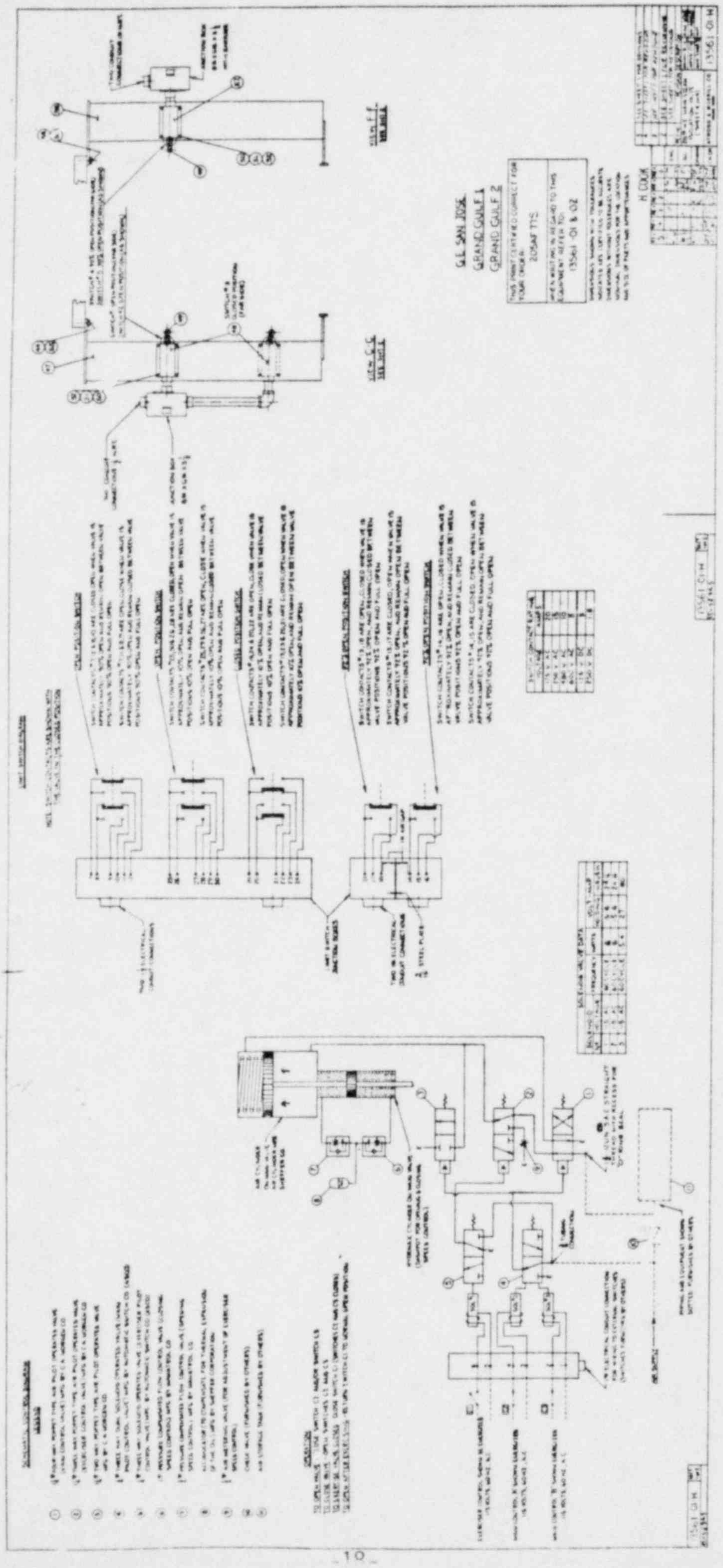
SECTION B-B


VIEW E-E
VIEW D-D
THIS PRINT CERTIFIED CORRECT FOR YOUR ORDER
205AF775
WHEN WRITING IN REGARD TO THIS EQUIPMENT REFER TO:
13561-01 & -02
EST. DRY WEIGHT 15,139#
EST. WET WEIGHT 16,564#
G.E. SAN JOSE
13561-01-H


G.E. SAN JOSE
GRAND GULF 1
GRAND GULF 2

ATTACHMENT NO. 2

RHR Heat Exchangers
E12-B001/B002

JUSTIFICATION FOR INTERIM OPERATION

NAME: RHR Heat Exchanger

MPL: E12-B001/B002

SAFETY FUNCTION:

To remove decay heat from the reactor.

FAILURE MODES:

Fail Open	____
Fail Closed	____
Loss of Power	____
Loss of Air	____
Loss of Pressure Integrity	____
Loss of Structural Integrity	____
Distortion of Mounting	X

FAILURE EFFECT:

A. Effect on Primary Use

Support structure could yield, under excessive seismic loads, causing heat exchanger nozzles to pick up additional load. If nozzles pick up additional load, they too might yield. However, pressure integrity and heat removal capability would be unimpaired.

B. Secondary Effect

None

DISCUSSION AND CONCLUSION:

An analysis of the RHR heat exchanger shows that the fundamental frequency is greater than 6 hertz. A static analysis of the heat exchanger, using a static coefficient greater than 1.5 times the peak of the faulted response spectra for all frequencies greater than 6 hertz, shows that stresses imposed on the heat exchanger are all less than allowable. Therefore, interim operation with the Grand Gulf RHR heat exchanger does not pose a safety hazard.

RWH:lm/13U-3
4/15/82

GENERAL ELECTRIC CO.
Nuclear Energy Business Group
ENGINEERING CALCULATION SHEET

NUMBER ______ DATE ______
SUBJECT ______ BY Jim Moten 4/16/82 SHEET 1 OF 11

GRAND GULF RHR HEAT EXCHANGER

INTERIM OPERATION

JUSTIFICATION

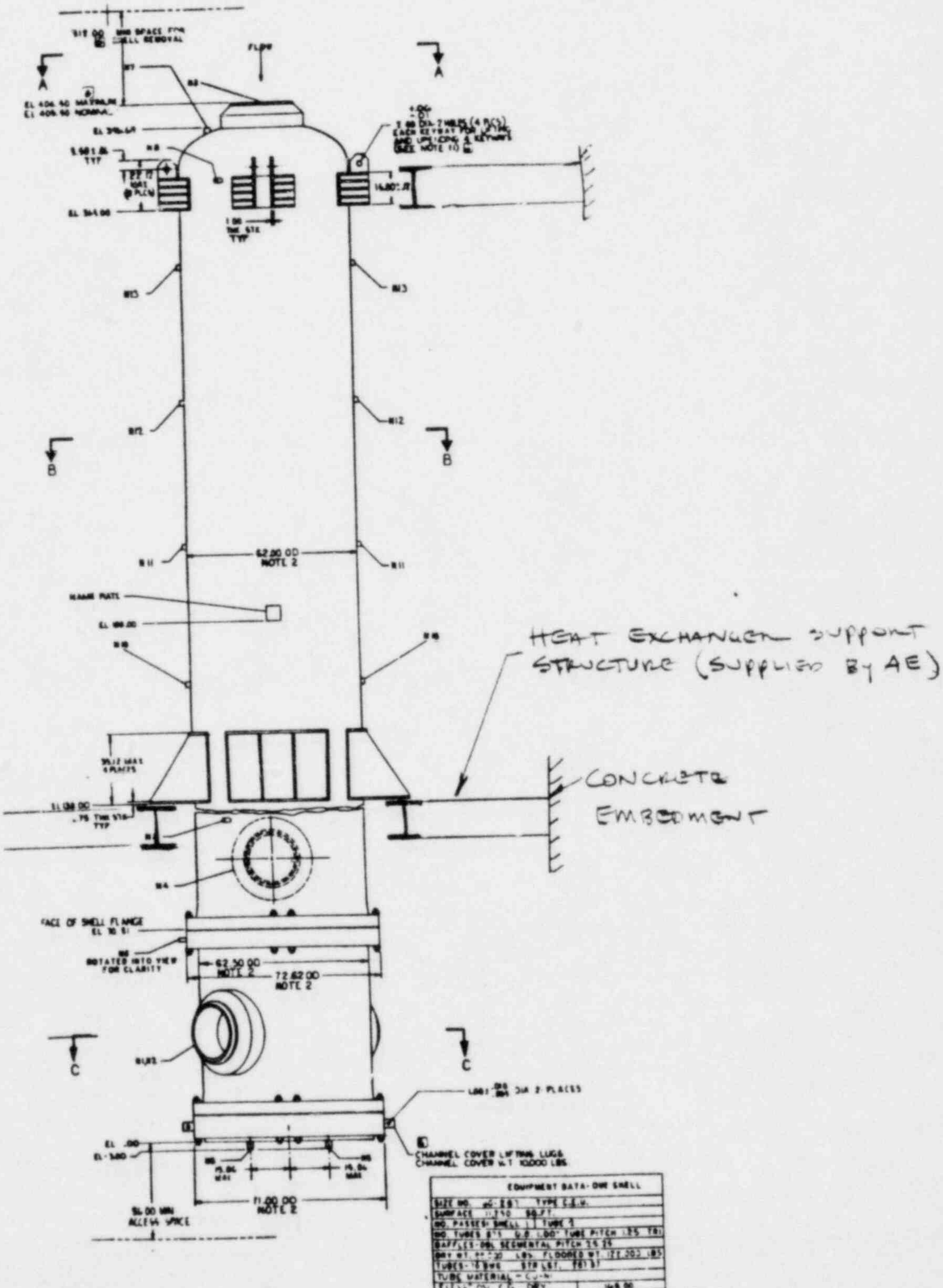
I GRAND GULF RHR HEAT EXCHANGER DESIGN

II. ESTIMATED HEAT EXCHANGER AND SUPPORT SYSTEM NATURAL FREQUENCY
1.) HAND CALCULATED VALUE
2.) COMPARISON WITH OTHER PLANTS

III. STATIC COEFFICIENT ANALYSIS
1.) ACCELERATION VALUE FROM RESPONSE SPECTRA CURVES.
2.) DISCUSSION OF STATIC COEFFICIENT
3.) DESCRIPTION OF ANALYSIS METHOD
4.) STRESS SUMMARY TABLE

IV. CONCLUSION

I <u>GRAND GULF RHR HEAT EXCHANGER DESIGN:</u>



GENERAL ELECTRIC CO.
Nuclear Energy Business Group
ENGINEERING CALCULATION SHEET

NUMBER ______ DATE ______
SUBJECT GRAND GULF RHR HX BY ______ SHEET 3 OF 11

I. ESTIMATION OF HEAT EXCHANGER AND SUPPORT SYSTEM NATURAL FREQUENCY.

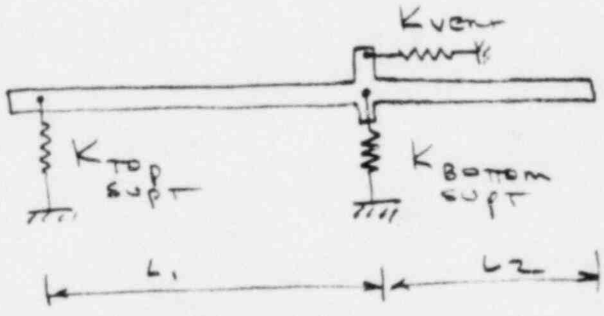
1.) HAND CALCULATED VALUE:

THE GRAND GULF RHR HEAT EXCHANGER HORIZONTAL NATURAL FREQUENCY WAS DETERMINED USING A SIMPLIFIED BEAM AND SUPPORT STIFFNESS MODEL FOR USE IN THE ORIGINAL SEISMIC CALCULATION. SEVERAL SIMPLIFYING ASSUMPTIONS WERE USED:

A.) MASS DISTRIBUTION WAS ASSUMED UNIFORM OVER THE HEAT EXCHANGER LENGTH

B) SUPPORT STRUCTURE WAS REPRESENTED BY SINGLE SPRINGS AT THE UPPER AND LOWER SUPPORT LOCATIONS.

C) BEAM MODEL IS SHOWN BELOW:



D.) MASS AND SECTION PROPERTIES WERE CALCULATED FROM THE HEAT EXCHANGER SHELL DIMENSIONS.

E.) MINIMUM REQUIRED SUPPORT STIFFNESS VALUES (K_{TOP}, K_{BOTTOM}) WERE SPECIFIED ON THE EQUIPMENT INTERFACE CONTROL DRAWING (ICD). TO THE PLANT AE.

RESULTS OF THE FREQUENCY ANALYSIS:

$$f_{n_H} = 18 \text{ HZ (HORIZONTAL)}$$
$$f_{n_V} > 30 \text{ HZ (VERTICAL)}$$

GENERAL ELECTRIC CO.

Nuclear Energy Business Group

ENGINEERING CALCULATION SHEET

NUMBER ______ DATE ______

SUBJECT ______ BY ______ SHEET 4 OF 11

2) COMPARISON WITH OTHER PLANTS

SINCE THE PREVIOUS CALCULATIONAL METHOD FOR SYSTEM FREQUENCY INCLUDED SEVERAL SIMPLIFYING ASSUMPTIONS, IT IS PRUDENT TO COMPARE THE RESULTS OF FINITE ELEMENT MODE AND FREQUENCY ANALYSES FOR OTHER PLANTS, USING SIMILAR HEAT EXCHANGERS TO THE GRAND GULF RESULTS.

GRAND GULF RHR HEAT EXCHANGER:

HAND CALCULATED FREQUENCY = 18 HZ
SHELL ID = 60"
SHELL THICKNESS = 1"
ELEVATION = 370" (TOP SUPPORT) 156" (BOTTOM SUPPORT)
SUPPORT STIFFNESS REQUIREMENT ON ICD = 9.3×10^6 LB/IN

SUSQUEHANNA RHR HEAT EXCHANGER

HAND CALCULATED FREQUENCY = 15 HZ
SHELL ID = 63"
SHELL THICKNESS = 1"
ELEVATION = 347" (TOP SUPPORT) 184 (BOTTOM SUPPORT)
SUPPORT STIFFNESS REQUIREMENT ON ICD = 10×10^6 LB/IN
SAP4 FINITE ELEMENT ANALYSIS RESULT = 7.5 HZ

KUO SHENG RHR HEAT EXCHANGER

HAND CALCULATED FREQUENCY = 18 HZ
SHELL ID = 52"
SHELL THICKNESS ≈ .9"
ELEVATION = 306" (TOP SUPPORT) 181" (BOTTOM SUPPORT)
SUPPORT STIFFNESS REQUIREMENT ON ICD = 4.5×10^6 LB/IN
SAP4 FINITE ELEMENT ANALYSIS RESULTS = 12 HZ

BASED ON THE ABOVE COMPARISON BETWEEN HAND CALCULATED FREQUENCY, AND SAP4 FINITE ELEMENT FREQUENCY, FOR SIMILAR HEAT EXCHANGERS,

IT IS EXPECTED THAT THE GRAND GULF RHR HX HORIZONTAL FREQUENCY WOULD BE GREATER THAN 7.5 HZ.

ALSO, FREQUENCIES DETERMINED FROM FINITE ELEMENT ANALYSES, ON RHR HEAT EXCHANGERS FROM EIGHT REPRESENTATIVE BWR PLANTS HAVE ALL BEEN GREATER THAN THE 7.5 HZ VALUE FOR SUSQUEHANNA. THEREFORE, SINCE THE GRAND GULF HEAT EXCHANGER IS EXPECTED TO BE GREATER THAN 7.5 HZ, USE OF 7.5 HZ IS CONSERVATIVE

III. STATIC COEFFICIENT ANALYSES —

1.) THE PLANT SPECIFIC SSE RESPONSE SPECTRA CURVES FOR THE RHR HEAT EXCHANGER (ATTACHED) HAVE A MAXIMUM ACCELERATION VALUE IN THE HORIZONTAL DIRECTIONS OF 0.65g AND IN THE VERTICAL DIRECTION OF 0.194g, USING 3% DAMPING. (FREQUENCIES AS LOW AS 6 HZ WILL STILL RESULT IN $S_H \doteq .65g$)

2.) THE USE OF A STATIC COEFFICIENT MULTIPLIER FOR INCREASING SPECTRA ACCELERATIONS IS ACCEPTABLE AS AN ALTERNATE TO DYNAMIC ANALYSIS. AN ACCEPTED VALUE FOR SIMPLE BEAM AND FRAME STRUCTURES IS 1.5. DEPENDING ON THE COMPLEXITY OF THE EQUIPMENT THE FACTOR CAN BE SLIGHTLY HIGHER THAN 1.5 BUT IT NEVER EXCEEDS 2.0 FOR STRUCTURES SIMILAR TO THE GRAND GULF RHR HEAT EXCHANGER. THEREFORE, FOR CONSERVATISM A 2.0 FACTOR CAN BE USED.

THE STATIC COEFFICIENT ACCELERATION IS:

$$S_H = (2.0)(.65) = 1.3g$$
$$S_V = (2.0)(.194) = .39g$$

GENERAL ELECTRIC CO.
Nuclear Energy Business Group
ENGINEERING CALCULATION SHEET

NUMBER ______ DATE ______
SUBJECT ______ BY ______ SHEET 6 OF 11

3.) DESCRIPTION OF ANALYSIS METHOD

A STATIC COEFFICIENT ANALYSIS OF THE RHR HEAT EXCHANGER USING S_H = 1.5g AND S_V = 1.75 g (INCLUDING STATIC WEIGHT) WAS PERFORMED USING STANDARD ENGINEERING METHO... THE ACCELERATION VALUE WAS APPLIED TO THE DISTRIBUTED WEIGHT, FORCES AND MOMENTS CALCULATED, NORMAL PRESSURE AND WEIGHT WAS INCLUDED, STRESSES CALCULATED, AND STRESSES WERE COMPARED TO ASME CODE ALLOWABLES. STATIC ACCELERATION WAS APPLIED SIMULTANEOUSLY IN THREE DIRECTIONS. NOZZLE LOADS WERE ASSUMED EQUAL TO MAXIMUM VALUES ON ICD.

4.) STRESS SUMMARY TABLE.

ATTACHED IS A COMPARISON OF CALCULATED TO ALLOWABLE STRESSES

IV CONCLUSION

BASED ON THE CONSERVATIVE APPROXIMATION OF FREQUENCY, THE CONSERVATIVE 2.0 STATIC FACTOR, THE MARGIN BETWEEN THE 1.3g AND 1.5g ACCELERATIONS, AND THE MARGIN BETWEEN CALCULATED AND ALLOWABLE STRESSES, THE EQUIPMENT IS CAPABLE OF WITHSTANDING GRAND GULF SEISMIC LOADS IN CONJUNCTION WITH ALL PLANT NORMAL LOADS.

Bechtel Power Corporation

Engineers—Constructors

15740 Shady Grove Road
Gaithersburg, Maryland 20760
301-948-2700

July 30, 1980

Grand Gulf 1 & 2 ____
Date Received ____
Assigned To ____
Answered ____

Mr. A. R. Smith, Project Manager
General Electric Company (M/C-392)
175 Curtner Avenue
San Jose, California 95114

Dear Mr. Smith:

Nuclear QA Is Not Applicable
Middle South Energy, Inc.
Grand Gulf Nuclear Station
Bechtel Job No. 9645
File: 0265/6410/M-001.0
Seismic Response Spectra
GEB-80/0216

In response to the request of your Mr. C. Morris for the seismic response spectra applicable to the RHR heat exchangers location, enclosed are the following spectra for floor elevation 119'-0" of the auxiliary building:

N213
N214
E213
E214
V213
V214

Very truly yours,

for R. S. Trick
A. Zaccaria
Project Engineer

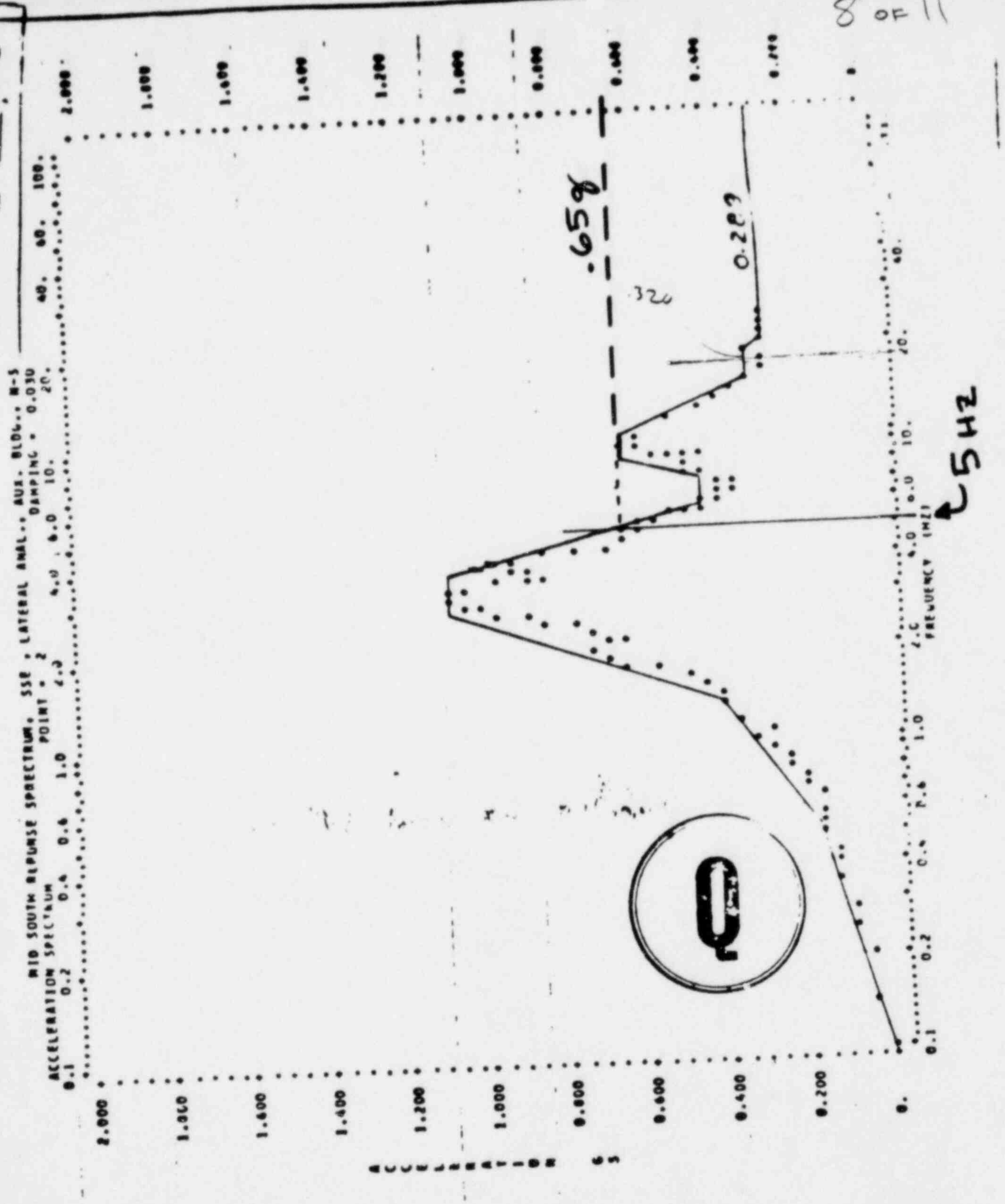
RCG:jgt

Enclosures: Seismic Response Spectra (6 sheets)

cc: J. P. McGaughy, Jr., w/1
L. F. Dale, 2/2
C. K. McCoy, w/1
T. H. Cloninger, w/1
T. E. Reaves, w/1
Dr. D. C. Gibbs, w/1
W. A. Shanks, w/1 (GE Res. Site Mngr.)
D. M. Lake, w/1
H. H. Weber, w/1
R. L. Scott, w/1

RECEIVED
AUG 7 1980
A. R. SMITH

Calc No. C-N0042 Rev 0

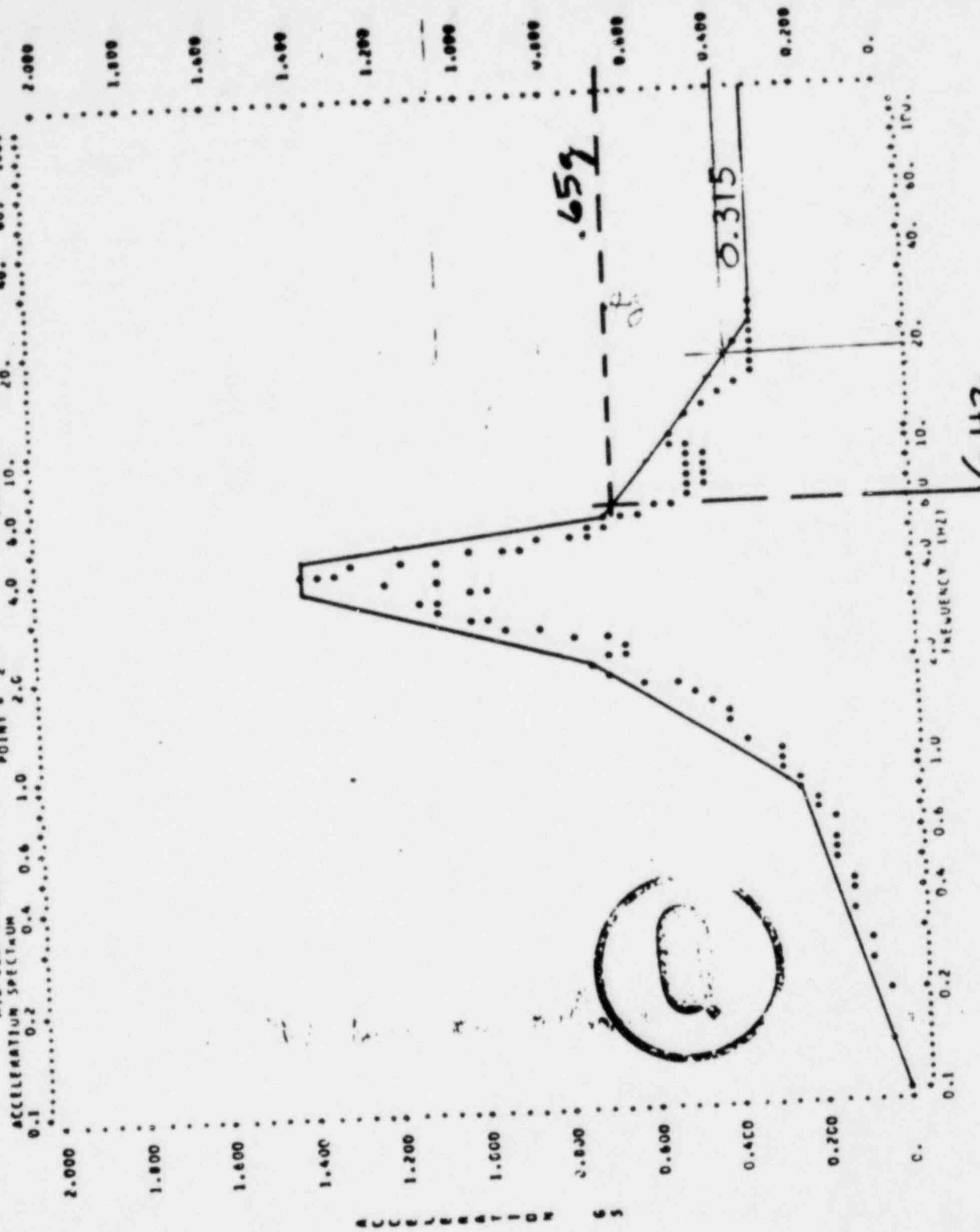


No	DATE	REVISIONS	BY	CH'K	APP'D
0	6/11/73	ISSUED FOR USE			

AUX. BLDG. FLOOR SPECTRUM
SSE, N-S, EL. 119'-0", 3%
GRAND GULF NUCLEAR STATION UNITS 1&2

SHEET 5 OF 32

C-1100B.A, 0



No.	DATE	REVISIONS	BY	CH'K	APPR
0	6/11/73	ISSUED FOR USE		TFH	

JOB No 9645

AUX. BLDG. FLOOR SPECTRUM
SSE, E-W, EL. 119'-0", 3%
GRAND GULF NUCLEAR STATION UNITS 1&2

E 214

SHEET 8 OF 32

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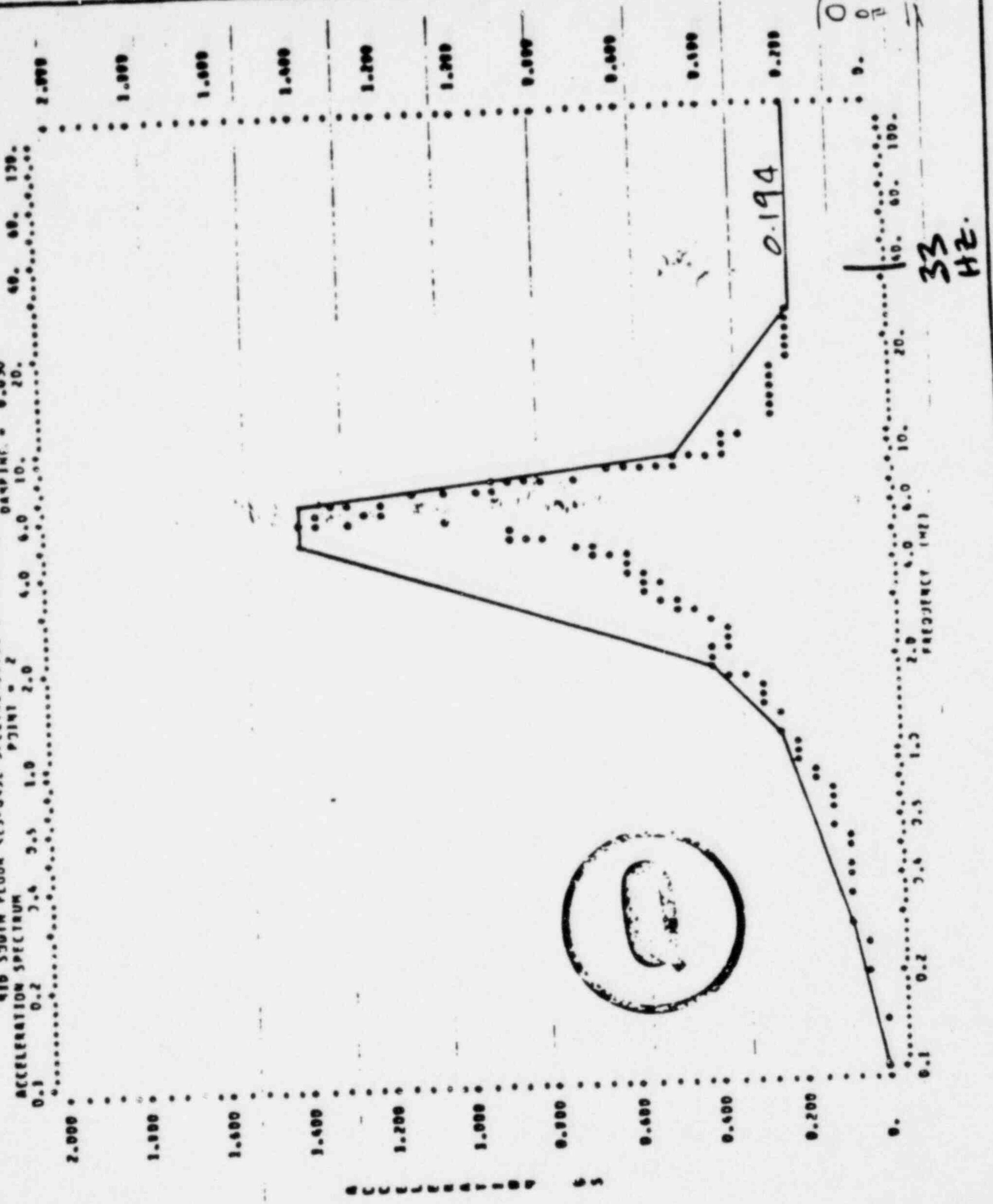
(0 of 1)



No.	DATE	REVISIONS	BY	CH'K	APP
0	6/11/73	ISSUED FOR USE			

AUX. BLDG. FLOOR SPECTRUM
SSE, VERT., EL. 119'-0", 3%
GRAND GULF NUCLEAR STATION UNITS 1&2

JOB No. 9645 — V214 REV

SHEET 8 OF 32

GG-

GENERAL ELECTRIC CO.
Nuclear Energy Business Operations
ENGINEERING CALCULATION SHEET

NUMBER GRAND GULF 1&2 - RHR HEAT EXCHANGERS DATE 4/7/82
SUBJECT STRESSES IN SHELL AND SUPPORT BY A.R. SCHICK SHEET 1 OF 1

REFERENCE:

(a) GE DWG. 762E937, Rev. 6 - "GRAND GULF 1&2 RHR HEAT EXCHANGER INTERFACE CONTROL DWG".

THE CRITICAL STRESSES IN THE SHELLS AND SUPPORTS OF THE GRAND GULF 1&2 RHR HEAT EXCHANGERS FOR THE SUPPORT LOADS* TABULATED IN NOTE 4 OF REF. (a) ARE LISTED BELOW:

STRESS LOCATION	UPSET		FAULTED	
	STRESS, psi	ALLOWABLE STRESS, PSI	STRESS, psi	ALLOWABLE STRESS, PSI
LONGITUDINAL STRESS IN THE SHELL JUST BELOW THE LOWER SUPPORTS	13,019	17,500	14,173	35,000
UPPER SUPPORTS				
MAX. STRESS IN SHELL - BIJLAARD ANALYSIS	17,666	26,250	18,028	42,000
PAD-TO-SHELL ATTACHMENT WELD:				
SHEAR STRESS	1,070	8,575	1,451	17,150
BENDING STRESS	850	16,078	1,152	32,156
LOWER SUPPORTS				
MAX. STRESS IN SHELL - BIJLAARD ANALYSIS	21,675	26,250	22,810	42,000
PAD-TO-SHELL ATTACHMENT WELD:				
SHEAR STRESS	4,099	8,575	5,367	17,150
BENDING STRESS	4,110	16,078	5,268	32,156
SHELL FLANGE: BOLT STRESS	27,899	37,500	28,906	50,000
HUB STRESS	38,279	39,375	39,769	52,500
FLANGE STRESS	24,637	26,250	25,594	35,000
LOWER SUPPORT ANCHOR BOLTS:				
SHEAR STRESS	—	—	4,985	10,000
TENSION STRESS	—	—	4,537	10,000

* THE LOADS OF NOTE 4 WERE CALCULATED ON THE BASIS OF THE FOLLOWING SEISMIC COEFFICIENTS:

DIRECTION	UPSET	FAULTED
HORIZONTAL	1.0g	1.5g
VERTICAL	0.5g	0.75g

ATTACHMENT NO. 3

CRD Solenoid Valve
C11-F009

The valve name plate data identified the Grand Gulf Unit 1 CRD Solenoid Valve as an Automatic Switch Company (ASCO) Model 8323A22 dual solenoid valve (See attached Communication Record dated 3/31/82 between D. Bost and C. Nakayama). The ASCO Model 8323A22 was tested as part of the Zimmer/LaSalle seismic requalification program conducted by NUTECH. The tests included resonance searchs from 1 to 100 Hz, biaxial random vibration seismic simulation, and fragility. The specimen functioned satisfactorily throughout testing. Peak loads were 8.6g horizontal and 8.1g vertical during seismic simulation and 12g during fragility testing with a 50 Hz sine wave input.

The following information is included in Attachment No. 1:

A) Telecon between NUTECH/MP&L
B) ASCO Bulletin 8323
C) Test Report of ASCO Solenoid Valve 8323 for W. H. Zimmer & LaSalle County Nuclear Power Plant

NUTECH COMMUNICATION RECORD

Persons Involved: D. Bost	Date/Time: 3/31/82 9:43 AM
Company: MP&L	Recorded By: CEN
☑ Telecon/Ph. No. (601) 437-5260 x2873	Copy To: GC, PD.
☐ Meeting/Location	Route To:
File:	Page 1 of 1

SUBJECT: JIO Information

Denny relayed the following information on the ASCO model solenoid valve:

Catalog No.: HT8323A22
Ser # : 626402
Orifice : 3/32
pipe : 1/4
electrical : 9 watts
50 hz
110 V.

Air : Air / 110.

I requested ~~pre opns~~, a teleconference between his preopns engineers on the B-21 sys and P Donnelly today. Denny will be tracking them down, and will call us back in 1-2 hrs to arrange the conference.

He will be sending us the acceptance letter for Dynamic Testing & Analyses + JIO work end of this week; we will need to follow up with a work order

Denny will be expecting us to Federal Express our write ups today.

3 Way Red-Hat® Dual Solenoid Valves

For Air, Gas, Water and Light Oil • 1/8" and 1/4" N.P.T.

General Description

Bulletin 8323 covers a compact 3 way valve that incorporates two independent solenoids providing individual control for two internal orifices. This valve offers the flexibility of two 2 way valves in a common body, as well as 3 way valving operation.

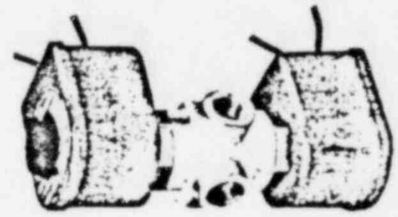
These 3 way direct acting solenoid valves have forged brass bodies and two solenoids suitable for any combination of A-C and D-C voltages.

Applications

This unique valve design is adaptable to many flow control requirements. For example, they may be used for inching or positioning of cylinders and diaphragms, diverting flow into one or two outlets, selection of one or two pressures into a common outlet, controlling air motors having an open exhaust, vending applications, gas samplings, etc.

The normally closed and normally open constructions are equipped with two operating solenoids for redundant control.

These valve designs are intended for those applications where unauthorized valve shift would be critical. Valve shifting without proper signal can be the result of normal power supply failures or possible coil failure. The valves are constructed so that uninterrupted control is maintained as long as either solenoid is energized. Separate electrical control circuits can be utilized to insure control in the event of normal electrical supply failure.



Specifications

Operation (Refer to Flow Diagrams on following page):

Note: These typical flow diagrams cover valves with normally closed solenoids (open when energized, closed when de-energized). Normally open construction is available for either, or both solenoids in 1/4" size – consult factory when required.

Pipe Sizes: 1/8" and 1/4" N.P.T.

Valve Body: Forged Brass (stainless steel available).

Valve Seat: Buna "N."

Solenoid Construction: Internal parts in contact with fluid are made of 300 and 400 Series Stainless Steel.

Solenoid Enclosures: Two types available:
(a) General Purpose (NEMA 1).
(b) Explosion-Proof and Watertight (NEMA 4, 7 and 9).

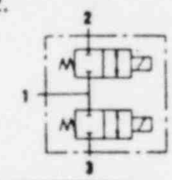
Electrical: Standard Voltages:
24, 120, 240, 480 volts, A-C, 60 Hz (or 50 Hz in 110 volt multiples).
6, 12, 24, 120, 240 volts, D-C.
Other voltages available when required.

Coil: Continuous Duty Molded Class A or F, as listed.

Temperature: To 200°F., as listed.

Installation: Mountable in any position without affecting operation.

Approvals: For UL listings, CSA and FM approvals refer to page 2.



SPECIFICATIONS

FORGED BRASS BODY, SOFT SEATING FOR GENERAL PURPOSE SERVICE

Pipe Size (Ins.)	Orifice Size (Ins.)	Max. Operating Pressure Differential (P.S.I.) Air-Gas A-C	Air-Gas D-C	Water A-C	Water D-C	Light Oil A-C	Light Oil D-C	Safe Body Working Pressure (P.S.I.)	Max.① A-C Fluid Temp. °F.	Cv Flow Factor	General Purpose Solenoid Enclosure Catalog Number	Optional Feature Ref.	Constr. Ref.	Explosion-Proof — Watertight Solenoid Enclosure Catalog Number	Optional Feature Ref.	Watt Rating A-C	Watt Rating D-C	Class of Coil Insulation	Approx.③ Shipping Weight (Lbs.) A	B
UNIVERSAL OPERATION (Refer to Flow Diagrams) Pressure at Any Orifice. Both Solenoids Normally Closed.																				
1/8	1/16	100	65	100	65	100	65	500	180	.09	83231	II	1	83232	VI	9	9.7	F②	2	2¾
	3/32	50	50	50	50	50	50	500	180	.15	83233	I	1	83234	V	6	9.7	A	2	2¾
	1/8	30	20	30	20	30	20	500	180	.21	83235	II	1	83236	VI	9	9.7	F②	2	2¾
1/4	1/16	100	65	100	65	100	65	500	180	.09	83237	II	1	83238	VI	9	9.7	F②	2	2¾
	1/16	125	125	125	125	125	125	500	200	.09	832313	III	2	832314	VII	15.4	16.8	A	4	4½
	3/32	40	40	40	40	40	40	500	180	.15	83239	I	1	832310	V	6	9.7	A	2	2¾
	3/32	110	65	110	65	110	65	500	200	.15	832315	IV	2	832316	VIII	20	16.8	F②	4	4½
	1/8	30	20	30	20	30	20	500	180	.31	832311	II	1	832312	VI	9	9.7	F②	2	2¾
	11/64	40	20	40	20	40	20	500	200	.38	832317	IV	2	832318	VIII	20	16.8	F②	4	4½

FORGED BRASS BODY, SOFT SEATING FOR AIR, GASES, WATER AND LIGHT OIL

Pipe Size (Ins.)	Orifice Size (Ins.)	Maximum Operating Pressure Differential (P.S.I.) A-C	D-C	Safe Body Work. Press. (P.S.I.)	Max.① A-C Fluid Temp. °F.	Cv Flow Factor	General Purpose Solenoid Enclosure A-C · A-C Solenoids Catalog Number	Opt. Feature Ref.	A-C · D-C Solenoids Catalog Number	Opt. Feature Ref.	Constr. Ref.	Explosion-Proof — Watertight Solenoid Enclosure A-C · A-C Solenoids Catalog Number	Opt. Feature Ref.	A-C · D-C Solenoids Catalog Number	Opt. Feature Ref.	Watt Rating Solenoid #1 A-C	Solenoid #2 A-C	Solenoid #2 D-C	Approx.③ Shipping Weight (Lbs.) A	B
NORMALLY CLOSED OPERATION																				
1/4	1/16	125	125	500	180	.09	832319	IX	832335	IX	3	832320	XI	832336	XI	6	15.4	16.8	3	3¾
	3/32	110	100	500	180	.15	832321	IX	832337	IX	3	832322	XI	832338	XI	9	15.4	16.8	3	3¾
	1/8	40	40	500	180	.31	832323	IX	832339	IX	3	832324	XI	832340	XI	6	15.4	16.8	3	3¾
	3/16	125	④	300	~~200~~ 110	.5	832325	X	~~832341~~	X	4	~~832326~~	XII	~~832342~~	XII	15.4	15.4	④	7	7¾
NORMALLY OPEN OPERATION																				
1/4	1/16	125	125	500	180	.09	832327	IX	832343	IX	3	832328	XI	832344	XI	6	15.4	16.8	3	3¾
	3/32	110	100	500	180	.15	832329	IX	832345	IX	3	832330	XI	832346	XI	9	15.4	16.8	3	3¾
	1/8	40	40	500	180	.31	832331	IX	832347	IX	3	832332	XI	832348	XI	6	15.4	16.8	3	3¾
	3/16	125	④	300	~~200~~ 110	.5	832333	X	~~832349~~	X	4	~~832334~~	XII	~~832350~~	XII	15.4	15.4	④	7	7¾

Notes: ① Maximum Fluid Temperature on D-C is 120°F. for 9.7 watt and 180°F. for 16.8 watt rated valves.
② D-C Coils supplied with Class A insulation.
③ Column A — Shipping weight for valves with General Purpose Solenoid Enclosure. Column B — Shipping weight for valves with Explosion Proof — Watertight Solenoid Enclosure.
④ For D-C construction — consult factory.

UNCONTROLLED COPY
FOR INFORMATION ONLY

VIBRATION TEST OF ASCO SOLENOID VALVE 8323

for

WM. H. ZIMMER AND LASALLE COUNTY
NUCLEAR POWER STATIONS

for

NUTECH
6835 Via Del Oro
San Jose, California 95119

by

Southwest Research Institute
6220 Culebra Road
San Antonio, Texas 78284

NUTECH Contract MK2-0205.01

SwRI Project No. 02-6056-007

October 16, 1981

Ernest R. Garcia
Staff Technician

for H. Norman Abramson
Vice President, Engineering Sciences

Daniel D. Kana
Manager, Structural Dynamics and Acoustics

REGISTERED PROFESSIONAL ENGINEER 30223

TABLE OF CONTENTS

TEST REPORT

1.0 INTRODUCTION

1.1 Purpose of Test

This test has been conducted to determine the dynamic qualification of a solenoid valve which is used to supply instrument air to activate or deactivate the Control Rod Drive Scram Discharge Volume drain and vent valves in the Wm. H. Zimmer and/or the LaSalle County Nuclear Power Plants. The valve was mounted to simulate in-service conditions and operated in typical sequences while subject to changes of state.

1.2 Reference

The tests described herein are based on previous information resulting from the following reference:

- SwRI Proposal 02-1470, "Seismic and LOCA Dynamic Tests for Zimmer SQRT Re-evaluation/Requalification," December 7, 1979.

2.0 SPECIFICATIONS AND STANDARDS

1) Nutech Test Specification, "Vibration Test of Asco Solenoid Valve 8323 for Wm. H. Zimmer and LaSalle County Nuclear Power Stations," MK2-02-112, Rev. 0, File No. 135.2401.0227.

2) IEEE Standard 344-1975, "Guide for Seismic Qualification of Class 1 Electric Equipment for Nuclear Power Generating Stations,"

3) SwRI Nuclear Quality Assurance Program Manual, (NQAPM), Rev. 2, November 4, 1980.

4) SwRI Division 02 Nuclear Projects Operating Procedure XII-EE-101-2, Calibration of Mechanical Sciences Dynamics Test Equipment, January 15, 1980.

5) SwRI Division 02 Nuclear Projects Operating Procedure XI-EE-101-1, Seismic Test of Electrical and Mechanical Components, June 7, 1978.

3.0 DESCRIPTION OF TEST SPECIMEN

The device is an ASCO 8323A22 (60 Hz, 120 Vac) 3-way solenoid air pilot valve. The test specimen is a representative nuclear power plant Class 1E device which is identical to those installed in various locations

that open-loop operation is necessary in this range. Table responses are monitored by accelerometers whose outputs can be analyzed according to several standard parameters. Acceleration or velocity response spectrum can be computed and plotted within seconds by a Spectral Dynamics SD321 Shock Spectrum Analyzer, or by a DEC PDP 11/70 computer system. Power spectral density can be computed by a Nicolet Scientific 444A FFT Analyzer or with a Zonic multichannel FFT processor. All time histories can be recorded on analog or digital tape, on oscillographs, or monitored on oscilloscopes. Large volumes of data are usually recorded first on analog tape and then digitized for processing through a digital system which includes a DEC PDP 11/70 computer as its central processor.

4.5 Electrodynamic Table Description

Part of the fragility tests were conducted with an electrodynamic shaker facility in order to achieve high acceleration levels. This facility contains an Unholtz-Dickie 1600 lb sine vector electrodynamic shaker which is powered by a 5 KVA amplifier. Vertical excitation is achieved by attachment of the specimen fixture directly to the shaker armature. Horizontal excitation is achieved by support of the specimen and fixture on a slip table whose plate is attached to the shaker armature.

5.0 TEST EQUIPMENT IDENTIFICATION

The equipment used for simulation of the dynamic environment, acquisition, and processing of dynamic data is given in Table 5.0-1.

6.0 CALIBRATION

- Instrumentation calibration was performed in accordance with Engineering Sciences Division Nuclear Projects Operating Procedure XII-EE-101-2, Calibration of Mechanical Sciences Dynamics Test Equipment.
- All accelerometers were calibrated using a reference standard Kistler 808K/561T which is traceable to the National Bureau of Standards.
- The Digital X-Y Plotter (Item 30) is calibrated with extreme set points which respond to signals from the Nicolet 444A FFT Analyzer.
- The Nicolet 444A (Item 31) was calibrated according to manufacturer's specifications.
- The Hewlett-Packard Tape Recorder (Item 32) was used solely as a signal source and was not calibrated on an absolute basis.

at Wm. H. Zimmer and LaSalle County Nuclear Power Stations. It is used to supply instrument air to activate or deactivate the Control Rod Drive Scram Discharge Volume drain and vent valves.

4.0 TEST FACILITY

4.1 Location

Southwest Research Institute
Department of Engineering Mechanics
6220 Culebra Road
San Antonio, Texas 78284

4.2 General Purposes

This facility has the capability of realistic simulation of an earthquake dynamic environment as well as all accepted standard approximations of such an environment. It has been designed principally for qualification testing of typical components to be used in nuclear and conventional power generation stations. It is also particularly suited to the study of structural scale model responses to seismic excitation. It can further be used as a general purpose shaker facility within its range of operation, and therefore can simulate nuclear plant operating transients.

4.3 Seismic Table Description

A 6 by 6 foot mounting surface can be excited with simultaneous vertical and horizontal motion that is arbitrary and independent along each axis. Extenders are utilized for mounting somewhat larger specimens, when necessary. Maximum table payload capacity is 6,000 pounds dead weight. Drive mechanisms are servo-controlled electrohydraulic and have the following capabilities:

	Horizontal	Vertical
Frequency Range	0 - 1000 Hz	0 - 1000 Hz
Force Capacity	10,000 lb	20,000 lb
Maximum Stroke	8.0 in.	7.0 in.
Maximum Velocity	90 in/sec	22 in/sec
Maximum Acceleration*	10 g	10 g

4.4 Associated Instrumentation

Excitation signals are provided typically by function generators or actual seismic signals recorded on analog instrumentation tape. Table displacement is accurately controlled at low to medium frequencies by automatic feedback to respond to an arbitrary voltage signal. Deterioration in control is experienced at higher frequencies such

*At zero payload

TABLE 5.0-1 TEST EQUIPMENT

NO	ITEM	MAKE	MODEL	SERIAL	REMARKS
1	TONE GENERATOR	MICRODOT	F220A	3058	FUNCTION GENERATOR
2	SWEEP OSCILLATOR	SPECTRAL DYNAM	SD104A-5	1119	3 DECADE SWEEP
3	SWEEP OSCILLATOR	SPECTRAL DYNAM	SD104A-5	1856	3 DECADE SWEEP
4	SERVO MONITOR	SPECTRAL DYNAM	SD105A	557	5-10K HZ
5	SERVO MONITOR	SPECTRAL DYNAM	SD105C-1	935	1-5K HZ
6	FILTER	SKL	308A	368	VARIABLE FREQ.
7	POWER AMPLIFIER	TEAM	1528	102	PILOT VALVE DRIVER
8	ACCELEROMETER	ENDEVCO	2221D	JC 18	1-5000 HZ
9	ACCELEROMETER	ENDEVCO	2221D	XB-75	1-5000 HZ
10	ACCELEROMETER	ENTRAN	EGC-500DS-20	30H8IR1212	20G
11	AMPLIFIER	SWR.		2	BRIDGE 10 CHANNEL
12	DYNAMIC ANALYZER	SPECTRAL DYNAM	SD120/122L	86/259	2 CHANNEL
13	X-Y RECORDER	HEWLETT-PACKAR	7005B	1429	ANALOG
14	OP. AMP. MANIFOL	ANALOG DEVICES	194	136	ANALOG OPNS.
15	OP. AMP. MANIFOL	ANALOG DIVICES	194	12171	ANALOG OPNS.
16	ACCELEROMETER	BELL % HOWELL	4-202-0001	19742	HORIZ. TABLE
17	ACCELEROMETER	BELL % HOWELL	4-202-0001	22529	VERT. TABLE
18	CONTROLLER	TEAM	1522		HORIZ. TABLE
19	CONTROLLER	SWRI		2	VERT. TABLE
20	OSCILLOSCOPE	TEKTRONIX	5111	B118209	STORAGE
21	SCOPE PLUG-IN	TEKTRONIX	5A14N	B053025	4-CHANNEL
22	SCOPE PLUG-IN	TEKTRONIX	5A14N	B053045	4-CHANNEL
23	SCOPE PLUG-IN	TEKTRONIX	5B12N	B065791	DUAL TIME BASE
24	COUNTER	HEWLETT-PACKAR	5512A	450-01511	PERIOD/FREQ.
25	TAPE RECORDER	AMPEX	PR 2230	9170879	14-CHANNEL
26	DIGITAL MULTIMET	WESTON	4442	1294	BATTERY POWER
27	DIGITAL MULTIMET	HEWLETT-PACKAR	3466A	1716A01910	4 1/2 DIGIT
28	DIGITAL SERVO DI	TEAM	1564	102	USE W/ TEAM 1522
29	ACCELEROMETER/CA	KISTLER	808K/561T	769/416	NBS TRACEABLE

In addition, the following equipment was also used.

30	X-Y PLOTTER	TEKTRONIX	4662	B043979	DIGITAL PLOTTER
31	SPECTRUM ANALZ	NICOLET	444A	8948425	FFT COMPUTER
32	TAPE RECORDER	H/P	3964A	1925A01062	4-CHANNEL
33	DIGITAL COMPUTER	DEC PDP 11/70			SIGNAL SYNTHESIS
34	A-D SYSTEM	CAMAC			DATA PROCESSING
35	COMPUTER	TEKTRONIX	4006-1	B036557	DIGITAL DISPLAY
36	EM SHAKER	UNHOLTZ-DICKIE	56	203	VIBRATION TABLE
37	AMPLIFIER	ENDEVCO	2721A	BJ94	CHARGE
38	AMPLIFIER	ENDEVCO	2721A	BJ98	CHARGE
39	PRESS XDUCER	VIATRAN	218-15	133170	RANGE 0-500 psi
40	PRESS XDUCER	VALIDYNE	DP7	20398	RANGE 0-500 psi

- Both pressure transducers were calibrated to 1.0V/100 psi by means of internal calibration resistors.
- The digital synthesis system (Items 33-35) were used solely for shaping of table input signals, and no calibration was required for this process.

7.0 TEST METHODS

7.1 Specimen Mounting

The specimen was mounted in accordance with Figure 7-1. The valve was clamped to unistruts which were then mounted on a bookend. The clamps were designed to hold the 1/2" copper tubing 6" on either side of the valve. There was also a clamp holding the upper conduit 6" from the valve. This configuration was used on the hydraulic vibration table as shown in Figures 9-1 and 9-2. The fragility tests were re-run on the EM shaker. A smaller bookend was used during this test and the clamps were located 3" on either side of the valve. Details of this arrangement are shown in Figures 9-5 and 9-6.

Identification of excitation axes is as follows:

Axes	Orientation
XZ	Front to back/Vertical
YZ	Side to side/Vertical

7.2 Instrumentation

One accelerometer was used to monitor motions on the specimen only during the resonance searches. Location of this accelerometer is shown on Figure 9-3. Orientation of the accelerometer axes was parallel to the excitation.

Accelerometers for measuring table excitation were located on the bookend. For the X-Z excitation, the horizontal accelerometer was on the back side of the bookend face while the vertical was mounted on the side face of the bookend. For the Y-Z excitation, both accelerometers were on the side face of the bookend. (See Figures 9-2 and 9-4.).

The functional test setup was as shown in Figure 7-2. A pressure of 100 psi was applied to the common point of the valve during all tests that required pressure. Pressure transducers were mounted at the common (C) and the normally closed (N/C) points and were monitored on an oscillograph along with the two table accelerometers and ac input power to the solenoid. A water pan and a 1000 mℓ graduated cylinder were used (as shown in Figure 7-2) for valve seat leakage detection.

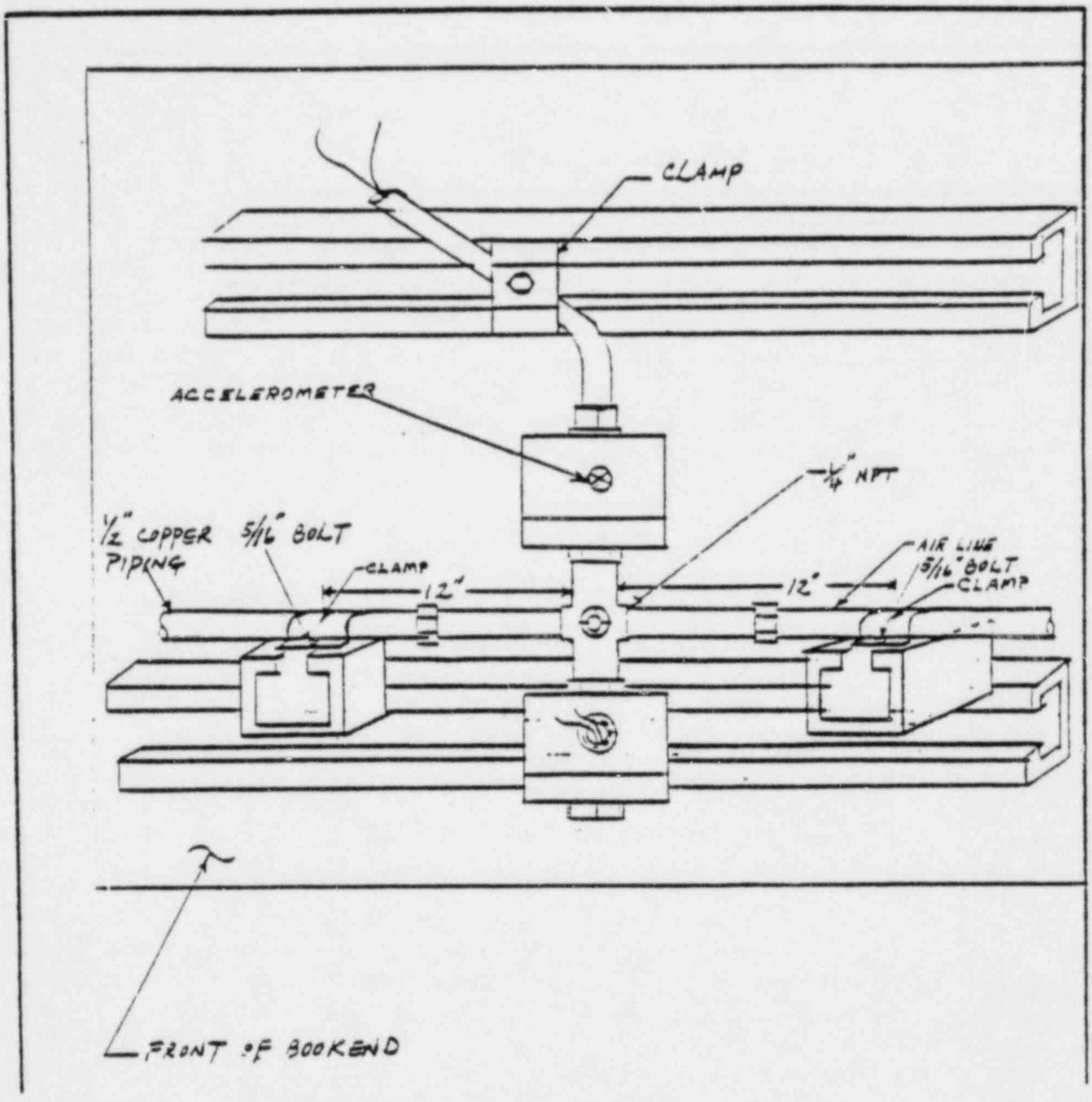


FIGURE 7-1. TEST SPECIMEN MOUNTING AND ACCELEROMETER LOCATION

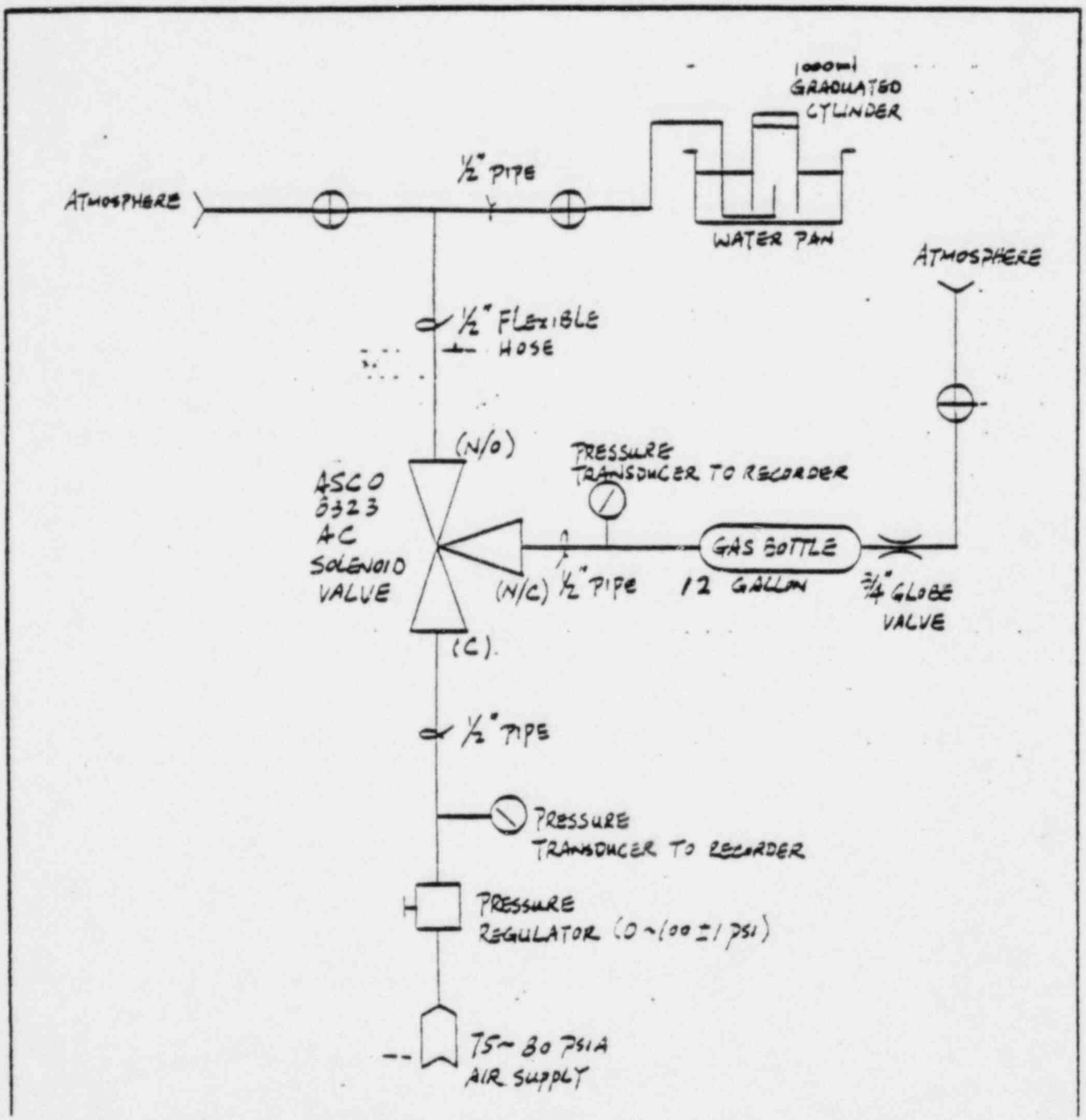


FIGURE 7-2. FUNCTIONAL TEST SETUP USED DURING ALL SOLENOID VALVE TESTING

7.3 Exploratory Testing

Exploratory testing began with a sine sweep in the Z-axis. The frequency range was 1-100 Hz with a 0.5 octave/minute sweep rate and 0.1 g peak drive. The response accelerometer was mounted on the side of solenoide "A" coincident with the table axis. Table control accelerometers were mounted on the bookend during all tests.

The table vertical axis was locked down prior to running the horizontal exploratory tests to preclude any possible rocking mode coupling with the table mechanism. The parameters for the two horizontal axes tests are the same as for the vertical axis.

7.4 Proof Testing

Biaxial random vibration tests with flat excitation in 1-50 Hz, and of 30-second duration were conducted for each of the two required orientations. A given peak g level was required to be met or exceeded for each test run. The series of tests consisted of four (4) Upset runs in the X-Z orientation, four (4) Upset runs in the Y-Z orientation, three (3) Emergency runs in the Y-Z orientation, and one (1) Emergency run in the X-Z orientation. Excess runs were necessary for those runs where the input RMS value was not properly adjusted so that the test peak value was greater than the required peak g-level. Upset condition runs in each orientation included one (1) run with the specimen de-energized, one (1) run with the specimen energized, and one (1) run where the specimen changed state. Emergency condition runs in each orientation included a specimen change of state in every case. (See Section 11.0 for PSD and Peak information.)

Drive signals for each run were formed by a digital computer synthesis process which is described by the diagram in Figure 7-3. Initially, the seismic table transfer function data with the free table were acquired for each of the horizontal and vertical axes during the preliminary tests. These data are used along with the prescribed level to synthesize an initial drive signal for each axis. This synthesis process is accomplished within the computer by operating on 34 bands of narrow band random data, each of 1/6 octave bandwidth. The amplitude of each band is modified according to the required level and the table transfer function in that band. The final result is summed together and a proportional analog time history is formed for each axis independently on respective channels of an analog tape recorder. These signals are then used to drive the seismic simulator. The corresponding table accelerations are monitored and fed back to the computer to produce a second iteration as necessary. The response level of the table signals are computed and compared with the required level to determine whether further adjustments in any of the individual 34 frequency bands are required.

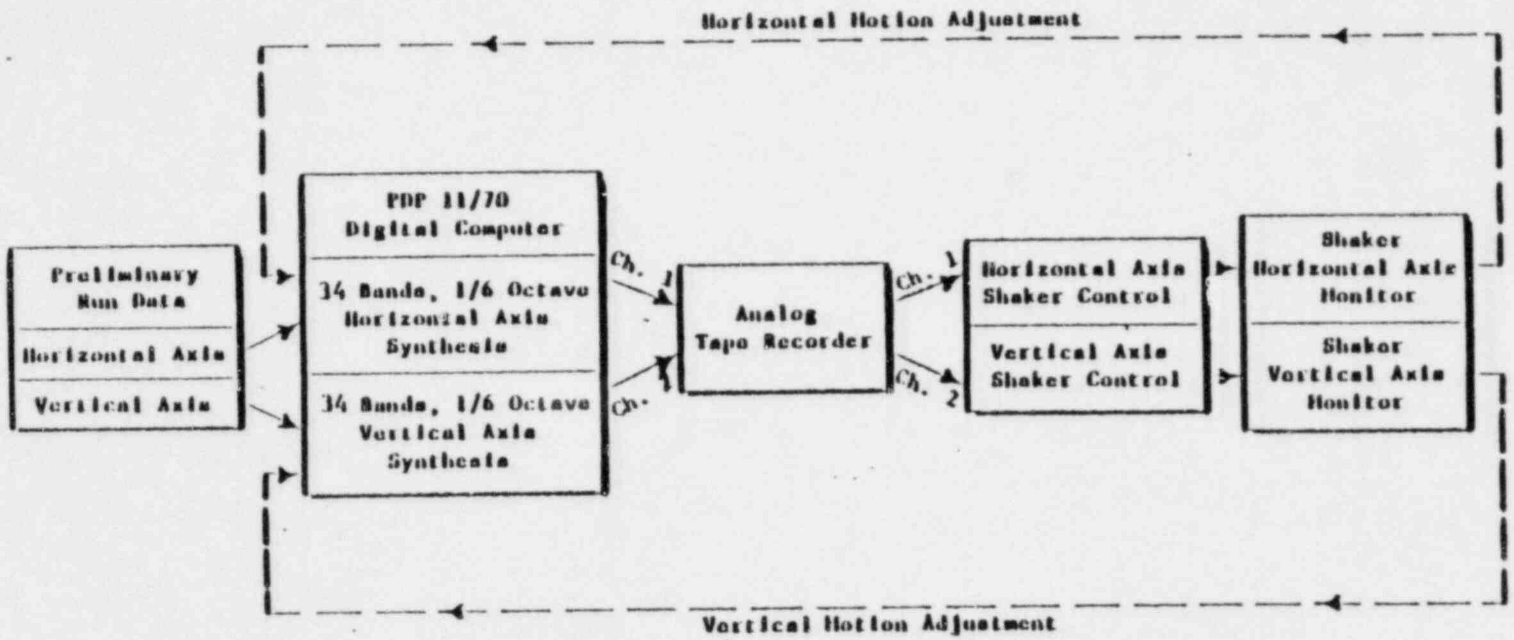


FIGURE 7-3. UPSET AND EMERGENCY SHAKER TABLE DRIVE

Table motions were monitored by independent horizontal and vertical accelerometers. Their output was recorded directly on an analog tape recorder and also on an oscilloscope for immediate visual display. During the preliminary test runs described above, it was found that high acceleration and frequency levels tended to cause some nonlinear rattling in the table, so that peak to RMS ratios were higher than that for normal random acceleration signals. Therefore, to make the test more conservative it was decided to filter the data by low pass below 65 Hz during its playback. Consequently, the peak value which occurred in the 1-50 Hz range was used as the basis for the test. Later, both unfiltered data as recorded on the tape recorder, and filtered data were compared. For example, peak levels for each of the filtered and unfiltered runs are shown in Tables 7-0.2 and 7-0.3, respectively. Note that the value for run number UPSYZ1A was 1.7 percent below minimum level inadvertently due to the procedure for monitoring the tests. For a given test run the value was monitored visually on the oscilloscope. Later, the test values were developed from time histories recorded on the oscillograph. The slight undertest for the one run was not noticed until the data were processed later. Since this represented a filtered peak value, no consequence was attributed to this result.

7.5 Fragility Testing

Since there were no resonances below 50 Hz, the only requirement for the fragility testing was to slowly increase the table input level with a sine wave at 50 Hz and observe whether or not a valve leak would develop.

Fragility testing was begun with the specimen mounted in the X-axis. The starting level was at 2.0 g and increased to a level of 7.4 g at which point bubbles were observed due to some air leak in the valve. Pressure on the valve at this time and for all tests was at 100 psi.

The fixture was rotated to the Y orientation and fragility test at 50 Hz run, again starting from 2.0 g peak. This time the level of input to the table was raised to a maximum of 10 g peak and no leakage was detected.

Anchors at the four corners of the shaker table were removed to run the Z-axis fragility test. The table amplitude could not be raised above ≈ 5.0 g peak in this orientation due to a table malfunction at this time.

The solenoid valve was then removed from the hydraulically driven table, mounted on a smaller bookend and set on the EM shaker table. This approach was taken in order to preclude a delay while repair of the seismic table was effected. In this setup the clamps were set 3 inches

from the valve. This was necessary to allow mounting on the smaller bookend. The different mounting distance was considered acceptable since no resonance was detected below 50 Hz with the previously used, wider separation. Fragility testing at 50 Hz sine wave in the Z-axis was raised to a maximum of 12 g peak with no leaks detected.

The solenoid valve was then rotated 90° to the X-axis and the g level increased to 10 g's and then to 12 g's at which point minor bubbling was noted. This test was again repeated with no bubbles noted.

The EM shaker was rotated 90° to tie the slip table for horizontal motion. The solenoid valve with fixture was mounted in the X-axis. The fragility test was then run in this manner up to 10 g's and dwelled for 30 seconds with no bubbles noted. Oscillograph records are given in Section 12.0.

7.6 Functional Tests and Monitoring

Prior to conduct of any dynamic tests, all functional tests were performed. Readout from table accelerometers, inlet and outlet pressure transducers and solenoid ac power were monitored and recorded on an oscillograph during proof testing only. Identification of the respective channels for each monitoring point is given in Table 7.0-1. Functional tests were also performed after each series of tests and at the end of all dynamic tests.

8.0 RESULTS AND CONCLUSIONS

Results from the resonance searches are given in the form of transfer functions in Section 10.0. It can be seen that only one resonance occurred near 85 Hz for excitation along the X-axis (front to rear).

For proof tests, the results appear as tape recorded unfiltered time histories, which were further processed into oscillograph time histories and power spectral densities (PSD's). These data are given in Section 11.0. Power spectral densities were computed for the first run in each orientation series. PSD for filtered data is given in Figures 11-1 thru 11-8, while corresponding PSD's for unfiltered data are given in Figures 11-9 thru 11-16. Peak values associated with these data are given in Tables 7.0-2 and 7.0-3, respectively. Time histories for these data are given in Figures 11-20 thru 11-52. Data for each test run consists of 1) filtered acceleration time histories, 2) unfiltered acceleration time histories, and 3) a set of uncalibrated unfiltered time histories with output for monitoring the instrument functions. The latter time history signals were included on the monitoring output in order to show time coherence. Calibrations for all oscillograph channels are given in Figures 11-17 thru 11-19.

TABLE 7.0-1 IDENTIFICATION OF MONITOR CIRCUITS ON OSCILLOGRAPH RECORDS

OSCILLOGRAPH CHANNEL	FUNCTION MONITORED
1	Horizontal Table Accelerometer
2	Vertical Table Accelerometer
3	Inlet Valve Pressure
4	Outlet Valve Pressure
5	Solenoid AC Power

TABLE 7.0-2 PEAK LEVELS FILTERED AT 65 HZ, LOW PASS 65 HZ

TEST NO.	HORIZONTAL PEAK	VERTICAL PEAK
UPSXZ1A	6.2 g	6.0 g
UPSXZ2	6.0 g	6.1 g
UPSXZ3	6.1 g	6.2 g
UPSYZ1	5.0 g	6.2 g
UPSYZ1A	5.9 g	7.2 g
UPSYZ2	6.0 g	7.3 g
UPSYZ3	6.0 g	6.9 g
EMSYZ1	6.3 g	7.2 g
EMSYZ2	6.5 g	7.5 g
EMSYZ3	7.4 g	8.1 g
EMSXZ1	8.6 g	8.1 g

TABLE 7.0-3 PEAK LEVELS OF UNFILTERED TIME HISTORIES

TEST NO.	HORIZONTAL PEAK	VERTICAL PEAK
UPSXZ1A	8.9 g	8.1 g
UPSXZ2	8.3 g	7.8 g
UPSXZ3	8.5 g	8.1 g
UPSYZ1	5.0 g	6.8 g
UPSYZ1A	5.9 g	7.9 g
UPSYZ2	6.0 g	8.1 g
UPSYZ3	6.0 g	7.9 g
EMSYZ1	6.9 g	9.8 g
EMSYZ2	6.9 g	9.3 g
EMSYZ3	8.8 g	11.9 g
EMSXZ1	11.4 g	10.8 g

For the functional outputs, the solenoid valve trace was included starting with Run UPSXZ3. There was an intermittent connection on the power switch for this run. This was corrected by the following run. Finally, Run UPSYZ1 was not completely covered on the oscillograph. Inadvertently the oscillograph recorder was not started on time for this run. However, the data on magnetic tape is complete.

A review of the fragility data shows that for repeat of the front to rear (X-axis) excitation on the EM shaker a higher fragility level was achieved than on the seismic simulator. A further study of the data revealed the following explanation. For the initial fragility run on the seismic simulator, the table accelerometers (see Figure 9-4) were used to measure the input fragility level. For the repeated test runs on the electromagnetic shaker, the fragility level was measured on a response accelerometer mounted directly on the valve. It appeared that the valve mounting on the EM shaker was stiffer than the previous mounting on the seismic simulator. However, since the resonance search was conducted on the seismic simulator mounting and revealed no resonance below 90 Hz, it was concluded that the valve mounting must have become loose during the initial fragility runs, and produced erroneous data. Fragility values taken from the tests on the EM shaker are considered valid.

A thorough visual inspection was performed on the solenoid valve after completion of dynamic tests. No apparent physical damage was detected. The complete system was found to function normally before, during, and after these tests. It is our conclusion that the ASCO valve identified in Section 3.0 did pass the requirements of this test.

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SECTION 9.0

PHOTOGRAPHS

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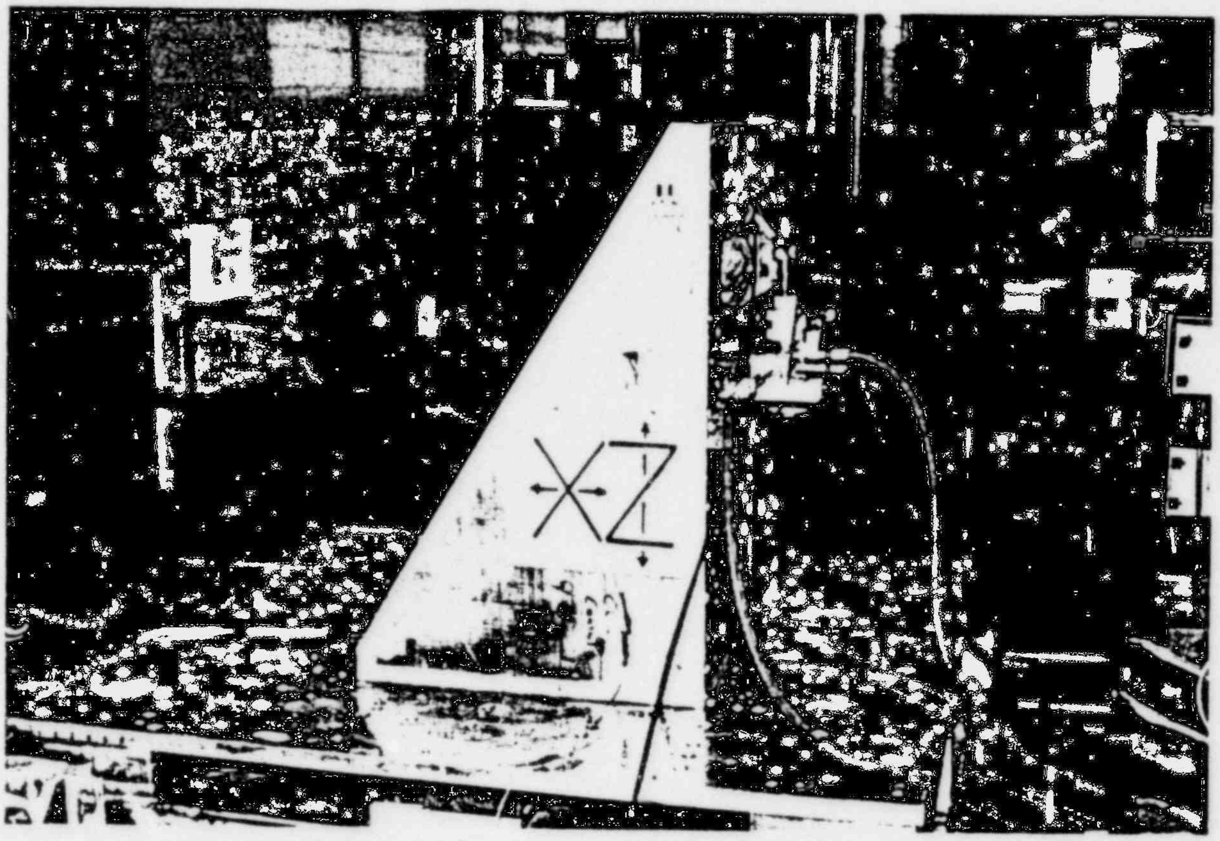

FIGURE 9-1. SOLENOID VALVE MOUNTED ON SwRI BIAXIAL TABLE FOR X-Z RANDOM TESTS

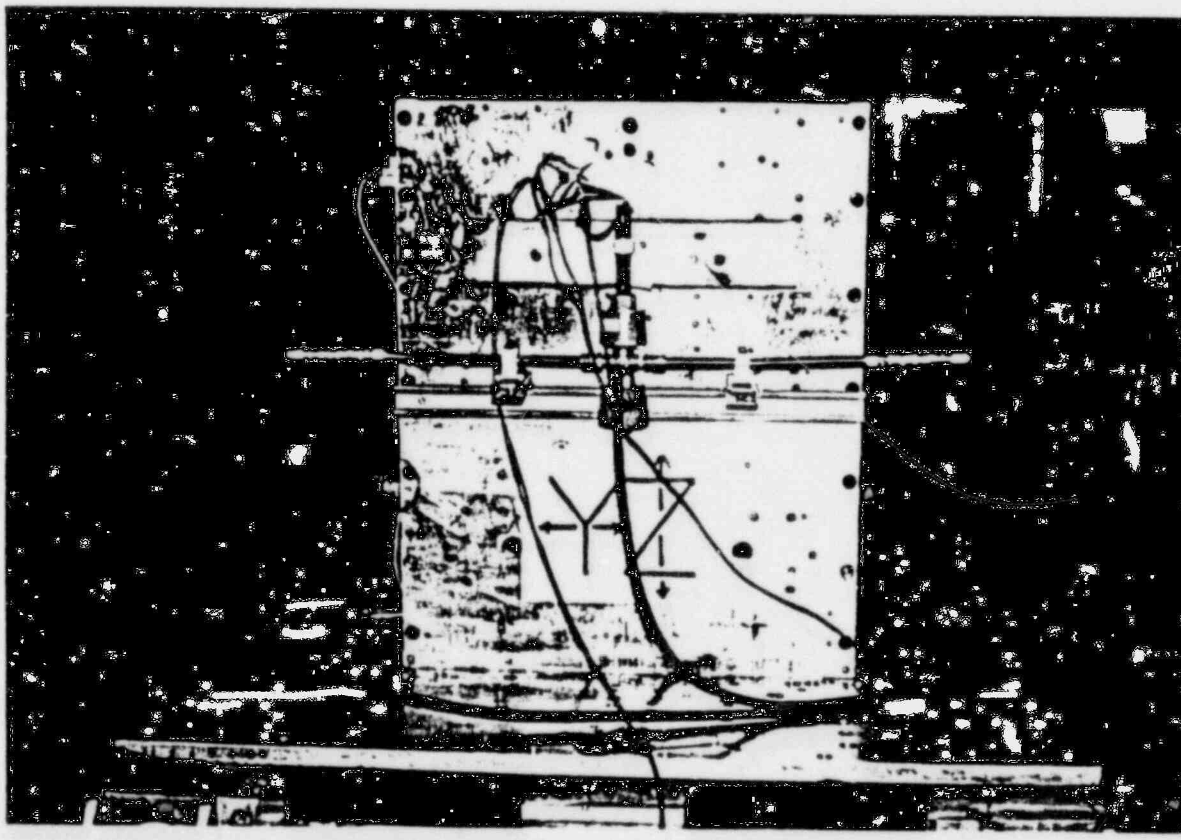

FIGURE 9-2. SOLENOID VALVE MOUNTED ON SwRI BIAXIAL TABLE FOR Y-Z RANDOM TESTS

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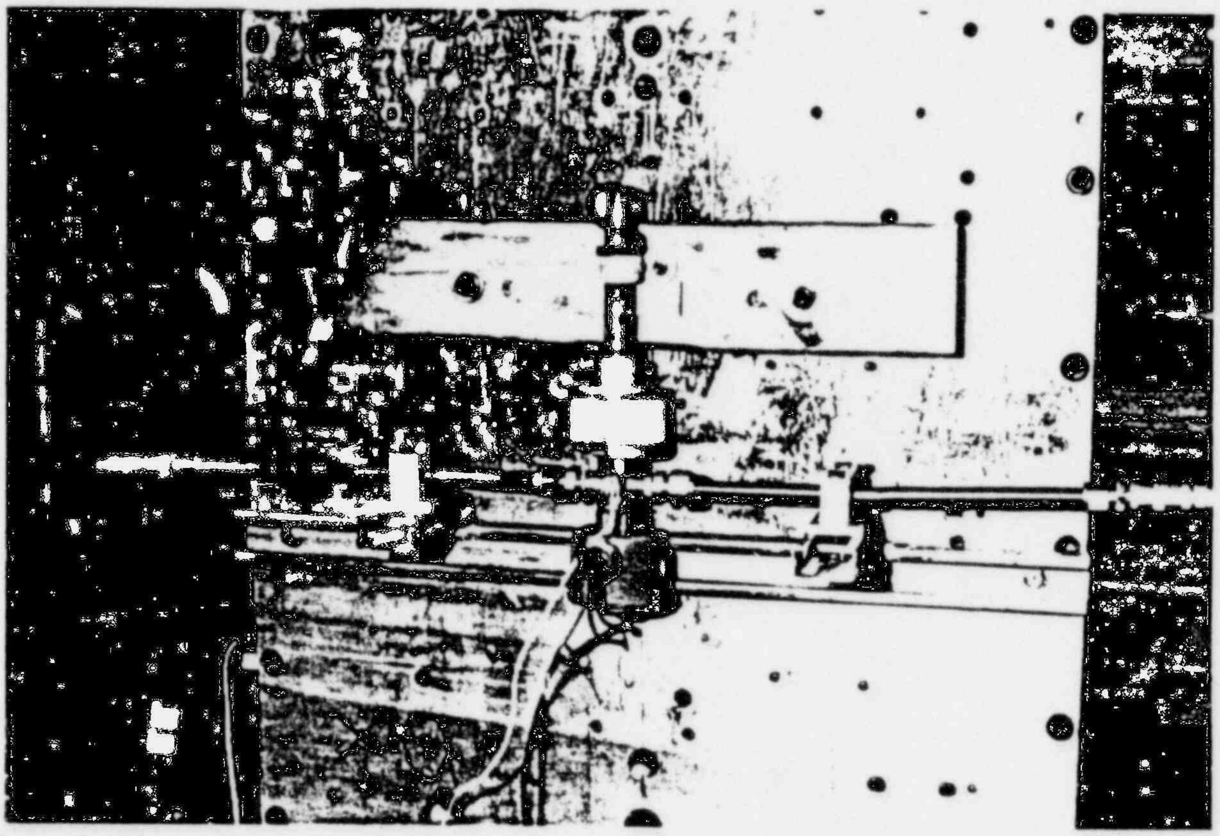

FIGURE 9-3. ACCELEROMETER LOCATION FOR X, Y & Z-AXES, RESONANCE SEARCH ON SOLENOID VALVE. ACCELEROMETER CIRCLED.

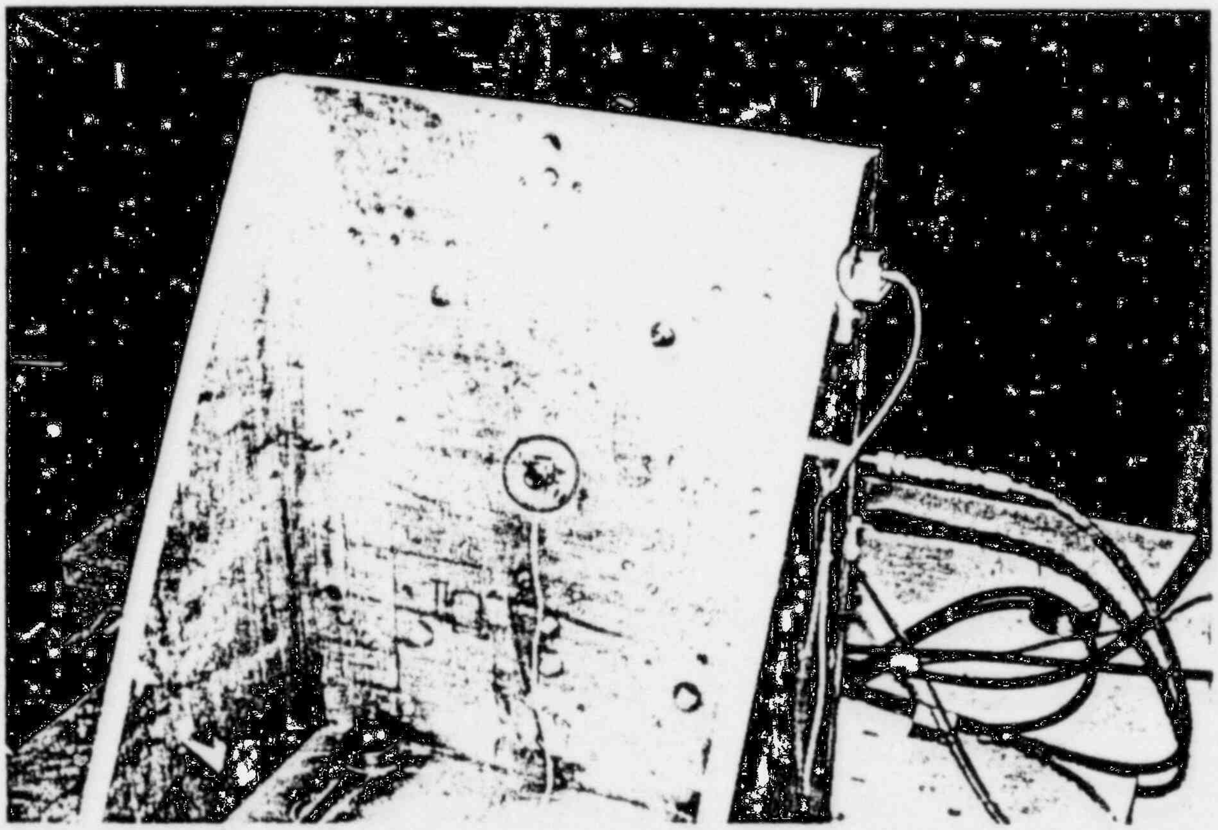

FIGURE 9-4. LOCATION OF INPUT MOTION ACCELEROMETERS MOUNTED ON THE BOOKEND. ACCELEROMETERS CIRCLED.

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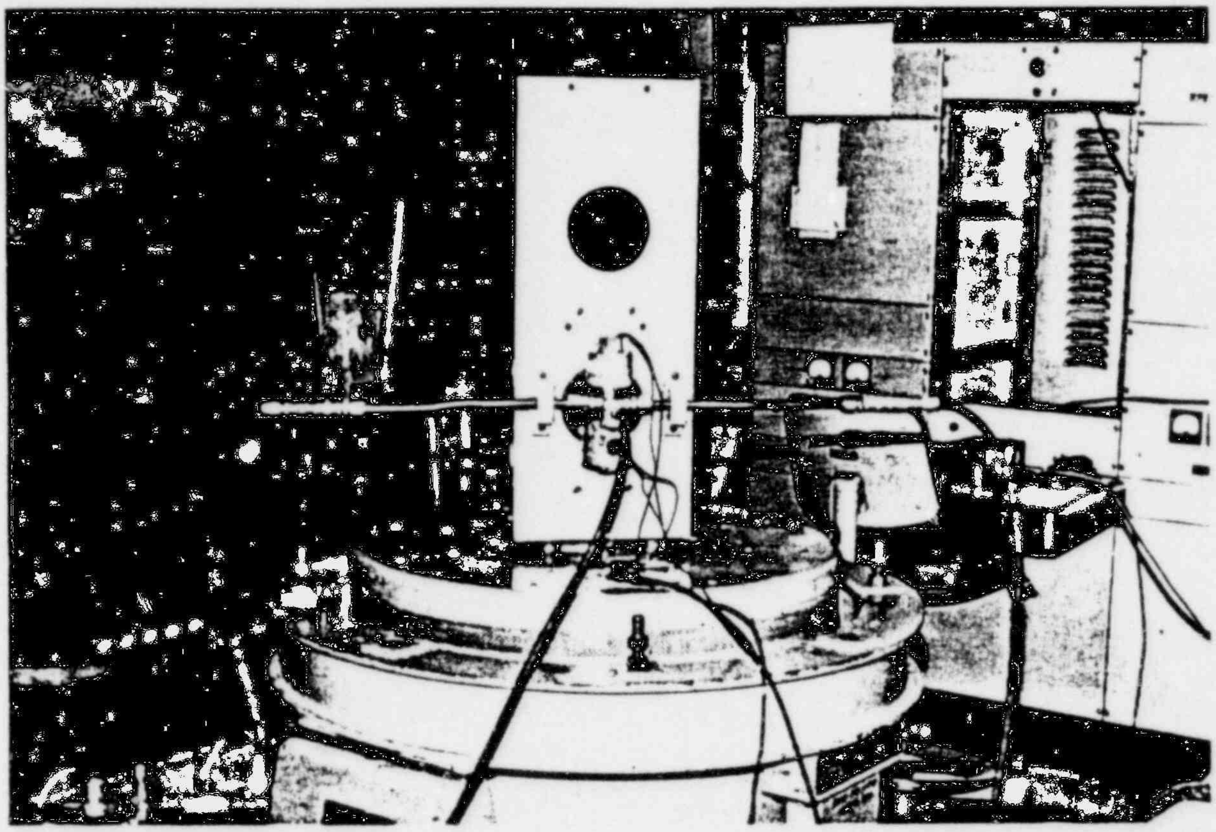

FIGURE 9-5. MOUNTING METHOD USED TO RUN SOLENOID VALVE FRAGILITY TESTS ON EM SHAKER FOR Z-AXIS

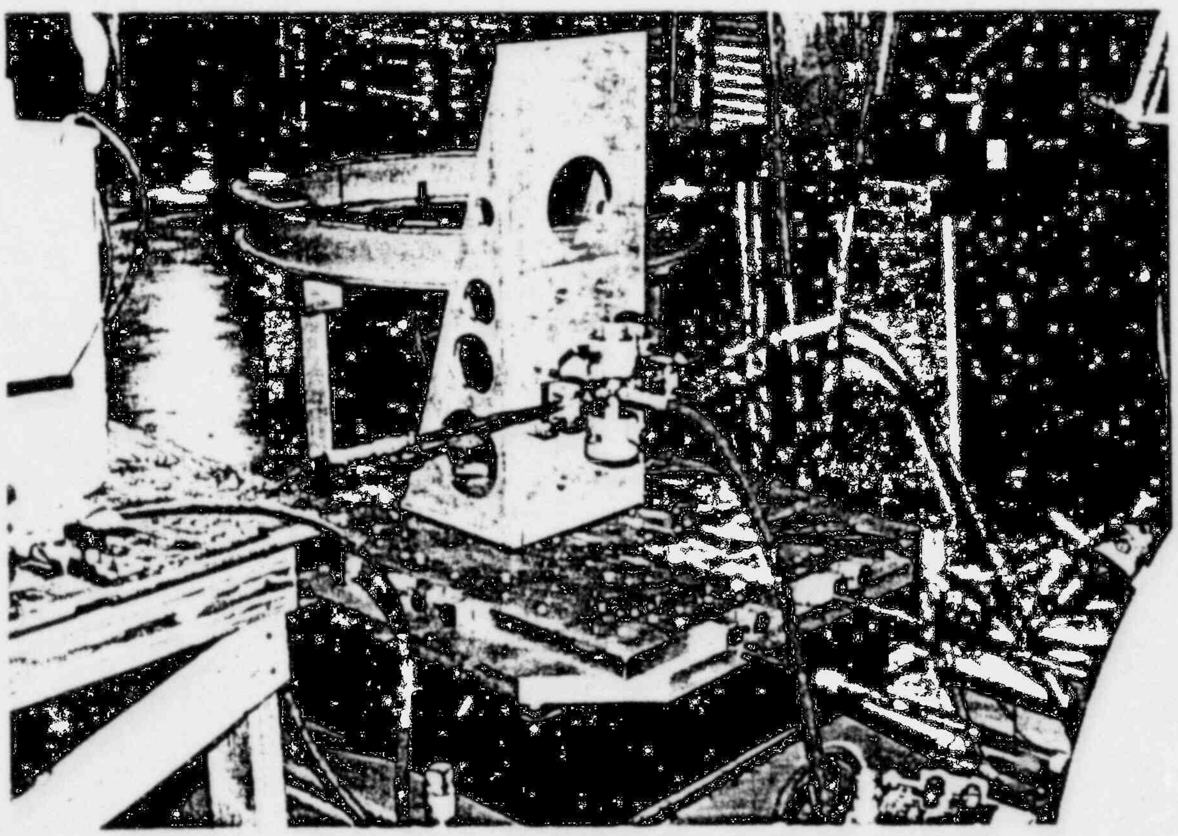

FIGURE 9-6. MOUNTING METHOD USED TO RUN SOLENOID VALVE FRAGILITY TESTS ON EM SHAKER FOR X-AXIS

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SECTION 10.0

EXPLORATORY TEST DATA

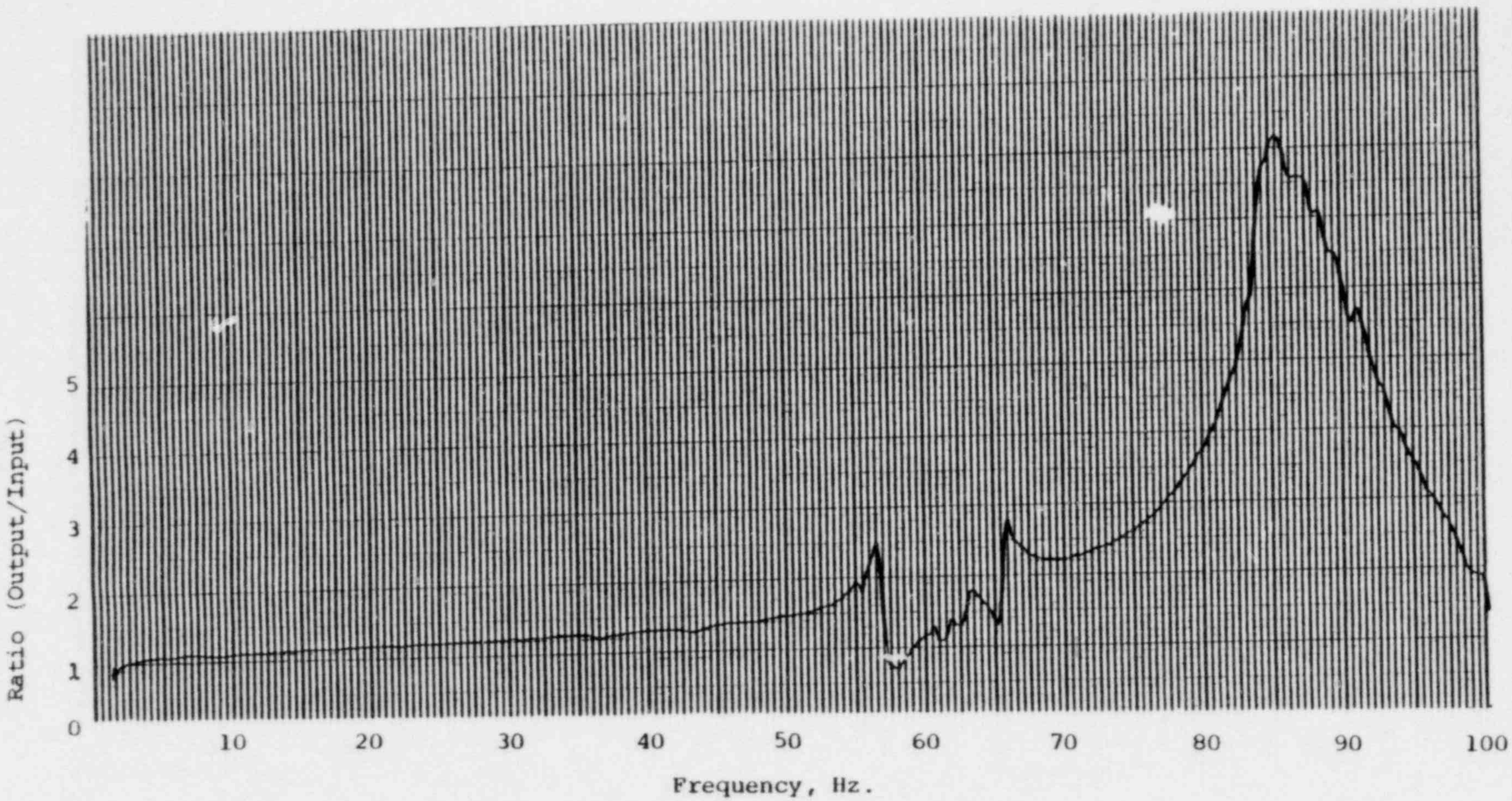


FIGURE 10-1. RESONANCE SEARCH, X-AXIS, ACCELEROMETER ON SOLENOID "A", INPUT 0.1 G PEAK, SWEEP 0.5 OCTAVE/MINUTE

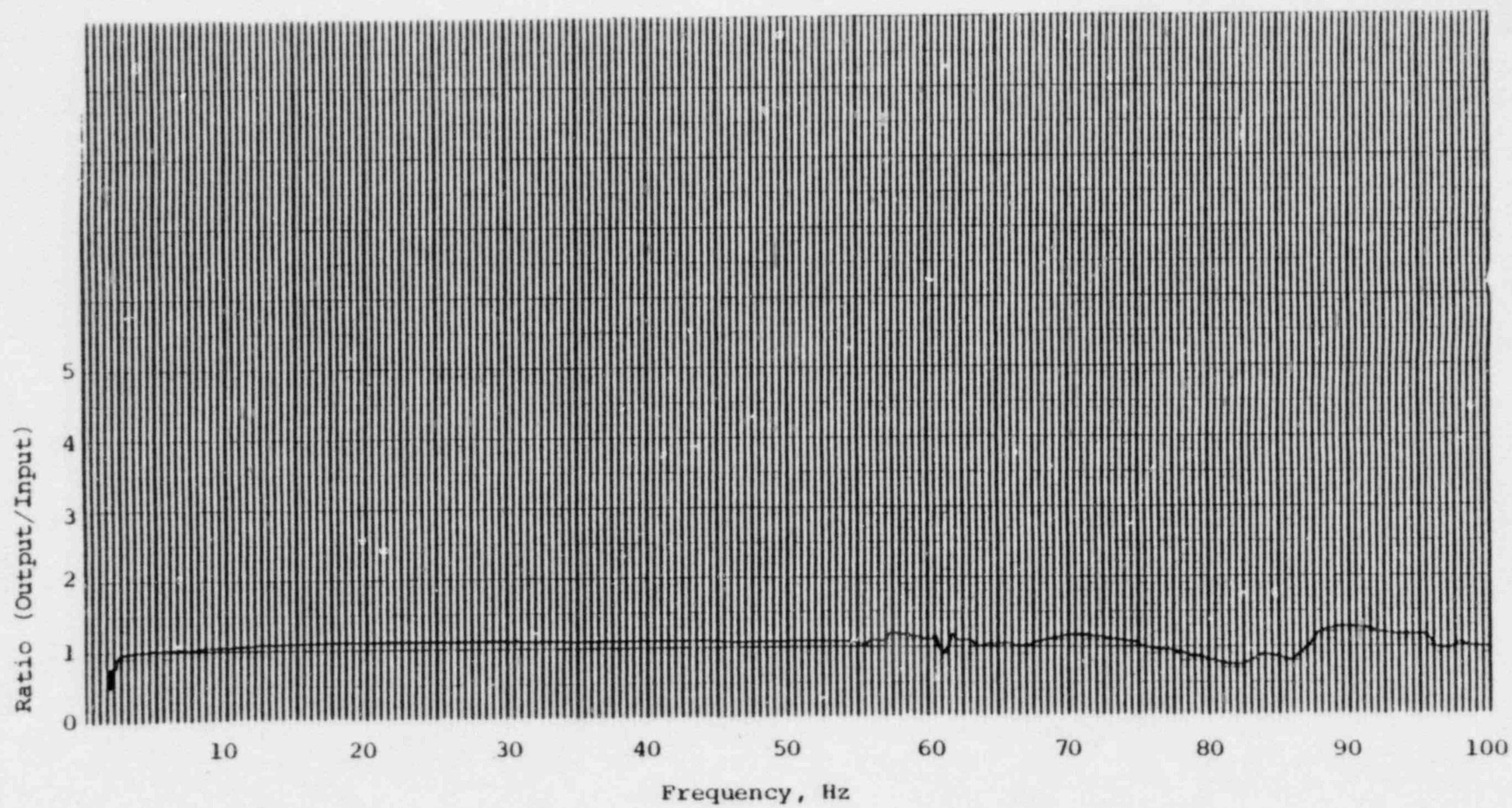


FIGURE 10-2. RESONANCE SEARCH, Y-AXIS, ACCELEROMETER ON SOLENOID "A", INPUT 0.1 G PEAK, SWEEP 0.5 OCTAVE/MINUTE

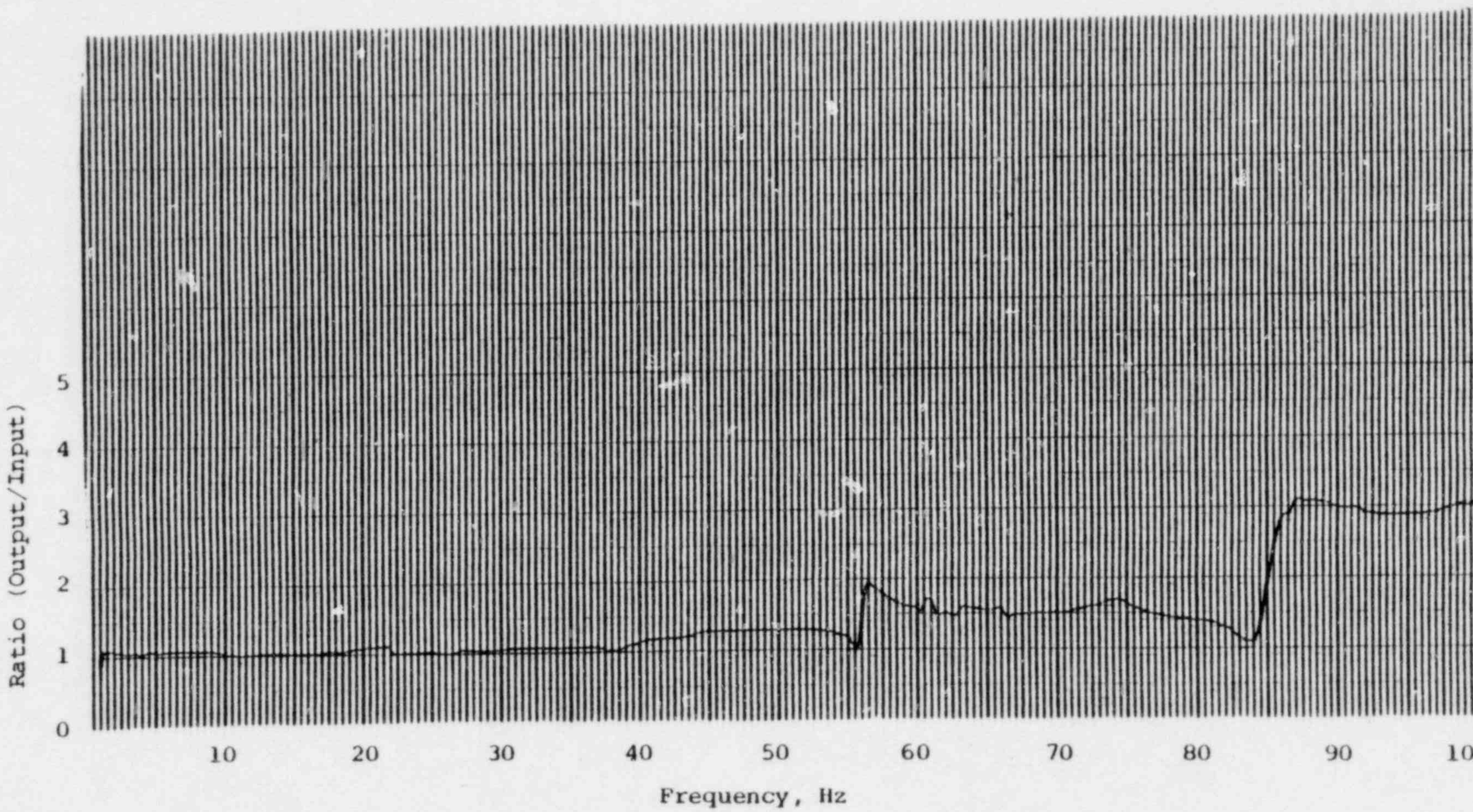
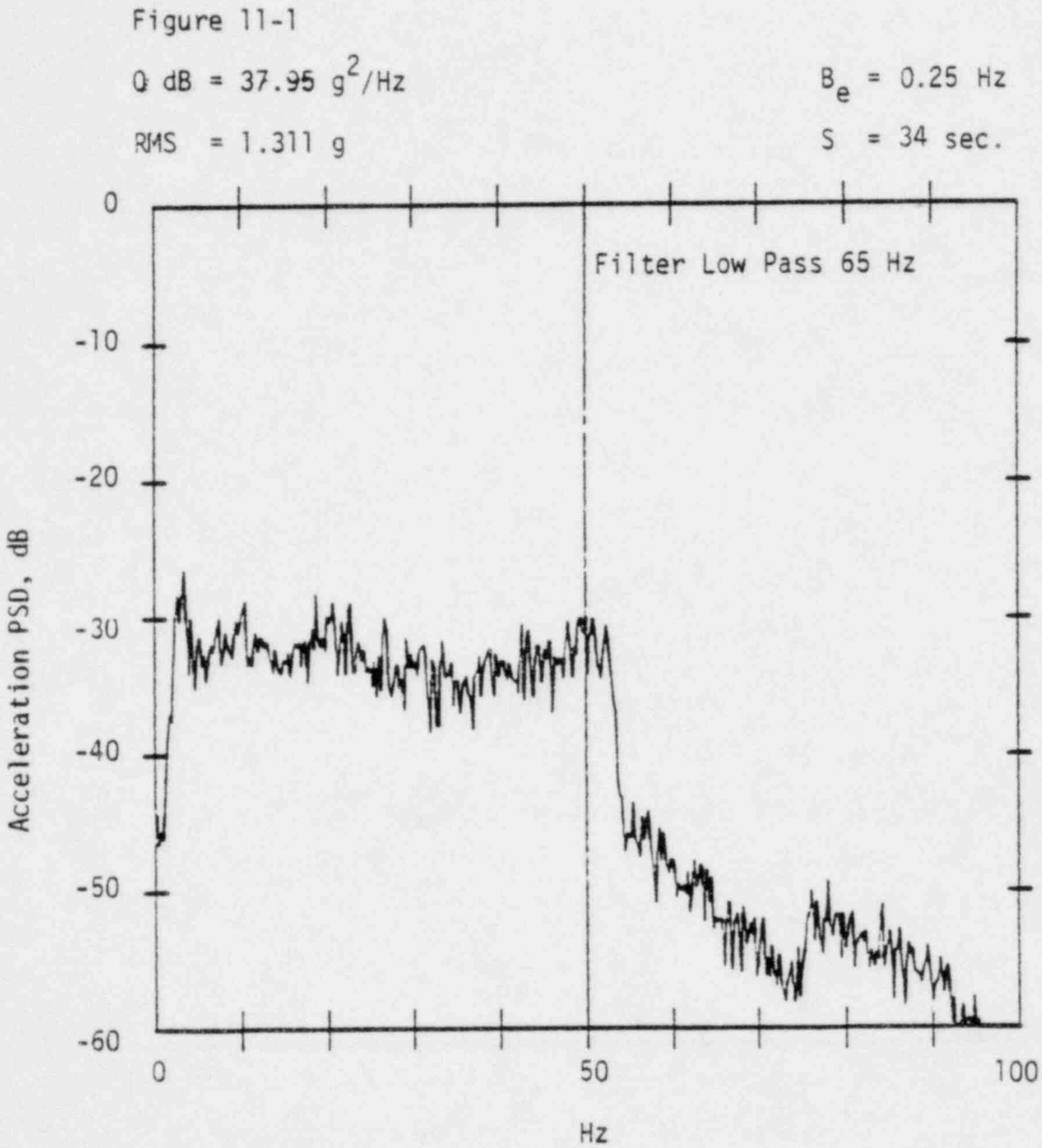


FIGURE 10-3. RESONANCE SEARCH, Z-AXIS, ACCELEROMETER ON SOLENOID "A", INPUT 0.1 G PEAK, SWEEP 0.5 OCTAVE/MINUTE

SECTION 11.0

PROOF TEST DATA



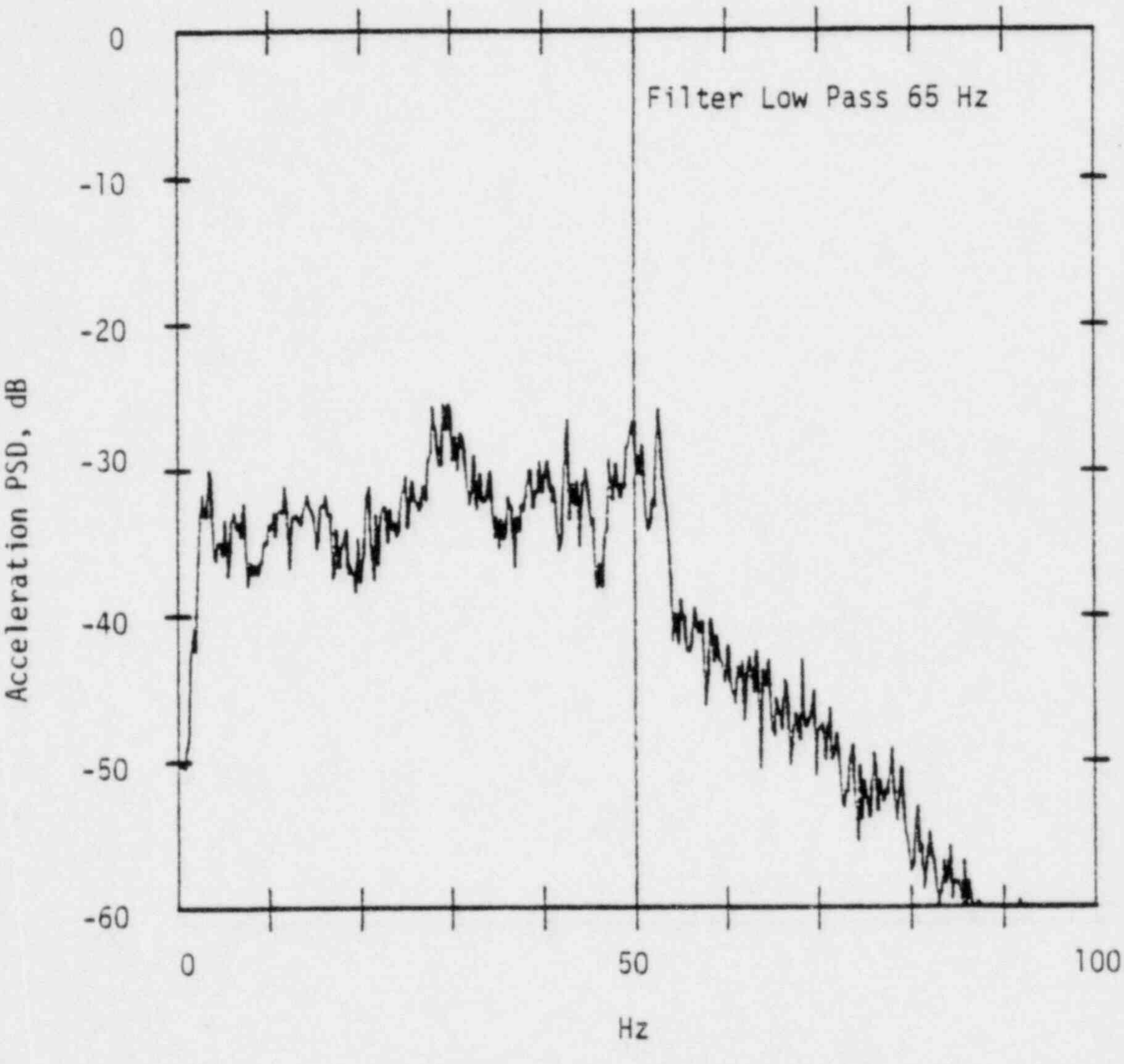
HORIZONTAL POWER SPECTRUM

AH - RUN UPXZ1A

Figure 11-2

0 dB = 37.95 g^2/Hz B_e = 0.25 Hz

RMS = 1.436 g   S = 34 sec.



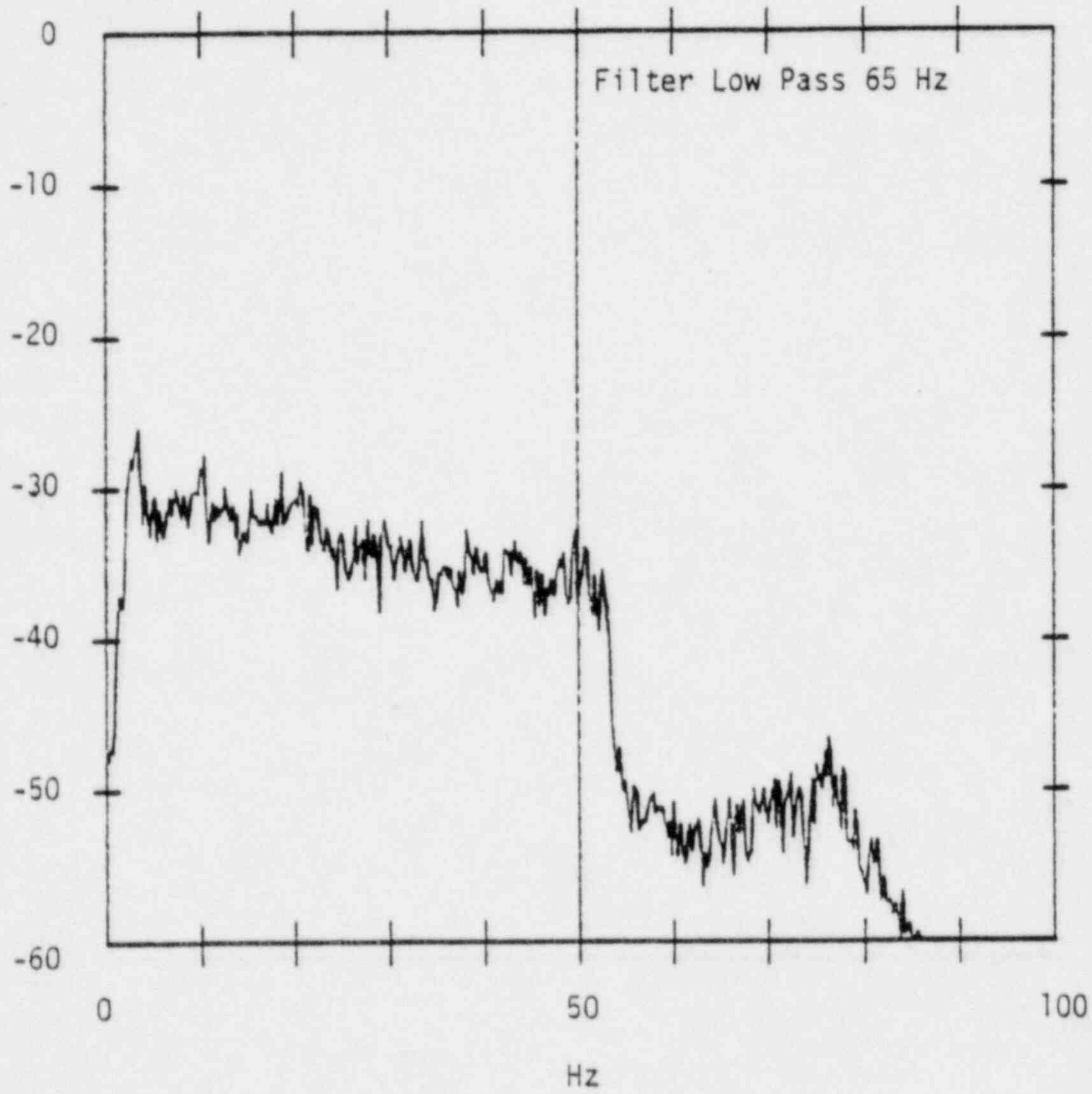
VERTICAL POWER SPECTRUM

AV - RUN UPXZ1A

Figure 11-3

0 dB = 37.95 g^2/Hz B_e = 0.25 Hz

RMS = 1.226 g S = 34 sec.



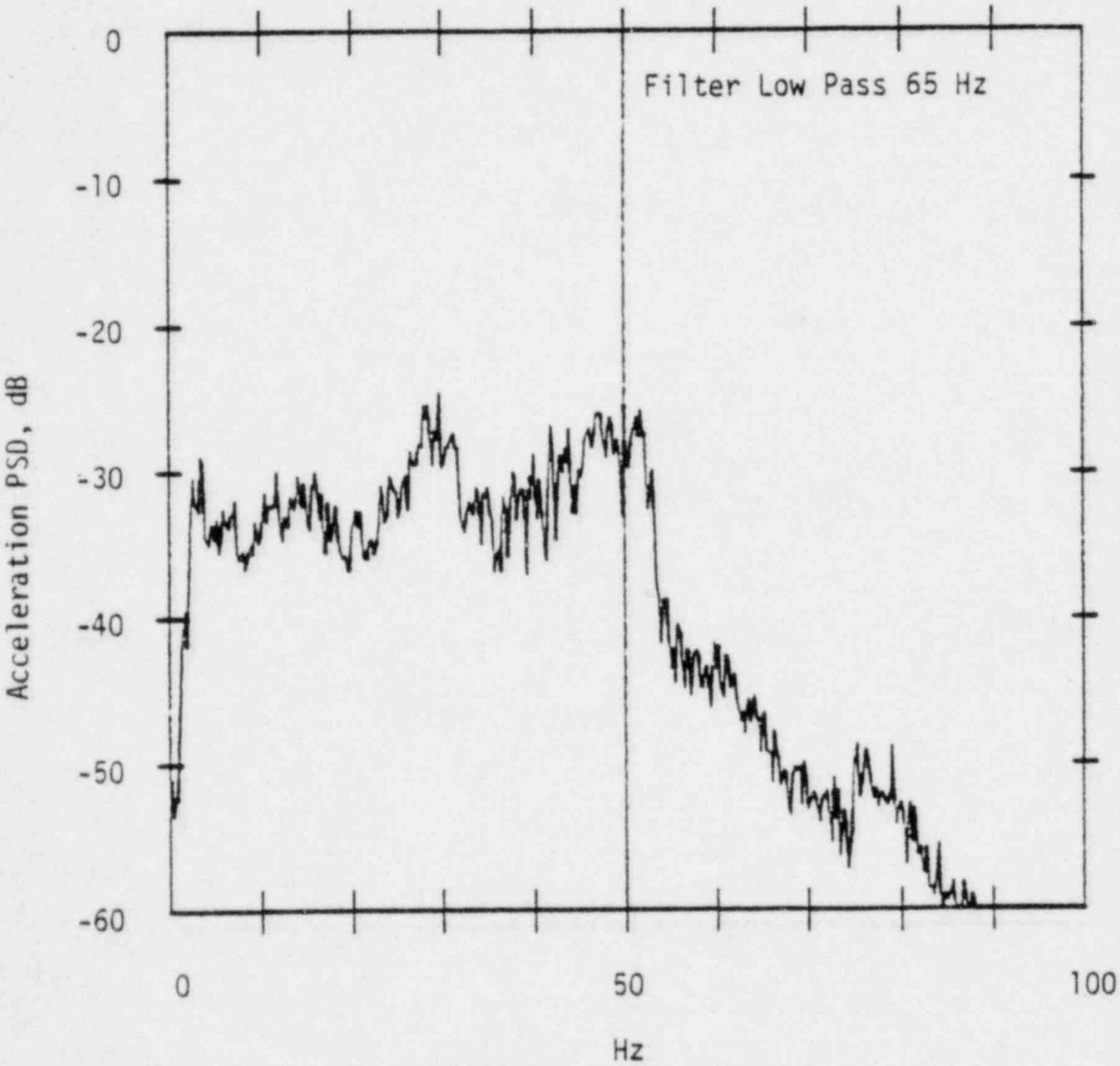
HORIZONTAL POWER SPECTRUM

AH - RUN UPYZ1A

Figure 11-4

0 dB = 37.95 g^2/Hz B_e = 0.25 Hz

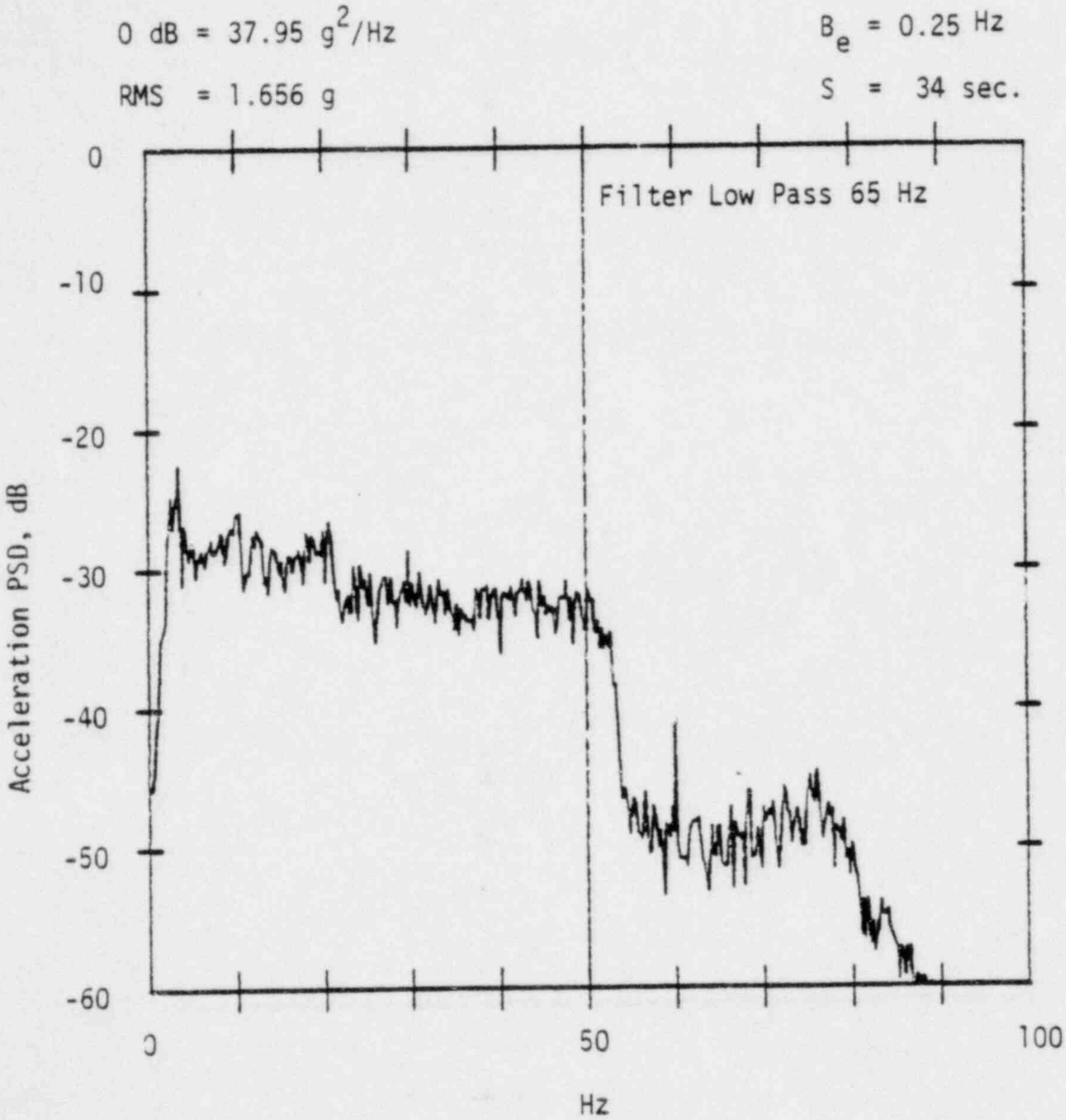
RMS = 1.601 g S = 34 sec.



VERTICAL POWER SPECTRUM

AV - RUN UPYZ1A

Figure 11-5



HORIZONTAL POWER SPECTRUM

AH - RUN EMSYZ3

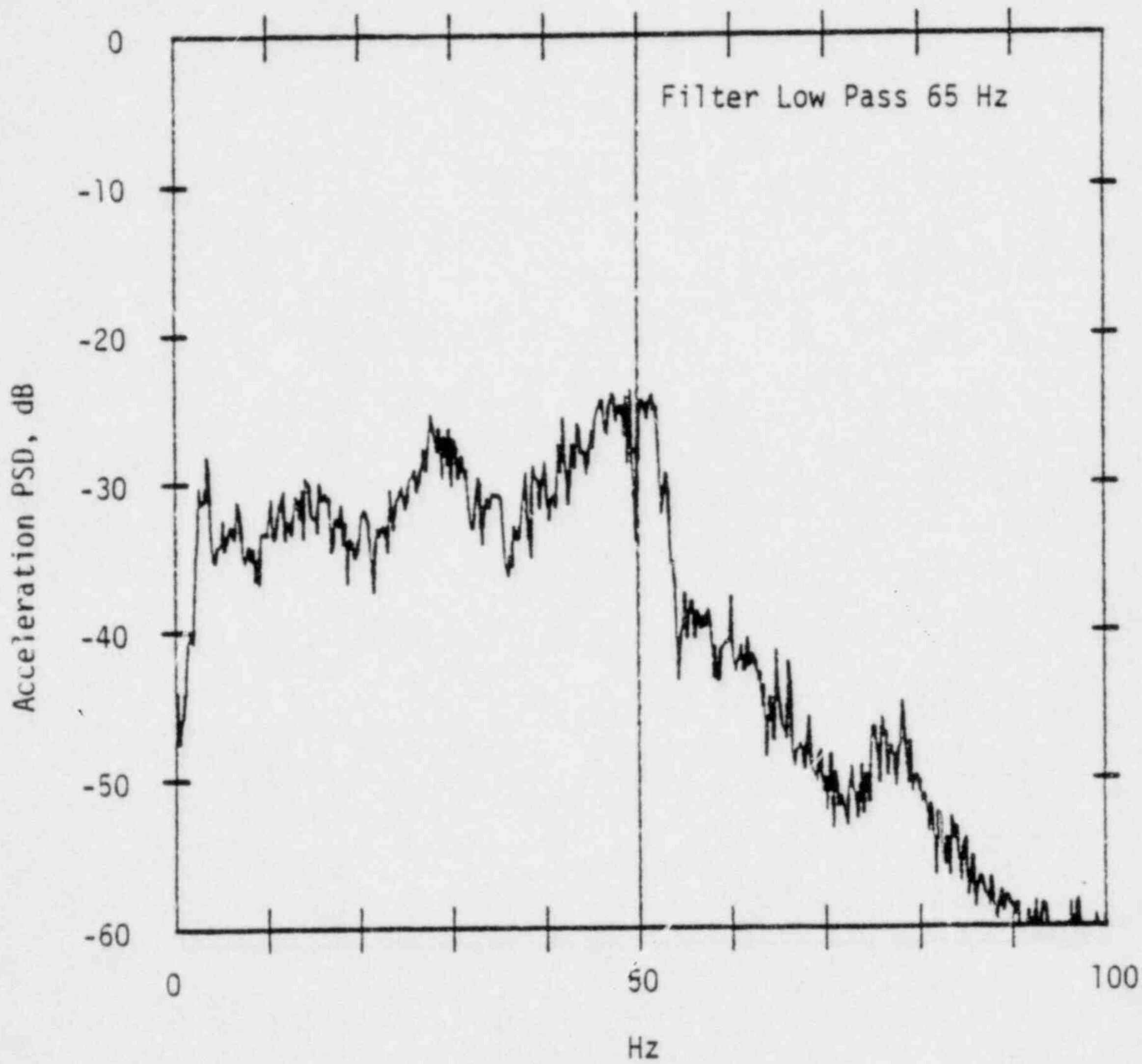
Figure 11-6

0 dB = 37.95 g^2/Hz

RMS = 1.825 g

B_e = 0.25 Hz

S = 34 sec.



VERTICAL POWER SPECTRUM

AV - RUN EMSYZ3

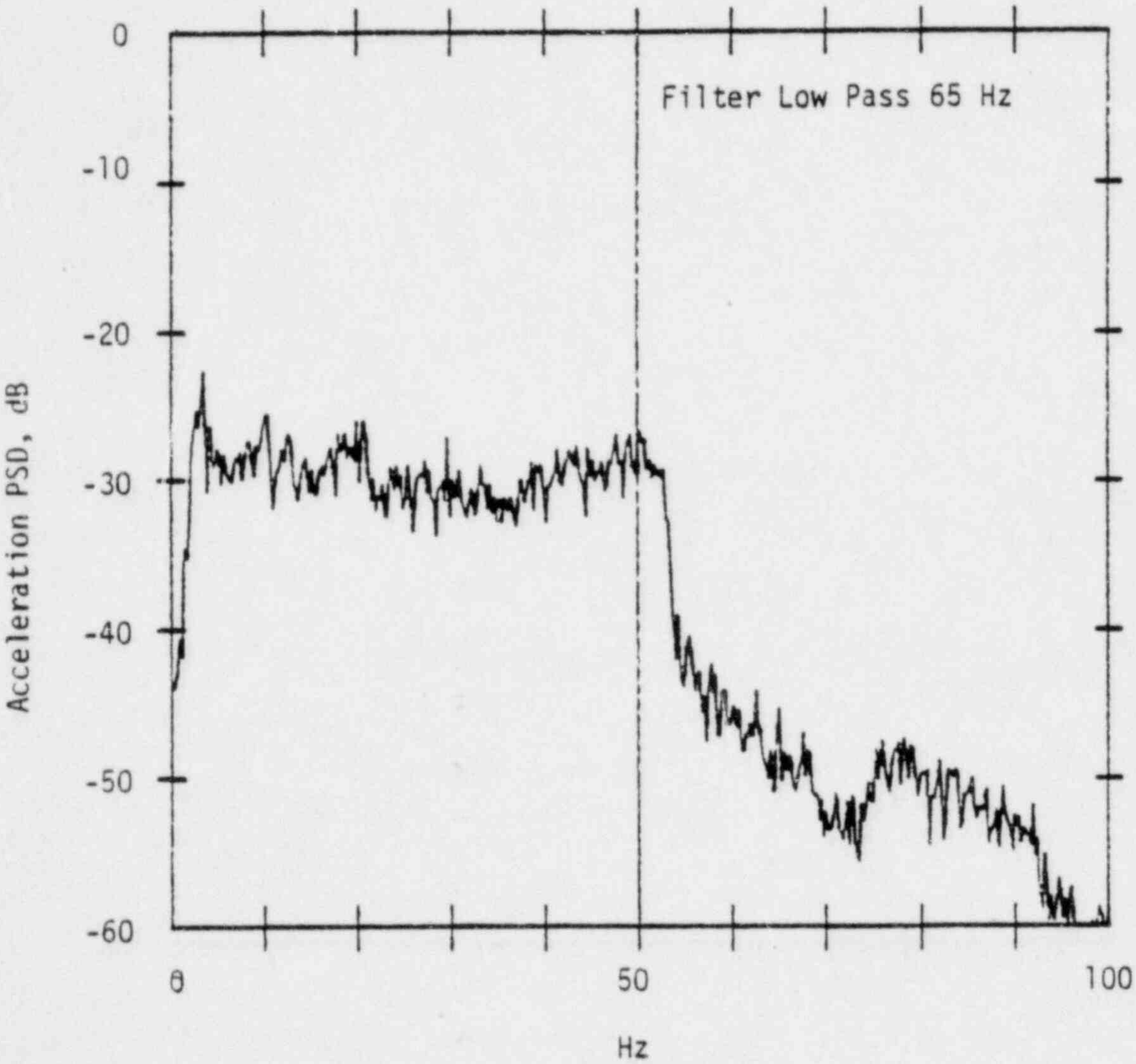
Figure 11-7

0 dB = 37.95 g^2/Hz

RMS = 1.906 g

B_e = 0.25 Hz

S = 34 sec.



HORIZONTAL POWER SPECTRUM

AH - RUN EMSXZ1

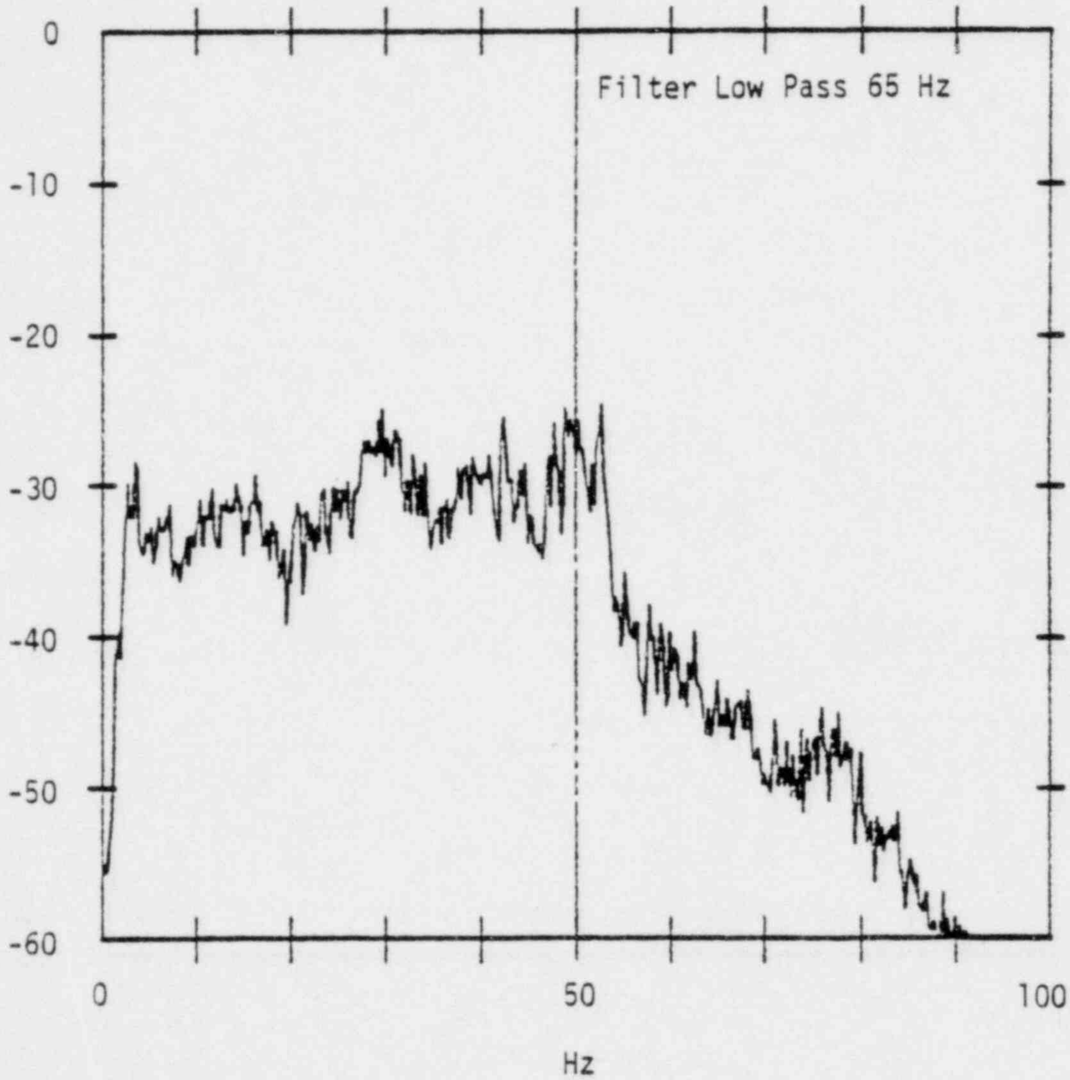
Figure 11-8

0 dB = 37.95 g^2/Hz

RMS = 1.671 g

B_e = 0.25 Hz

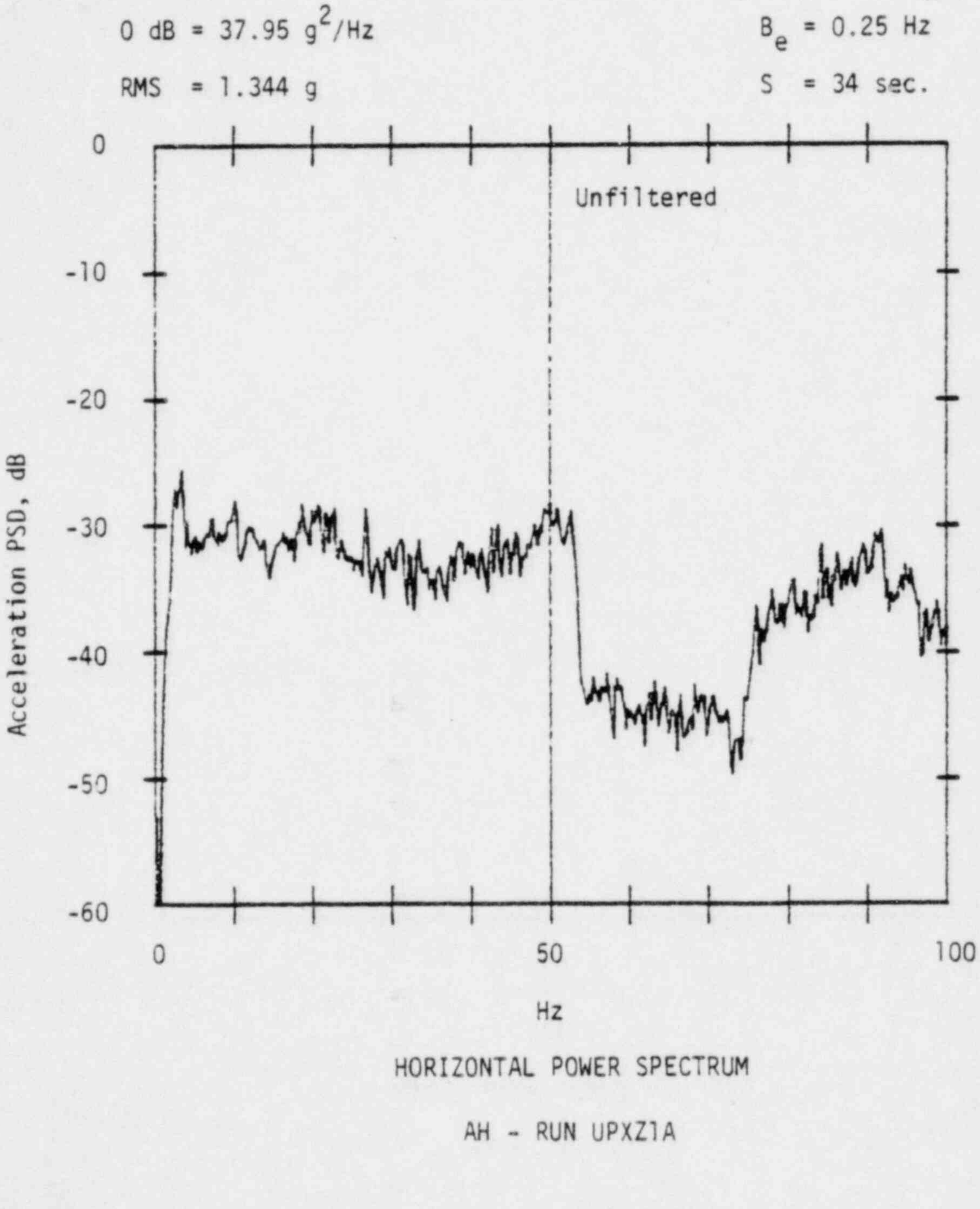
S = 34 sec.



VERTICAL POWER SPECTRUM

AV - RUN EMSXZ1

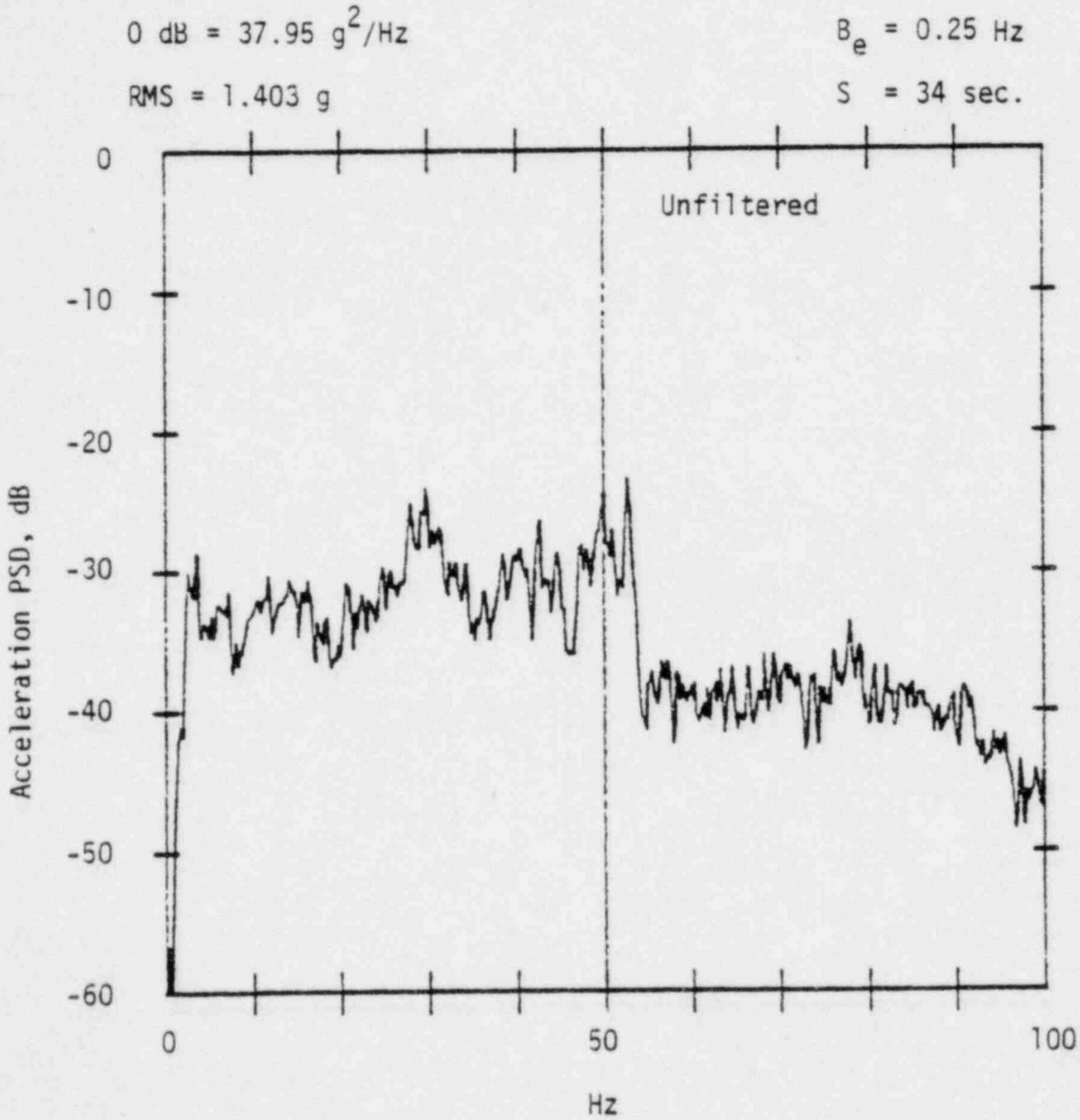
Figure 11-9



HORIZONTAL POWER SPECTRUM

AH - RUN UPXZ1A

Figure 11-10



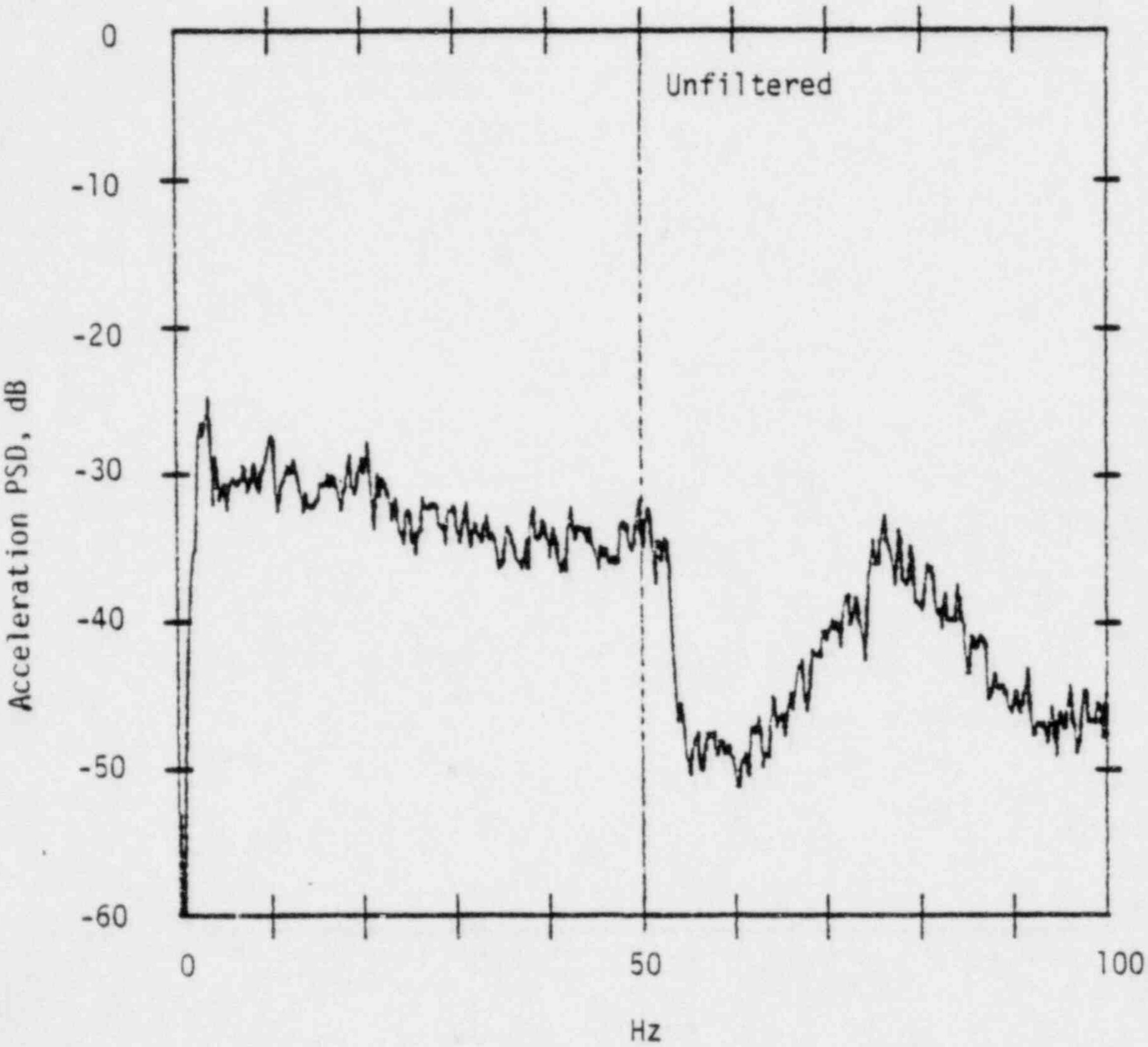
VERTICAL POWER SPECTRUM

AV - RUN UPXZ1A

Figure 11-11

0 dB = 37.95 g^2/Hz B_e = 0.25 Hz

RMS = 1.193 g S = 34 sec.



HORIZONTAL POWER SPECTRUM

AH - RUN UPYZ1A

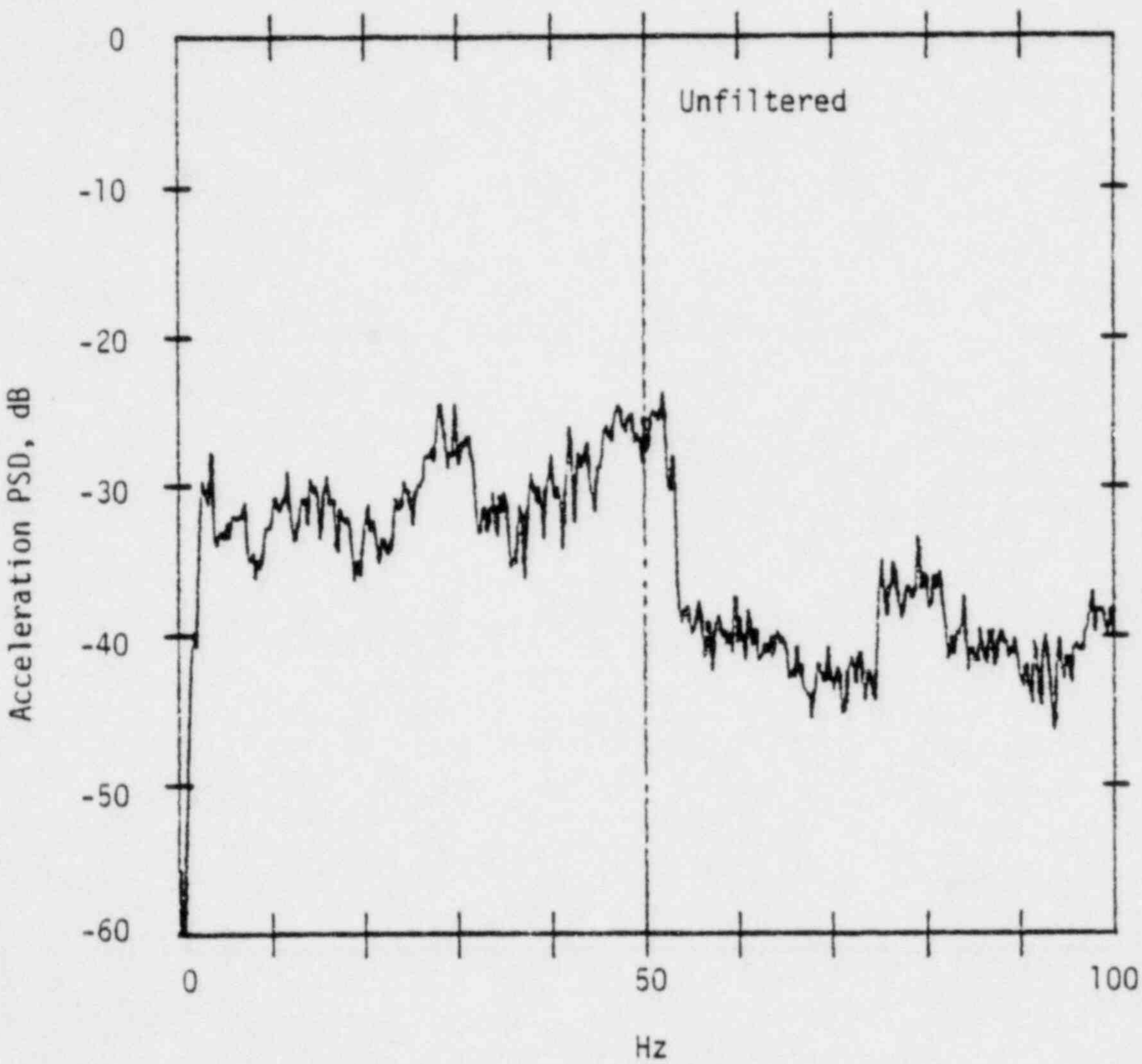
Figure 11-12

0 dB = 37.95 g^2/Hz

RMS = 1.553 g

B_e = 0.25 Hz

S = 34 sec.



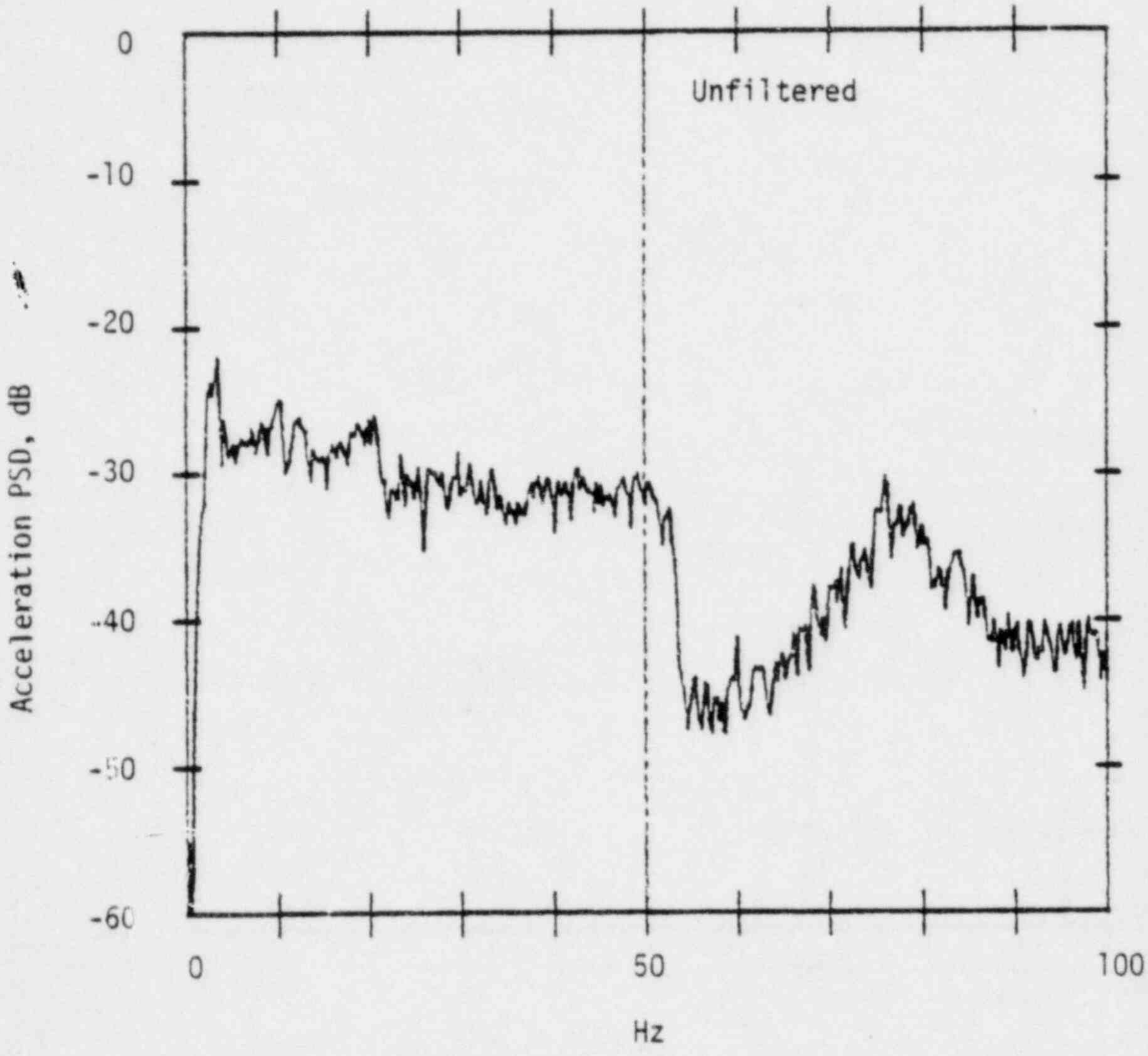
VERTICAL POWER SPECTRUM

AV - RUN UPYZ1A

Figure 11-13

0 dB = 37.95 g^2/Hz B_e = 0.25 Hz

RMS = 1.605 g S = 34 sec.



HORIZONTAL POWER SPECTRUM

AH - RUN EMSYZ3

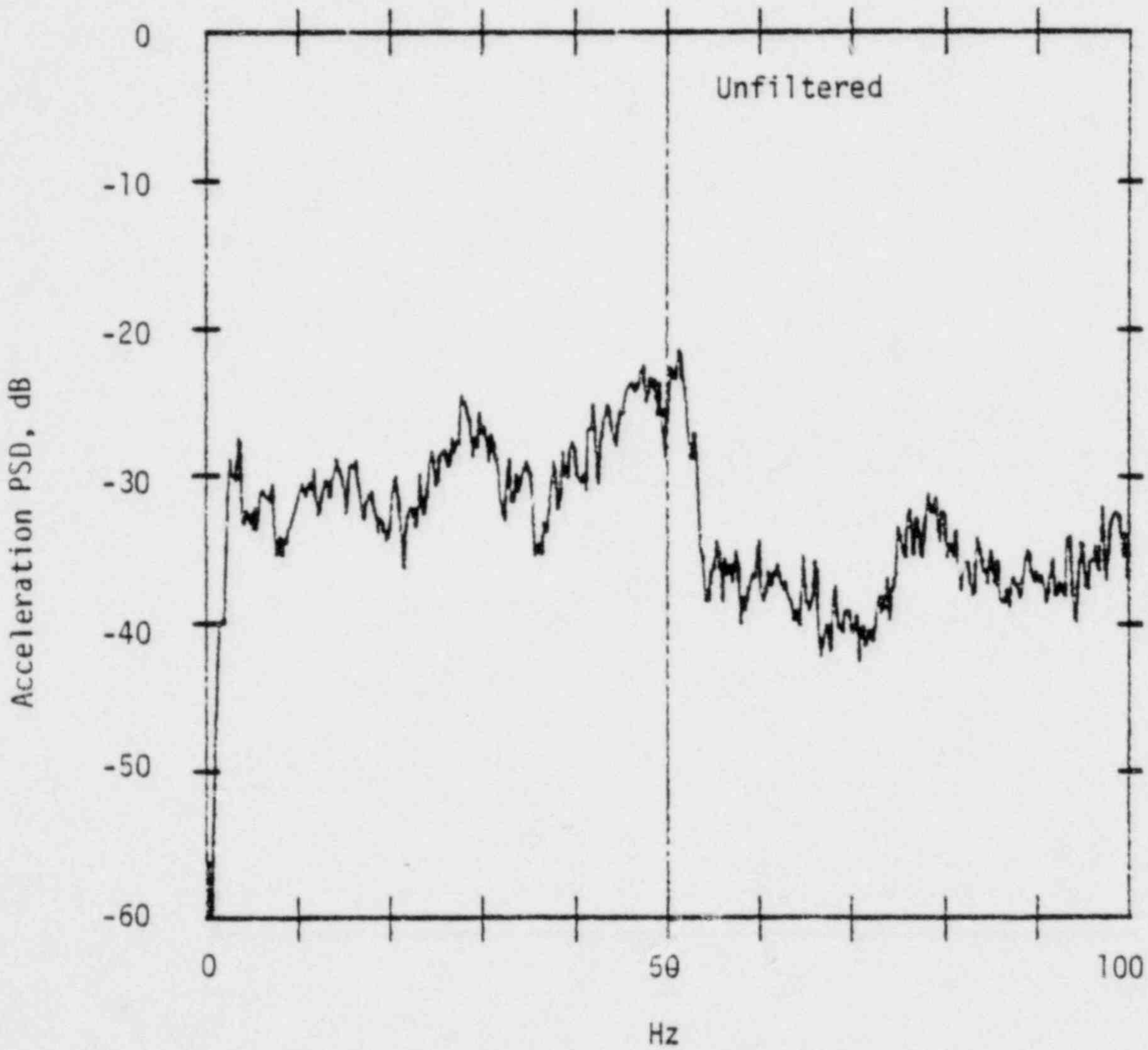
Figure 11-14

0 dB = 37.95 g^2/Hz

RMS = 1.825 g

B_e = 0.25 Hz

S = 34 sec.



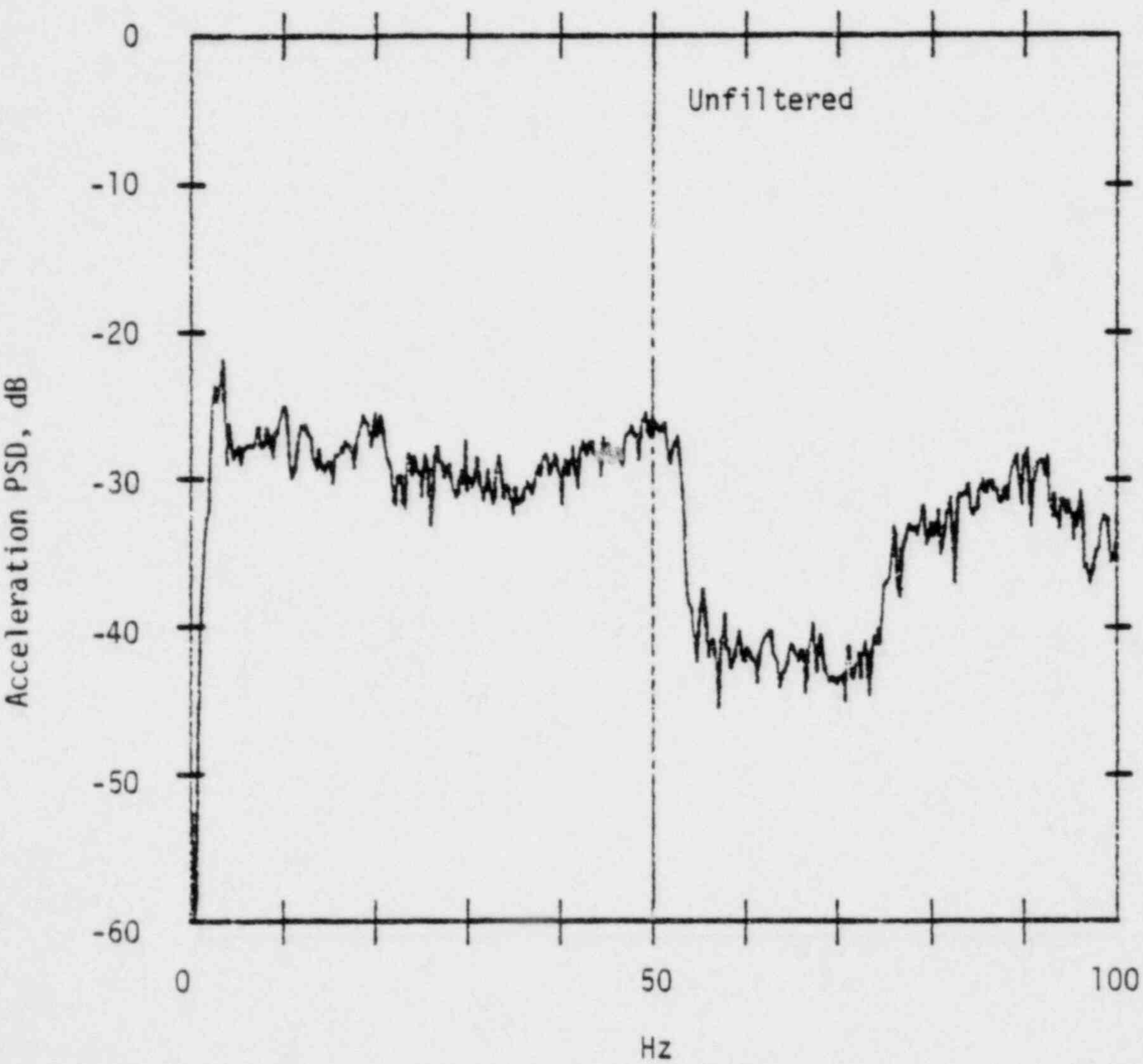
VERTICAL POWER SPECTRUM

AV - RUN EMSYZ3

Figure 11-15

0 dB = 37.95 g^2/Hz B_e = 0.25 Hz

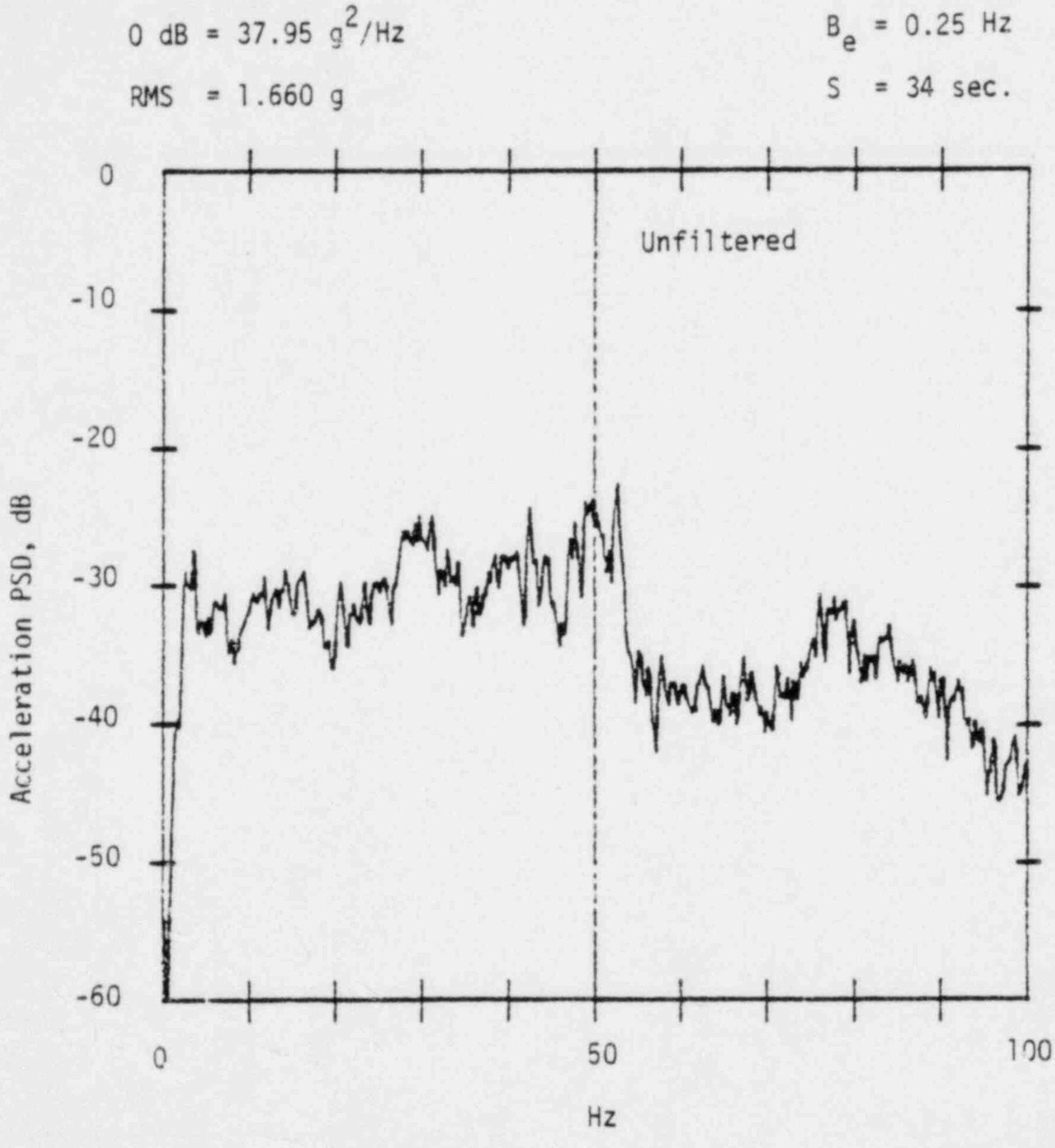
RMS = 1.935 g   S = 34 sec.



HORIZONTAL POWER SPECTRUM

AH - RUN EMSXZT

Figure 11-16



VERTICAL POWER SPECTRUM

AV - RUN EMSXZ1

Figure 11-17

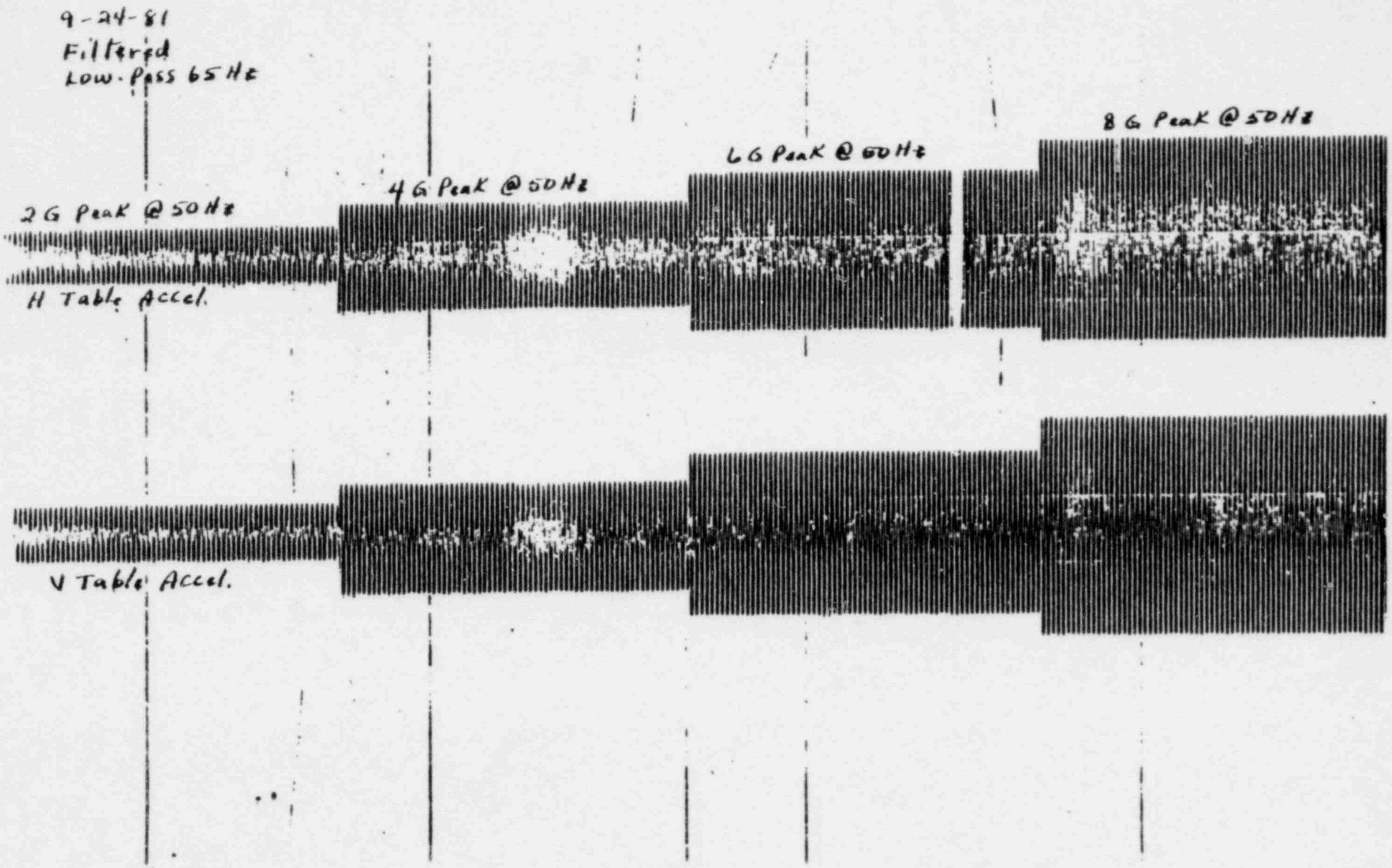
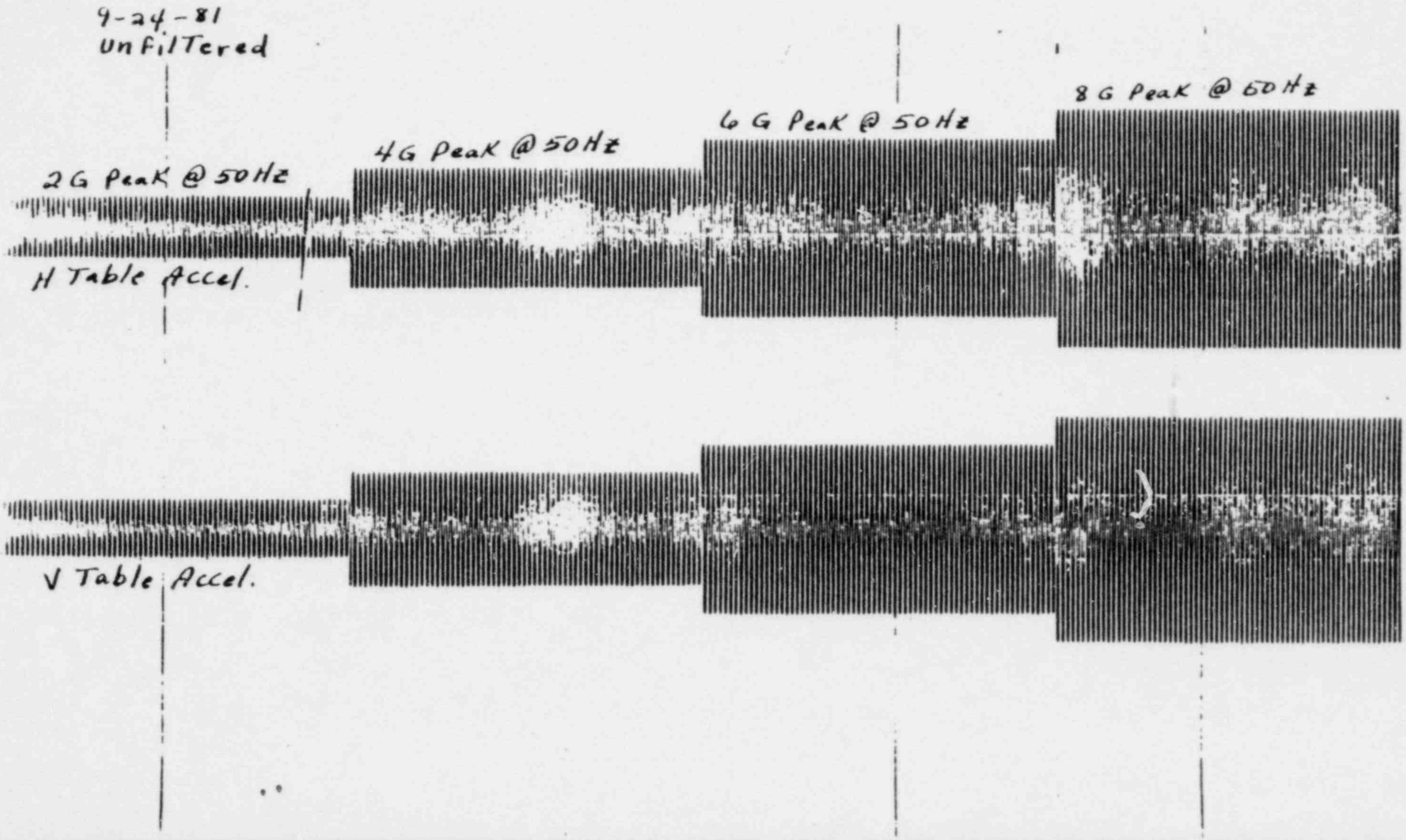

9-24-81
Filtered
Low-Pass 65 Hz
2 G Peak @ 50 Hz
4 G Peak @ 50 Hz
6 G Peak @ 60 Hz
8 G Peak @ 50 Hz
H Table Accel.
V Table Accel.

Figure 11-18



9-24-81
unfilTered
2G Peak @ 50Hz
4G Peak @ 50Hz
6 G Peak @ 50Hz
8 G Peak @ 60Hz
H Table Accel.
V Table Accel.

Figure 11-19

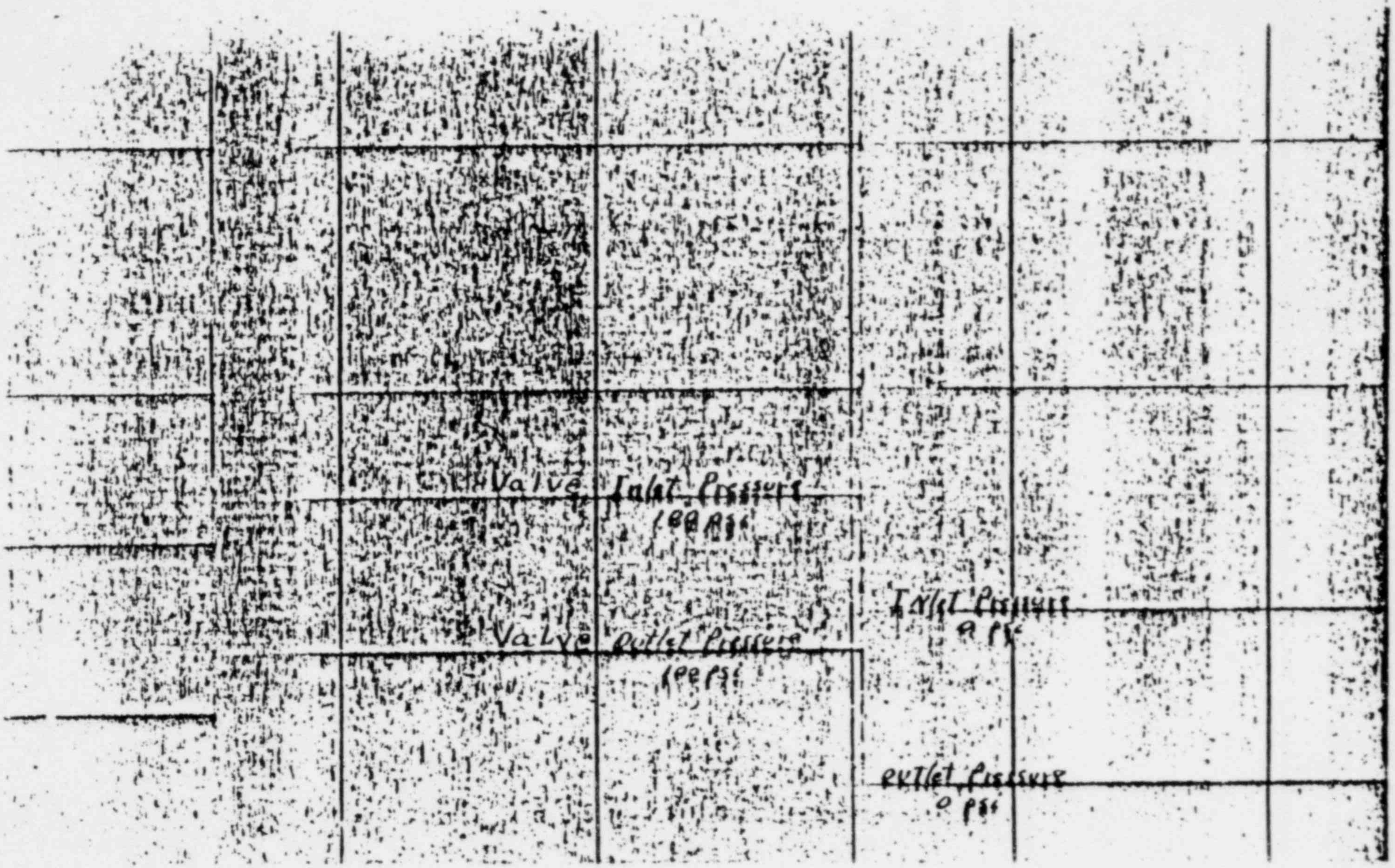
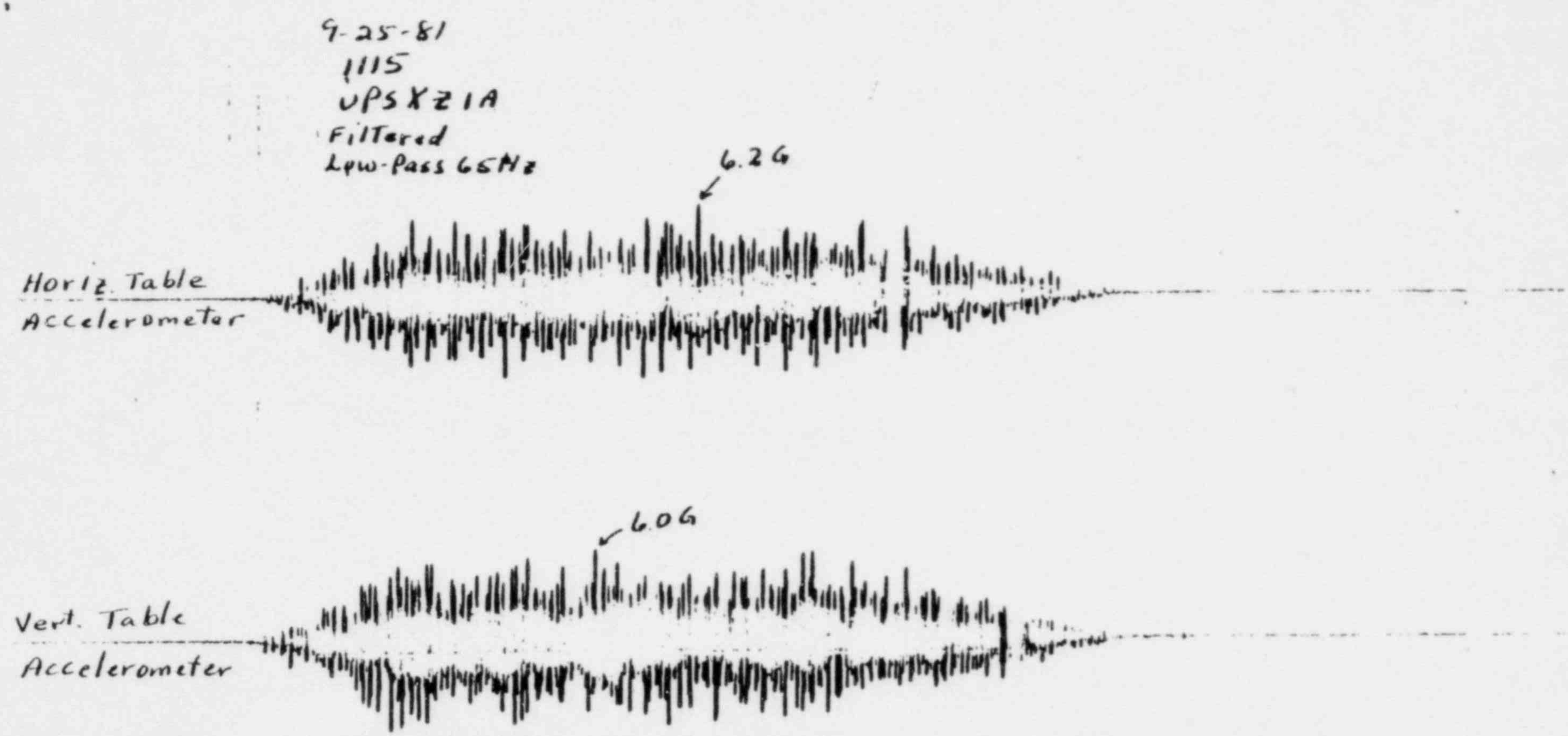

Valve Inlet Pressure
100 psi
Valve Outlet Pressure
100 psi
Inlet Pressure
0 psi
Outlet Pressure
0 psi

Figure 11-20



9-25-81
1115
UPSXZ1A
Filtered
Low-Pass 65Hz
6.2G
Horiz. Table
Accelerometer
6.0G
Vert. Table
Accelerometer

Figure 11-21

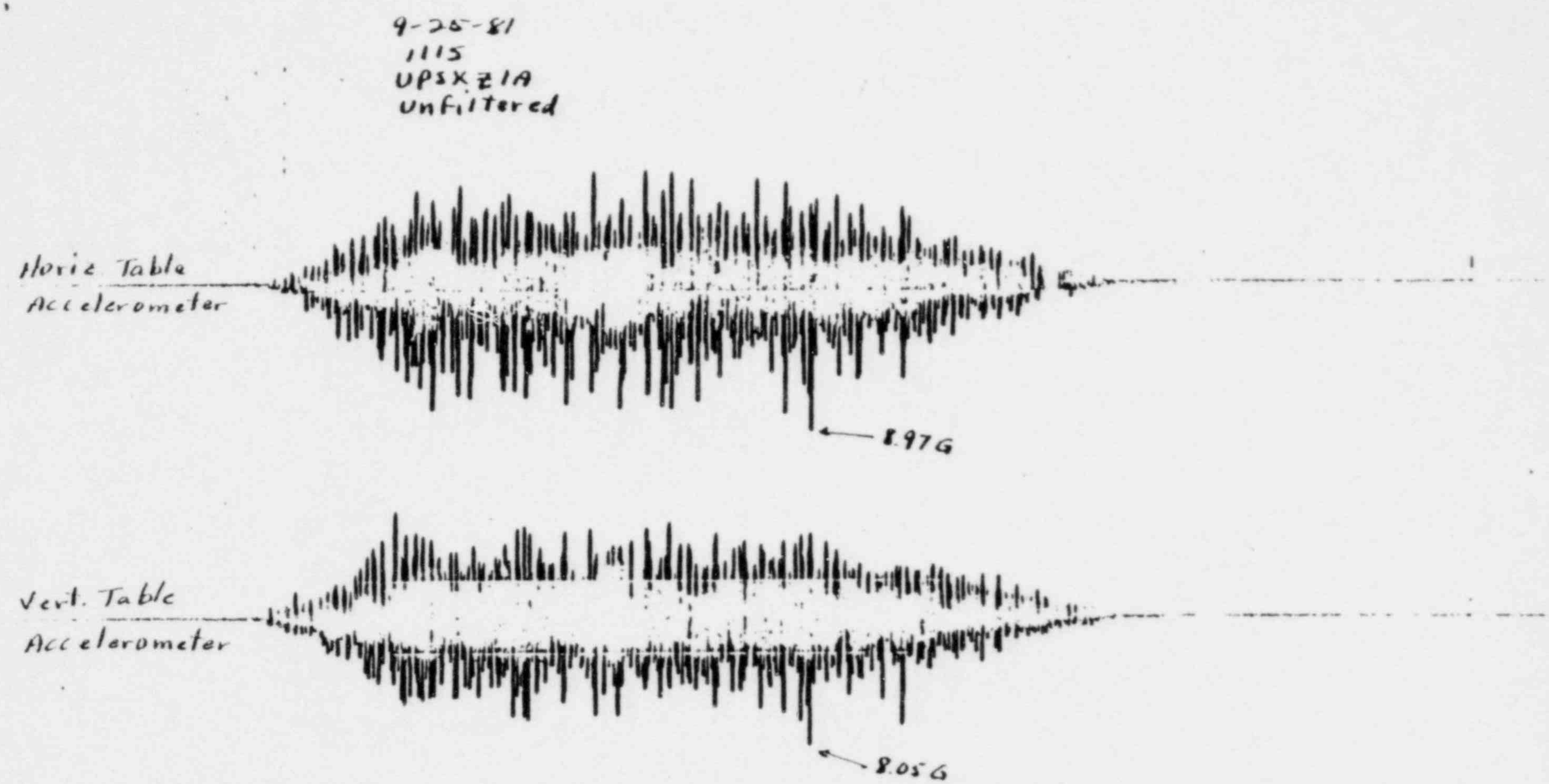

9-25-81
1115
UPSXZ1A
unfiltered
Horiz Table
Accelerometer
8.97G
Vert. Table
Accelerometer
8.05G

Figure 11-22

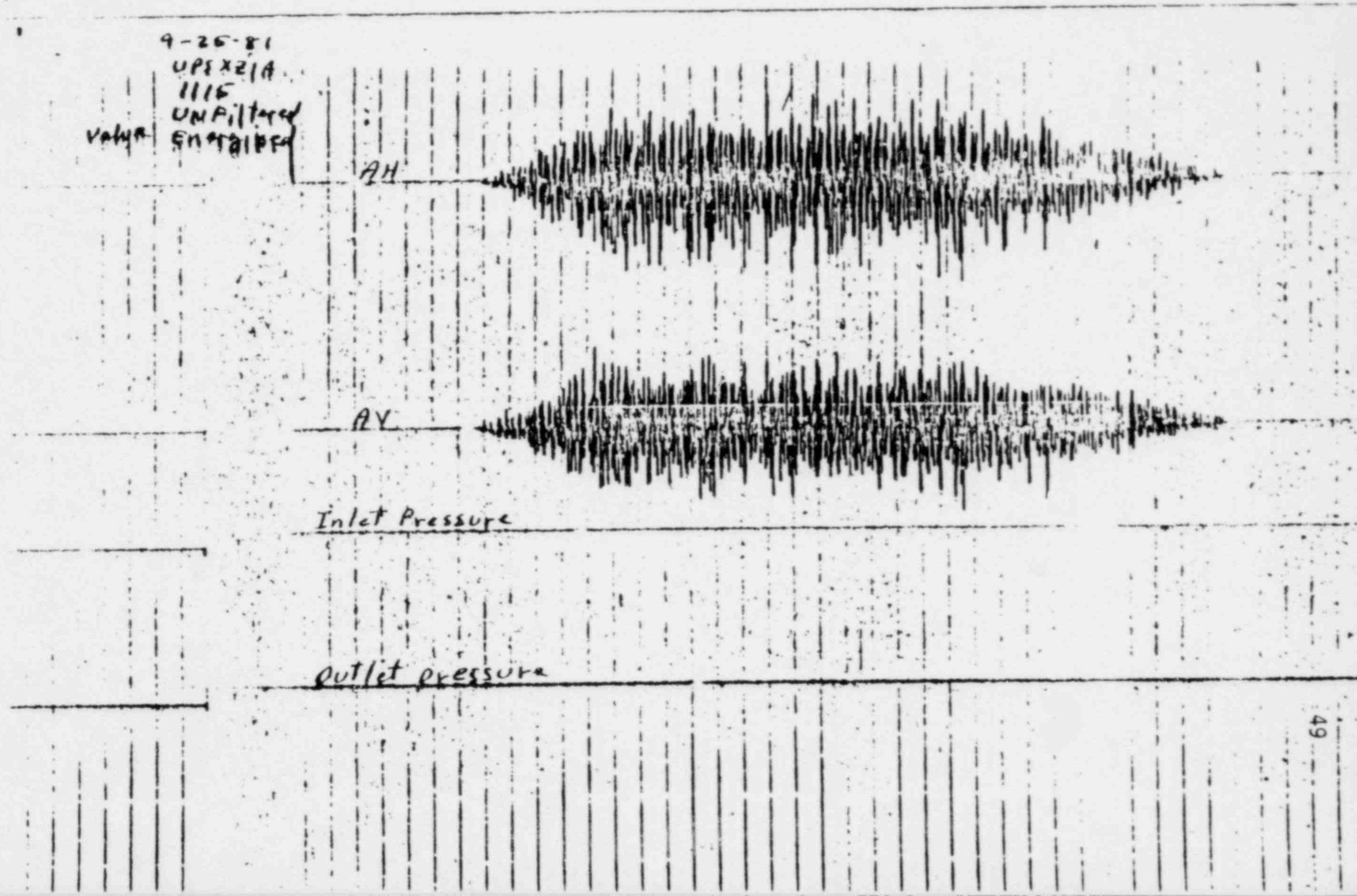

9-26-81
UPSX21A
1115
Unfiltered
Valve Energized
AH
AV
Inlet Pressure
Outlet Pressure

Figure 11-23

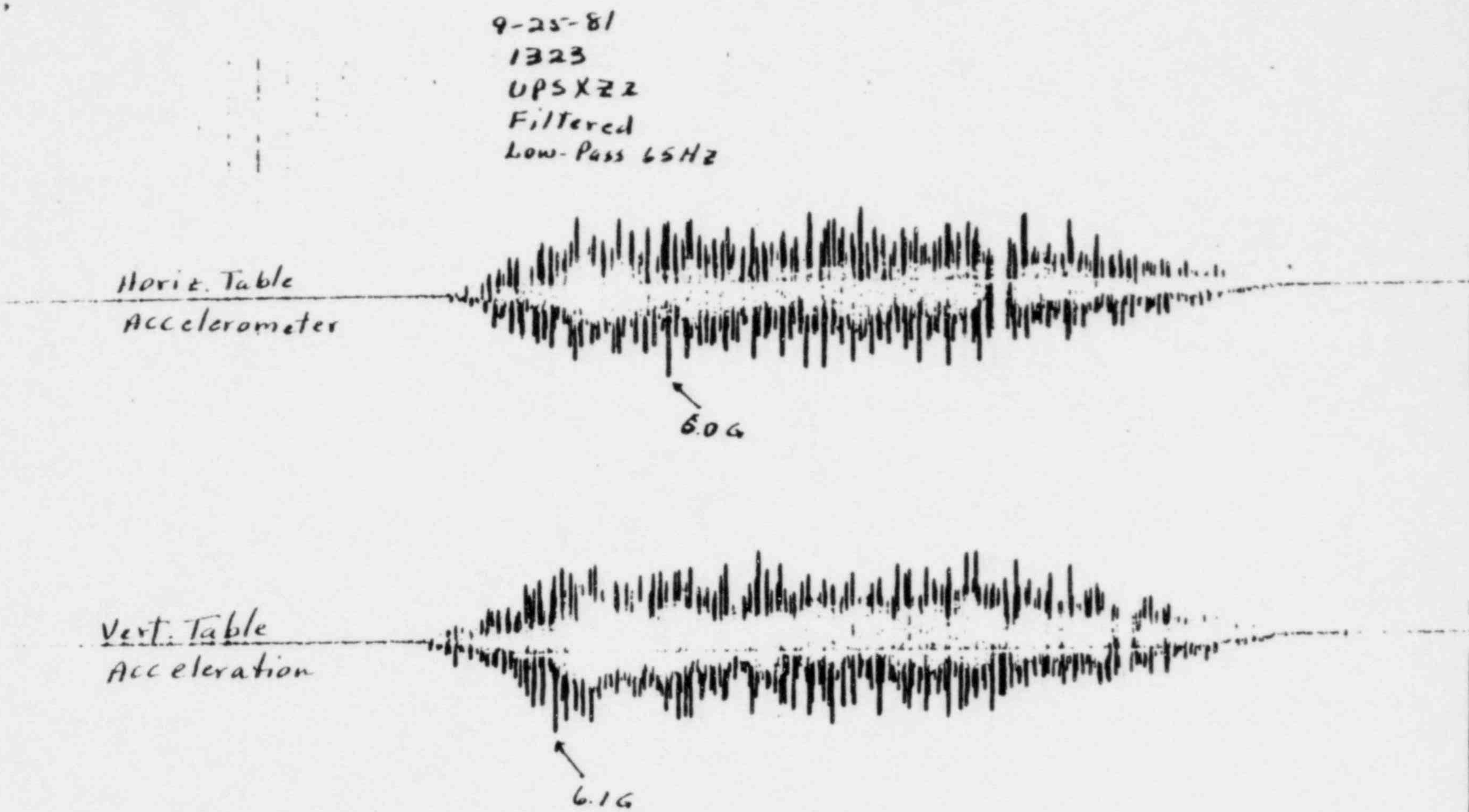
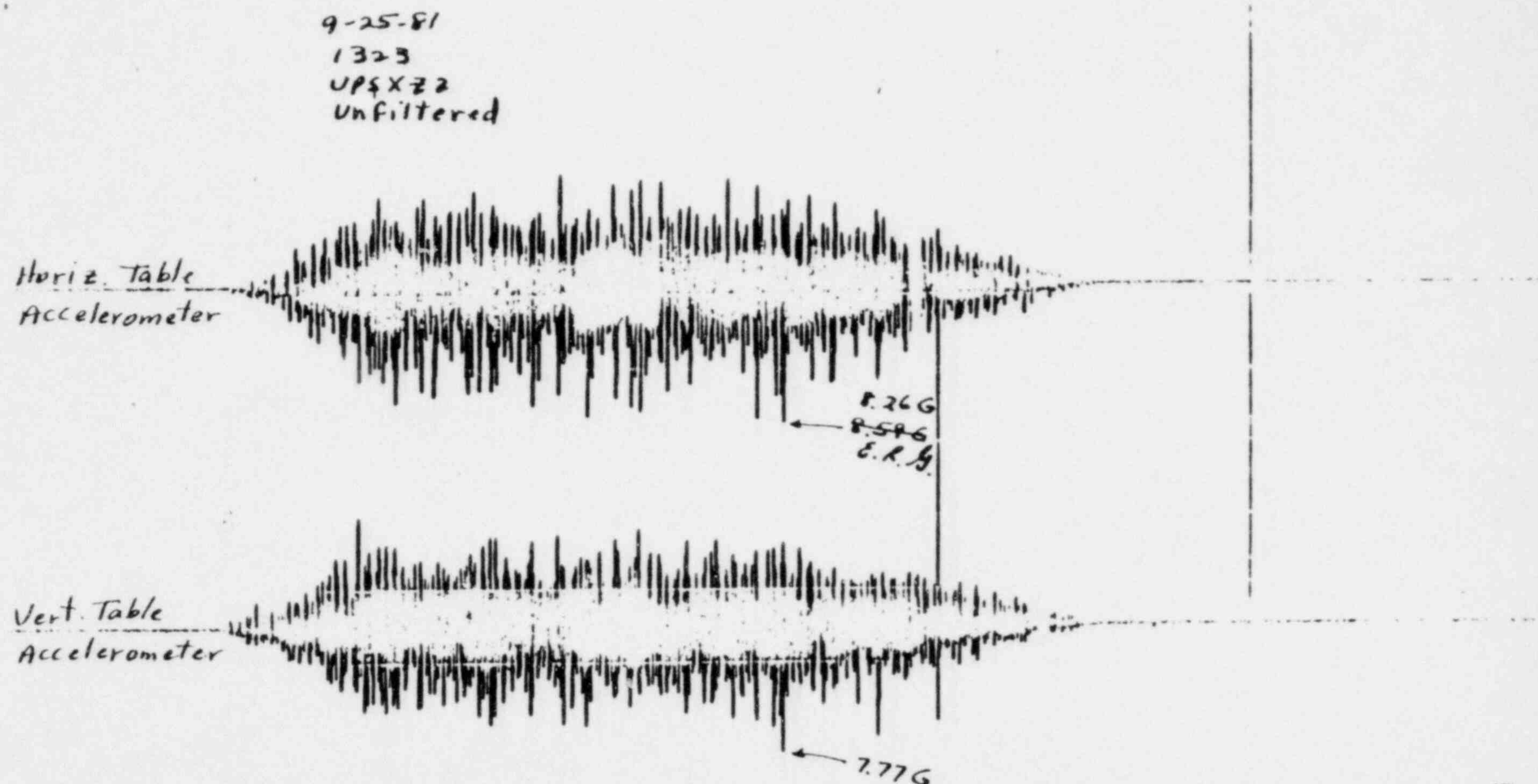

9-25-81
1323
UPSXZZ
Filtered
Low-Pass 65Hz
Horiz. Table
Accelerometer
6.0G
Vert. Table
Acceleration
6.1G

Figure 11-24



9-25-81
1323
UP$XZZ
Unfiltered
Horiz. Table
Accelerometer
8.26G
8.59G
E.R.G.
Vert. Table
Accelerometer
7.77G

Figure II-25

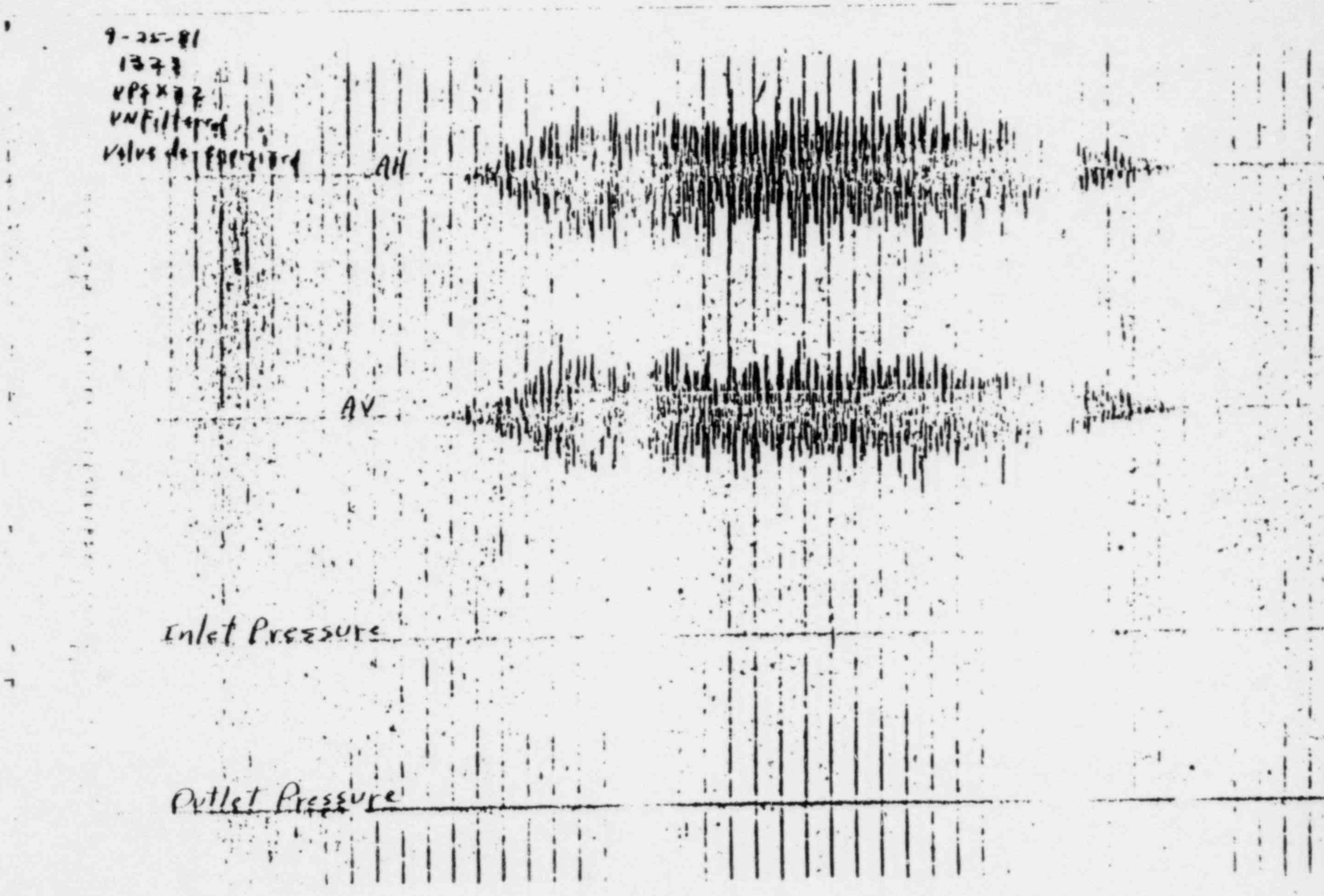


Figure 11-26

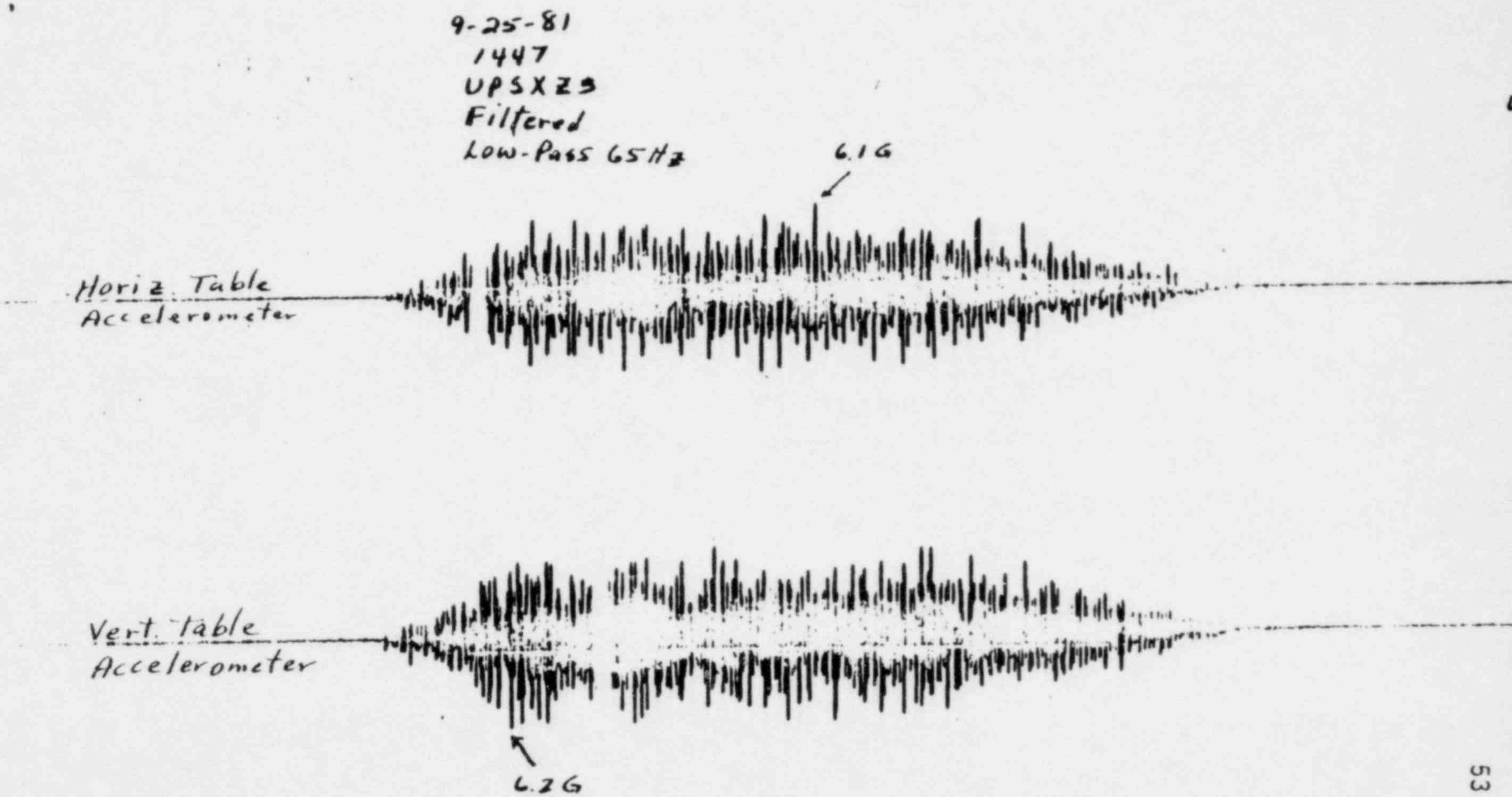

9-25-81
1447
UPSXZ3
Filtered
Low-Pass 65Hz
6.1G
Horiz. Table
Accelerometer
Vert. Table
Accelerometer
6.2G

Figure 11-27

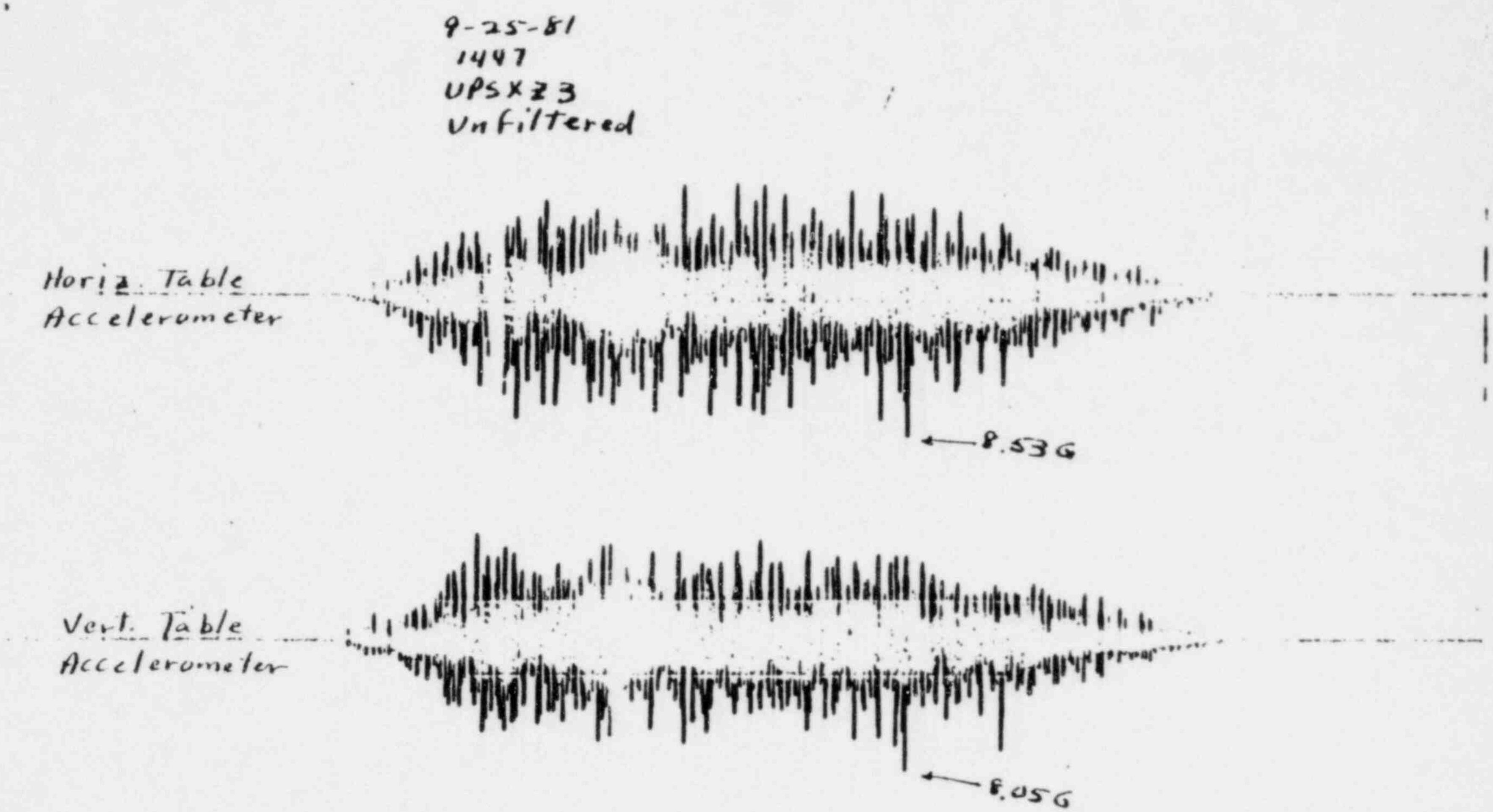
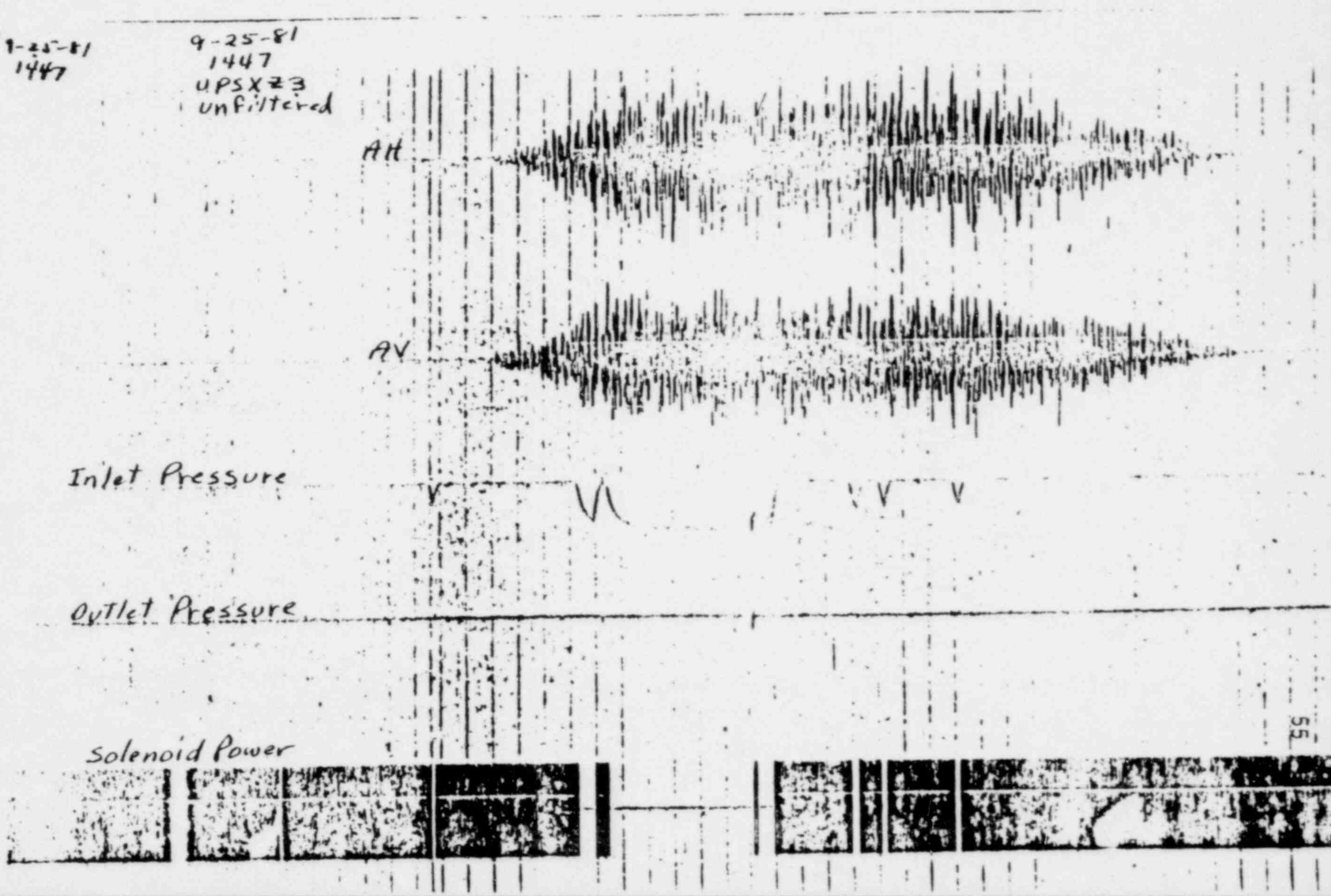

9-25-81
1447
UPSXZ3
Unfiltered
Horiz. Table
Accelerometer
8.53G
Vert. Table
Accelerometer
8.05G

Figure 11-28



9-25-81
1447
9-25-81
1447
UPSXZ3
unfiltered
AH
AV
Inlet Pressure
Outlet Pressure
Solenoid Power

Figure 11-29

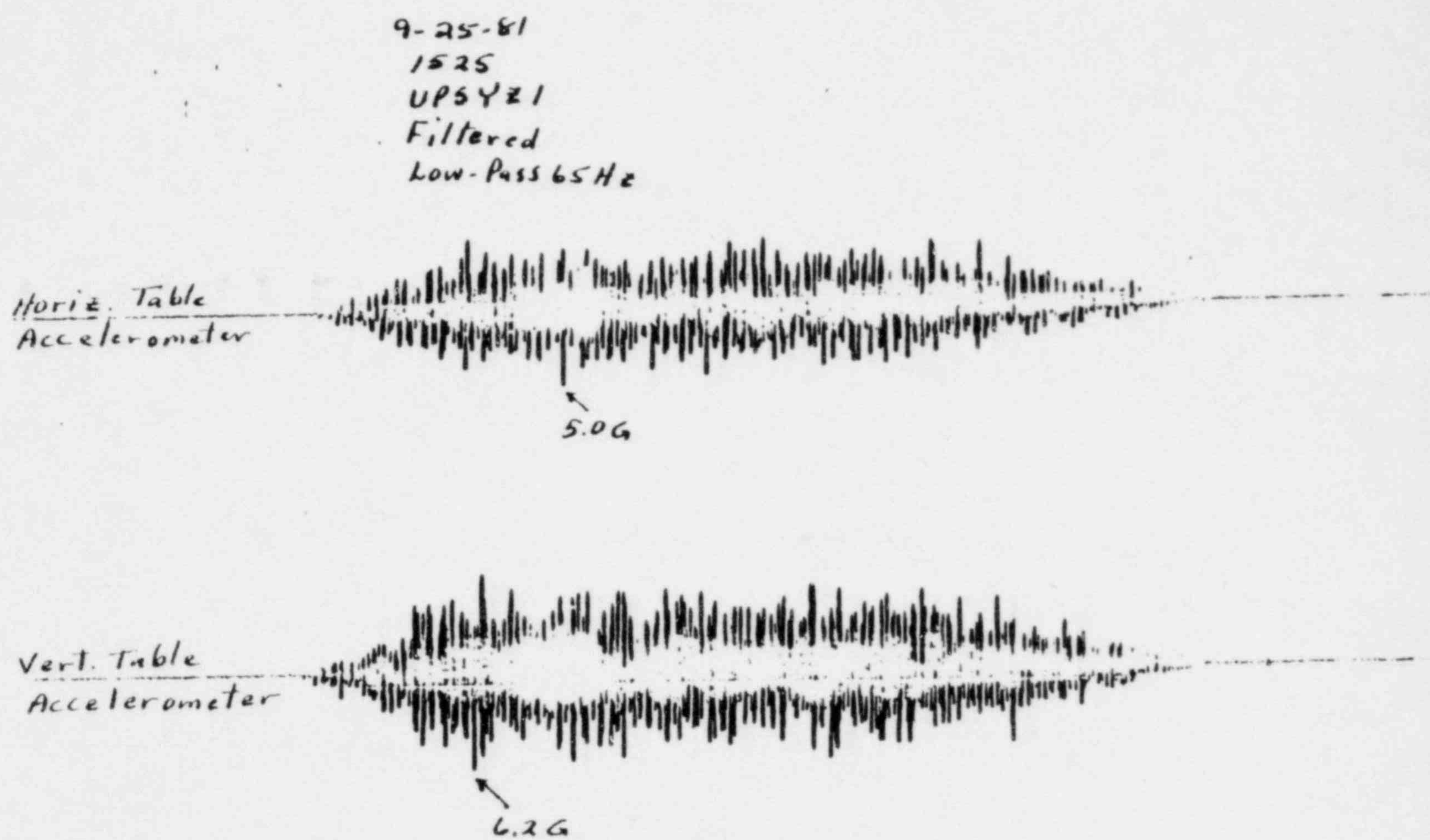

9-25-81
1525
UPSYZ1
Filtered
Low-Pass 65Hz
Horiz. Table
Accelerometer
5.0G
Vert. Table
Accelerometer
6.2G

Figure 11-30

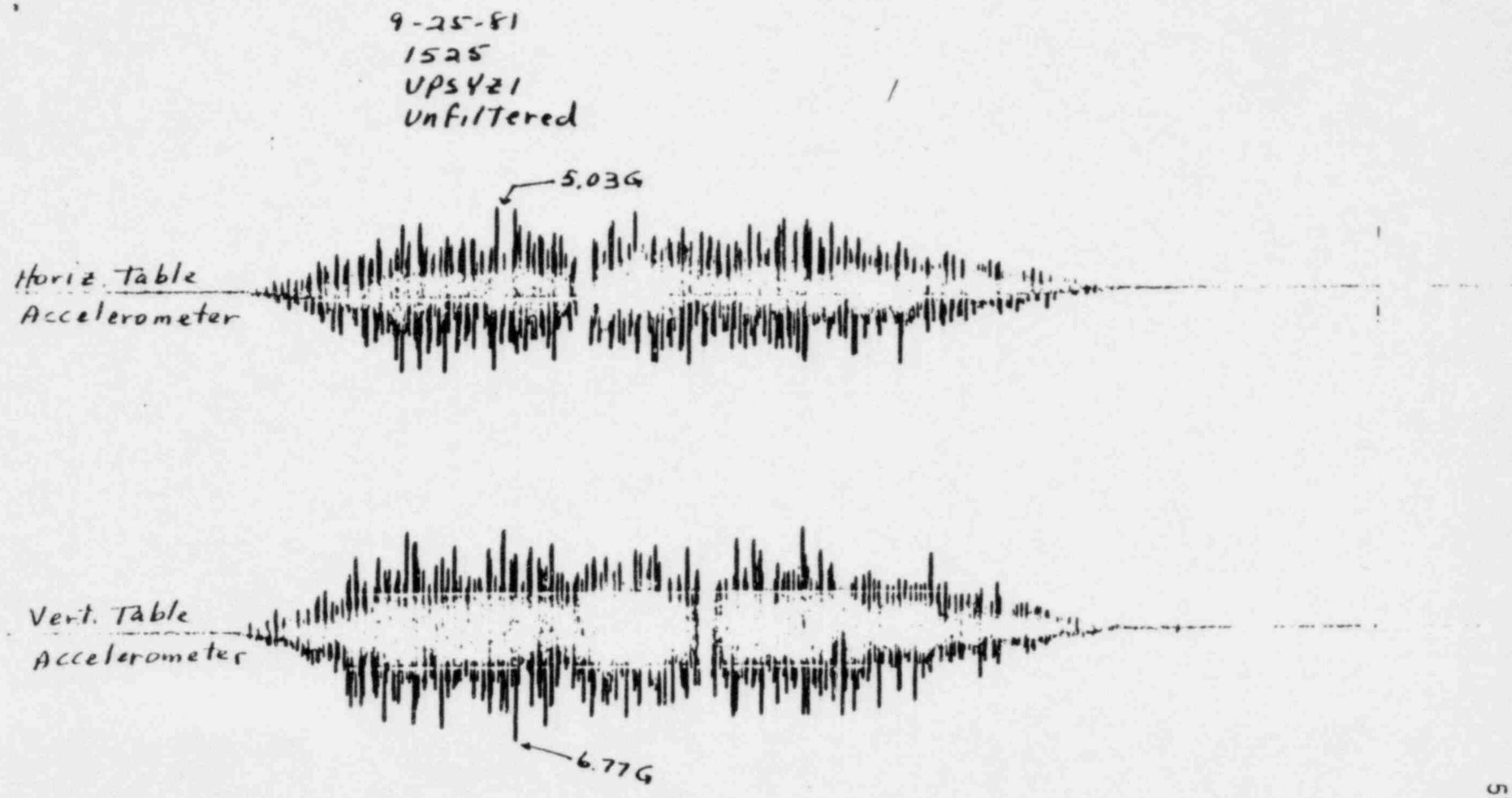

9-25-81
1525
UPS4Z1
Unfiltered
5.03G
Horiz. Table
Accelerometer
Vert. Table
Accelerometer
6.77G

Figure 11-31

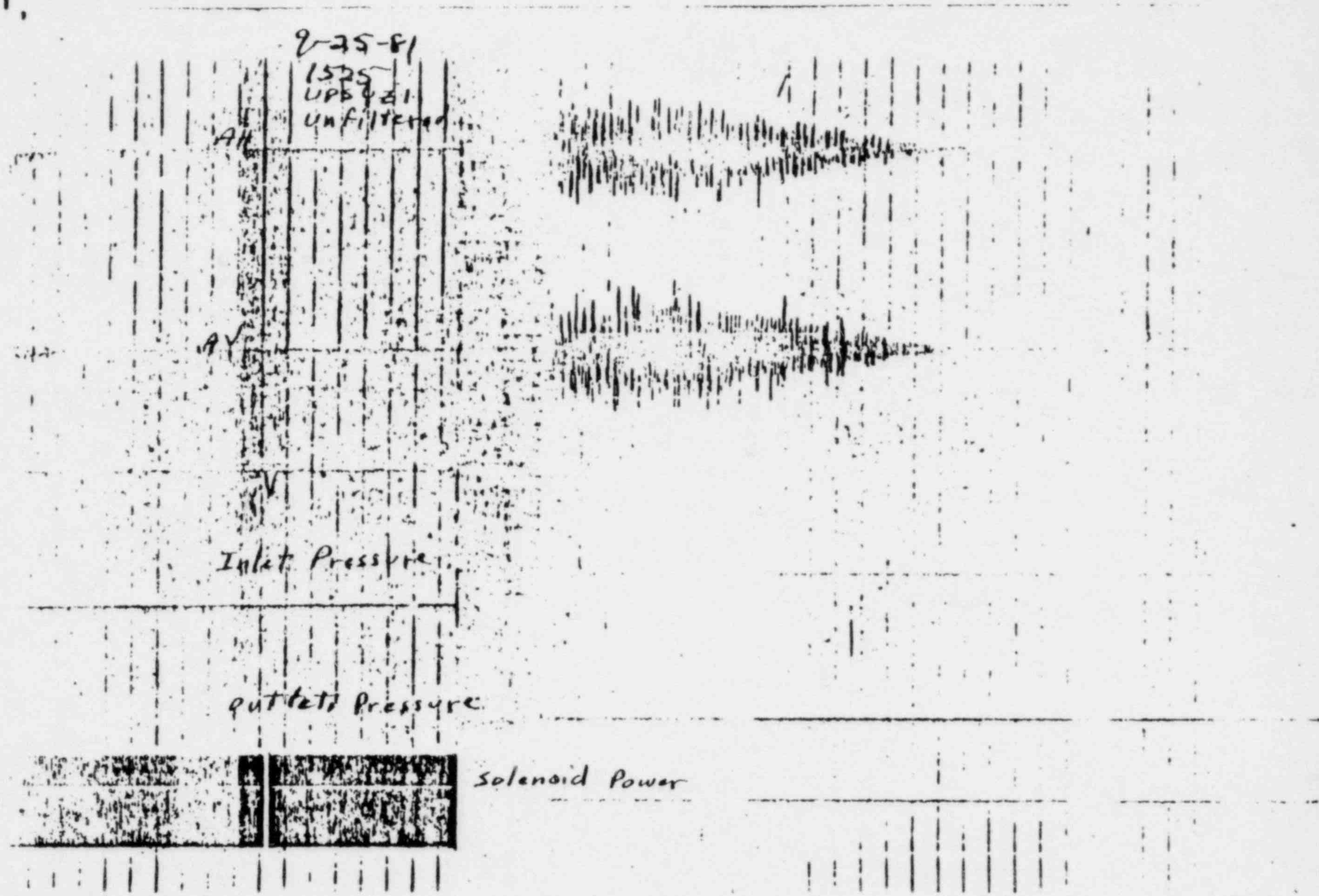


Figure 11-32

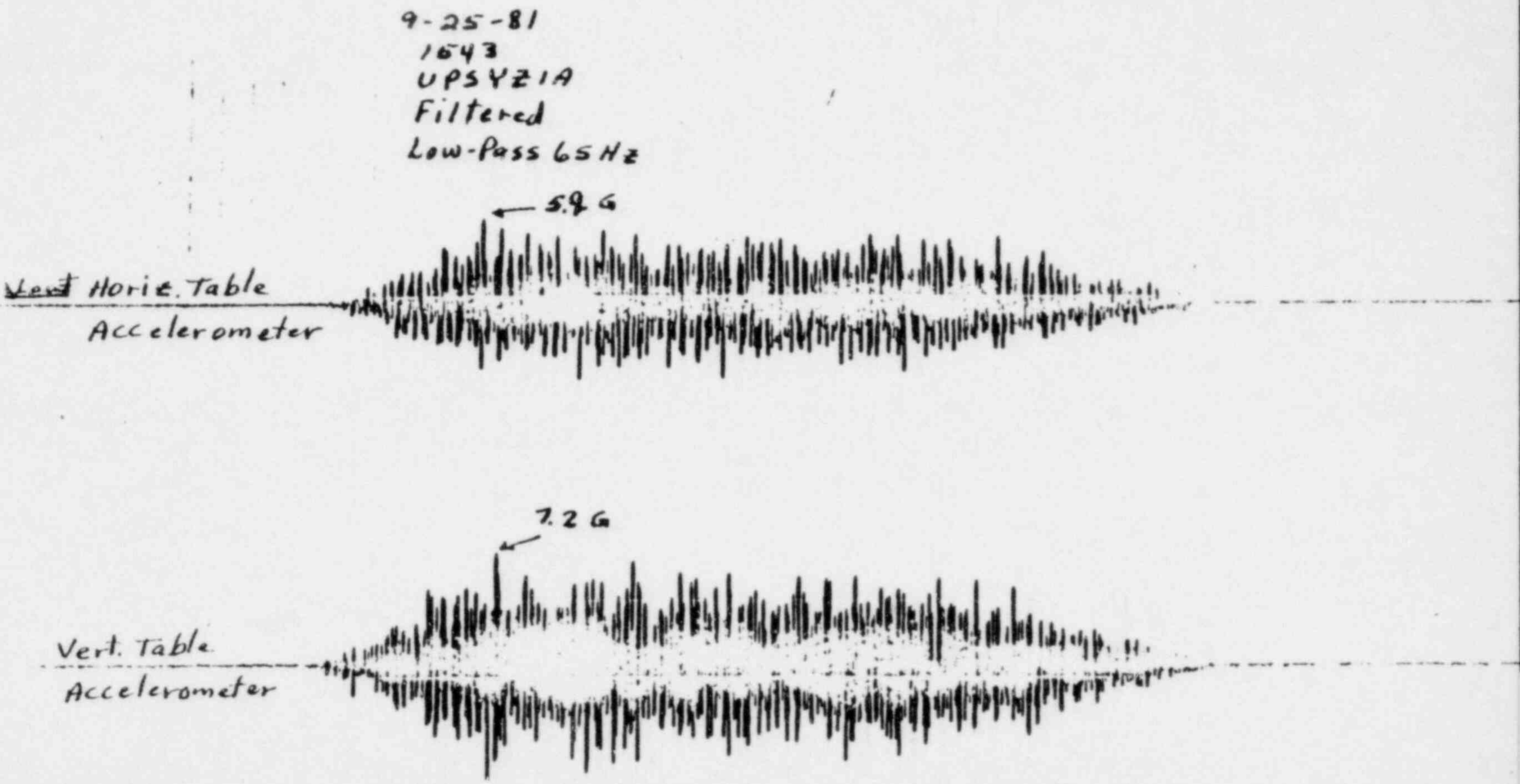

9-25-81
1543
UPSYZ1A
Filtered
Low-Pass 65 Hz
5.9 G
Vert Horiz. Table
Accelerometer
7.2 G
Vert. Table
Accelerometer

Figure 11-33

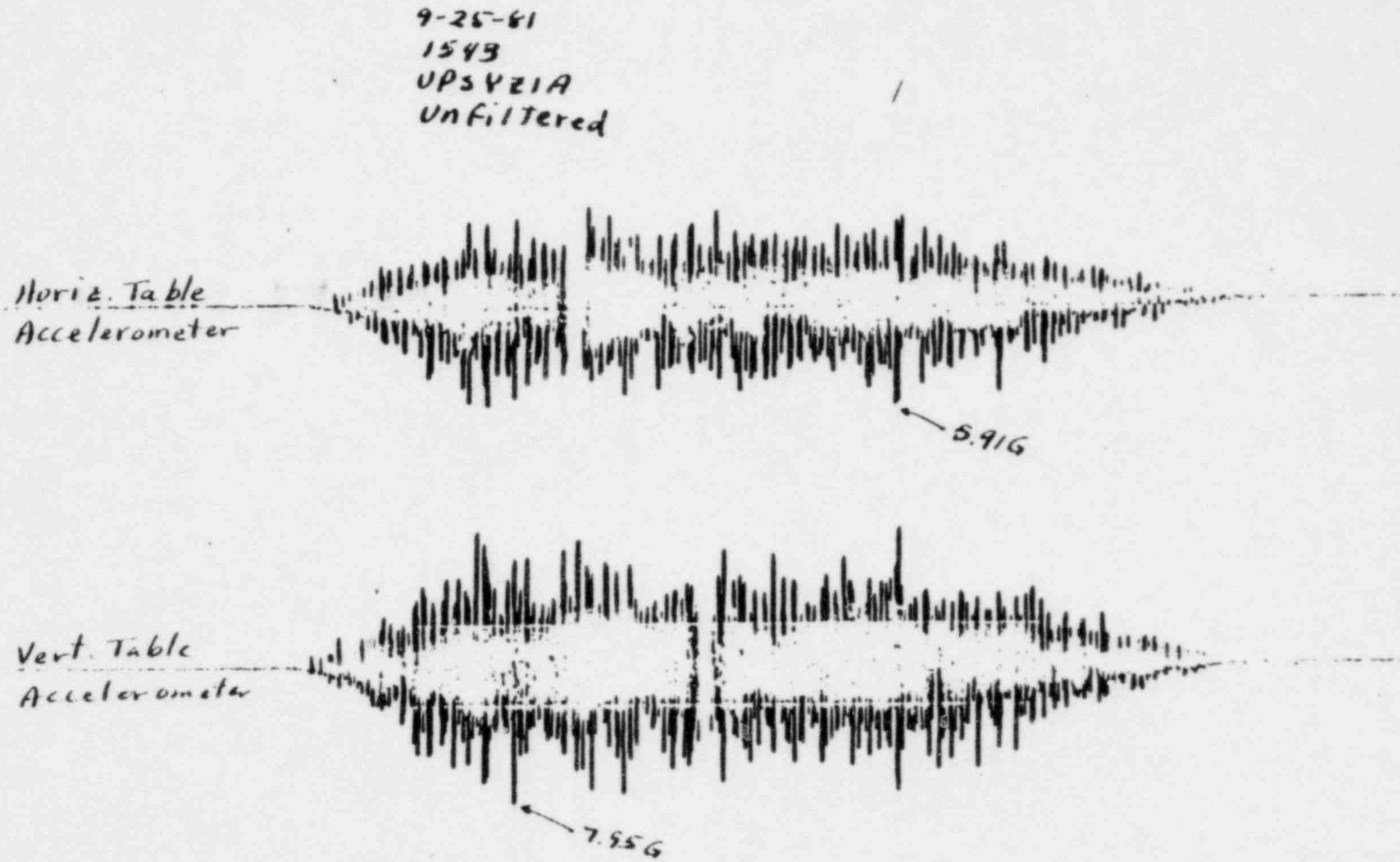

9-25-61
1543
UPSV21A
Unfiltered
Horiz. Table
Accelerometer
5.91G
Vert. Table
Accelerometer
7.55G

Figure 11-34

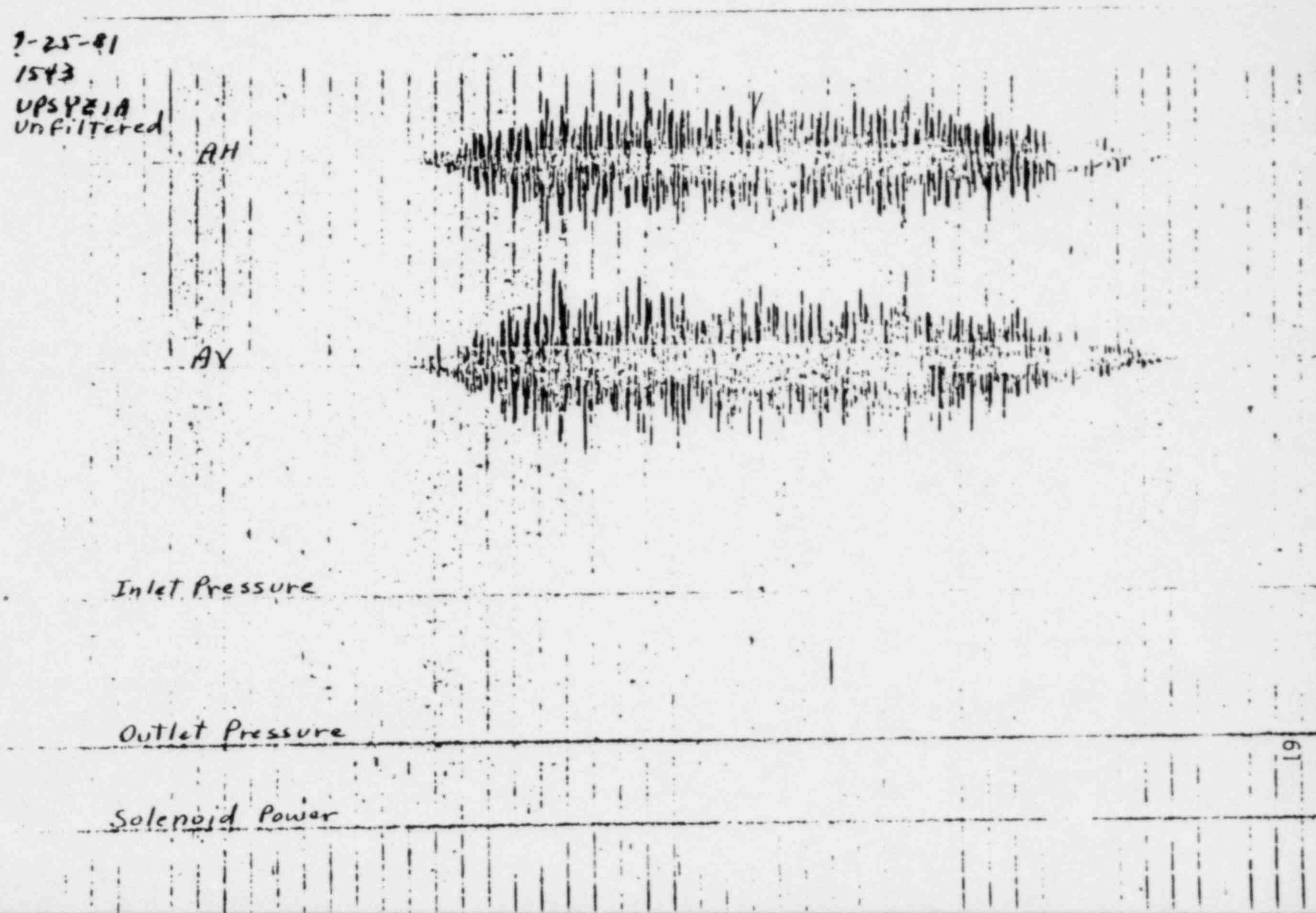

9-25-81
1543
UPSYZ1A
Unfiltered
AH
AV
Inlet Pressure
Outlet Pressure
Solenoid Power

Figure 11-35

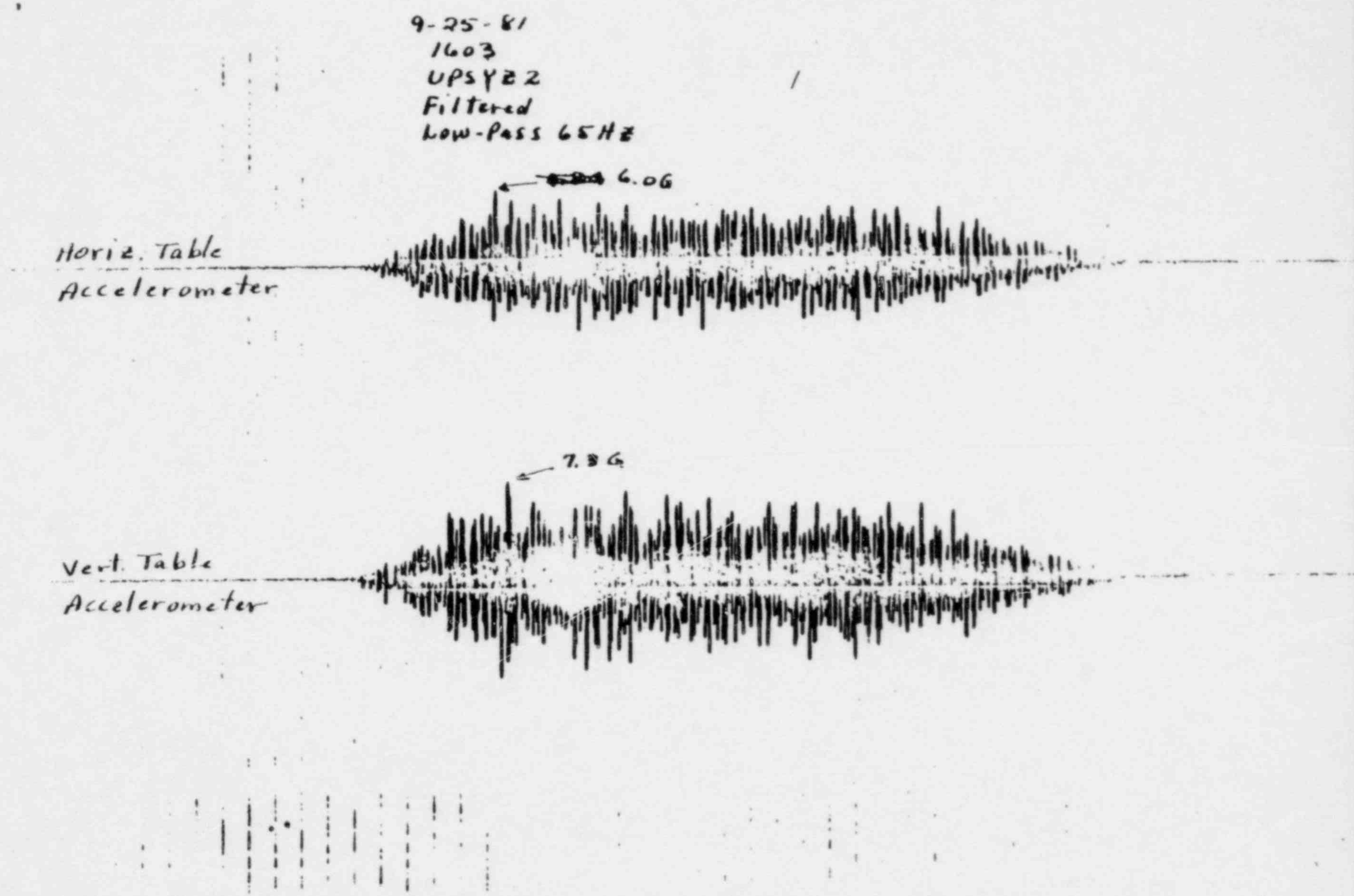

9-25-81
1603
UPSYZ2
Filtered
Low-Pass 65HZ
6.0G
Horiz. Table
Accelerometer
7.8G
Vert. Table
Accelerometer

Figure 11-36

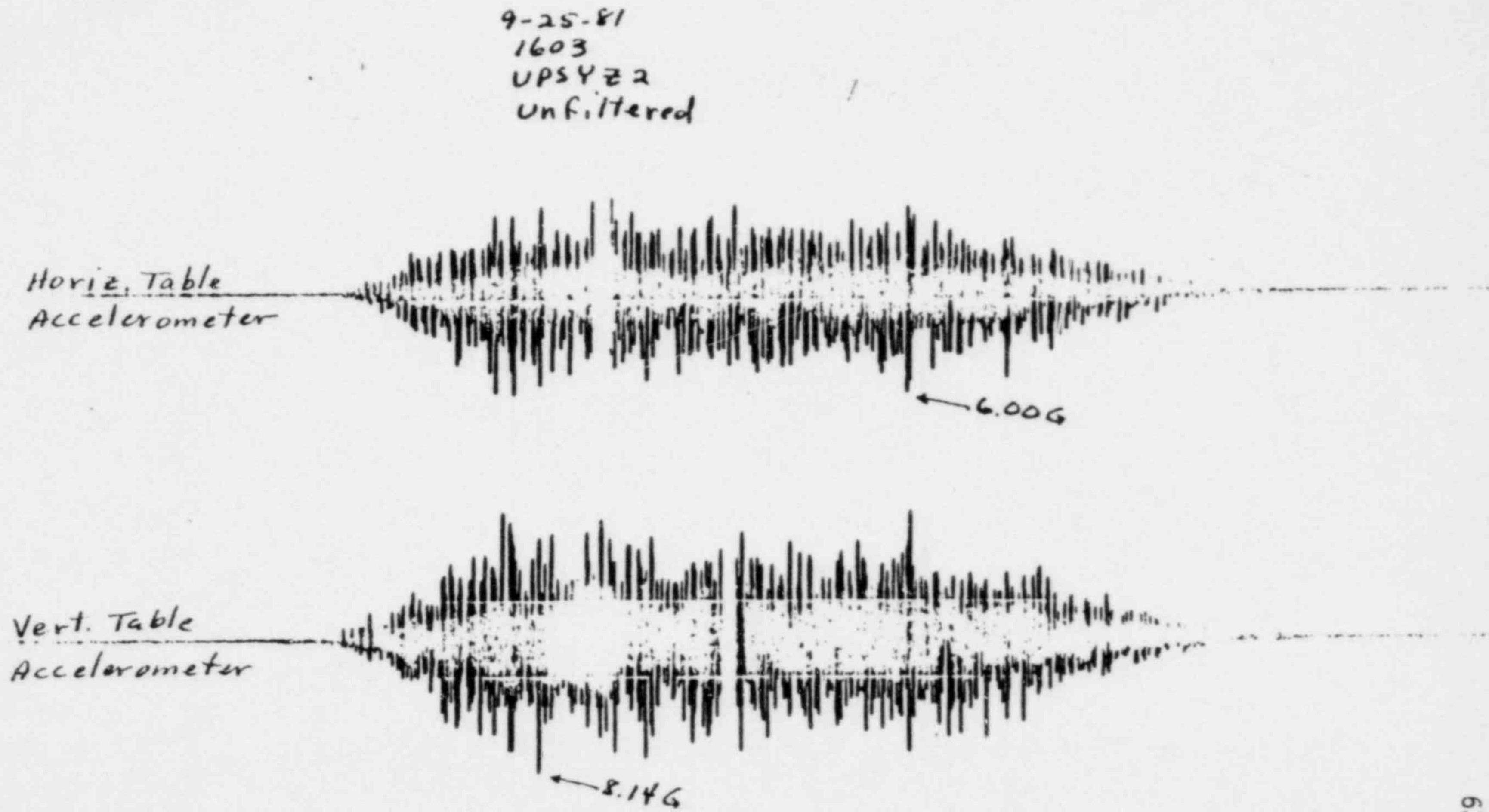

9-25-81
1603
UPSYZ2
Unfiltered
Horiz. Table
Accelerometer
6.00G
Vert. Table
Accelerometer
8.14G

Figure 11-37

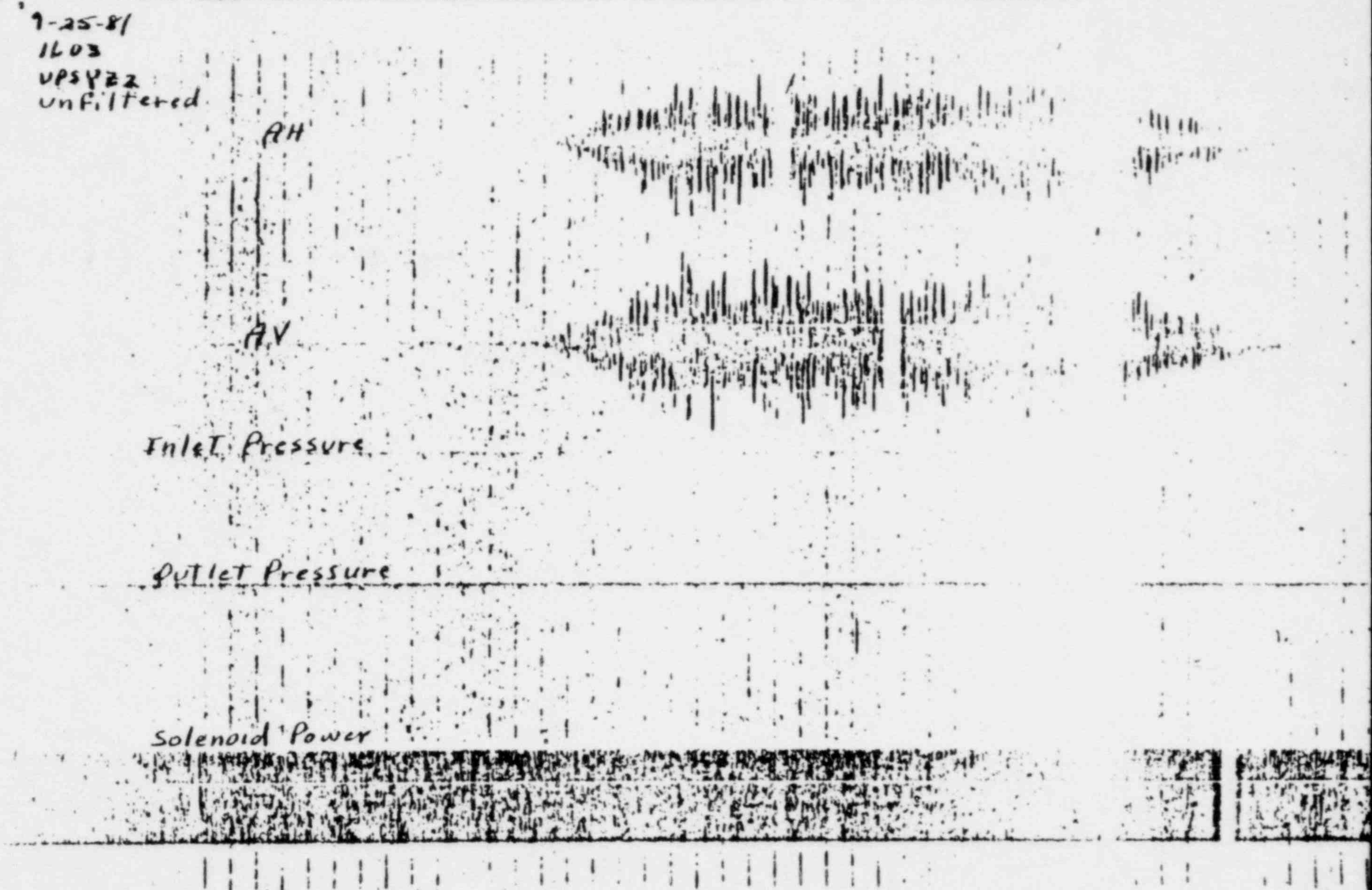
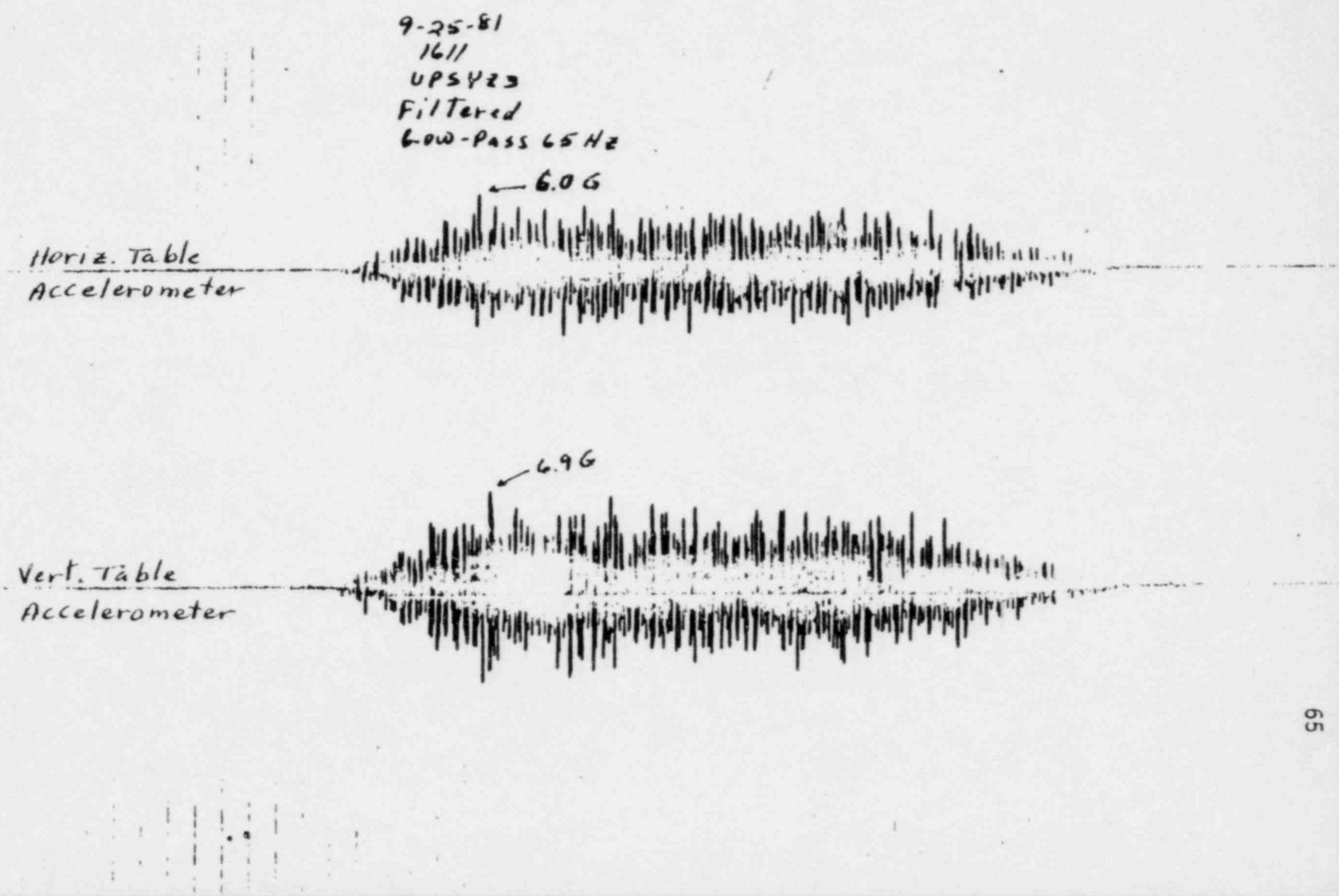

9-25-81
1L03
UPSYZZ
unfiltered
AH
AV
Inlet Pressure
Outlet Pressure
Solenoid Power

Figure 11-38



9-25-81
1611
UPS423
Filtered
Low-Pass 65 Hz
6.0 G
Horiz. Table
Accelerometer
6.9G
Vert. Table
Accelerometer

Figure 11-39

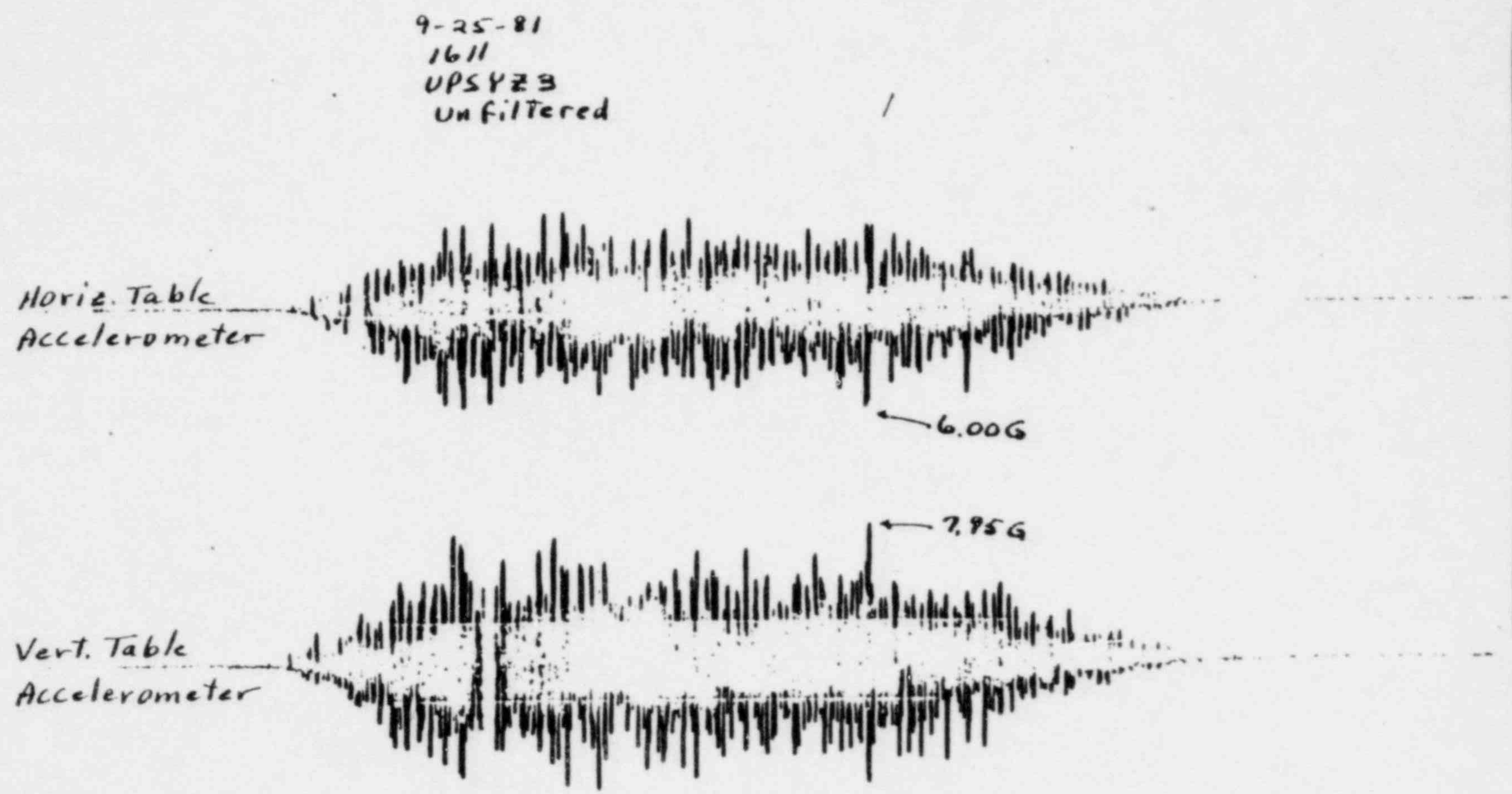

9-25-81
1611
UPSYZ3
Unfiltered
Horiz. Table
Accelerometer
6.00G
7.95G
Vert. Table
Accelerometer

Figure 11-40

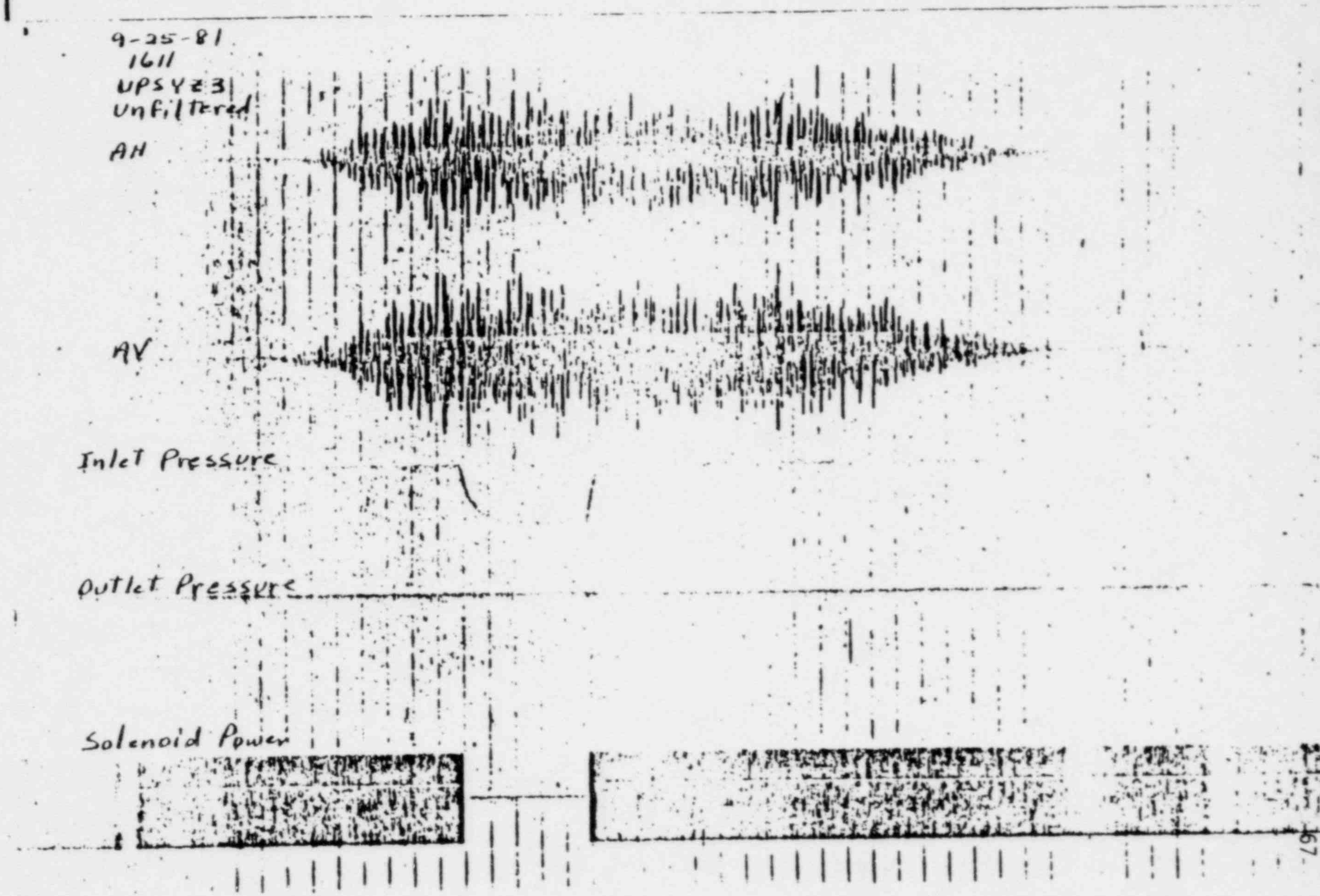

9-25-81
1611
UPSYZ3
Unfiltered
AH
AV
Inlet Pressure
Outlet Pressure
Solenoid Power

Figure 11-41

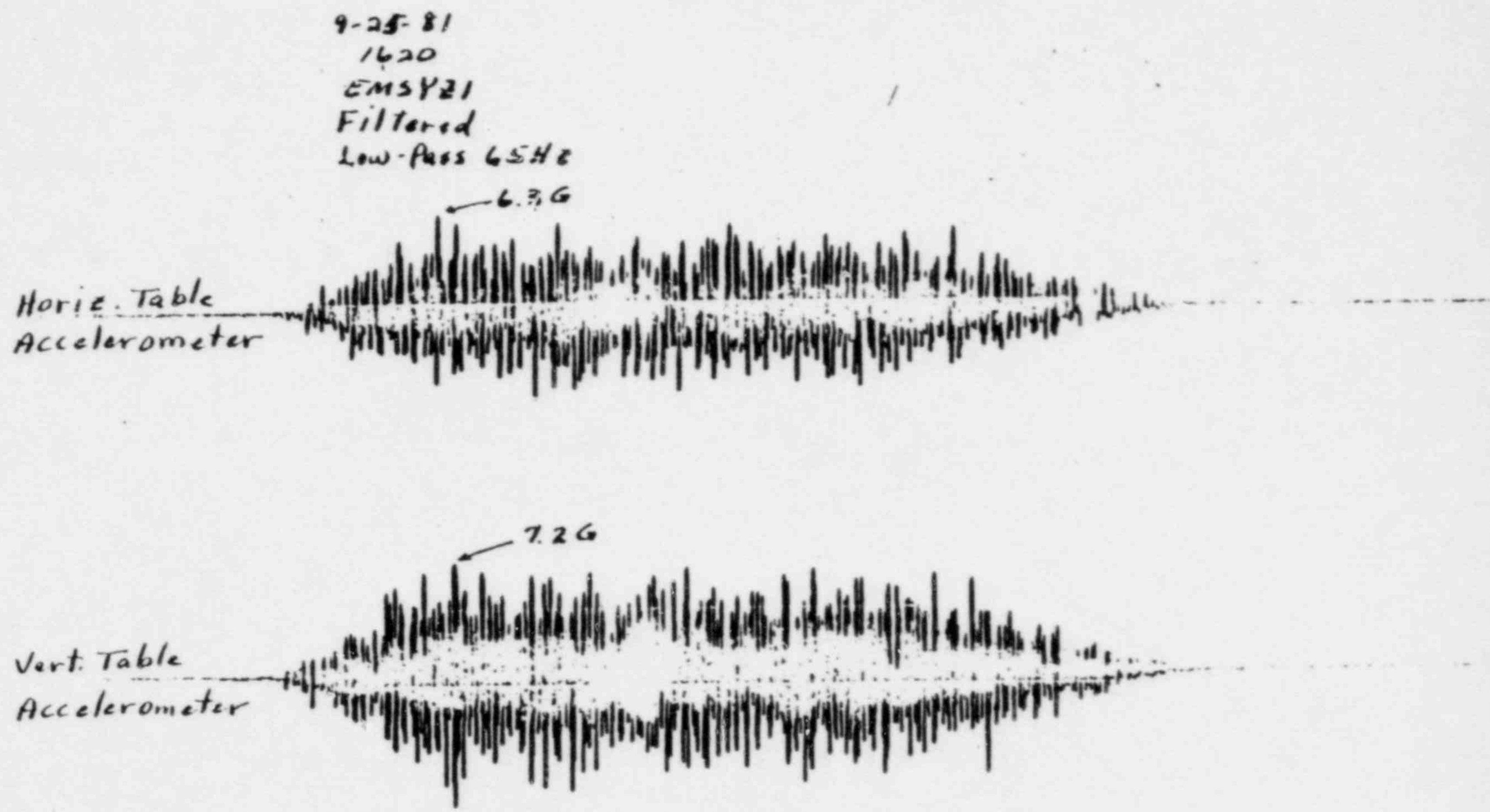

9-25-81
1620
EMSY21
Filtered
Low-Pass 65Hz
6.3G
Horiz. Table
Accelerometer
7.2G
Vert. Table
Accelerometer

Figure 11-42

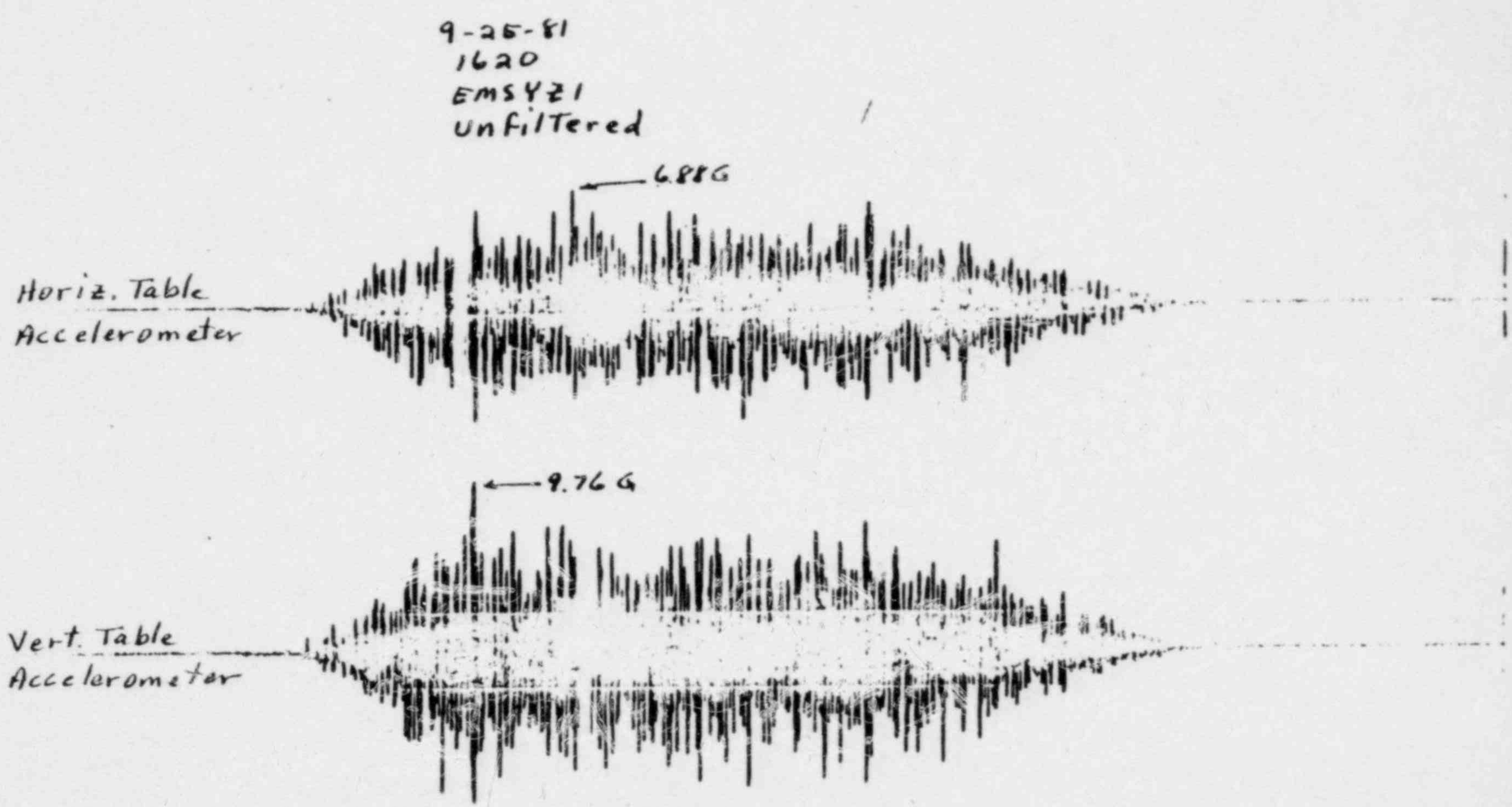

9-25-81
1620
EMSYZ1
unfiltered
6.88G
Horiz. Table
Accelerometer
9.76 G
Vert. Table
Accelerometer

Figure 11-43

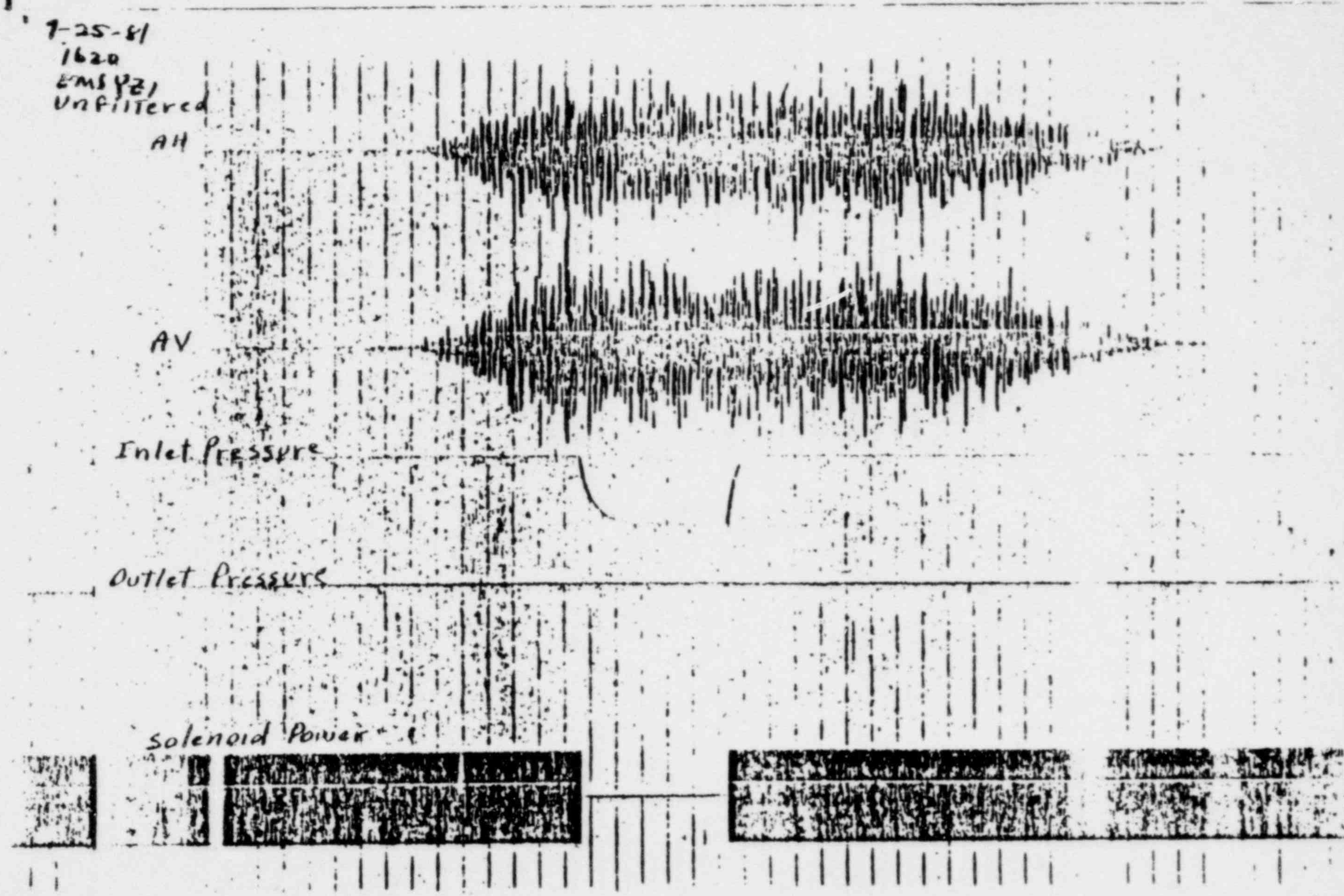

7-25-81
1620
EMS YZ1
Unfiltered
AH
AV
Inlet Pressure
Outlet Pressure
Solenoid Power

Figure 11-44

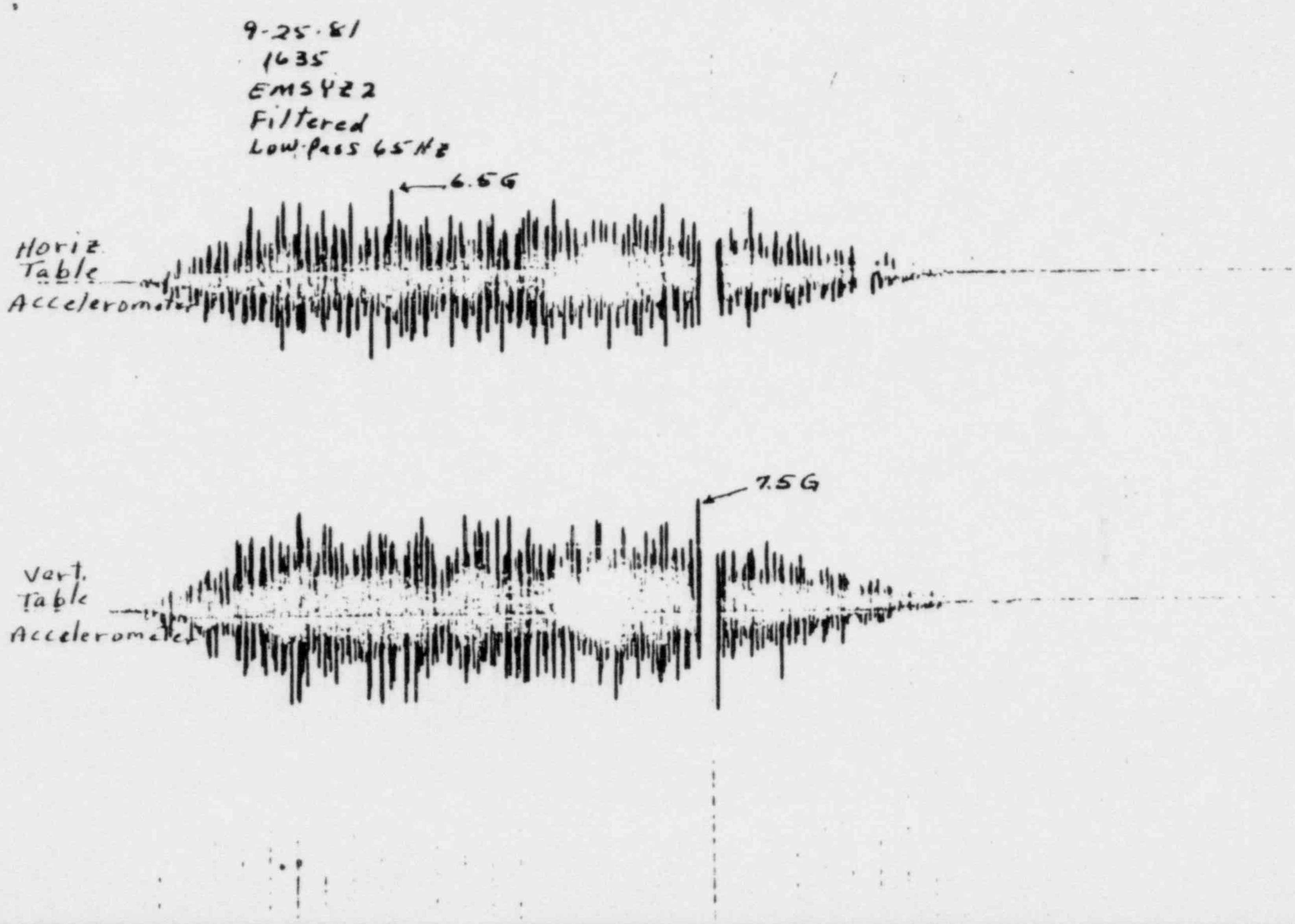
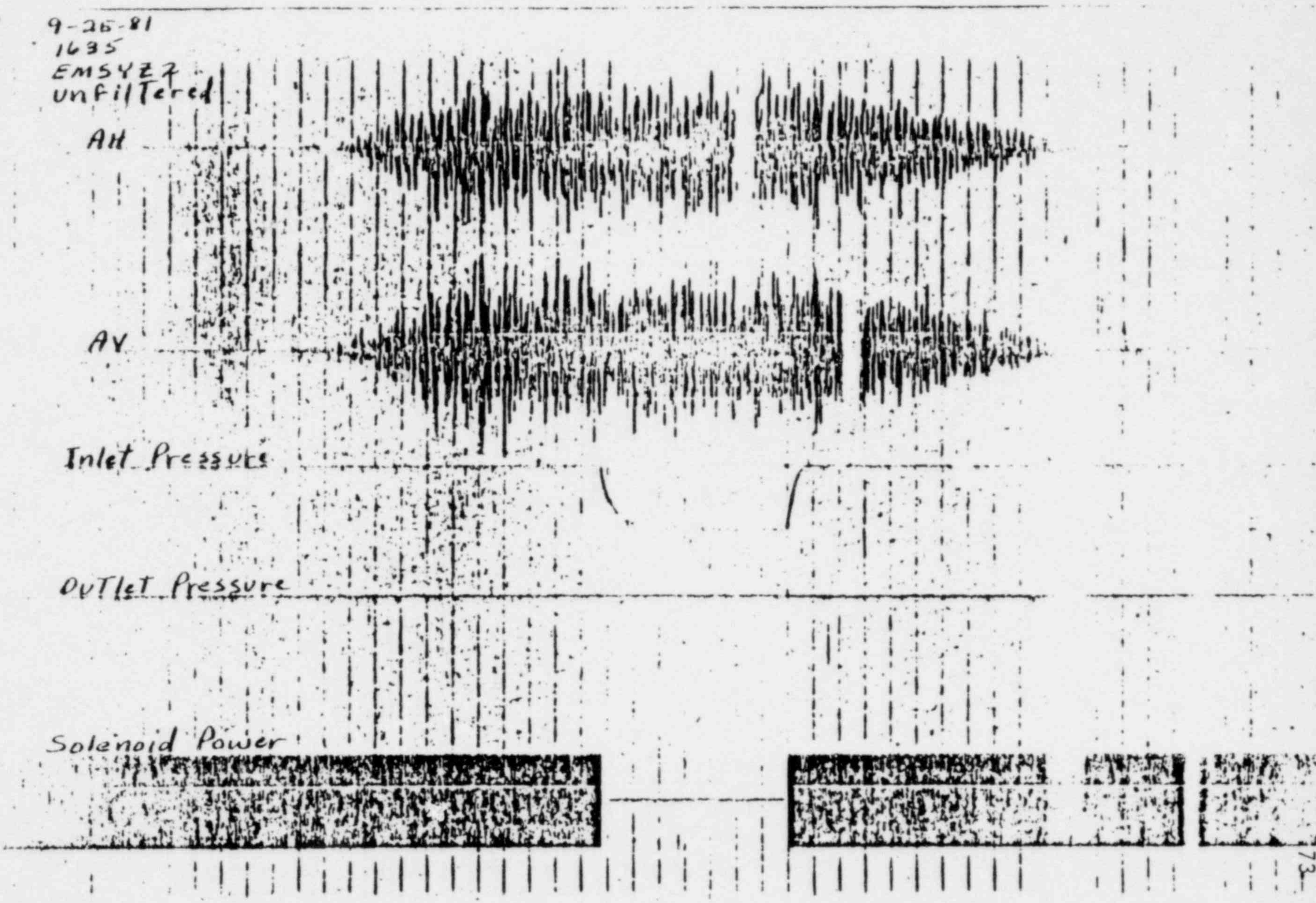

9-25-81
1635
EMSYZ2
Filtered
Low-Pass 65 Hz
6.5G
Horiz
Table
Accelerometer
7.5G
Vert.
Table
Accelerometer

Figure 11-45


9-25-81
1635
EMSYZ2
Unfiltered
Horiz. Table
Accelerometer
6.95G
Vert. Table
Accelerometer
9.33G

Figure 11-46



9-26-81
1635
EMSYZZ
unfiltered
AH
AV
Inlet Pressure
Outlet Pressure
Solenoid Power

Figure 11-47

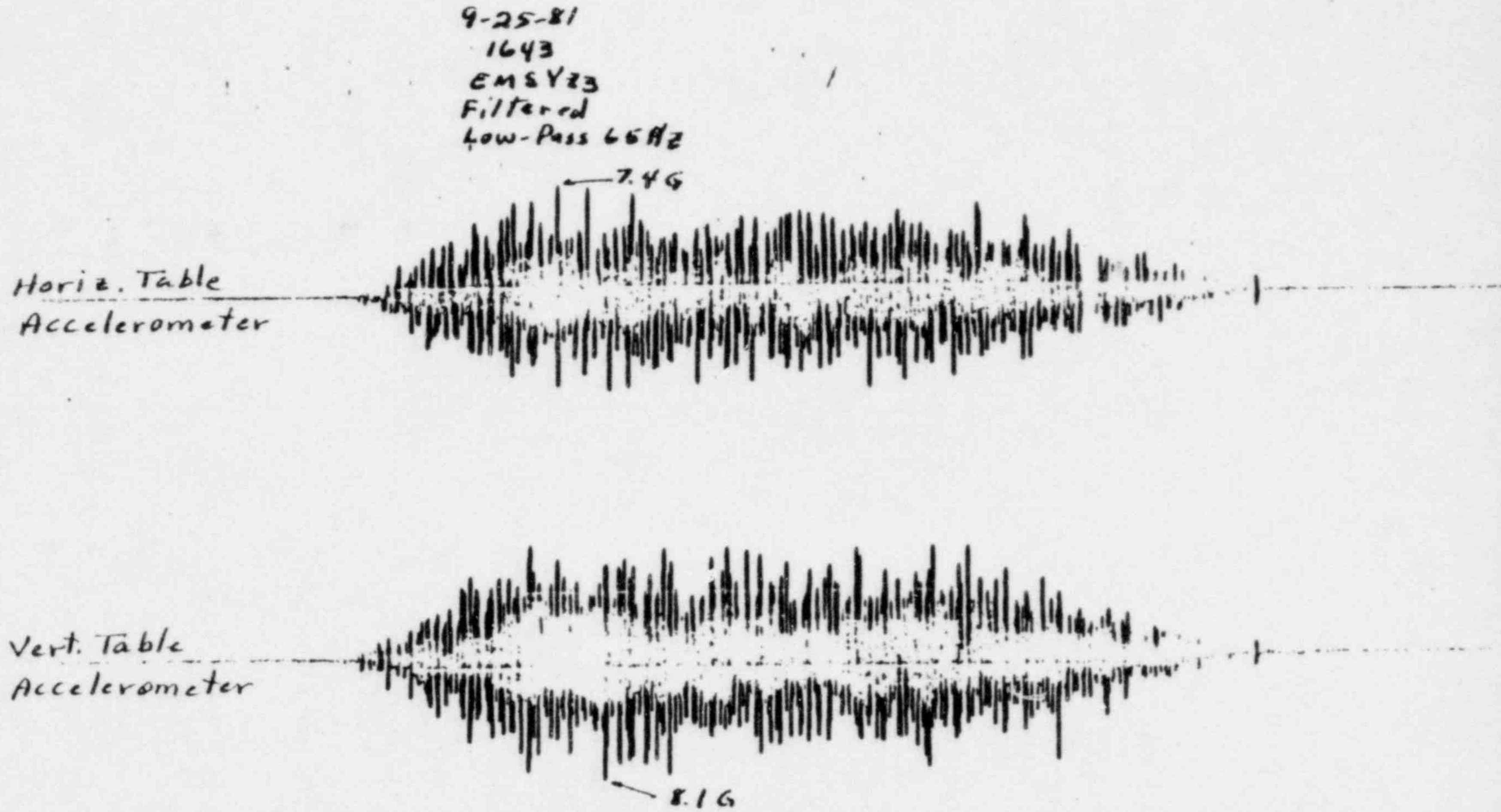
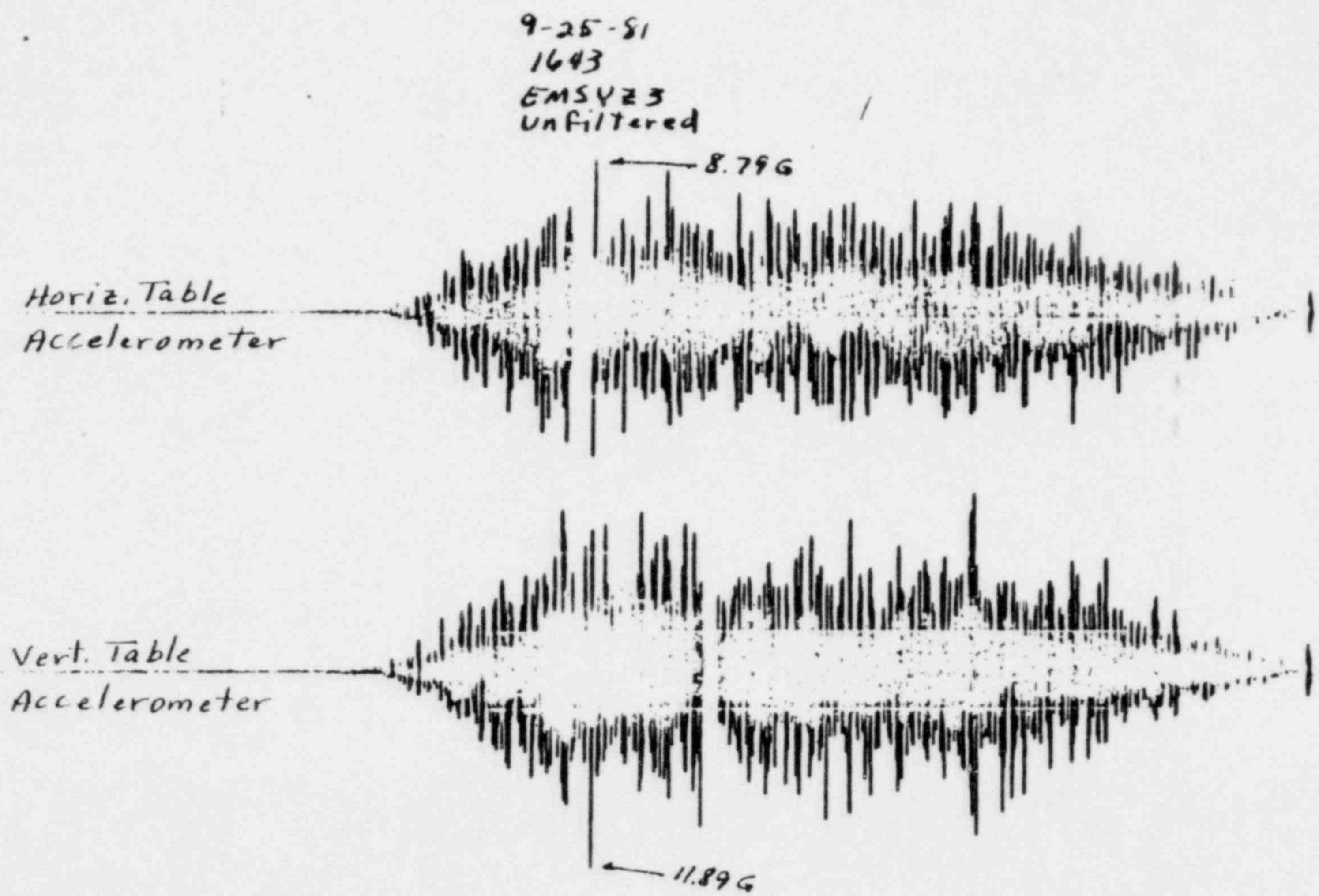

9-25-81
1643
EMSY23
Filtered
Low-Pass 65Hz
7.4G
Horiz. Table
Accelerometer
Vert. Table
Accelerometer
8.1G

Figure 11-48


9-25-81
1643
EMSVZ3
Unfiltered
8.79G
Horiz. Table
Accelerometer
Vert. Table
Accelerometer
11.89G

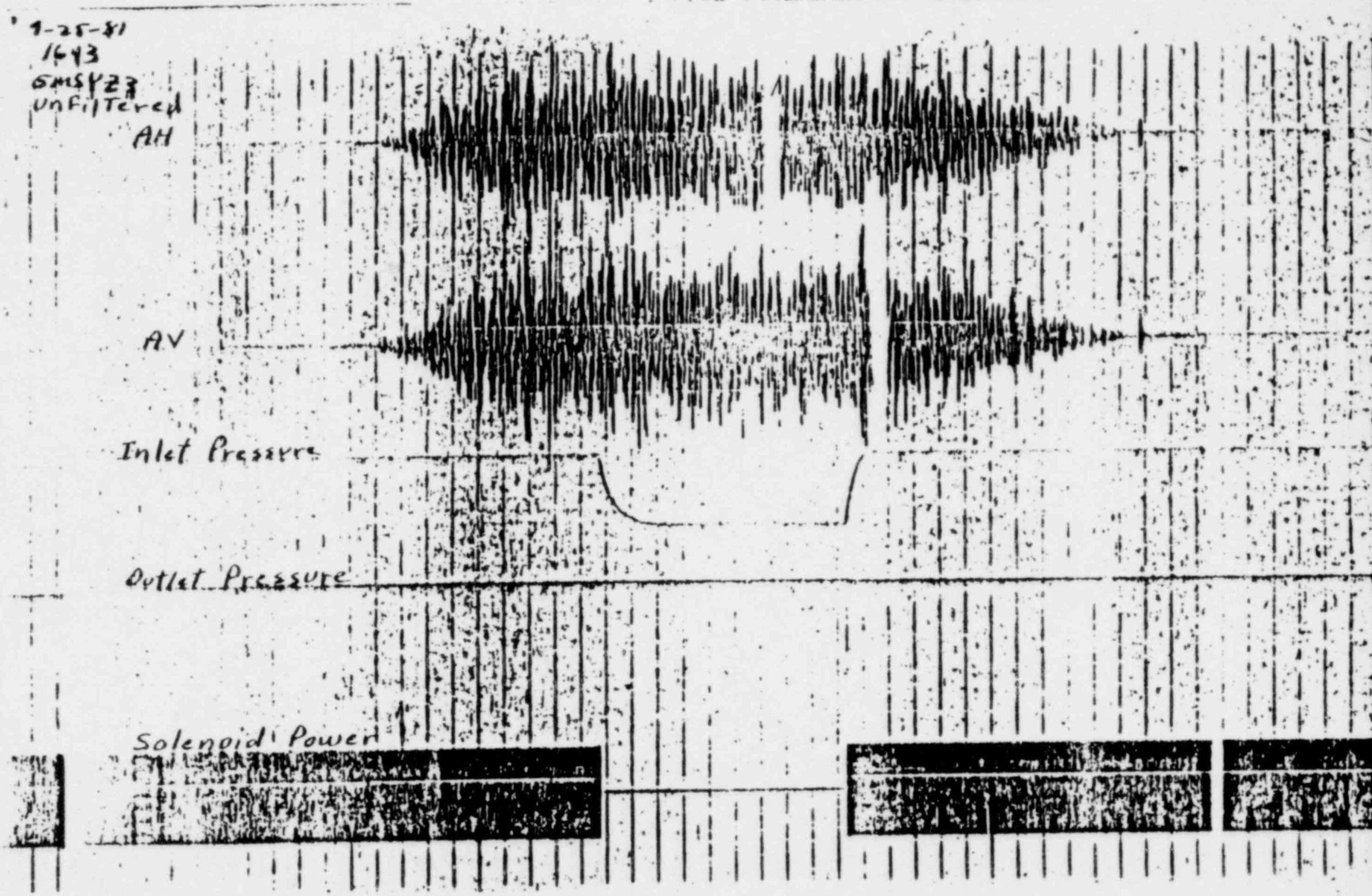

1-25-81
1643
GMSY23
unfiltered
AH
AV
Inlet Pressure
Outlet Pressure
Solenoid Power

Figure 11-49

Figure 11-50

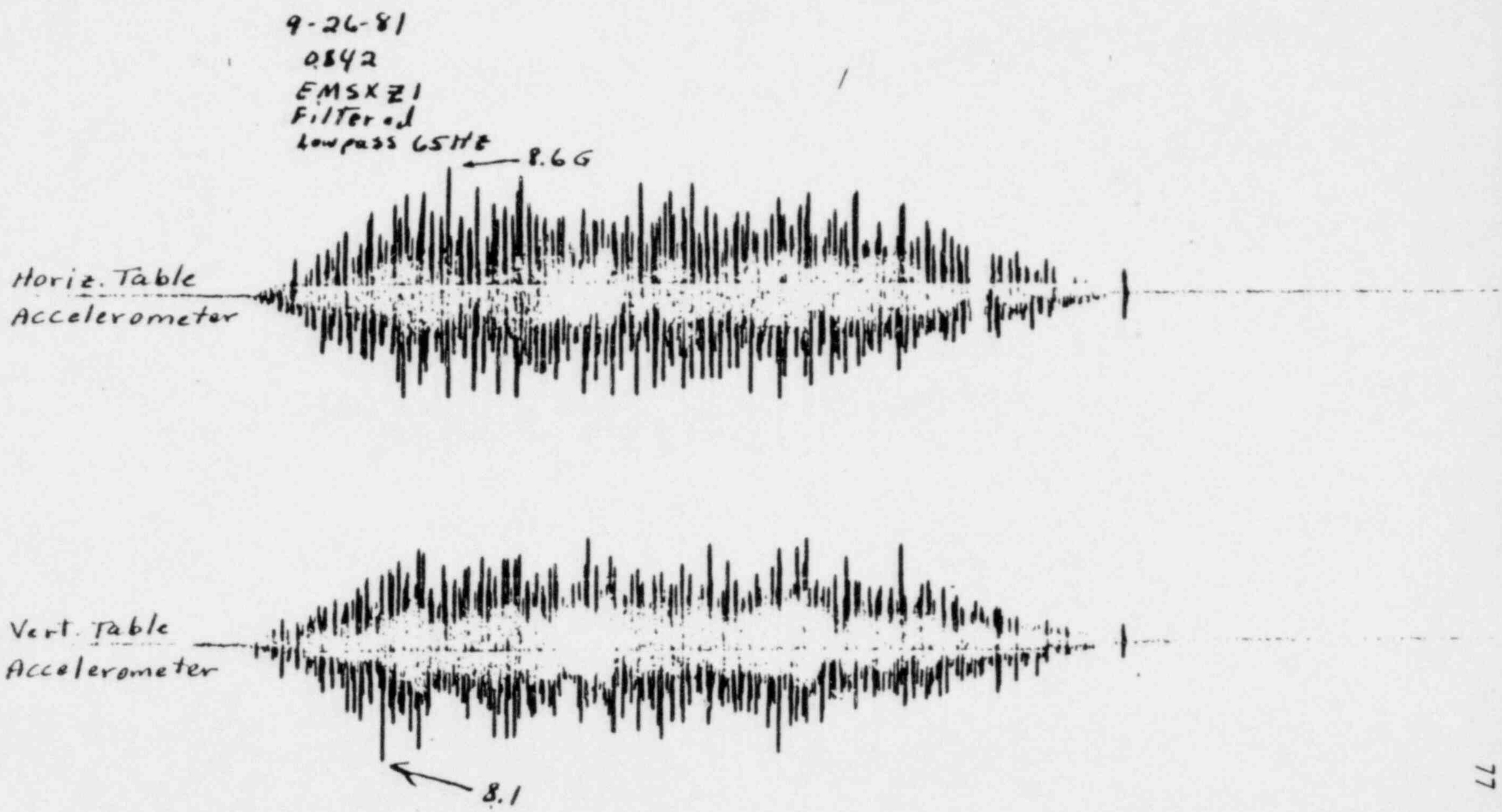

9-26-81
0842
EMSXZ1
Filtered
Lowpass 65HZ
8.6G
Horiz. Table
Accelerometer
Vert. Table
Accelerometer
8.1

Figure 11-51

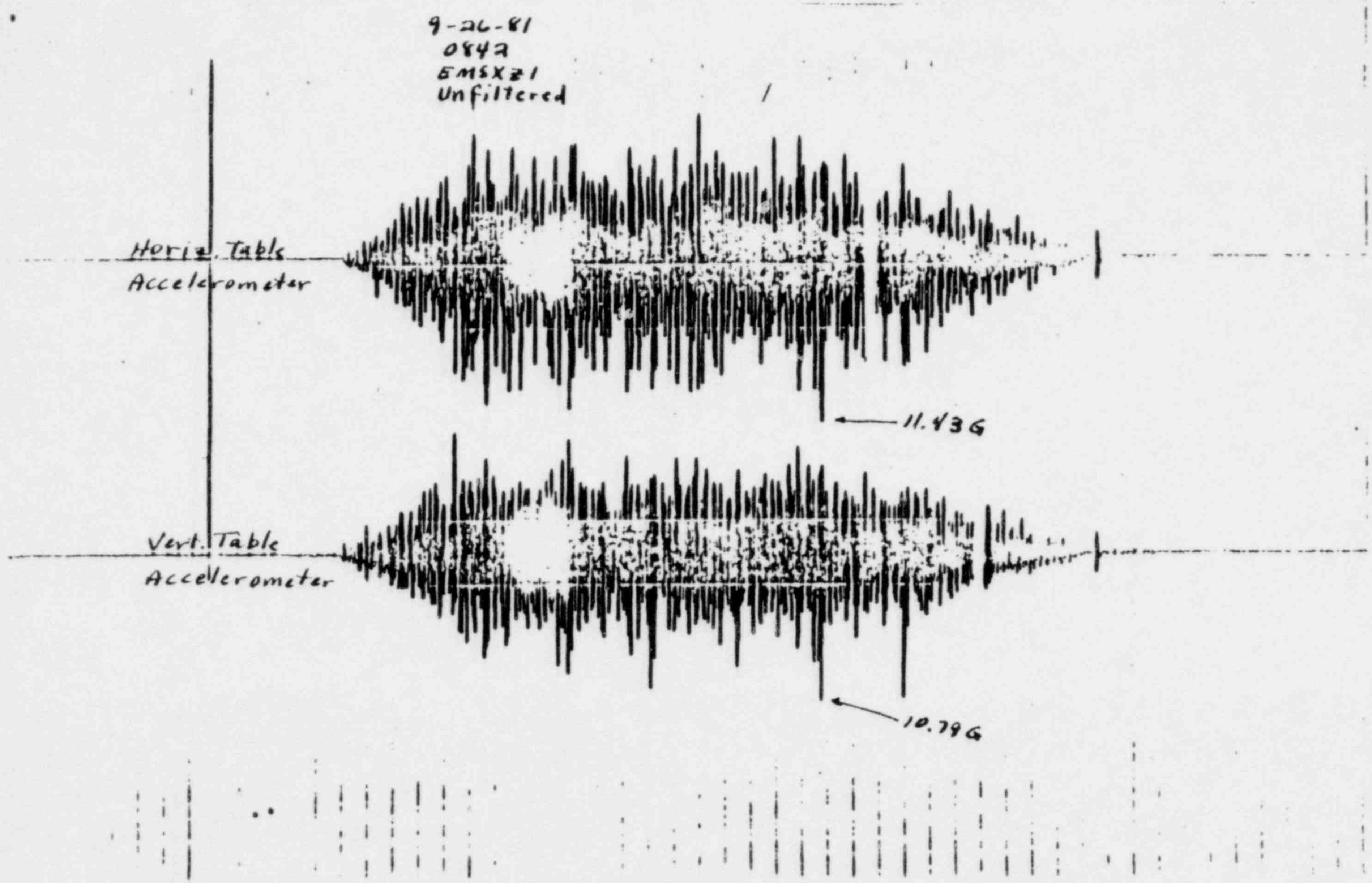
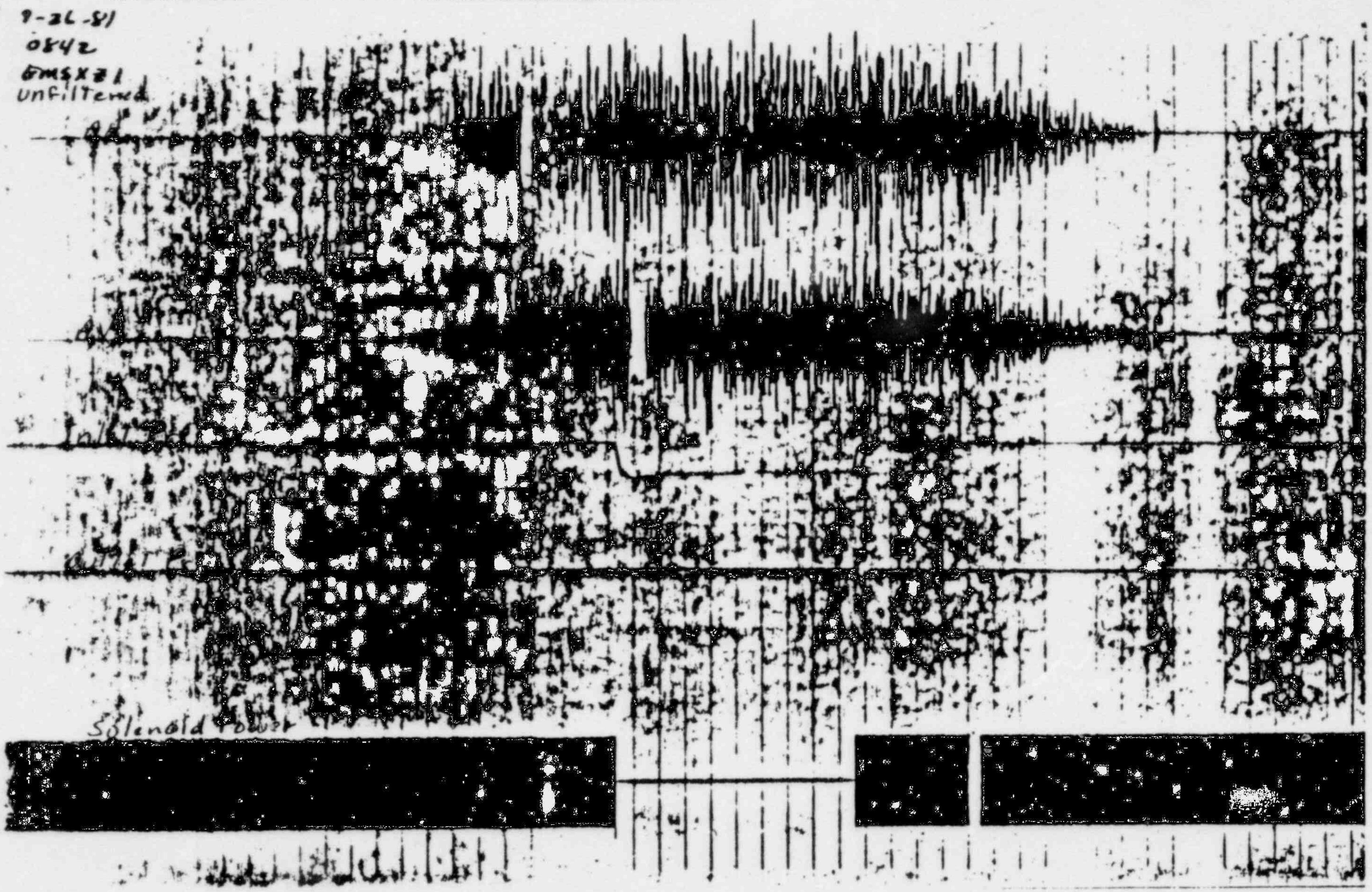

9-26-81
0842
EMSXZ1
Unfiltered
Horiz. Table
Accelerometer
11.43G
Vert. Table
Accellerometer
10.79G

Figure 11-52



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SECTION 12.0

TEST SPECIMEN DATA

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nutech
San Jose, California

Project Zimmer/La Salle SQRT Requalification Program File No.
Owner Cincinnati Gas and Electric Company/Commonwealth Edison Company
Client Cincinnati Gas and Electric Company/Commonwealth Edison Company

TABLE I

TEST SPECIMEN DATA

INSTRUMENT NAME:	SOLENOID AIR PILOT VALVE
MODEL NO.:	ASCO 8323A22
SERIAL OR ID. NO.:*	84609J
MANUFACTURER:	AUTOMATIC SWITCH CO.
SPECIAL FEATURES IF ANY:	NONE
FUNCTION:	SUPPLY INSTRUMENT AIR FOR ACTUATION OF AIR OPERATED VALVE
DIMENSIONS:	7 1/16"H X 3 7/16"W X 2 3/4"D
WEIGHT:	3.1 LB
REQUIRED RANGE:	14.7 ~ 100 PSIG
MAXIMUM PERMISSIBLE LEAKAGE RATE:	0.1 SCFH/INCH OF NOMINAL VALVE SIZE
MONITORING REQUIREMENTS:	CHANGE OF STATE AND VALVE SEAT LEAKAGE
MOUNTING DETAILS:	SEE FIGURE 1
CHATTER TIME:	N/A
NOMINAL VALVE SIZE:	1/2"

*TO BE COMPLETED BY SwRI

Revision	0					Page 11
Prepared By/Date	[illegible] 9/4/81					of 11
Checked By/Date	[illegible] 9/10/81					

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SECTION 13.0

ANALOG TAPE LOG

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ANALOG TAPE LOG

Tape Speed 3-3/4 ips

Tape channel designation and accelerometer location.

Channel 1	AH, Horizontal Accelerometer on Bookend
Channel 2	AV, Vertical Accelerometer on Bookend

TAPE FOOTAGE	DATA
840	X-Y Plotter Cal, 5.0 g pulse, Chan. 1
915	SW Cal., 1.0 g peak @ 50 Hz
924	SW Cal., 1.0 g peak @ 10 Hz
930	SW Cal., 2.0 g peak @ 10 Hz
935	SW Cal., 2.0 g peak @ 50 Hz
940	SW Cal., 8.0 g peak @ 50 Hz
948	SW Cal., 6.0 g peak @ 50 Hz
954	SW Cal., 4.0 g peak @ 50 Hz
965	UPS No. 1, X-Z Axis
1000	UPS No. 1A, X-Z Axis
1031	UPS No. 2, X-Z Axis
1064	UPS No. 3, X-Z Axis
1086	UPS No. 1, Y-Z Axis
1112	UPS No. 1A, Y-Z Axis
1135	UPS No. 2, Y-Z Axis
1162	UPS No. 3, Y-Z Axis
1185	EMS No. 1, Y-Z Axis
1209	EMS No. 2, Y-Z Axis
1235	EMS No. 3, Y-Z Axis
1256	EMS No. 1, X-Z Axis

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SECTION 14.0

SwRI LABORATORY DATA LOG

… IDENT. … ORATORY DATA LOG … INSTITUTE

TEST PROCEDURE REF. Neutech ASCO SOLENOID VALVE 8323 … PAGE

TEST NAME Seismic   MK2-02-112 Rev. 0

PROTEC…

DATE	TIME	OBSERVATIONS
9-10-81	14:30	① Check calibration and perform… model 218-15, s/n 133170 pressu… Range 0-500 PSI with output… The calibration was checked at several… psi and was found to be accurate.
	14:50	② Calibrate Validyne model DP7 s/n … Ametek pressure meter and fix [illegible] Validyne transducer for 1 volt / 100 … it at several different pressure … pot settings on board were as follows … Span = 1.76. The cal switch gives a … deflection (scope on 1 volt/division) wi… set as above.
9-11-81	0800-1130	Made recommended set-up of Solenoid Va… in Test procedure reference for functional c…
	1230-1600	An inspection of specimen was performed p… to any tests. There was no visual evidence o… abnormalities. Valve was also cycled with an… without pressure. Operated properly. Several s… pressure levels were applied as follows:

Input Transducer	Output transducer	
0.645V	0.685V	No visible leak a… any pressure.
0.809V	0.859V	
1.007V	1.073V	

Both transducer cals are 3.94V with internal resisto…

Tests Conducted By: S.K. Wilson
Ernie Garcia

Witness SwRI Gov't

SOUTHWEST RESEARCH INSTITUTE

LABORATORY DATA LOG

TEST ITEM IDENT. NUTECH ASCO SOLENOID VALVE 8323 PAGE 2 OF 7

TEST PROCEDURE REF. MK2-02-112 Rev. D

TEST NAME Seismic PROJECT NO. 02-6056-007

DATE	TIME	OBSERVATIONS
9-12-81	0900	Accelerometer Entran Model EGC-500DS-20 S/N 30H8I-R12-12 was calibrated according to XII-EE-101-2 for use with NUTECH ASCO Solenoid Valve 8323. All other equipment envolved is within cal specs.
	0910	All items designated for cyclic calibration were varified to be within calibration. All items designated for calibration-before-use were calibrated according to QA procedure.
	1111	Exploratory testing began with sine sweep in Z-Axis. Frequency is 1-100 Hz with 0.5 octave/minute sweep and 0.1 G Peak. Response accelerometers is mounted on side of Solenoid A coincident with table axis. Table control accelerometers are mounted on the bookend
	1120	Anchored all four corners of table relative to the floor to run horizontal resonance Searches.
	1157	Resonance Search in X-Axis. Levels are all the same as for Z-Axis.
	1215	Rotated bookend with Solenoid valve to the Y-Axis.
	1228	Resonance Search in Y-Axis. Levels are the same as for Z-Axis

Tests Conducted By: Ernie Garcia Witness SwRI Gov't

SOUTHWEST RESEARCH INSTITUTE

LABORATORY DATA LOG

TEST ITEM IDENT. NUTECH ASCO SOLENOID VALVE PAGE 3 OF 7

TEST PROCEDURE REF. MK2-02-112 Rev. 0

TEST NAME Seismic PROJECT NO. 02-6056-007

DATE	TIME	OBSERVATIONS
9-25-81	0810	Ran recheck of functionals on ASCO Valve 8323 prior to start of seismic tests. Applied a 100 psi input at the common point. Check for leakage at the N/O after valve was activated. No measurable leak was detected.
Tape	1055	UPSET condition in X-Z Axis. UPSXZ1 Noticed after the test that tape inputs were improperly connected. Test will be repeated.
tape 1000	1115	UPSXZ1A was run with the valve energized this is slight deviation from test plan, but the second run will be with valve de-energized.
Tape 1031	1323	UPSXZ2 X-Z Axis with valve de-energized.
tape 1064	1447	UPSXZ3. Valve started energized, was de-energized and re-energized during the test.
	1503	Functional check was performed on valve after the three UPSET condition tests in the X-Z Axis. No leak with 100 psi was detected.
	1510	Rotated bookend with valve to the Y-Z Axis to run tests in this direction.

Tests Conducted By: Ernie Garcia Witness SwRI Gov't

SOUTHWEST RESEARCH INSTITUTE

LABORATORY DATA LOG

TEST ITEM IDENT. NUTECH ASCO SOLENOID VALVE PAGE 4 OF 7

TEST PROCEDURE REF. NKA-02-112 Rev. 0

TEST NAME Seismic PROJECT NO. 02-6056-007

DATE	TIME	OBSERVATIONS
9-25-81 Tape 1086	1525	UPSYZ1. Valve de-energized the peak acceleration on the horizontal axis was below 6 g's. this test will be repeated.
Tape 1112	1543	UPSYZ1A Valve de-energized.
Tape 1135	1603	UPSYZ2. Valve energized. NO leaks detected
Tape 1162	1611	UPSYZ3. Valve cycled. Valve was checked for leaks after this UPS test. None detected.
Tape 1185	1620	EMSYZ1. Valve cycled. Valve checked for leaks. None detected.
Tape 1209	1635	EMSYZ2 Repeat of 1620 due to horizontal acceleration being slightly low.
Tape 1235	1643	EMSYZ3 Repeat to increase horizontal acceleration.
9-26-81	0815	Rotated bookend with Solenoid Valve to the X-Z Axis
Tape 1256	0842	EMSXZ1. Valve cycled with 120 psi applied.
	0850	Functional check performed. NO leaks detected. Also performed visual check. No apparent physical damage noticed.

Tests Conducted By: Ernie Garcia Witness SwRI Gov't

SOUTHWEST RESEARCH INSTITUTE

LABORATORY DATA LOG

TEST ITEM IDENT. NUTECH ASCO SOLENOID VALVE PAGE 5 OF 7

TEST PROCEDURE REF. MK2-02-112 Rev. 0

TEST NAME Seismic PROJECT NO. 02-6056-007

DATE	TIME	OBSERVATIONS
9-26-81	0950	Ran fragility test in the X-Axis. Used 50 Hz and started at 2.0 G PK. Level was swept up while watching for leaks. Bubble began to come thru at 7.4 G PK. Table was anchored at all four corners relative to the floor for horizontal axes fragility tests. Pressure on the valve was 100 psi.
	1005	Fragility test in Y-Axis. Input level was slowly increased to a level of 10 G peak and no leaks were detected. The upper solenoid has a vibration sound continuously after this test.
	1025	Fragility test in Z-Axis. Could not increase table input more than 5 g peak. No leaks detected at this point.

Tests Conducted By: Ernie Garcia Witness SwRI Gov't

SOUTHWEST RESEARCH INSTITUTE

LABORATORY DATA LOG

TEST ITEM IDENT. Nuteck ASCO SOLENOID (VAlve 83-23) PAGE 6 OF 7

TEST PROCEDURE REF. MK2-02-112 Rev.0

TEST NAME Seismic PROJECT NO. 02-6056-007

DATE	TIME	OBSERVATIONS
9-30-81	14:00	set-up equipment and pressure transducers and ocillograph for sine dwell at 50 Hz. Ocillograph used to record both pressures and the on-off functions of the solenoid. Two digital voltmeters used to monitor input and output pressure calibrated 1volt/100psi. Put pressure on input and output and made functional check of item before test. Test will consist of raising the g level at 50 Hz from 2g's to a maximum of 10g's and note if there is any leakage during test while operating the solenoid. input pressure at: 102 psi output pressure at: 96.8 psi
10-1-81	8:00	Recheck all set-up and add accellerometer output to Ocillograph. Apply pressure and make functional check. input pressure = 106 psi Output pressure = 112 psi
	9:10	start bringing up g's level till reaching 10g's, then going to a maximum of about 12g's with no sign of leakage. (Fn = 50 Hz) Z-Axis
	9:18	end test, will now rotate test item 90° and retest.
	9:30	start test with item moved 90°, brought g's level up to 10gs then to 12g's and dwelled for several

Tests Conducted By: S. K. Wilson Witness SwRI Gov't

SOUTHWEST RESEARCH INSTITUTE

LABORATORY DATA LOG

TEST ITEM IDENT. VALVE 8323 Nutech ASCO SOLENOID PAGE 7 OF 7

TEST PROCEDURE REF. MK2-02-112-Rev. 0

TEST NAME Seismic PROJECT NO. 02-6056-007

DATE	TIME	OBSERVATIONS
		minets, bubbles were noted. X-Axis
10-1-81	9:35	End first test in 90° position.
	9:40	Start test again in 90° position raising g's level to a maximum of 12g's. dwelled at 10gs for 30 sec, at 11g's for 30sec., and then to 12g's. No bubbles noted this time. (fn = 50Hz)
	9:45	End test in 90° rotation X-Axis
	10:00	switch test item to slip table in horizontal front to back Axis. Make check of pressures and all Equipment, check oscillograph.
	12:51	Start shaking in front to back position at 50Hz bringing level up to 10g's slowly. input psi = 103 psi output psi = 110 psi Dwelled at 10g's for 30 seconds with no bubbles noted.

Tests Conducted By: S. K. Wilson Witness SwRI Gov't

ATTACHMENT NO. 4

Conductivity Cell
E12-N025A, B

nutech
San Jose, California

Project Grand Gulf Nuclear Station File No.

Owner Mississippi Power and Light Co.

Client Mississippi Power and Light Co.

INTERIM SEISMIC QUALIFICATION ANALYSIS

FOR THE CONDUCTIVITY CELL

(1" VALVE CONNECT TO

THE RHR LINE)

Revision	O					Page 1 of 12
Prepared By/Date	BF / 4-16-82					
Checked By/Date	YPC for AJ 4/16/82					

Contents

I. Purpose

Evaluate (based on seismic category 1, and ASME Class 2 equipment) the pressure integrity of the conductivity cell when subjected to combined operating and seismic loading.

II. Conductivity Cell Environment

Design Condition (Reference 1)

Temperature = 350° F
Pressure = 500 psi

Operating Condition (Reference 1)

Temperature = 250° F
Pressure = 310 psi

Seismic Loads (Reference 2)

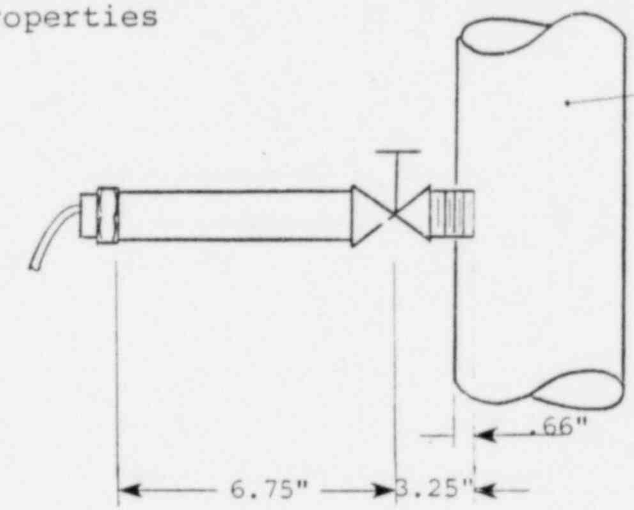
Peak excitation acceleration = 6g

III. Method of Analysis

The most critical component affecting the pressure integrity of the conductivity cell is the 1" nipple. (Which connects the 1" valve to the RHR line.) The stress in the 1" nipple is estimated according to dead weight, thermal expansion, and seismic loads.

The seismic response is calculated with the conservative assumption that the excitation is the harmonic force with a frequency to which the conductivity cell responds most critically.

IV. Dimensions and Properties



Properties:

Nipple:

Size =	1" N.P.T. schedule 80	(3)
O.D. =	1.315	(4)
I.D. =	.957	(4)
Wall Thickness =	.179	(4)
Height of Thread =	.06957	(5)
Engagement Length =	.66"	(5)
Material =	316 SS	(6)
S_m =	19650 psi (@ design temperature of 350° F)	(7)
Damping = ξ =	1% (small pipe)	(8)

Valve:

Material = Stainless Steel ASTM A351
CF - 8M
CF - 3M (3)

Weight = 10 pounds (6)

Assumption

- o The 6.75" pipe is made of the same material that the 1" nipple is made of (316 SS)

  Weight of the 6.75" pipe = $\frac{6.75}{12} * 2.172 = 1.22$ lb

- o The weight of the nut and the assembly at the end of the 1" pipe is the same or less than the weight of the valve (10 lbs). Note that this assumption is very conservative.

V. Calculation of the section modulus and the cross-sectional area of the nipple.

Assume the weakest point is the bottom of the thread.

$$S_N = \frac{I}{C}$$

Where

$$I = \frac{\pi}{64}\left[(OD_{min})^4 - ID^4 \right]$$

$$= \frac{\pi}{64}\left[(1.315 - 2* .06957)^4 - 957^4 \right]$$

$$= .05267 \quad in^4$$

and

$$C = OD/2 - \text{Thread Height}$$

$$= 1.315/2 - .06957$$

$$= .5879 \quad in$$

Substituting the values for I and C into equation (1), the section modulus of the nipple can be calculated

$$S_N = .05267/.5879$$

$$= .0896 \quad in^3$$

$$A_N = \frac{\pi}{4}\left[(OD_{min})^2 - ID^2 \right]$$

$$= \frac{\pi}{4}\left[(1.315 - 2* .06957)^2 - .957^2 \right]$$

$$= .367 \quad in^2$$

VI. Stress Calculation Due to Dead Weight

Depending on the orientation of the RHR line (vertical or horizontal), there will be either membrane or bending stress due to dead weight.

- Membrane Stress

$$\sigma_{DW} = \frac{weight}{A_N}$$

$$= \frac{10 + 1.22 + 10}{.367}$$

$$= 58.\ \text{psi}$$

- Bending Stress

$$\sigma_{DW} = \frac{M}{S_N}$$

$$= \frac{10*(3.25-.66)+1.22(\frac{6.75}{2} +3.25-.66)+10(6.75+3.25-.66)}{.0896}$$

$$= 1413\ \text{psi}$$

use $\sigma_{DW} = 1413$ psi

VII. Stress Calculation Due to Thermal Expansion

Since one side of the 1" pipe is connected to a flexible wire, then the entire assembly can grow without any

restriction. Consequently, the stress due to thermal expansion is zero.

$$\sigma_{TH} = 0$$

VIII. Stress Calculation Due to Internal Pressure

$$\sigma_P = \frac{Pr}{t}$$

$$= \frac{500\ (.957/2)}{.179 - .06957}$$

$$= 2187 \text{ psi}$$

IX. Stress Calculation Due to Seismic Loads

A simple finite element model of the entire assembly is set up (for details see Appendix A). Natural frequencies for the entire assembly are then obtained.

First natural frequency = W_N = 98.9 Hz

The dynamic magnification factor can now be calculated from the following equation (9)

$$DLF = \frac{1}{\sqrt{\left[1 - \left(\frac{W}{W_N}\right)^2\right]^2 + \left[2\,\xi\left(\frac{W}{W_N}\right)\right]^2}}$$ (harmonic excitation, Conservative)

using

$$W_N = 98.9 \text{ Hz}$$

$W = 33$ Hz (highest frequency content of an earthquake)

One can calculate the DLF to be

$$DLF = \frac{1}{\sqrt{\left[1 - \left(\frac{33}{98.9}\right)^2\right]^2 + \left[2*.01\left(\frac{33}{98.9}\right)\right]^2}}$$

= 1.13 (The assembly responds almost statically to earthquakes)

Responds acceleration = 6*1.13 = 6.78 g

Now the bending moment at the base of the 1" nipple can be calculated by multiplying the inertia forces (F = ma) by the appropriate moment arms.

M = 10* 6.78 * (3.25 - .66) + 1.22*6.78*(6.75/2 + 3.25 - .66)

+ 10*6.78 *(6.75 + 3.25 - .66)

= 858 in-lb

$$\sigma_S = \frac{M}{S_N}$$

$$= \frac{858}{.0896}$$

= 9578 PSI

X. Stress Summary and Code Evaluation

The following is a summary of the stress calculated for the conductivity cell.

Event	Stress (psi)
Dead Weight	1413
Thermal Expansion	0
Internal Pressure	2187
Seismic	9578
TOTAL	13,178 (Allowable S_M=19,650 psi)

XI. Conclusion

Since the total stress calculated for the 1" nipple due to all loads (dead weight, thermal expansion, internal pressure, and seismic loads) is only 13,178 psi, and one S_m for the nipple is 19,650 psi, it is then concluded that the 1" nipple (which is the weakest point) and consequently the entire assembly for the conductivity cell, will meet the requirements of the ASME Boiler and Pressure Vessel Code, 1980 Edition.

This qualifies the conductivity cell to be Safe to operate in the environments explained in Section II of this report.

Project Grand Gulf Nuclear Station File No.

Owner Mississippi Power and Light Co.

Client Mississippi Power and Light Co.

References

1. General Electric DWG 163C1544 SH No.2, "Purchased Part Conductivity Cell."

2.

3. General Electric DWG 163C1544 SH No. 1, "Purchased Part Conductivity Cell."

4. Properties of Pipe Table, Bergen-Paterson catalog.

5. Machinery's Handbook, 18th Edition, Industrial Press, Southeast.

6. NUTECH Communication Record, Telephone Conversation between Steven Hicks (from Foxboro Corp.) and R. Morton, File 32.1206.0001.

7. ASME Boiler and Pressure Vessel Code, 1980, Section III, Division 1, Appendix I, Table I-1.2.

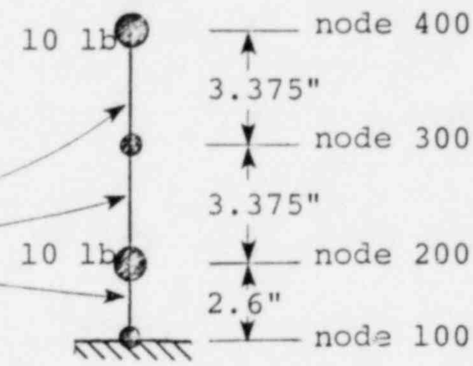
8. U.S. Atomic Energy Commission, Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants."

9. William T. Thomson, "Theory of Vibration With Applications", 2nd Edition, Prentice Hall, 1981.

APPENDIX A

Simple Finite Element Model of the Entire Assemble of the Conductivity Cell:

PISTAR computer program is used to build a finite element model for the following:



Natural frequencies are calculated from a PISTAR model extraction run (Run ID = BOF325L). The next two pages are copies of inputs and outputs of the PISTAR model extration computer run.

INPUT DATA ECHO PRINT

```
    1         11        21        31        41        51        61        71        81
    :         :         :         :         :         :         :         :         :

  1 TITLE     CONDUCTIVITY CELL
  2 ID        CLIENT=GRAND GULF NUCLEAR STATION
  3 ID        PROJECT NAME=EQUIPMENT QUALIFICATION
  4 ID        PROJECT NUMBER=MPL-0607
  5 ID        PREPARED BY=B. FATEMI
  6 ID        CHECKED BY=
  7 GEOMETRY  CONDUCTIVITY CELL
  8 START     100
  9 CLASS 2
 10 PIPE      100  200  0.0       2.6       0.0                           1    1
 11 PIPE      200  300  0.0       3.375     0.0                           1    1
 12 PIPE      300  400  0.0       3.375     0.0                           1    1
 13 ADD WEIGHT200           10.0      10.0      10.0
 14 ADD WEIGHT400           10.0      10.0      10.0
 15 PROPERTY  1                                           1.00SCH80 WATER
 16 MATERIAL  1                                           STAINLESS
 17 ANCHOR    100
 18 END GEOM
 19 LOADING   DW,MOD. EXT.
 20 CASE      DW
 21 DEAD LOAD
 22 PRINT               YES
 23 CASE      MX
 24 FREQUENCY           1.        1000.
 25 END LOADS

    :         :         :         :         :         :         :         :         :
    1         11        21        31        41        51        61        71        81
```

Prepared By/Date BF/4-15-82

Checked By/Date [illegible] AT 4/16/82

Page A-[illegible] of [illegible]

F R E Q U E N C I E S A N D P E R I O D S

-- VERSION 1.5.2 --

EIGENVALUE PROBLEM LOADING CONDITION MX

MODE NUMBER	CIRCULAR FREQUENCY (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SEC)
1	.6217E+03	.9894E+02	.1011E-01
2	.6217E+03	.9894E+02	.1011E-01
3	.4725E+04	.7519E+03	.1330E-02
4	.4725E+04	.7519E+03	.1330E-02
5	.7992E+04	.1272E+04	.7865E-03

Prepared by/Date LF /4-15-82
Checked by/Date JE / AJ 4/16/82

ATTACHMENT NO. 5

Air Operated Butterfly Valves
M-257.0/M-258.0

A. ORIENTATION

The first item was to provide an explanation as to how the Bechtel design and qualification account for the orientation of valves in the piping systems. Of particular interest was any possible detrimental affects of the pipe hangers or piping elbows on the overall valve qualification. Our response to this item is that pipe analysis is performed by Bechtel using the pipe isometric drawings which show the physical configuration of elbows, flanges, pipe routing, valves and actuator orientation, etc. Support locations and types are modeled to obtain the proper flexibility and maintain code and SAR stress limits for the various loading combinations. The result of this analysis is not just that the NRC concerns are addressed, but they are the basis for our design.

B. LOADING

The second item was to compare the required plant loads for the valves to the loading used in qualifying the valves. When the analysis previously discussed was performed, the plant loads, including margin, were determined. These loads are as follows:

System	Valve Number	Pratt Order Number	Design Loading	Static Test Loading
P44	F116, 117, 118, 119	D-0073-1	3 g's	5 g's
P44	F122, 123	D-0073-2	3 g's	5 g's
P44	F120, 121	D-0073-3	3 g's	5 g's
G41	F019, 045	D-0089-1	3 g's	5 g's

The vendor, Henry Pratt, qualified the valves by testing one valve of each family of valves, and then showing that the test of the "parent" valve qualifies all other members of that valve family.

C. PRATT-BETTIS: PRD-81/44

The materials specified by Bettis for its springs are either AISI5160 or AISI1065. If AISI5160 material was not properly heat treated, the material would be "soft" (Rockwell Hardness Approx. 32), have low tensile strength, demonstrate no workability and permanently distort after the first deflection (approx. 50% of the deflection). Similar results could be expected from AISI1065 but to a lesser extent. The Bettis actuators have been bench tested in place and tested by CTO and Startup. The testing has not shown any permanent distortion of the springs, therefore, it must be assumed that appropriate heat treatment was done.

ATTACHMENT NO. 5 (Cont'd)

During the jobsite modifications of the Bettis actuators, Bechtel Field Engineering and Quality Control inspected the actuator components to determine size and configuration of the components. The results were documented and submitted to Bechtel Project Engineering for review and evaluation.

Bechtel Project Engineering has determined that in most cases, the measured dimensions agreed with the dimensions on the vendor drawings or in the stress report. Minor discrepancies existed in the air and spring cylinder dimensions.

The minor discrepancies in the dimensions are acceptable since they have little or no effect on the center of gravity of the cylinder, the analysis, or the actuator operation. Bettis actuator components have stress design safety-factors from 2.5 to over 50.

The most critical dimensions and sizes for design stress considerations were consistent between design documents and jobsite measurement. These dimensions are the rod sizes, bolt sizes, and bolt patterns, yoke keys and thread engagement between cylinders and adapters.

Based on the nonconformance of the critical dimensions and the design safety factors, Bechtel Project Engineering has determined that there is sufficient evidence that the actuator dimensions and components comply with the design documents.

Materials were not reviewed for specific ASTM designation, however, all materials that were degradable were replaced as part of the modification effort, i.e., seals and lubricants, or pins/rollers with the coating used in qualification testing.

The above information has been extracted from two (2) Bechtel letters to MP&L's Quality Assurance Organization. The above information will be utilized to close out PRD-81/44 on April 20, 1982.

D The following information is included in Attachment No. 5:

1. Henry Pratt letter dated December 15, 1981
2. Henry Pratt letter dated April 2, 1982
3. Henry Pratt test report

TELEPHONE 312-844-4000 · TELEX 720-424

PRATT

HENRY PRATT COMPANY

creative engineering for fluid systems

401 SOUTH HIGHLAND AVENUE · AURORA, ILLINOIS 60507

December 15, 1981

BECHTEL POWER CORP.
RECEIVED
DEC 18 1981

JOB NO. 9645

Bechtel Power Corporation
15740 Shady Grove Road
Gaithersburg, MD 20760

ATTN: Mr. R. S. Trickovic
Project Engineer

SUBJ: Grand Gulf Nuclear Station
P.O. 9645-M-257/258,
Revisions 30 and 36 Respectively
HPCo S.O. D-28579

Gentlemen:

In accordance with the above referenced order, enclosed please find one (1) copy of Henry Pratt certification of nonactive valve assemblies.

Should you have any questions or need additional information, please let us know.

Very truly yours,

HENRY PRATT COMPANY

Roger D. Nelson

Roger D. Nelson
Nuclear Project Manager

RDN/clt

Enclosure

TELEPHONE 312-844-4000 · TELEX 720-424

PRATT

HENRY PRATT COMPANY

creative engineering for fluid systems

401 SOUTH HIGHLAND AVENUE · AURORA, ILLINOIS 60507

December 14, 1981

SUBJECT: Bechtel Grand Gulf Project
Seismic Analysis Report for Active & Non-Active Valve Assemblies

Reference: Pratt Job Numbers D-0073-1, D-0073-2
D-0073-3, D-0089-1

Henry Pratt Company does not differentiate between active and non-active in the structural design of nuclear butterfly valves. In view of the fact that the active valve assemblies are already found to be adequate for the specified loading conditions on the basis of the functional qualification reports already approved by Bechtel Power Corporation, and that the Bechtel approved seismic analysis reports for both active and non-active valve assemblies demonstrate the structural integrity of those valve assemblies for conditions more severe than required in the specifications, we hereby certify that the structural integrity of both the active and non-active valve assemblies are considered adequate for their specified service conditions.

JOHN V. BALLUN
39860
REGISTERED
PROFESSIONAL
ENGINEER
OF
ILLINOIS

H B Washburn
H. B. Washburn
Senior Test Engineer

Certified By: J V Ballun
J. V. Ballun, P.E.

HBW:dg

TELEPHONE 312-844-4000 · TELEX 720-424

PRATT

HENRY PRATT COMPANY

creative engineering for fluid systems

401 SOUTH HIGHLAND AVENUE · AURORA, ILLINOIS 60507

TRANSMITTAL
4-6-82 82/0275
0276/M-257.0
7 9645-M-257.0
Passive to Active Valve Qual.
Henry Pratt

RECEIVED
APR 5 1982
F. M. PARKS

April 2, 1982

Bechtel Power Corp.
15740 Shady Grove Road
Gaithersburg, MD 20877

ATTN: Mr. Frank M. Parks, Purchasing

SUBJ: Grand Gulf Nuclear Station
P.O. 9645-M-257
File 0763/M-257.0
Passive to Active Valve Qualification
HPCo Proposal No. X-51-8180

Gentlemen:

With reference to your request for quotation dated March 9, 1982, to include ten (10) valves in Pratt functional qualification test report for active valves, we are submitting herewith our proposal.

This proposal is based on the selection of prequalified parent valve assemblies.

The selected parent valve assemblies have been prequalified in accordance with the attached "Henry Pratt Functional Qualification Requirements for Power Operated Safety Related Active Butterfly Valve Assemblies for Nuclear Power Plants".

For valve assemblies of similar design the parent valve qualification will be extended to generically qualify the candidate valve assemblies utilizing generic qualification rules.

Below on the left are selected parent valve assemblies which were subjected to the test program. On the right are the generically qualified valve assemblies (candidate valves).

Parent Valve Assemblies		Candidate Valve Assemblies
36" (1100) T412-SR4 D-0038-3 * Section 6A of existing report	will qualify	D-0073-1 24" (1100) T316-SR2 D-0073-2 30" (1100) T416-SR3 D-0073-3 36" (1100) T420-SR1 * Results to be included in Section 6B of existing report

12" (1100) 721C-SR80-12 will qualify D-0089-1 10" (1100) 732C-SR80
D-0089-4

* Old loads add on valve Section 1A

* Will become part of Section 1B of the add on report.

NOTE: It is assumed that the previously accepted qualification reports and procedures are still acceptable to Bechtel and as such the above valve qualification program will be integrated with those reports.

Should any additional tests be required, they would be quoted at additional cost.

The cost for revised functional qualification reporst as indicated above is $18,000.

Completion of the analysis and submittal will be ten (10) weeks from receipt of a written purchase order.

This proposal is valid for 30 days; payment terms are net 30 days.

Truly yours,

HENRY PRATT COMPANY

John F. Triplett
Manager, Spare Parts Department

JFT/clt

BECHTEL POWER CORP.
RECEIVED
DEC 5 1979
JOB No. 9645

HENRY PRATT FUNCTIONAL QUALIFICATION PROGRAM
FOR
POWER OPERATED-SAFETY RELATED
ACTIVE VALVE ASSEMBLIES

Project Site: Grand Gulf Nuclear Station
Port Gibson, Mississippi

Customer: Mississippi Power & Light Company

Engineer: Bechtel Power Corporation

Specification: 9645-M-257.0
9645-M-258.0

P.O. Number: 9645-M-257.0
9645-M-258.0

VENDOR'S DOCUMENT REVIEW
1 [X] Approved - Mfg. may proceed
2 [ ] Approved - Submit final dwg. - Mfg. may proceed
3 [ ] Approved - ...
4 [ ] Not Approved - Correct and ...
5 [ ] Review not required - Mfg. may proceed
Approval of this drawing does not relieve ... compliance ...
12/12/79
JOB NO. 9645 | BECHTEL CORPORATION POWER & INDUSTRIAL DIVISION P.O. BOX 607, GAITHERSBURG, MD.

9645-M258.0-QS-26.0-10-0

Prepared By: Henry B Washburn 11-8-79 Date

Reviewed By: [signature] 11-9-79 Date

Certified By: Bomi M. Zarola 11/9/79 Date

BOMI M. ZAROLA 30701 REGISTERED PROFESSIONAL ENGINEER OF ILLINOIS

705274

TABLE OF CONTENTS

PART I

HENRY PRATT COMPANY

FUNCTIONAL QUALIFICATION REQUIREMENTS
FOR
POWER-OPERATED SAFETY-RELATED ACTIVE BUTTERFLY VALVE ASSEMBLIES
FOR
BECHTEL/GRAND GULF

FOREWARD

Power-operated safety-related active valve assemblies are required to perform their safety-related functions under specified operating conditions, including normal, upset, emergency and faulted plant conditions. It is the purpose of this standard to provide guidance for the preparation of functional specifications for the qualification of valves, actuators and the combination thereof (valve assemblies) by test and analysis for the intended service.

This standard provides a method by which a valve assembly can be qualified to the conditions specified by the manufacturer. If these conditions are at least as severe as the functional operating conditions specified by the owner, the valve assembly can thus be considered qualified.

PART I

TABLE OF CONTENTS

1.0 SCOPE

This standard establishes the rules for functional qualification of power-operated safety-related active butterfly valve assemblies.

1.2 Functional qualification consists of tests and/or analyses to demonstrate that a valve assembly will perform its required safety-related function. Generic qualification rules allow qualification of a candidate valve by analyses which demonstrate design similarity to a valve assembly qualified by testing.

1.3 Generic Qualification Rules

The following rules, as stated, relate specifically to butterfly valves. The Generic Family Valve Assembly is qualified provided the test valve assembly successfully passes all tests noted in this standard and the Generic Qualification Rules and/or ratios listed below are satisfied.

1.3.1 The GFVA is limited to size between 50% and 200% of the QTVA.

1.3.2 The GFVA and QTVA have similar seat taper angles.

1.3.3 Disc/seat interference of the GFVA $\geq$ QTVA.

1.3.4 The GFVA and QTVA have the same basic seating surface materials.

1.3.5 The materials of construction of similar components of the GFVA have physical properties $\geq$ than those of the QTVA.

1.3.6 $\frac{\text{Rated torque of actuator}}{\text{Calculated valve operating torque}} \geq 1$

NOTE: The magnitude of the rated torque of the actuator above the calculated valve operating torque is not considered in the qualification rules since the maximum torque transmitted to the valve shaft is never greater than the value of the calculated valve operating torque.

1.3.7 Actuator and attached accessories have been qualified separately in accordance with I.E.E.E. 344 and I.E.E.E. 382.

1.3.8a. The ratio $\frac{S_1}{S_2} > 1$ (Combined bonnet stress is less than the yield strength of bonnet material.)

Where S_1 = Yield strength of bonnet material

S_2 = Combined bonnet stress due to seismic and operating loads.

1.3.8b. The ratio $\frac{S_3}{S_4} > 1$ (Bonnet to valve bolting stress is less than the yield strength of bolt material.)

Where S_3 = Yield strength (proof load) of bonnet to valve bolting
S_4 = Calculated stress of bonnet to valve bolting

1.3.8c. The ratio $\frac{S_5}{S_6} > 1$ (Adapter plate to bonnet bolt stress is less than the yield strength of the bolt material.)

Where S_5 = Yield strength (proof load) of adapter plate to bonnet bolting
S_6 = Calculated stress of bonnet to adapter plate

1.3.8d. The ratio $\frac{S_7}{S_8} > 1$ (Actuator to adapter plate bolt stress is less than the yield strength of the bolt material.)

Note: In the case where an adapter plate is not used:

S_5 = Yield strength (proof load) of actuator to bonnet
S_6 = Calculated stress of bonnet to adapter plate bolting

S_7 and S_8 are not present

1.3.9 Δ_L of QTVA or GFVA < .002".

Where Δ_L = the calculated bonnet deflection at the base of the operator due to seismic or test loads.

Note: Since the deflections of the yoke assembly are extremely small .002" is an arbitrary limit. Considerably more deflection than .002" would be required to the cause binding in the operator to shaft connection or clearances. The actual deflections are significantly less than .002".

2.0 DEFINITIONS

2.1 Rated Torque of Actuator - Nominal torque capability of actuator under nominal motive power conditions as defined by the manufacturer.

2.2 Calculated Valve Operating Torque - Maximum torque required to operate valve for the intended service conditions.

2.3 Cold Working Pressure - The valve pressure rating at 100°F (38C).

2.4 Operating Time - The time required for the valve to complete each half of operating cycle.

2.5 Motive Power - The electrical, fluid or mechanical energy required to operate the valve assembly.

2.6 Operating Cycle - The movement of a valve closure element through its required operating travel under defined operating conditions, terminating with a return to the starting position.

2.7 Power Operated Active Valve Assembly - A butterfly valve assembly that must perform a mechanical motion to fulfill its system safety function through the application of external motive power.

2.8 Valve Actuator - A device which provides the torque necessary for valve operation.

2.9 Valve Assembly - A valve actuator combination including attached functional accessories:

2.9.1 Test Valve Assembly (TVA) - A valve assembly selected for qualification testing.

2.9.2 Qualified Test Valve Assembly (QTVA) - A test valve assembly which has been qualified by all appropriate testing required by this standard.

2.9.3 Generic Family Valve Assembly (GFVA) - A valve assembly to be qualified by analysis which shows that the requirements for design similarity with the QTVA valve have been met.

2.9.4 Qualified GFVA - A generic family valve assembly which has been qualified in accordance with 2.9.3.

3.0 FUNCTIONAL QUALIFICATION REQUIREMENTS

Functional qualification shall be demonstrated by suitable tests and/or analyses showing, on the basis of rules provided herein, that a valve assembly is qualified for defined limiting service conditions. The functional qualification shall demonstrate the following:

3.1 Valve shut-off capability and pressure boundary meeting applicable leakage tolerances.

3.2 Cyclic operability of the valve assembly.

3.3 Operability during and after loading representative of the maximum seismic incident.

4.0 INSPECTION, VERIFICATION AND RECORD CONTROL

Inspections of the test valve assembly on which testing is required shall be performed prior to and upon completion of the qualification test series.

4.1 Pre-test inspection shall be performed according to the test plan for such items as:

a. Control settings.

b. Securing of fasteners.

c. Motive power drive system.

d. Test equipment calibration.

4.2 A Functional Qualification Report shall be prepared for each valve assembly qualified. This report shall provide complete identification of the valve by type, size, pressure rating, actuator, and other data as appropriate. Any specific limitations restricting qualification shall be stated.

4.3 The Functional Qualification Report for a GFVA shall include the test plan, test results and inspections for the QTVA and the analyses used to show that the GFVA satisfies design similarity with the QTVA.

4.4 The Function Qualification Report shall be certified by one or more registered professional engineers competent in the field.

5.0 QUALIFICATION TEST PROGRAM

5.1 Test Plan - A Test Plan shall be prepared with appropriate inspection and test record forms to define test objectives, test fluids, conditions of the test, permissible maintenance or adjustments, and acceptance criteria. Where prequalified parts of the valve assembly (i.e. valve actuator, etc.) are utilized as part of the valve assembly qualification, the test plan shall reference the report upon which such prequalification is based.

5.2 Orientation - Functional Qualification tests for the valve orientation which results in the most severe loading of the valve assembly qualify the valve assembly for all orientations.

6.0 QUALIFICATION TESTS

6.1 Prerequisite Conditions

6.1.1 Installation for Tests - A test valve assembly shall be supported as required to permit testing in accordance with the applicable appendix and provided with appropriate means for pressurization and valve leakage measurement. All accessory equipment shall be adjusted to the manufacturer's recommended settings. Electric, pneumatic, or hydraulic connections for motive power shall be functionally equivalent to the actual valve assembly attachments.

6.1.2 Record Control Points - Prior to start of test sequence, all system conditions shall be recorded as applicable to the test valve assembly and test installation according to the test plan.

7.0 TEST REQUIREMENTS

All of the tests listed below shall be conducted in accordance with the appropriate appendix:

Leakage. . . . . Appendix A

Cold Cyclic . . . . Appendix B

Hot Cyclic . . . . Appendix C

Temperature-Pressure . . . . . . Appendix D

Seismic. . . . . Appendix E

Vibration. . . . . Appendix F

PART I

APPENDIX A
VALVE LEAKAGE TEST

Scope and Applicability

Valve leakage tests are intended to show that the test valve assembly is capable of meeting seat and stem packing sealing requirements.

Valve leakage tests are required for all test valve assemblies.

Test Requirements

A.1 The test valve assembly shall be installed in accordance with Section 5.2, providing for pressurization of the test valve assembly and for collection and/or measurement of valve mainseat leakage in both directions for qualification of bidirectional valves or in the direction corresponding to the intended use for specific qualification.

A.2 Leakage tests shall be made by applying cold working pressure or a lower pressure across the closure. The test fluid may be water (which may contain a corrosion inhibitor), steam, air, or inert gas. If a lower pressure is used, the functional qualification report for the valve shall include both the maximum rated pressure and the maximum rated valve seat sealing differential pressure. The test pressure shall be applied across the closure member in the direction producing the most adverse seating condition.

A.3 The leakage rate test duration shall be adequate to determine the leakage rate, but no less than five minutes.

A.4 Valve leakage shall be determined by placing the valve disc in the closed position. The test pressure shall then be applied across the closed disc.

A.5 Packing leakage shall be observed at cold working pressure with the valve in the partially open position. For valves without leakoff connections, packing leakage shall be observed and the leak rate estimated. For valves with lantern rings and leakoff connections, leakage at the leakoff connections shall be measured and recorded. The initial packing leakage test shall be performed after fully cycling the test valve assembly 10 times. The leakage rate test duration shall be adequate to determine the leakage rate, but no less than 5 minutes.

PART I

APPENDIX B
COLD CYCLIC TEST

Scope and Applicability

Cold cyclic tests are intended to show that a test valve assembly is capable of closing and opening under the most adverse combination of motive power and system pressure.

Cold cyclic tests are required for all test valve assemblies.

Test Requirements

B.1 The test fluid shall be as described in A.2.

B.2 The test valve assembly shall be operated according to the following requirements and sequence:

B.2.1 One operating cycle, utilizing such voltage or actuating pressure, resulting in the nominal torque that is available, consisting of closing against internal pressure* followed by opening with a differential pressure* in the normal direction across the test valve assembly.

B.2.2 Three operating cycles, utilizing such voltage or actuating pressure, resulting in the maximum torque that is available with the test valve assembly depressurized.

B.2.3 Three operating cycles, utilizing such voltage or actuating pressure, resulting in the minimum torque that is available, closing against internal pressure* and opening with a differential pressure* in the normal direction across the test valve assembly.

B.3 During each operating cycle the operating time in each direction of travel shall be recorded.

---

*Internal pressure and differential pressure to be applied in cyclic testing shall be the maximum rated line pressure and differential operating pressure respectively for which the test valve assembly is to be qualified. Differential pressure need not be maintained after the test valve assembly is unseated.

PART I

APPENDIX C
HOT CYCLIC TEST

Scope and Applicability

Hot cyclic tests are intended to show the test valve assembly operability as for cold cyclic tests, but including imposed conditions of elevated system temperature, in excess of 200°F (93°C).

Test Requirements

C.1 The test fluid shall be as described in A.2.

C.2 The test fluid temperature shall be the highest temperature for which the test valve assembly is to be qualified. Test fluid and valve metal temperature shall be allowed to reach steady state before testing and shall be maintained during testing.

C.3 The test valve assembly shall be operated according to the following requirements and sequence:

C.3.1 One operating cycle, utilizing such voltage or actuating pressure, resulting in the nominal torque that is available, consisting of closing against internal pressure* followed by opening with a differential pressure* in normal direction across the test valve assembly.

C.3.2 Three operating cycles utilizing such voltage or actuating pressure, resulting in the minimum torque that is available, closing against internal pressure* followed by opening with a differential pressure in normal direction across the test valve assembly.

C.4 While the test valve assembly is pressurized*, it shall be closed utilizing such voltage or actuating pressure, resulting in the maximum torque that is available to seat the valve, and with the system at test pressure. The test valve assembly shall then be allowed to cool to 125°F (52°C) or lower. The test valve assembly shall then be opened, unseating against differential pressure* utilizing such voltage or actuating pressure resulting in the minimum torque that is available.

---

*Internal pressure and differential pressure to be applied in cyclic testing shall be the maximum rated line pressure (corresponding to the test temperature) and differential operating pressure respectively for which the test valve assembly is to be qualified. The test valve must successfully open under each of two conditions: (1) with balanced pressure in the test valve assembly and (2) with maximum rated operating differential pressure across the valve closure in the direction producing the greatest resistance to opening, unless the valve is unidirectional, in which case the differential shall be in the normal direction, or the valve is symmetrical, in which case the differential may be in either direction. Differential pressure need not be maintained after the test valve assembly is unseated.

PART I

APPENDIX D
TEMPERATURE-PRESSURE TEST

Scope and Applicability

Temperature-pressure tests are intended to show that the test valve assembly is capable of meeting seat sealing requirements following exposure to test fluids of specified temperature-pressure conditions.

This test is applicable for isolation valves where the safety related function of the valve is to close and remain in the closed position.

Test Requirements

D.1 The test fluid shall be as described in A.2.

D.2 The test fluid temperature shall be the highest temperature for which the test valve assembly is to be qualified.

D.3 The test valve assembly shall be operated according to the following requirements and sequence.

D.3.1 Close test valve assembly utilizing such a voltage or actuating pressure resulting in the minimum torque that is available.

D.3.2 Expose closed test valve assembly to given temperature-pressure conditions.

D.3.3 Following exposure to temperature-pressure conditions, perform leakage test in accordance with Appendix "A".

PART I

APPENDIX E
SEISMIC LOADING TEST

Scope and Applicability

The intent of this procedure is to show that a valve assembly will perform its function during and after specified loading. Seismic loading testing is required for each test valve assembly.

Test Requirements

E.1 The test valve assembly may be mounted in any selected orientation. (See Paragraph 5.2)

E.2 A static load shall be applied in line with the center of gravity of the valve operator. The static load shall equal twice the operator weight applied in the vertical direction (downward) and three times the operator weight in a direction parallel to the valve nozzle centerline applied simultaneously.

E.3 A cold cyclic test shall be performed in accordance with Appendix B coincident with application of the loading specified in Paragraph E.2 above.

PART I

APPENDIX F
VIBRATION TEST

Scope and Applicability

The purpose of this test is to verify the test valve assembly operability when subjected to vibration.

Vibration testing is required of all test valve assemblies.

Test Requirements

F.1 Except for the required cycling, tests F.2, F.3, and F.4 shall be performed with the test valve assembly in the normal operating positions for which the valve is to be qualified.

F.2 Exploratory vibration test - Vibration shall be essentially sinusoidal with amplitudes to produce maximum acceleration of at least 0.2g (zero to peak Exploratory vibration shall be performed by a sweep of the full frequency range at a rate not exceeding one octave per minute. Resonance shall be defined as a frequency at which acceleration of the actuator at the plane of the center of gravity perpendicular to the stem centerline exceeds the test acceleration value by a factor of 3 or more.

F.3 The test frequencies at which resonances occur shall be noted and recorded.

Variable frequency test - Tests shall be performed at a minimum force of 0.5 g (zero to peak) in the three mutually perpendicular axes at the following frequencies: 3.5, 4.5, 6, 8, 11, 15, 21, 29, 39, 53, 71, and 95 Hz which are within the test frequency range determined in F.2. Tests shall also be performed at resonant frequencies. Operability of the test valve assembly shall be demonstrated by performing one operating cycle, as per B.2.1 except pressurization is not required, at each frequency.

F.4 Endurance test - The test valve assembly shall be vibrated for a total of at least three minutes at each of the observed resonant frequencies with a minimum force at 0.5g (zero to peak) applied. At the conclusion of each endurance test, with the test valve assembly still vibrating, operability of the test valve assembly shall be demonstrated by performing one operating cycle. The test shall be performed at 33 Hz in any of the three mutually perpendicular axes where resonant frequencies are not found.

PART II

HENRY PRATT COMPANY

FUNCTIONAL QUALIFICATION REPORT OF RESULTS

FOR

POWER OPERATED-SAFETY RELATED

ACTIVE BUTTERFLY VALVE ASSEMBLIES

Prepared for: Bechtel/Grand Gulf

SELECTION OF TEST VALVE ASSEMBLIES FOR QUALIFICATION

BECHTEL/GRAND GULF

Selection of test valve assemblies (parent valves) shown below will be qualified by actual testing described in Part I "Henry Pratt Functional Qualification Requirements for Power Operated Safety Related Active Butterfly Valve Assemblies".

Upon successful completion of the test program, a "Functional Qualification Report" will be issued for each of the selected test valve assemblies (parent valves) certifying that these valves are qualified by all appropriate testing.

Valve assemblies of similar design (candidate valves) will be qualified by certifying that the generic qualification rules are satisfied.

Active nuclear valves of this order can be sorted into one group based on design similarity:

1. Pneumatically operated type 1100 valve assemblies

In accordance with the above grouping, the list below on the left shows the selected test valve assembly (parent valve) which will be subjected to the test program and the list on the right shows the generically qualified valves (candidate valves).

Group 1 - Pneumatically Operated Type 1100 Valves

	Qualified Test Valve (Parent Valve)	Generically Qualified Valves (Candidate Valves)
1.	D-0089-4 12" 1100 (NXL) with 721C-SR-80-12	D-0089-5 12" 1100 (NXL) with 721C-SR-80-12

SELECTION OF TEST VALVE ASSEMBLIES FOR QUALIFICATION

BECHTEL/GRAND GULF

Selection of test valve assemblies (parent valves) shown below will be qualified by actual testing described in Part I "Henry Pratt Functional Qualification Requirements for Power Operated Safety Related Active Butterfly Valve Assemblies".

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Group 1 - Pneumatically Operated Type 1100 Valves

	Qualified Test Valve (Parent Valve)	Generically Qualified Valves (Candidate Valves)
1.	D-0089-4 12" 1100 (NXL) with 721C-SR-80-12	D-0089-5 12" 1100 (NXL) with 721C-SR-80-12

TEST INSTRUMENTATION AND CALIBRATION DATA

Item No.	Item Identification	Manufacturer	Model	Mfg. Serial No.	HPCo Serial No.	HPCo Calibration Procedure No.
1	Pressure Gauge	Robert Shaw	313D 0 - 600 psig	N/A	L-28	QAP 2 Para. 8.15.2
2	Pressure Gauge	Robert Shaw	313D 0 - 160 psig	N/A	L-29	QAP 2 Para. 8.15.2
3	Pressure Gauge	Robert Shaw	T21-313B 0 - 300 psig	N/A	L-30	QAP 2 Para. 8.15.2
4	Pressure Gauge	Robert Shaw	T21-313B 0 - 800 psig	N/A	L-31	QAP 2 Para. 8.15.2
5	Pressure Gauge	Robert Shaw	T21-313B 0 - 800 psig	N/A	L-32	QAP 2 Para. 8.15.2
6	Pressure Gauge	Robert Shaw	T21-313B 0 - 800 psig	N/A	L-33	QAP 2 Para. 8.15.2
7	Pressure Gauge	Robert Shaw	T21-313B 0 - 1,500 psig	N/A	L-34	QAP 2 Para. 8.15.2
8	Pressure Gauge	Robert Shaw	T21-313B 0 - 1,500 psig	N/A	L-35	QAP 2 Para. 8.15.2
9	Pressure Gauge	Robert Shaw	T21-313B 0 - 1,500 psig	N/A	L-36	QAP 2 Para. 8.15.2
10	Pressure Gauge	Robert Shaw	T21-313B 0 - 400 psig	N/A	L-37	QAP 2 Para. 8.15.2
11	Pressure Gauge	Robert Shaw	T21-313B 0 - 400 psig	N/A	L-38	QAP 2 Para. 8.15.2
12	Pressure Gauge	Robert Shaw	T21-313B 0 - 400 psig	N/A	L-39	QAP 2 Para. 8.15.2
13	Dead Weight Tester	Ashcroft	1305B 0 - 10,000 psig	1HA09029	DWT #1	QAP 2 Para. 8.10
14	Motor Controller	Arwal Control	N/A	N/A	L-EMC-1001	QAP 2 Para. 8.28
15	Circuit Tester	Weston	785	851	851	QAP 2 Para. 8.19
16	Potentiometer	Leeds and Northrup	-200 to 1000^{o}F	1316771	1316771	QAP 2 Para. 8.30

PART II

Section 1 A

FUNCTIONAL QUALIFICATION REPORT
FOR
QUALIFIED TEST VALVE ASSEMBLY (QTVA)

Job. No. D-0089-4

Prepared By: Henry B Washburn 11-8-79
Date

Reviewed By: Scott J Kelm 11-9-79
Date

Certified By: [signature] 11/9/79
Date

BONI M. ZAROLA
30701
REGISTERED PROFESSIONAL ENGINEER OF
ILLINOIS

PART II

Section 1 A ADD-ON

FUNCTIONAL QUALIFICATION REPORT

FOR

QUALIFIED TEST VALVE ASSEMBLY (QTVA)

Job No. D-0089-A

THIS TEST VALVE ASSEMBLY WAS SUBJECTED TO ALL APPROPRIATE TEST REQUIREMENTS (PART I, PARAGRAPH 7.0) AND IT IS CONSIDERED A QUALIFIED TEST VALVE ASSEMBLY

Job No. D-0089-4

1. DESCRIPTION AND CHARACTERISTICS

Valve Size and Type			12" NXL (1100)	
Standard Pressure Class			150	
Cold Working Pressure			275	psi
Rated Differential Pressure			200	psi
Maximum Service Temperature			200	°F
Actuator Type	—	Electric Motor	✓	Air
Actuator Size	721G-80-12			
Normal Motive Power	—	Vac	110	psi
Minimum Motive Power	—	Vac	80	psi
Maximum Motive Power	—	Vac	110	psi

M Job No. D-0069-4

2. BASE LINE DATA OF QTVA TO BE USED FOR GENERIC QUALIFICATION OF GFVA

Reference Paragraph		
1.3.1	Valve Size	12" NXL (1100)
1.3.2	Seat Taper Angle	15°
1.3.3	Disc/Seat Interference	.030
1.3.4	Seating Surface Materials	STAINLESS STEEL/EPT
1.3.5	Materials of Construction	
	Body	ASME SA-516 GR.70
	Disc	ASME SA-516 GR.70
	Shaft	ASME SA-564 TY. 630-H1150
	Bearing	ASTM B-438 GR. 1 TYPE 2
	Seat	EPT
	Retainer Segments	—
	Packing	EPT
	Thrust Collar	SAE 660 BRONZE
	Bottom Cover	ASME SA-516 GR.70
	Bonnet	ASTM A-36
	Bolts: Valve to bonnet	SAE GR.8
	Bonnet to Actuator	SAE GR.8
	Adaptor plate to actuator	—
1.3.6	Actuator Rated Torque @ 80 PSI	3420
	Calculated Operator Torque	2750
	Ratio = 1.24	
	Operating Time	
	Open to Close	4 Sec.
	Close to Open	4 Sec.

M Job No. D-0089-4

RESULTS OF QUALIFICATION RULES 1.3.8 and 1.3.9 FOR QTVA

Rule 1.3.8

a. S_1 = 36000 Yield strength of bonnet material

S_2 = 5187 Calculated bonnet stress

S_1/S_2 = 6.9 > 1

b. S_3 = 120000 Yield strength (proof load) of bonnet to valve bolting

S_4 = 46848 Calculated stress of bonnet to valve bolting

S_3/S_4 = 2.56 > 1

c. S_5 = 120000 Yield strength (proof load) of to bonnet bolting

S_6 = 36077 Calculated stress of to bonnet bolting

S_5/S_6 = 3.33 > 1

d. S_7 = — Yield strength (proof load) of actuator to adapter plate bolting

S_8 = — Calculated stress of actuator to adapter plate bolting

S_7/S_8 = — > 1

Rule 1.3.9

Δ_L of QTVA = .00105" Deflection of test valve

Δ_L of QTVA .002"

Reference Addendum 1 & 2 for equations used to determine stresses and deflection for Rules 1.3.8 and 1.3.9.

Job No. D-0089-4

3. COPY OF FUNCTIONAL QUALIFICATION REPORT OF ACTUATOR TO SHOW COMPLIANCE TO IEEE 344 and IEEE 382

Reference

Paragraph

1.3.7

Job No. D-0089-4

STATEMENT OF CERTIFICATION

QUALIFICATION TESTING

GH-BETTIS Actuator Model N-721C-SR80 is hereby certified to be of the same construction as Bettis Actuator Model N-732C-SR80 which was qualified to the requirements of ANSI 278.2.1, Draft 3, Rev. 0, Feb. 1977 (IEEE 382) with the exception of LOCA by testing at Southwest Research Institute, San Antonio, Texas. Applicable test margins as described in paragraph 6.3.1.5 of IEEE 323-1974 were utilized with the exception of (8). Refer to SWRI Test Report No. 02-4854-RPT-1 .

The LOCA testing required to complete the qualification program is scheduled to begin at Wyle Laboratories, Huntsville, Alabama on September 11. Upon successful completion of that testing a revised statement of certification will be issued referencing the applicable test report number.

SEISMIC ANALYSIS

In addition to the seismic test results obtained in the above referenced tests, Bettis Seismic Analysis Report No. R-1062-25 Rev.A is offered as further supportive evidence to the rigidity of this actuator.

Joel D. Page

JOEL D. PAGE
Senior Engineer
Nuclear Products

JP/ksy
8-31-78

Job No. D-0089-4 VALVE LEAKAGE TEST

4.1.0 To demonstrate valve shut-off capability and pressure boundary meeting applicable leakage tolerances (para. 3.1). Test valve assembly to be mounted on test stand with the valve shaft oriented horizontally as shown in Figure 1.

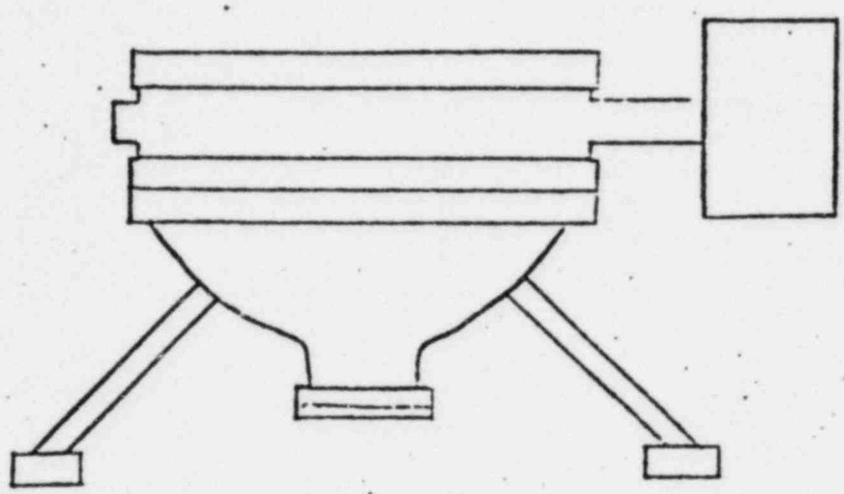


FIGURE 1

4.1.1 Pre-Test Inspection

4.1.2 Adjust limit switches for proper open and closed positions of valve disc.

4.1.3 Measure normal motive power to actuator.

— Vac. 100 psi

4.1.4 Measure required torque settings of fasteners. (Ft. Lb.)

Bonnet to trunnion	Required 95	Measured 95
Bonnet to ~~adaptor plate~~	Required —	Measured —
~~Adaptor plate to~~ actuator	Required 95	Measured 95
Adaptor plate to trunnion	Required —	Measured —
Bottom cover to trunnion	Required 95	Measured 95

4.1.5 Verify calibration of required test equipment.

Job No. D-0089-A

4.1.6 Test Procedure (Appendix A)

a. With the test valve assembly in the most adverse position (as shown in Figure 1) operate the valve with normal motive power starting from full closed position three operating cycles.

Measure and Record:

Motive Power	— Vac.	100 psi	
Operating Time	Cycle #1	Cycle #2	Cycle #3
Closed to Open	2.3 sec.	2.3 sec.	2.3 sec.
Open to Closed	2.4 sec.	2.4 sec.	2.4 sec.

b. Repeat Step a with minimum motive power.

Motive Power	— Vac.	80 psi	
Operating Time	Cycle #1	Cycle #2	Cycle #3
Closed to Open	3.1 sec.	3.0 sec.	3.1 sec.
Open to Closed	2.3 sec.	2.4 sec.	2.4 sec.

c. With the valve disc in the closed position, cover the disc with a pool of water deep enough to submerge disc/seat interference line.

d. Using air as test fluid, pressurize valve assembly to 200 psi differential pressure across disc. Hold pressure for a minimum time of five minutes (A-3). Observe and record leakage (A-4). Bubble tight condition of valve seat is considered a successful qualification of the TVA.

Leakage NONE Bubble Tight TO AT LEAST 200 PSI

e. Repeat steps c and d with pressure on opposite side of valve disc for bi-directional qualification

Leakage NONE Bubble Tight TO AT LEAST 200 PSI

Job No. D-00B9-A

f. For the packing leak test the TVA is to be sandwiched in between two test heads as shown in Figure 2.

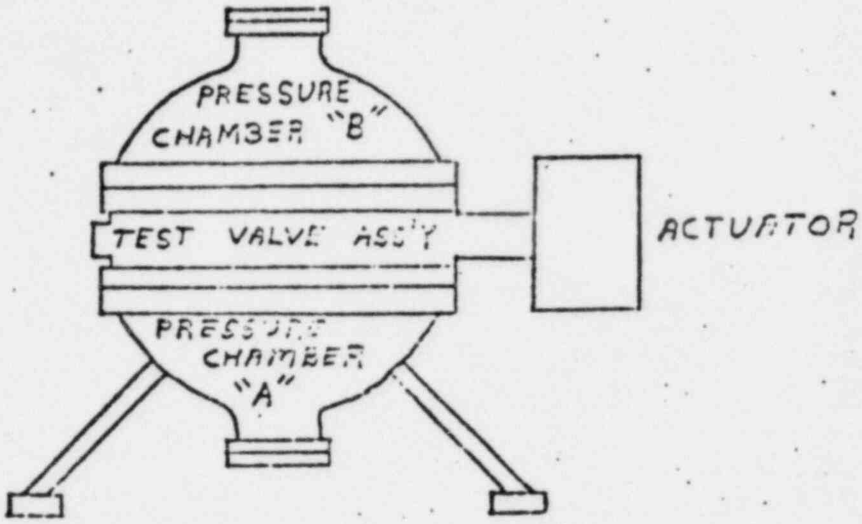


FIGURE 2

g. With normal motive power applied to the actuator, cycle the TVA 10 times. Record cycle time for the first and tenth cycles.

Record:

Motive power	— Vac.	100	psi
1st Cycle	Open to Close	2.4	sec.
	Close to Open	2.3	sec.
10th Cycle	Open to Close	2.3	sec.
	Close to Open	2.3	sec.

h. With the valve disc in the open position, pressurize test valve assembly to cold working pressure of 275 psi using air as test fluid. Hold cold working pressure for a time period of 5 minutes. Observe leakage by applying soap solution around packing. Soap bubble tight condition of packing is considered successful qualification of TVA.

Leakage Observed None   Soap Bubble Tight To ATLEAST 275 Psi

Job No. D-0089-4

4.2.0 Cold Cyclic Test

To demonstrate cyclic operability of the TVA (3.2) under the most adverse combination of motive power and system pressure. The test valve assembly is to be sandwiched between two test heads with the valve shaft oriented horizontally as shown in Figure 3.

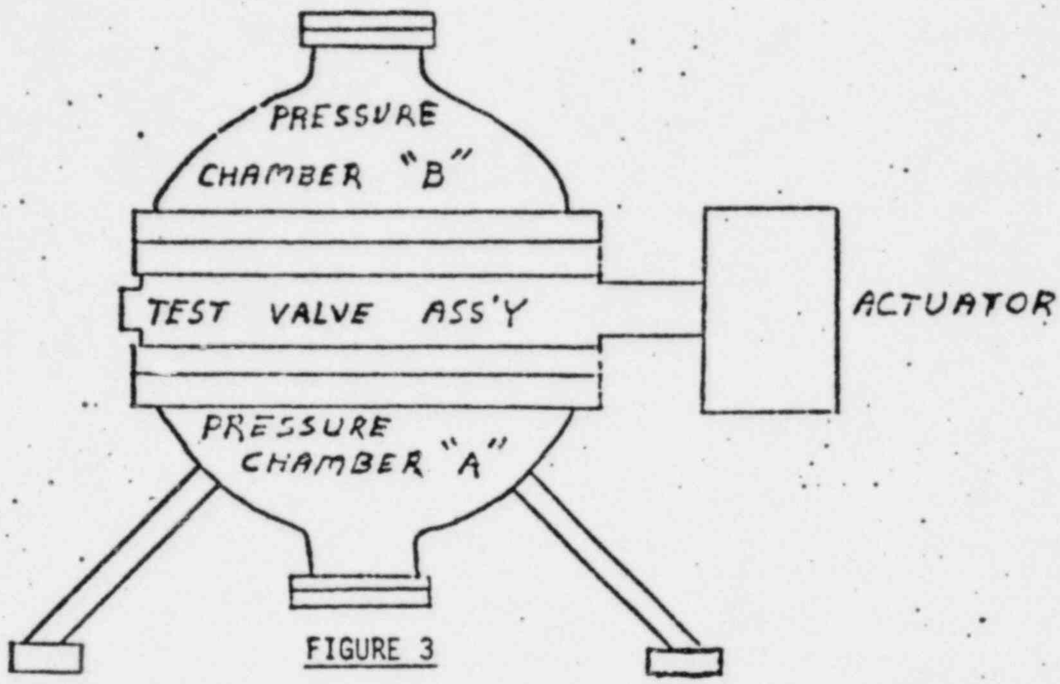


FIGURE 3

4.2.1 Pre-Test Inspection

4.2.2 Adjust limit switches for proper closed and open position of valve disc.

4.2.3 Measure motive power to actuator.

—— Vac. 100 psi

4.2.4 Measure required torque settings of fasteners. (Ft. Lb.)

Bonnet to trunnion	Required 95	Measured 95
Bonnet to ~~adapter plate~~	Required —	Measured —
~~Adaptor plate to~~ actuator	Required 95	Measured 95
Adaptor plate to trunnion	Required —	Measured —
Bottom cover to trunnion	Required 95	Measured 95

4.2.5 Verify calibration of required test equipment.

Job No. D-0089-4

4.2.6 Test Procedure (Appendix B)

a. With the valve disc in the full open position pressurize pressure chamber A & B (Figure 3) to cold working pressure of 275 psi using air as test fluid. With minimum motive power of — Vac or 80 psi applied to actuator operate valve disc to full closed position.

b. Reduce air pressure to 75 psi in pressure chamber B, and to 275 psi in pressure chamber A, to obtain a differential pressure of 200 psi across the closed valve disc.

c. With minimum motive power of — Vac or 80 psi applied to actuator, open valve disc.

d. Repeat steps a, b, and c twice.

e. Data to be Recorded.

In step "a"	1st Cycle	2nd Cycle	3rd Cycle
Pressure in Chamber A	275 psi	275 psi	275 psi
Pressure in Chamber B	275 psi	275 psi	275 psi
Motive Power	(— Vac	— Vac	— Vac
	(80 psi	80 psi	80 psi
Operating Time			
Open to Close	2.1 sec	2.3 sec	2.2 sec
In step "b"			
Pressure in Chamber A	275 psi	275 psi	275 psi
Pressure in Chamber B	75 psi	75 psi	75 psi
Motive Power	(— Vac	— Vac	— Vac
	(80 psi	80 psi	80 psi
Operating Time			
Close to Open	3.1 sec	3.1 sec	3.0 sec

Job No. D-0089-A

f. Repeat steps a to d using nominal motive power of — Vac or 100 psi.

g. Data to be Recorded

Step f, a	1st Cycle	2nd Cycle	3rd Cycle
Pressure in Chamber A	275 psi	275 psi	275 psi
Pressure in Chamber B	275 psi	275 psi	275 psi
Motive	(— Vac	— Vac	— Vac
	(100 psi	100 psi	100 psi
Operating Time			
Open to Close	2.5 sec	2.5 sec	2.6 sec

Step f, b			
Pressure in Chamber A	275 psi	275 psi	275 psi
Pressure in Chamber B	75 psi	75 psi	75 psi
Motive	(— Vac	— Vac	— Vac
	(100 psi	100 psi	100 psi
Operating Time			
Close to Open	2.3 sec	2.3 sec	2.3 sec

h. With the test valve assembly depressurized and maximum power of — Vac or 110 psi applied to actuator, perform three operating cycles.

Data to be recorded:

Operating Time	1st Cycle	2nd Cycle	3rd Cycle
Open to Close	2.6 sec	2.6 sec	2.7 sec
Close to open	2.0 sec	2.1 sec	2.1 sec

i. Measured operating times within operating times specified in paragraph 1.3.6 are considered successful qualification of the test valve assembly.

4.3.0 To demonstrate cyclic operability of TVA under the most adverse combination of motive power, system pressure and loading representative of the maximum seismic incident, the test valve assembly is sandwiched between two test heads as shown in Figure 4.

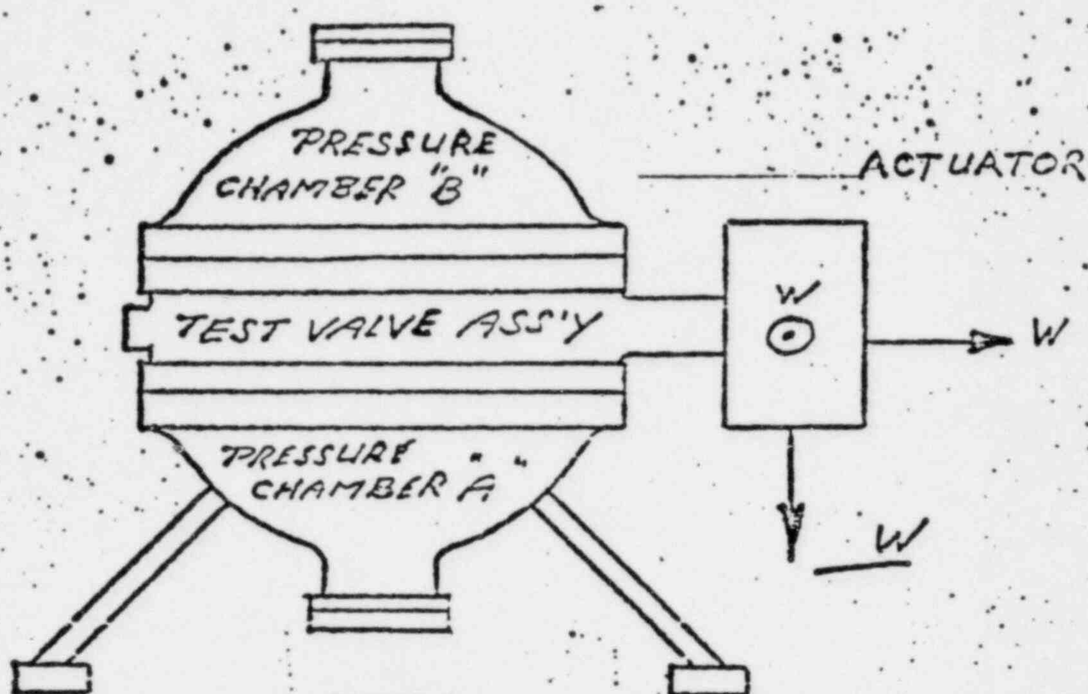


FIGURE 4

4.3.1 Pre-Test Inspection

4.3.2 Adjust limit switches for proper closed and open position of valve disc.

4.3.3 Measure motive power to actuator

— Vac   100 psi

4.3.4 Measure required torque settings of fasteners. (Ft. Lb.)

Bonnet to trunnion	Required 95	Measured 95
Bonnet ~~to adaptor plate~~	Required —	Measured —
~~Adaptor plate~~ to actuator	Required 95	Measured 95
Adaptor plate to trunnion	Required —	Measured —
Bottom cover to trunnion	Required 95	Measured 95

Job No. D-0089-9

4.3.5 Test Procedure (Appendix E)

a. The test valve assembly is subjected to a static load equivalent to 5 times the weight of the actuator applied simultaneously in each of the three mutually perpendicular axes through the center of gravity of the actuator and in the least rigid direction of the yoke. The least rigid direction of the yoke is determined as the direction of the yoke having the smaller moment of inertia.

b. With the static load applied as described in Paragraph (a) and with the valve disc in the full open position, pressurize pressure Chamber A and B to a cold working pressure 275 psi. Use air as test fluid. With minimum motive power of — Vac or 80 psi applied to actuator, operate valve disc to full closed position.

c. Reduce air pressure to 75 psi in pressure Chamber B and 275 psi in pressure Chamber A to obtain a differential pressure of 200 psi across valve disc.

d. With minimum motive power of — Vac or 80 psi applied to actuator, open valve disc.

e. Repeat Steps a, b, and c twice.

f. Data to be recorded:

In Step A

Pressure in Chamber A	275 psi	275 psi	275 psi
Pressure in Chamber B	275 psi	275 psi	275 psi
Motive Power	— Vac	— Vac	— psi
	80 psi	80 psi	80 psi

Operating Time

Open to Close	2.3 sec	2.3 sec	2.4 sec

Job No. D-0089-4

In step b	1st Cycle	2nd Cycle	3rd Cycle
Pressure in Chamber A	275 psi	275 psi	275 psi
Pressure in Chamber B	75 psi	75 psi	75 psi
Motive Power	(— Vac	— Vac	— Vac
	(80 psi	80 psi	80 psi
Operating Time			
Close to Open	3.0 sec	3.0 sec	3.0 sec

g. Repeat steps a to d using normal motive power of — Vac or 100 psi.

h. Data to be Recorded

Step g, b	1st Cycle	2nd Cycle	3rd Cycle
Pressure in Chamber A	275 psi	275 psi	275 psi
Pressure in Chamber B	275 psi	275 psi	275 psi
Motive Power	(— Vac	— Vac	— Vac
	(100 psi	100 psi	100 psi
Operating Time			
Open to Close	2.7 sec	2.5 sec	2.6 sec
Step g, c			
Pressure in Chamber A	275 psi	275 psi	275 psi
Pressure in Chamber B	75 psi	75 psi	75 psi
Motive Power	(— Vac	— Vac	— Vac
	(100 psi	100 psi	100 psi
Operating Time			
Close to Open	2.3 sec	2.2 sec	2.1 sec

i. With the test valve assembly depressurized and maximum motive power of — Vac or 110 psi applied to actuator, perform three operating cycles.

Job No. D-0089-4

Data to be recorded:

Operating time	1st Cycle	2nd Cycle	3rd Cycle
Open to Close	2.4 sec	2.7 sec	2.7 sec
Close to Open	1.9 sec	1.9 sec	1.9 sec

j. Measured operating times within operating times specified in paragraph 1.3.6 are considered successful qualification of the test valve assembly.

4.3.6 Valve Leakage Test

To demonstrate that the test valve is capable of meeting seat and shaft packing sealing requirements after exposure to the most adverse combination of motive power, system pressure and seismic loading tests, the test valve assembly is mounted on test stand with the valve shaft oriented horizontally as shown in Figure 5.

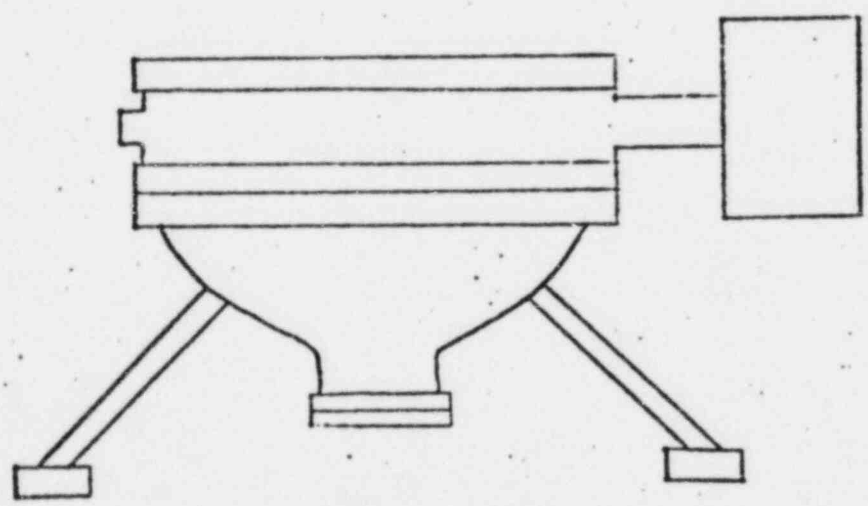


FIGURE 5

4.3.7 Pre-Test Inspection

4.3.8 Adjust limit switches for proper open and closed positions of valve disc.

4.3.9 Measure normal motive power to actuator.

— Vac 100 psi

Job No. D-0089-4

4.3.10 Measure required torque setting of fasteners. (Ft. Lb.)

Bonnet to trunnion	Required 95	Measured 95
Bonnet ~~to adaptor plate~~	Required —	Measured —
~~Adaptor plate~~ to actuator	Required 95	Measured 95
Adaptor plate to trunnion	Required —	Measured —
Bottom cover to trunnion	Required 95	Measured 95

4.3.11 Verify calibration of required test equipment.

4.3.12 Test Procedure (Appendix A)

a. With the test valve assembly in the most adverse position (as shown in Figure 1) operate the valve with normal motive power starting from full closed position three operating cycles.

Data to be Recorded

Motive Power — Vac 100 psi

Operating Time	1st Cycle	2nd Cycle	3rd Cycle
Closed to Open	2.3 sec	2.3 sec	2.3 sec
Open to Closed	2.4 sec	2.4 sec	2.4 sec

b. Repeat step a with minimum motive power.

Motive Power — Vac 80 psi

Operating Time	1st Cycle	2nd Cycle	3rd Cycle
Closed to Open	31 sec	3.0 sec	3.1 sec
Open to Closed	2.3 sec	2.4 sec	2.4 sec

c. With the valve disc in the closed position, cover the disc with a pool of water deep enough to submerge disc/seat interference line.

d. Using air as test fluid, pressurize valve assembly to 200 psi differential pressure across disc. Hold pressure for a time period of five minutes (A-3). Observe and record leakage (A-4). Bubble tight condition of valve seat is considered a successful qualification of TVA.

Leakage Observed NONE Bubble Tight TO ATLEAST 200 Psi

Job No. D-0089-4

e. Repeat steps c and d with pressure on opposite side of valve disc for bi-directional qualification.

Leakage Observed NONE   Bubble Tight To ATLEAST 200psi

f. For the packing leak test the TVA is to be sandwiched between two test heads as shown in Figure 6.

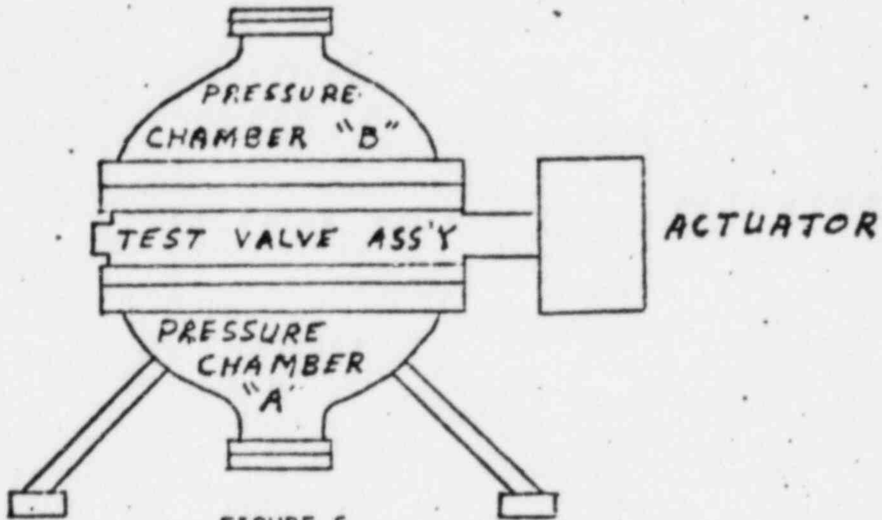


FIGURE 6

g. With normal motive power applied to the actuator, cycle the TVA 10 times. Record cycle time for the first and tenth cycles.

Data to be Recorded

Motive Power	— Vac	100 psi
1st Cycle	Open to Close	2.4 sec
	Close to Open	2.3 sec
10th Cycle	Open to Close	2.4 sec
	Close to Open	2.4 sec

h. With the valve disc in the open position, pressurize test valve assembly to cold working pressure of 275 psi using air as test fluid. Hold cold working pressure for a time period of 5 minutes. Observe leakage by applying soap solution around packing. Soap bubble tight condition of packing is considered successful qualification of TVA.

Leakage Observed NONE   Soap Bubble Tight To ATLEAST 275 PSI

Job No. D-0089-1

4.5.0 Vibration Test

To demonstrate operability of the test valve assembly during and after vibratory disturbances, and to establish the validity of natural frequency calculations the test valve assembly is to be mounted on a seismic test machine with the valve shaft oriented horizontally. (Para. 5.2 of Qualification Requirements)

4.5.1 Pre-Test Inspection

a. Receiving inspection - Identification and visual inspection of TVA for evidence of damage due to shipping. To be performed in the presence of HPCo. representative.

b. Description of test valve assembly mounting to seismic test machine - photograph of test apparatus to be included.

c. Adjust limit switches for proper open and closed position of valve disc.

d. Measure motive power to actuator.

— Vac 100 psi

e. Describe test equipment and calibration methods including location and number of control and response accelerometers.

4.5.2 Test Procedure

a. With the test valve assembly mounted to the seismic test machine in the most adverse position (para. 5.2 of Qualification Requirements) operate valve with nominal motive power starting from full closed position.

Measure and record:

Motive power — Vac 100 psi

Operating time

Closed to open 2.5 sec

Open to closed 2.6 sec

Job No. D-0089-4

b. Resonance search - A steady state sinusoidal resonant search to be performed in each of the three mutually perpendicular axis. Input test level amplitude to be at least 0.2g (zero to peak). The frequency range of 3.5 to 95 Hz to be covered with a sweep rate not exceeding one octave per minute. For the purpose of this test resonance is defined as a frequency at which acceleration of the actuator at the plane of the center of gravity perpendicular to the shaft centerline exceeds the input acceleration level by a factor of 3 or more.

c. Variable frequency test - A variable frequency test to be performed with a minimum input test level of 0.5 g (zero to peak) in the mutually perpendicular axis of the following frequencies. 3.5, 4.5, 6, 8, 11, 15, 21, 29, 39, 53, 71, and 95 Hz. At each of the above frequencies repeat step a and record motive power and each helf of operating time.

d. Endurance test - The test valve assembly to be vibrated with a minimum input of 0.5g (zero to peak) in the three mutually perpendicular axis at resonant frequencies found in step b and at 33 Hz, for a time period of three minutes. At the conclusion of each of the three minute vibration test with the test assembly still vibrating, operability of the test valve assembly to be demonstrated by performing step a.

e. Measured operating times within operating time specified in paragraph 1.3.6 and rechecked in para. a are considered successful qualification of test valve assembly.

SEE ATTACHED Wyle LABORATORIES TEST REPORT DATED 8-20-79

4.5.3 Explanation of Vibration Test Report:

4.5.3.1 The following Wyle Laboratories Test Report (No. 44679-1) shows transmissibility plots for various pairs of accelerometers.

In conjunction with the Bechtel approved procedure developed to show compliance with the requirements of specifications 9645-M-257.0, 9645-M-258.0 and paragraph 4.5.2B on page 18 of this report, a transmissibility factor of three or more defines a natural frequency for the valve/operator assembly.

The transmissibility plots on pages 21, 31 and 41 of the Wyle Seismic Simulation Test Report (No. 44679-1) show that in the three major axes of excitation, the lowest natural frequencies occur at 41 and 78 Hz for the X and Y axes, respectively. There were no natural frequencies found below 95 Hz in the Z axis.

The other plots of transmissibility are included for informational purposes only and are not intended to demonstrate valve/operator rigidity. First, those plots that include accelerometers HCA and VCA show the shaker table and mounting structure responses and cannot be applied to the valve assembly. Secondly, the plots that are of cross coupling (i.e. input acceleration in one direction and output acceleration measured in another direction) are not relevant to the structural rigidity.

Since the transmissibility plots on pages 21, 31 and 41 of Wyle Laboratories Seismic Simulation Report (No. 44679-1) show the absence of natural frequencies below 33 Hz, we certify that the valve and operator structure is a rigid body at frequencies below 33 Hz and that this report meets the requirements of Bechtel Specification No.'s 9645-M-257.0 and 9645-M-258.0.

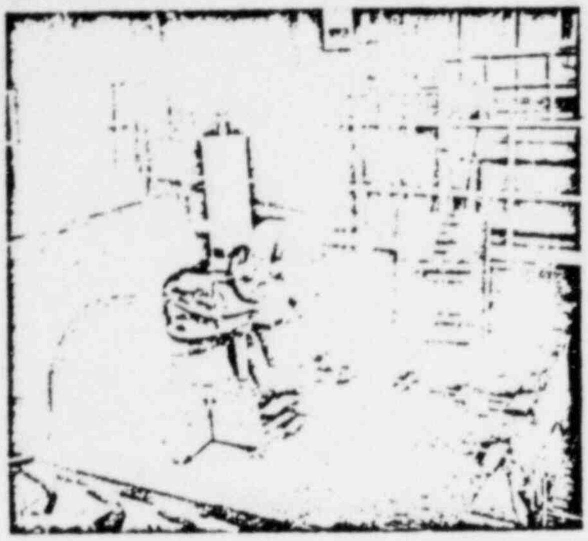
SEISMIC SIMULATION TEST PROGRAM

ON

A 12" VALVE ASSEMBLY

FOR

HENRY PRATT COMPANY
401 SOUTH HIGHLAND AVENUE
AURORA, ILLINOIS 60507



SEISMIC SIMULATION
Test Report

REPORT NO. 44679-1

WYLE JOB NO. 44679

CUSTOMER P. O. NO. B8429

PAGE 1 OF 60 PAGE REPORT

DATE August 20, 1979

SPECIFICATION (S) See References in Section 7.0

1.0 CUSTOMER Henry Pratt Company

ADDRESS 401 South Highland Avenue, Aurora, Illinois 60507

2.0 TEST SPECIMEN 12" Valve Assembly

3.0 MANUFACTURER Henry Pratt Company

4.0 SUMMARY

A 12" Valve Assembly, hereinafter called the specimen, was subjected to a Seismic Simulation Test Program as required by the Henry Pratt Purchase Order Number B8429, and Wyle Laboratories' Seismic Test Procedure 541/2014/DK, dated June 26, 1979, Revision A.

The test program consisted of single-axis sine sweep testing, single-axis variable frequency testing, and single-axis endurance testing. The specimen was instrumented with accelerometers and electrically and pneumatically powered and monitored for functional operation during the test program.

It was demonstrated that the specimen possessed sufficient integrity to withstand, without compromise of structure or function, the prescribed seismic environment.

STATE OF ALABAMA
COUNTY OF MADISON } ss

Ala. Professional Eng. Reg. No. 6363

James W. Foreman, being duly sworn, deposes and says: 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.

SEAL James W. Foreman

SUBSCRIBED and sworn to before me this 24th day of August 1979

Virginia R. Dent

Notary Public in and for the County of Madison, State of Alabama.

My Commission expires June 13, 1983

PREPARED BY Bruce L. Fowler
B. Fowler

APPROVED BY Herschel D. Jordan

WYLE Q. A. M. Kimbrell

WYLE LABORATORIES
SCIENTIFIC SERVICES AND SYSTEMS GROUP
HUNTSVILLE, ALABAMA

4.0 SUMMARY (Continued)

Table I contains the test run descriptions, including test numbers, axes, frequencies, and input acceleration.

Photograph 1 shows the specimen mounted on the Wyle Multiaxis Seismic Simulator Table.

Photographs 2 and 3 show the specimen-mounted accelerometers.

Appendix I contains transmissibility plots of the specimen response accelerometers.

Appendix II contains the Instrumentation Log Sheets and the Instrumentation Equipment Sheets.

Appendix III contains the Wyle Seismic Test Procedure 541/2014/DK, dated June 26, 1979, Revision A.

5.0 TEST REQUIREMENTS

5.1 Specimen Mounting and Orientation

A 12" Valve Assembly, hereinafter called the specimen, shall be installed on Wyle's Multiaxis Seismic Simulator Table. The specimen shall be tested in the first horizontal (X) axis and then rotated 90 degrees about its vertical centerline for the second test orientation. The specimen valve stem shall remain horizontal during the test. The specimen shall be tested in the following sequence:

1) Pretest Functional
2) Sine Sweep [1st horizontal (X) axis]
3) Sine Sweep [vertical (Y) axis]
4) Variable Frequency Test [1st horizontal (X) axis]
5) Variable Frequency Test [vertical (Y) axis]
6) Endurance Test [1st horizontal (X) axis]
7) Endurance Test [vertical (Y) axis]
8) Post-Test Functional
9) Sine Sweep [2nd horizontal (Z) axis]
10) Variable Frequency Test [2nd horizontal (Z) axis]
11) Endurance Test [2nd horizontal (Z) axis]
12) Post-Test Functional

5.2 Sine Sweep Test

A sine sweep test (approximately 0.2 g) from 3.5 to 95 Hz shall be performed in each of the three orthogonal axes. The sweep rate shall be one octave per minute.

5.3 Variable Frequency Test

A variable frequency (sine dwell) test shall be performed in each of the three orthogonal axes. The input test level shall be approximately 0.5 g (within the limitations of the test machine) at the following frequencies: 3.5, 4.5, 6, 8, 11, 15, 21, 29, 39, 53, 71, and 95 Hz. Duration of the test shall be sufficient to allow the specimen to cycle close to open to close.

5.0 TEST REQUIREMENTS (Continued)

5.4 Endurance Test

An endurance test (sine dwell) shall be performed in each of the three orthogonal axes. The input test level shall be approximately 0.5 g (within the limitations of the test machine) at the resonant frequencies* found in Paragraph 5.2 and at 33 Hz. Duration of the test shall be at least three (3) minutes.

*Resonant frequencies are defined as a frequency at which the acceleration of the actuator center of gravity exceeds the input acceleration level by a factor of 3 or more.

5.5 Specimen Response

Six (6) specimen-mounted uniaxial piezo-electric accelerometers shall be provided for the specimen during the test. Placement of the accelerometers shall be as directed by the Henry Pratt Technical Representative or the Wyle Test Engineer. The accelerometers shall be recorded on FM tape and oscillograph recorders during the sine sweep test. Transmissibility plots of these accelerometers shall be provided in the test report.

5.6 Electrical Powering

Standard electrical power of 120 VAC shall be provided for the specimen.

5.7 Pneumatics

Air at a pressure of 80-110 psig shall be provided for the specimen.

5.8 Electrical Monitoring

Two (2) electrical monitoring channels shall be provided for the specimen. One (1) of the electrical monitoring channels shall monitor the solenoid voltage for the actuator. One (1) channel shall consist of a potentiometer used to monitor the shaft position of the specimen. The electrical monitoring channel and the output of the potentiometer shall be recorded on an oscillograph recorder.

5.9 Functional Tests

The specimen shall be operated prior to and after the test program and the cycling time recorded. During the variable frequency test and at the conclusion of the endurance test (after each 3-minute test), the specimen shall be operated and the cycling time recorded.

6.0 TEST PROCEDURES AND RESULTS

6.1 Specimen Mounting and Orientation Procedures

The specimen, described in Paragraph 5.1, was installed on Wyle's Multi-axis Seismic Simulator Table. The specimen was tested in the X and Y axes and then rotated 90 degrees about its vertical centerline for testing in the Z axis (see Photograph 1 for orientation of axes). The specimen was attached to a Wyle-fabricated fixture such that its valve stem remained horizontal throughout the test. Specimen mounting simulated in-service mounting conditions as closely as practical. The specimen was tested as shown below:

1) Pretest Functional
2) Sine Sweep (X axis)
3) Sine Sweep (Y axis)
4) Variable Frequency Test (X axis)
5) Variable Frequency Test (Y axis)
6) Endurance Test (X axis)
7) Endurance Test (Y axis)
8) Post-Test Functional
9) Sine Sweep (Z axis)
10) Variable Frequency Test (Z axis)
11) Endurance Test (Z axis)
12) Post-Test Functional

6.2 Sine Sweep Test Procedures

A low-level (approximately 0.2 g) single-axis sine sweep test, from 3.5 Hz to 95 Hz, was performed in each test axis to establish major resonances. The sweep rate was one octave per minute.

6.2.1 Sine Sweep Test Results

A description of the sine sweep tests, including test numbers, axes and input accelerations, are contained in Table I.

6.0 TEST PROCEDURES AND RESULTS (Continued)

6.2 Sine Sweep Test Procedures (Continued)

6.2.1 Sine Sweep Test Results (Continued)

Transmissibility plots of the specimen response accelerometers divided by the control accelerometers from the sine sweep tests are presented in Appendix I. In addition, transmissibility plots of the actuator center of gravity response accelerometer divided by the valve body response accelerometer are included in Appendix I.

It was demonstrated that the specimen possessed sufficient integrity to withstand the sine sweep tests without compromise of structure function.

6.3 Variable Frequency Test Procedures

A variable frequency (sine dwell) test was performed in each of the three orthogonal axes. The input test level was 0.5 g at the following frequencies: 3.5, 4.5, 6, 8, 11, 15, 21, 29, 39, 53, 71, and 95 Hz. Duration of the test was sufficient to allow the specimen to cycle close to open to close.

6.3.1 Variable Frequency Test Results

It was demonstrated that the specimen possessed sufficient integrity to withstand, without compromise of structure or function, the prescribed simulated environment.

A description of the variable frequency tests, including test numbers, axes, frequencies, and input accelerations are contained in Table I.

6.4 Endurance Test Procedures

An endurance test (sine dwell with 0.5 g input) was performed in each of the three orthogonal axes at resonant frequencies* found in Paragraph 6.2 and at 33 Hz. Duration of the test was three (3) minutes. The specimen was cycled close to open to close after three minutes while the specimen was still vibrating.

*Resonant frequencies were defined as a frequency at which the acceleration of the actuator center of gravity exceeded the valve body acceleration level by a factor of 3 or more.

6.4.1 Endurance Test Results

The specimen demonstrated sufficient integrity to withstand the endurance test without compromise of structure or function.

A description of the endurance tests, including test numbers, axes, frequencies, and input accelerations, are contained in Table I.

6.0 TEST PROCEDURES AND RESULTS (Continued)

6.5 Specimen Response Procedures

Six (6) specimen-mounted uniaxial piezo-electric accelerometers were provided for the specimen during the test. Placement of the accelerometers was directed by the Henry Pratt Technical Representative. The accelerometers were recorded on FM tape and oscillograph recorders during the sine sweep test.

Photographs 2 and 3 show the accelerometer locations.

6.5.1 Specimen Response Results

Transmissibility plots of the specimen response accelerometers divided by the control accelerometers from the sine sweep tests are presented in Appendix II.

6.6 Electrical Powering Procedures

Standard electrical power of 120 VAC was provided for the specimen to actuate the solenoid valve.

6.7 Pneumatics Procedures

Air at a pressure of 80-110 psig was provided for the specimen.

6.7.1 Pneumatics Results

Air pressure readings taken prior to the open and close cycles are contained in Appendix I.

6.8 Electrical Monitoring Procedures

Two (2) electrical monitoring channels were provided for the specimen during the seismic testing. One (1) of the electrical monitoring channels monitored the solenoid voltage for the actuator and one (1) channel consisted of a potentiometer used to monitor the shaft position of the specimen. The electrical monitoring channel and the output of the potentiometer were recorded on an oscillograph recorder.

6.8.1 Electrical Monitoring Results

It was demonstrated that the specimen possessed sufficient integrity to withstand, without compromise of electrical function, the simulated seismic environment.

6.0 TEST PROCEDURES AND RESULTS (Continued)

6.9 Function Tests

The specimen was operated prior to and after the test program and the cycling time recorded. During the variable frequency test and at the conclusion of the endurance test, the specimen was operated and the cycling time recorded.

Functional Test Results

The cycling time in going from close to open ranged between 1.0 and 1.7 seconds. The cycling time in going from open to close ranged between 0.42 and 0.50 seconds.

Cycling times are contained in Table I.

7.0 REFERENCES

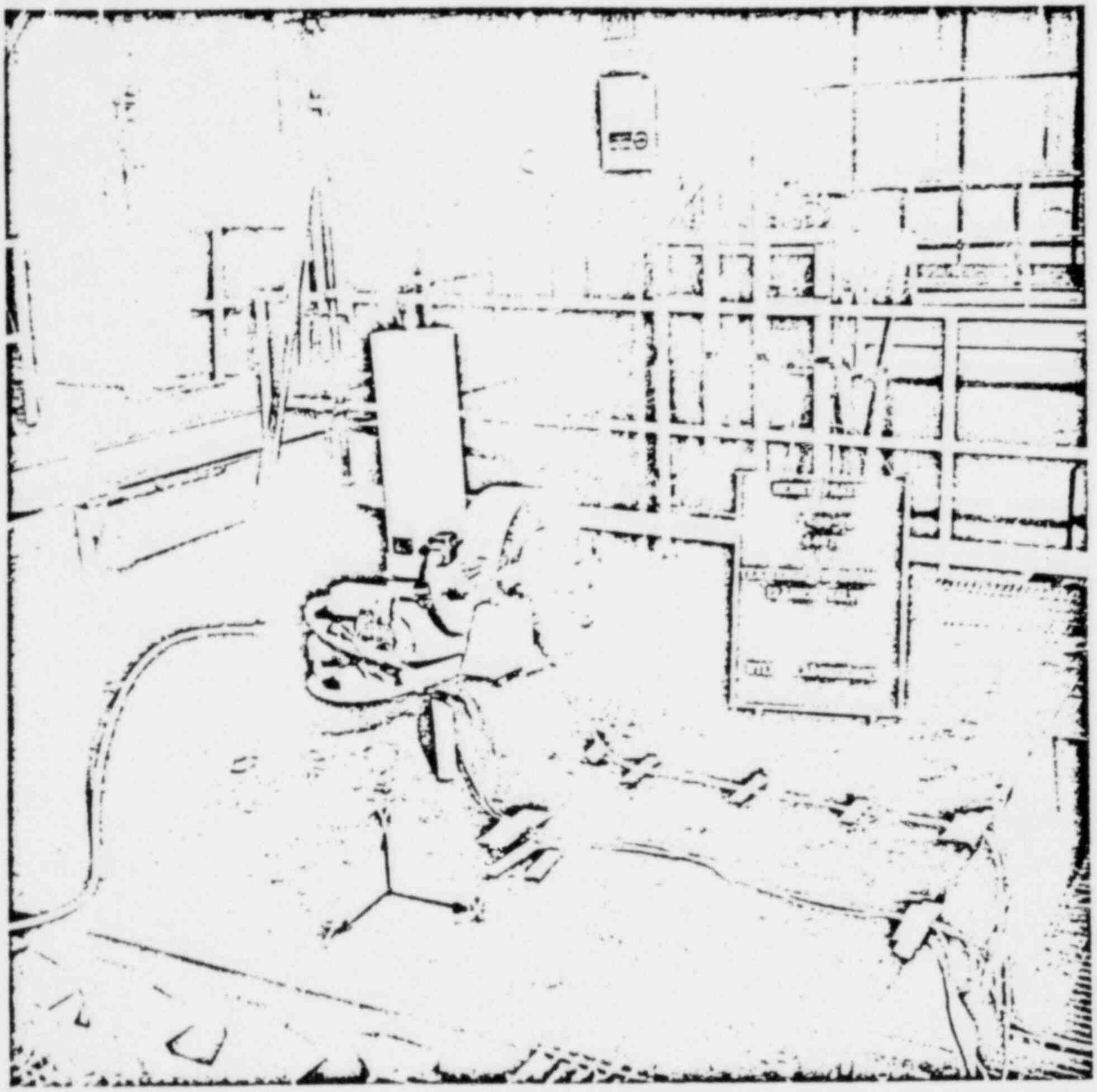
7.1 The Henry Pratt Purchase Order Number B8429.

7.2 Wyle Laboratories' Seismic Test Procedure 541/2014/DK, dated June 26, 1979, Revision A.

TABLE I

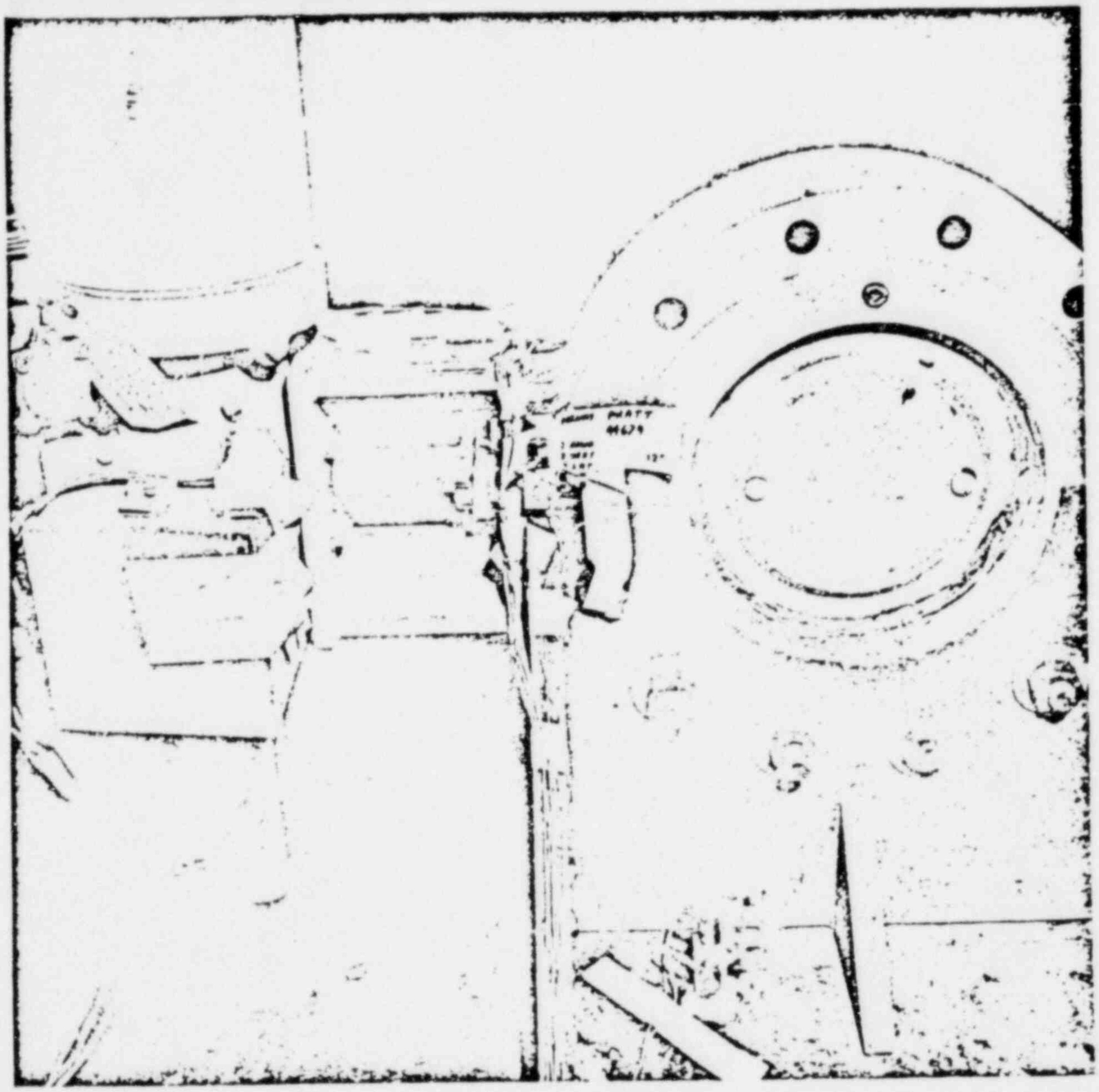
TEST RUN DESCRIPTIONS

TEST NO.	TYPE OF TEST	AXIS	INPUT ACCELERATION (G)	PRESSURE (PSIG)		FREQUENCY (HZ)	STROKE TIME (SEC)	
				OPEN	CLOSE		OPEN	CLOSE
1	Sine Sweep	X	0.2	-	-	3.5-95	-	-
2	Sine Sweep	Y	0.2	-	-	3.5-95	-	-
3	Variable Frequency	X	0.5	84	80	3.5	1.5	0.45
4	Variable Frequency	X	0.5	86	86	4.5	1.2	0.48
5	Variable Frequency	X	0.5	100	96	6.0	1.1	0.45
6	Variable Frequency	X	0.5	102	100	8.0	1.05	0.45
7	Variable Frequency	X	0.5	90	80	11.0	1.2	0.48
8	Variable Frequency	X	0.5	82	80	15.0	1.5	0.45
9	Variable Frequency	X	0.5	90	86	21.0	1.4	0.45
10	Variable Frequency	X	0.5	98	94	29.0	1.2	0.45
11	Variable Frequency	X	0.5	102	100	39.0	1.05	0.48
12	Variable Frequency	X	0.5	88	80	53.0	1.4	0.50
13	Variable Frequency	X	0.5	86	80	71.0	1.4	0.42
14	Variable Frequency	X	0.5	88	82	95.0	1.4	0.42
15	Variable Frequency	Y	0.5	102	97	3.5	1.1	0.45
16	Variable Frequency	Y	0.5	100	88	4.5	1.2	0.48
17	Variable Frequency	Y	0.5	80	80	6.0	1.7	0.48
18	Variable Frequency	Y	0.5	88	82	8.0	1.3	0.45
19	Variable Frequency	Y	0.5	90	86	11.0	1.2	0.45
20	Variable Frequency	Y	0.5	94	90	15.0	1.1	0.48
21	Variable Frequency	Y	0.5	100	96	21.0	1.1	0.48
22	Variable Frequency	Y	0.5	103	97	29.0	1.1	0.45
23	Variable Frequency	Y	0.5	104	100	39.0	1.0	0.48
24	Variable Frequency	Y	0.5	92	82	53.0	1.3	0.45
25	Variable Frequency	Y	0.5	82	80	71.0	1.5	0.48
26	Variable Frequency	Y	0.5	90	86	95.0	1.2	0.48
27	Endurance Test	X	0.5	88	80	33.0	1.3	0.45
28	Endurance Test	X	0.5	103	99	41.0	1.1	0.45
29	Endurance Test	X	0.5	88	82	52.0	1.3	0.45
30	Endurance Test	Y	0.5	80	80	33.0	1.6	0.45
31	Endurance Test	Y	0.5	100	96	[illegible]3.0	1.1	0.48
32	Endurance Test	Y	0.5	84	80	88.0	1.45	0.48
33	Sine Sweep	Z	0.2	-	-	3.5-95	-	-
34	Variable Frequency	Z	0.5	100	86	3.5	1.2	0.48
35	Variable Frequency	Z	0.5	94	86	4.5	1.2	0.45
36	Variable Frequency	Z	0.5	102	94	6.0	1.1	0.45
37	Variable Frequency	Z	0.5	104	99	8.0	1.0	0.48
38	Variable Frequency	Z	0.5	103	91	11.0	1.1	0.45
39	Variable Frequency	Z	0.5	88	80	15.0	1.3	0.42
40	Variable Frequency	Z	0.5	96	88	21.0	1.2	0.45
41	Variable Frequency	Z	0.5	102	84	29.0	1.1	0.48
42	Variable Frequency	Z	0.5	105	99	39.0	1.1	0.48
43	Variable Frequency	Z	0.5	92	83	53.0	1.3	0.46
44	Variable Frequency	Z	0.5	106	96	71.0	1.1	0.48
45	Variable Frequency	Z	0.5	104	100	95.0	1.1	0.48
46	Endurance Test	Z	0.5	90	84	33.0	1.3	0.48
47	Endurance Test	Z	0.5	86	79	38.0	1.4	0.42



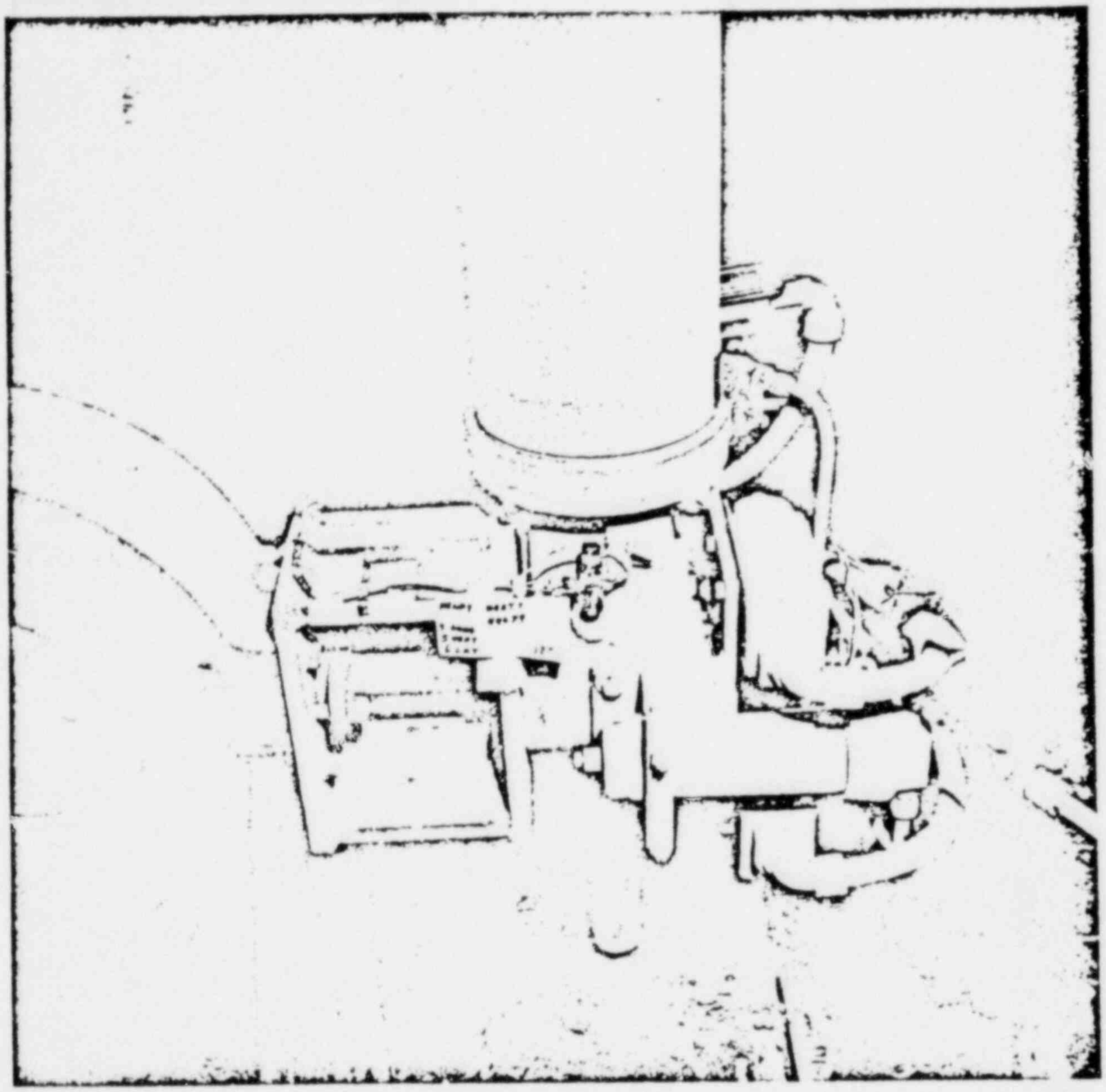
PHOTOGRAPH 1

TEST SETUP



PHOTOGRAPH 2

ACCELEROMETER LOCATIONS, 1X, 2Y, 3Z



PHOTOGRAPH 3

ACCELEROMETER LOCATIONS 3X, 4Y, 5Z

APPENDIX I

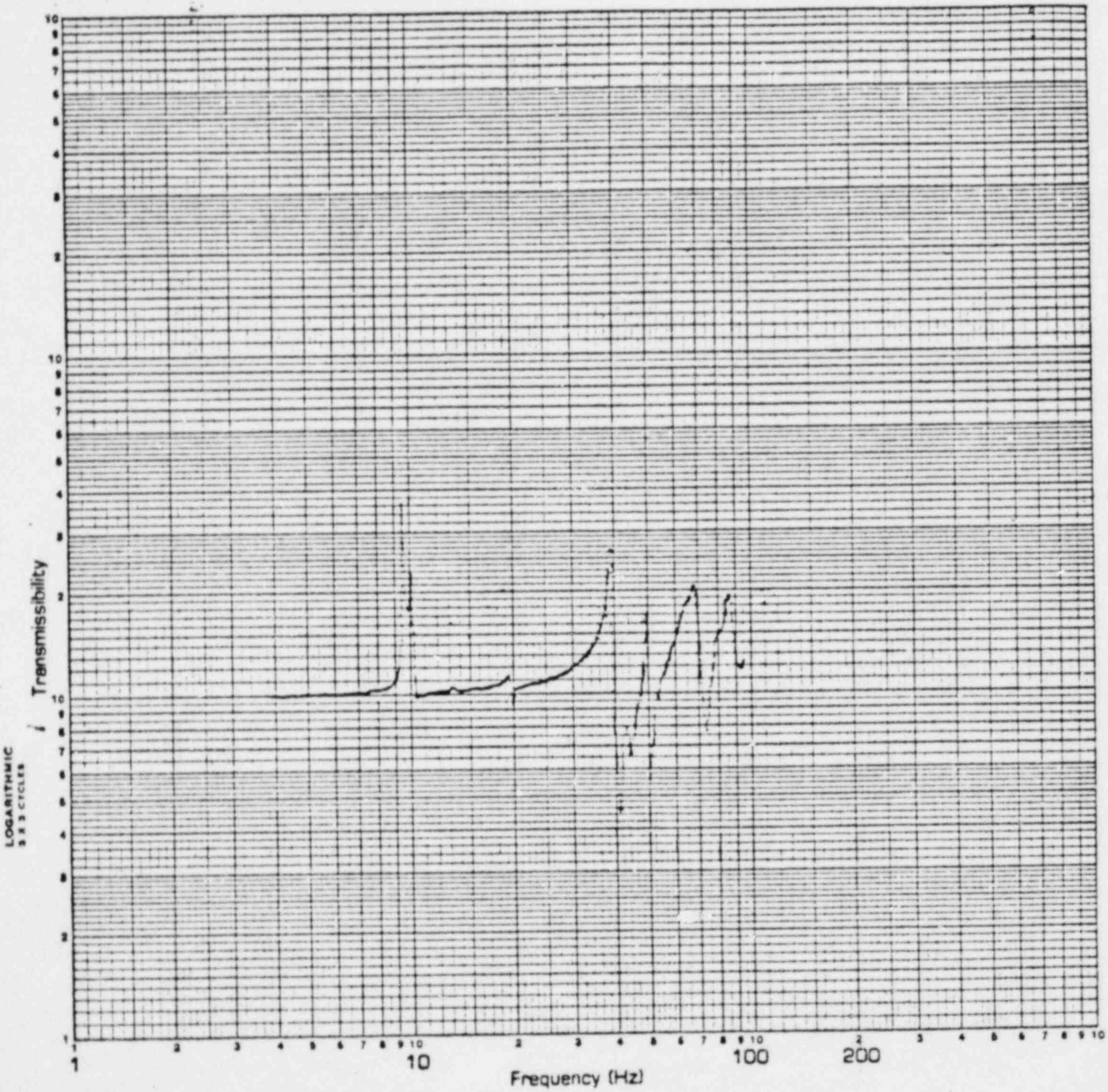
TRANSMISSIBILITY PLOTS

Test Run 1	X Axis (Longitudinal)
Test Run 2	Y Axis (Vertical)
Test Run 33	Z Axis (Lateral)

HCA = Horizontal Control Accelerometer
VCA = Vertical Control Accelerometer

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

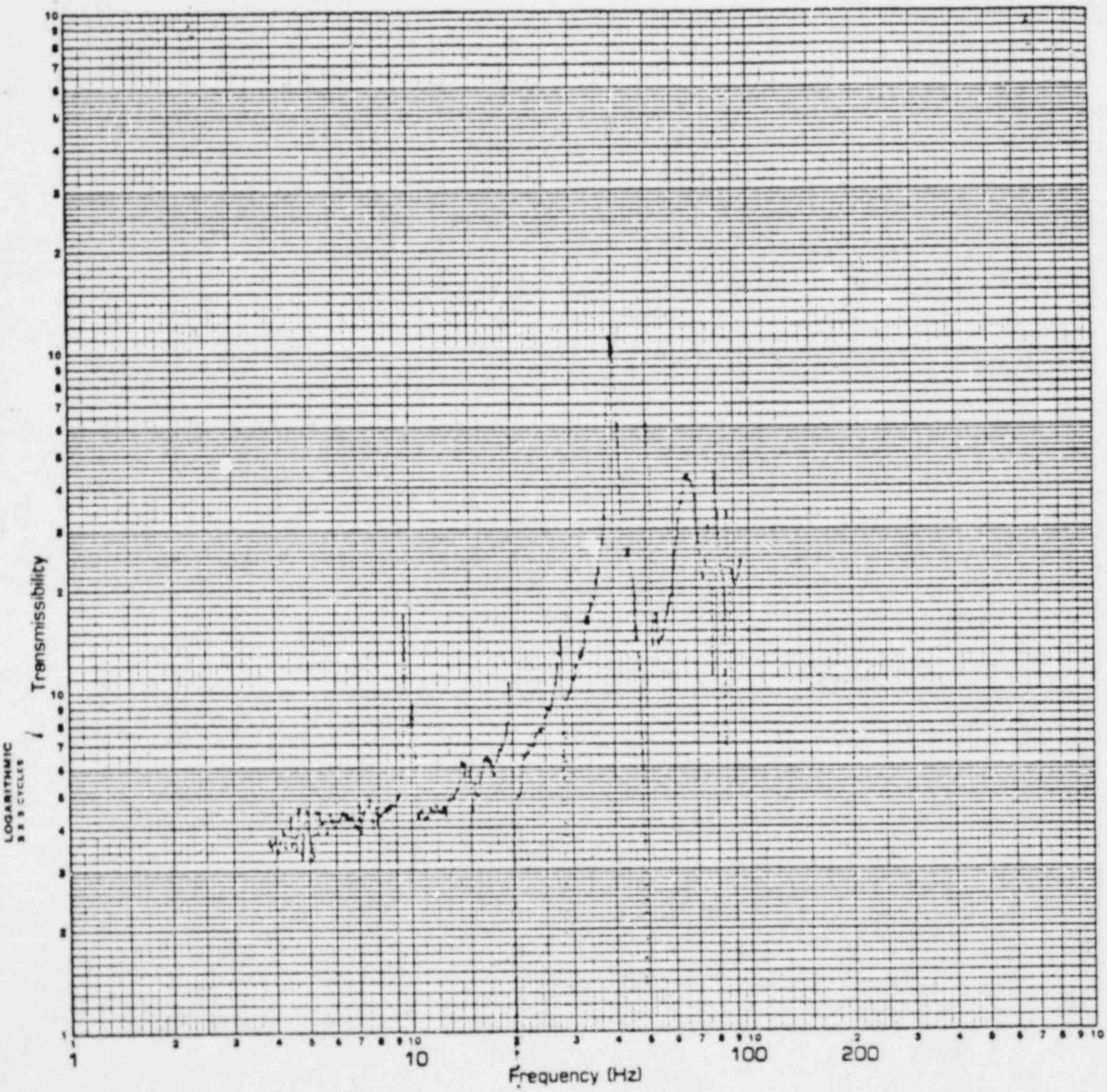
AXIS LONG

ACCEL NO. 1 LONG NO. HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 12"

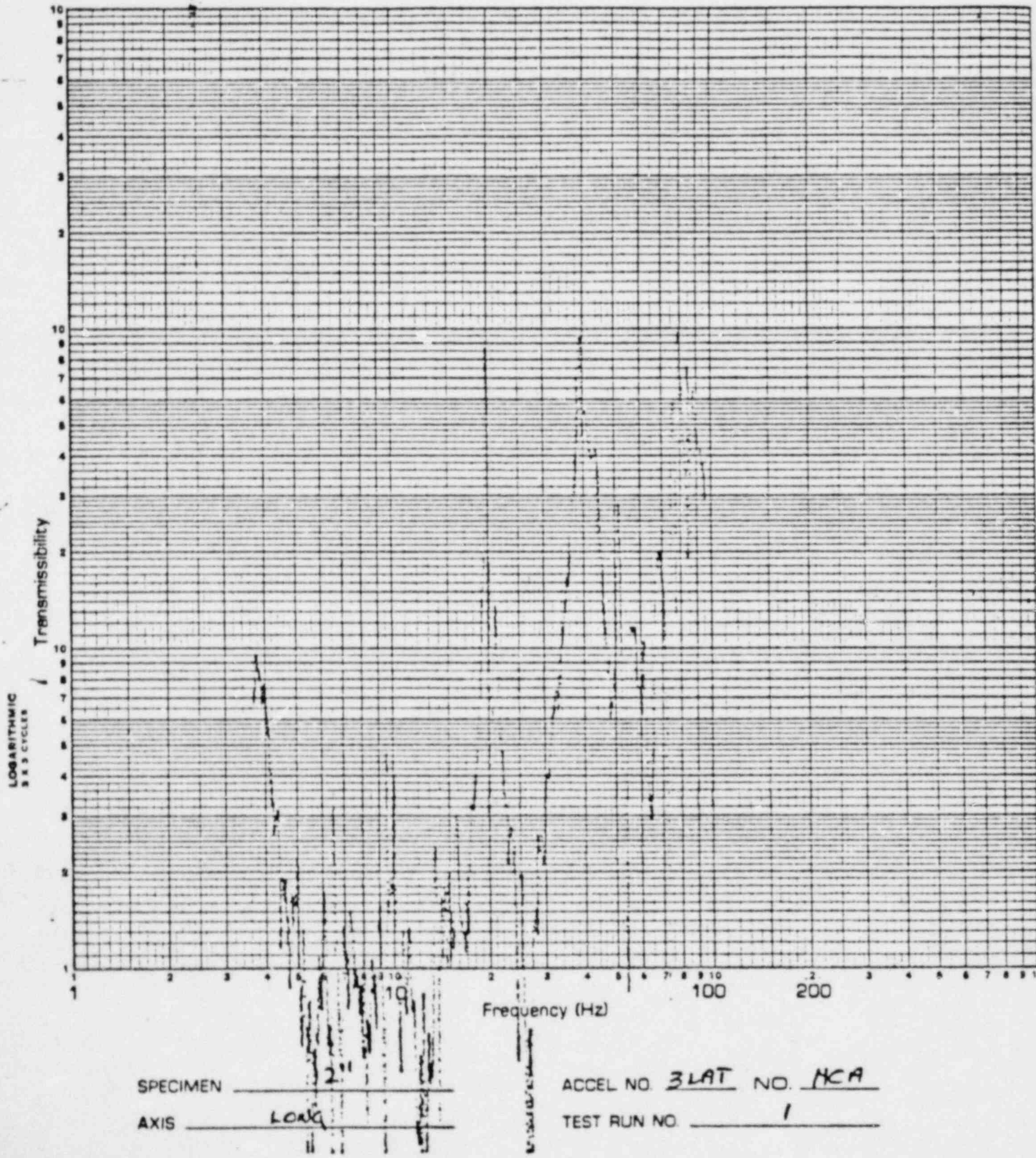
AXIS LONG

ACCEL NO. 2VERT NO. HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 2"

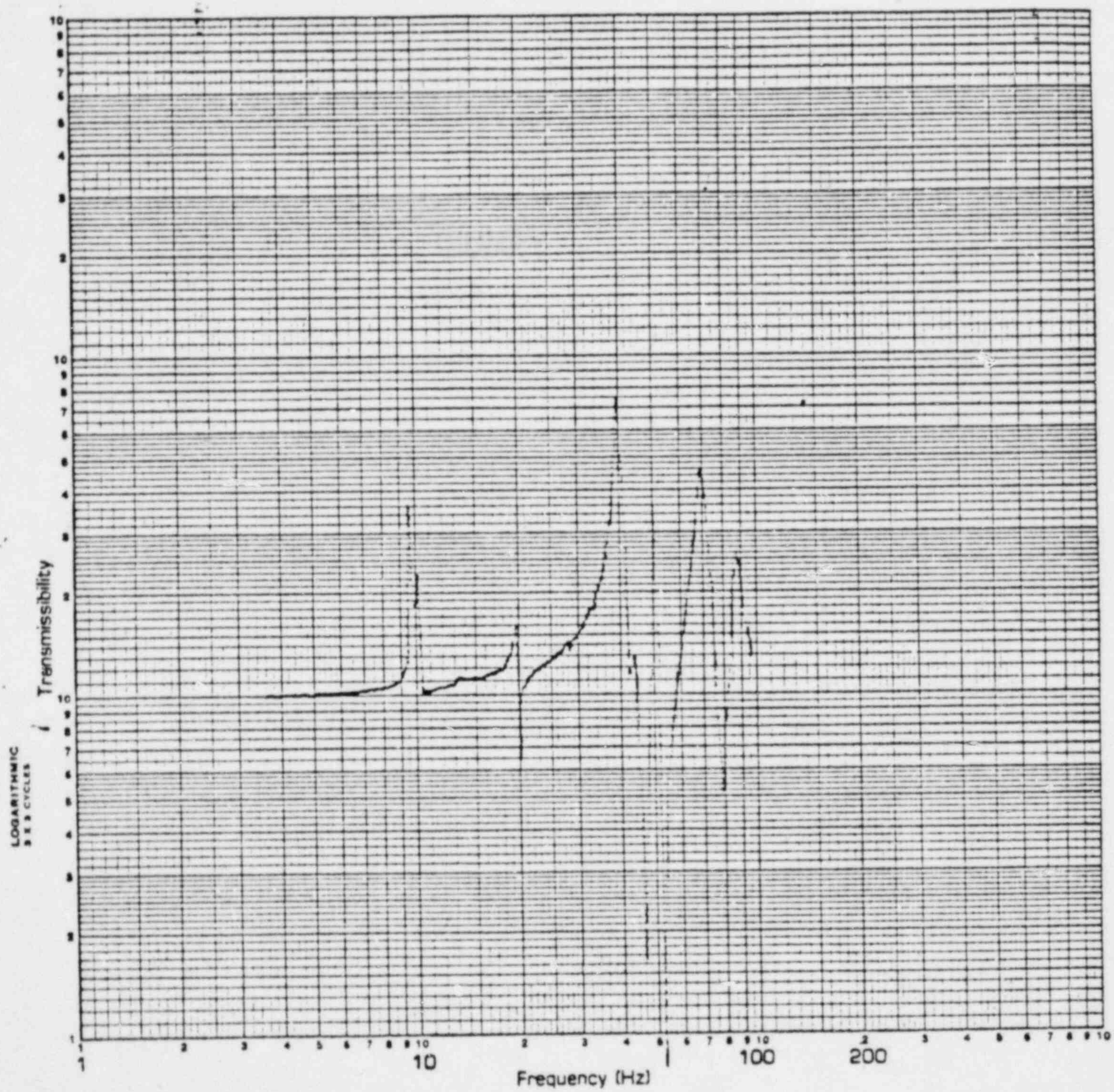
AXIS LONG

ACCEL NO. 3LAT NO. HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

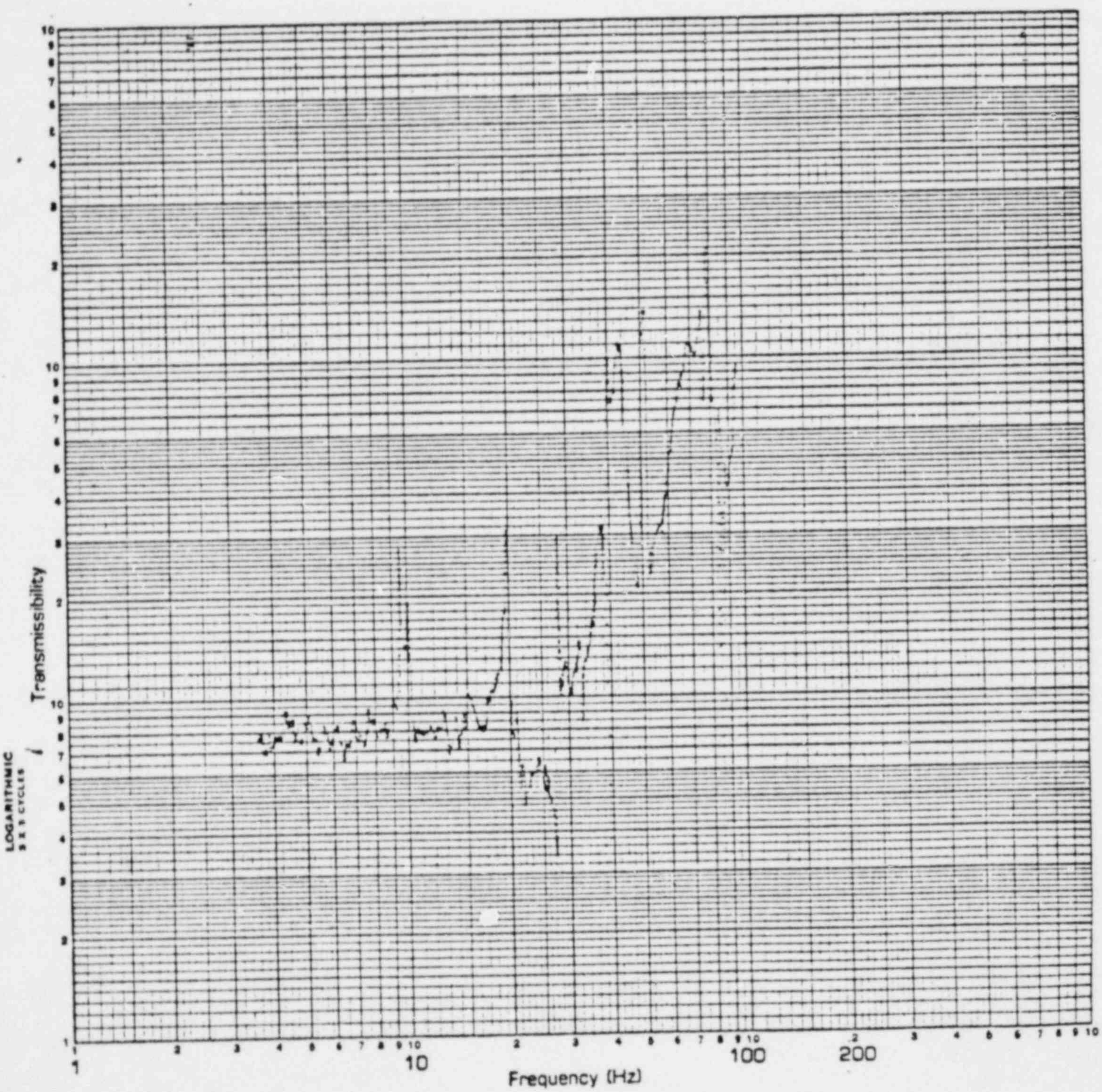
AXIS LONG

ACCEL NO 4 LONG NO. HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 12"

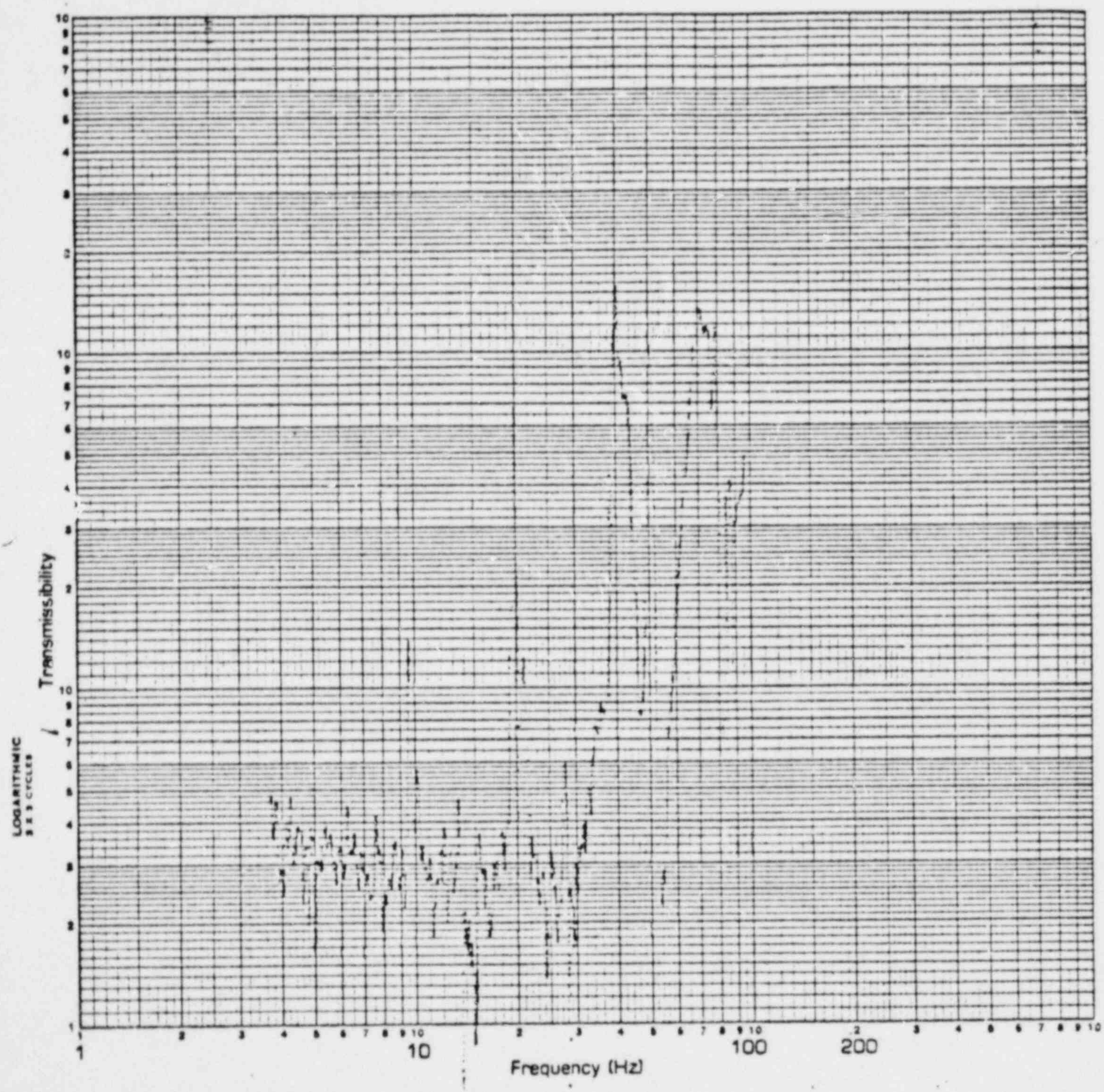
AXIS LONG

ACCEL NO. 5 VERT NO. HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☑ 100 ☐ 1000 ☐



SPECIMEN 12"

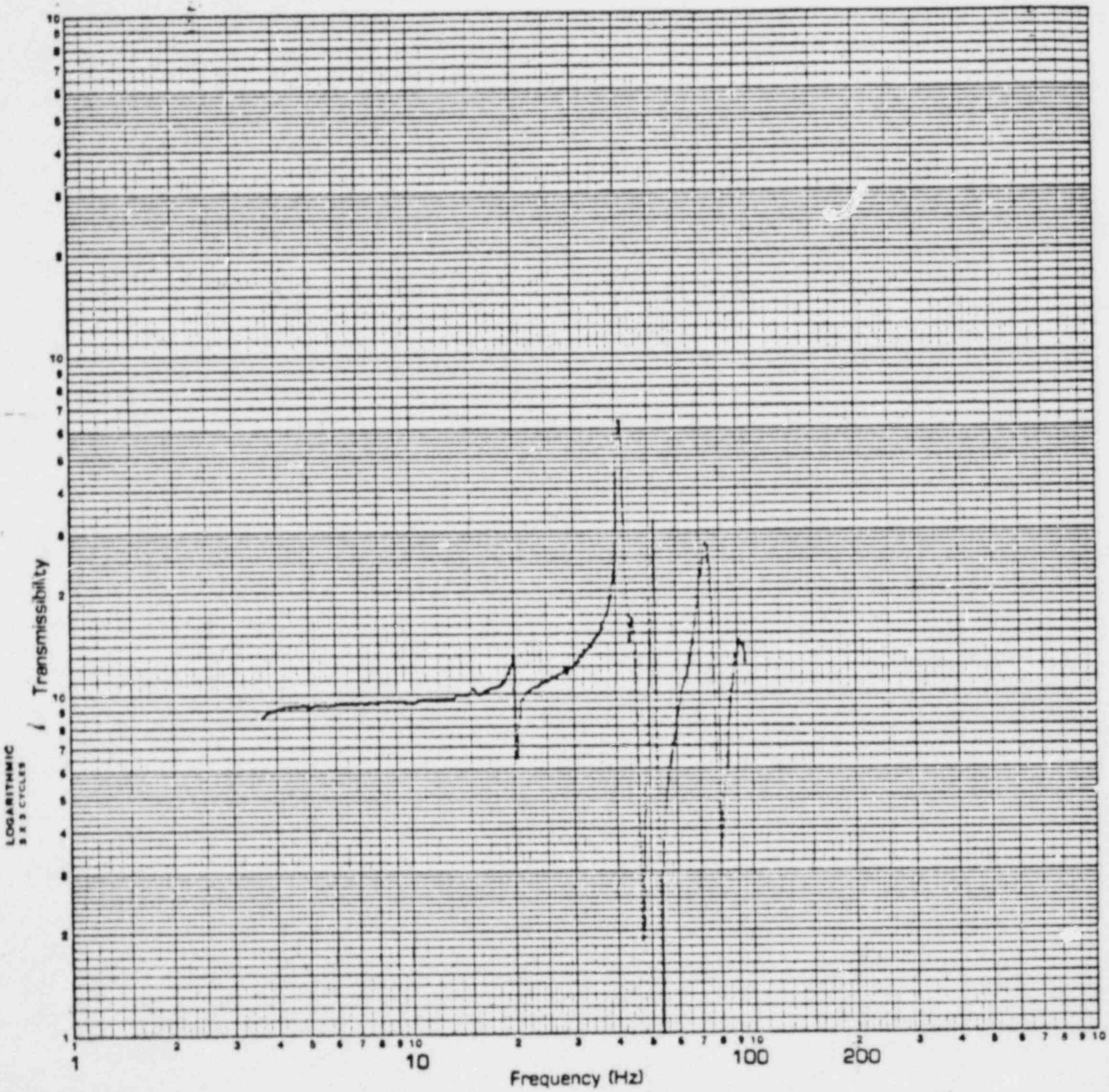
AXIS LONG

ACCEL NO. 6LHT NO. HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

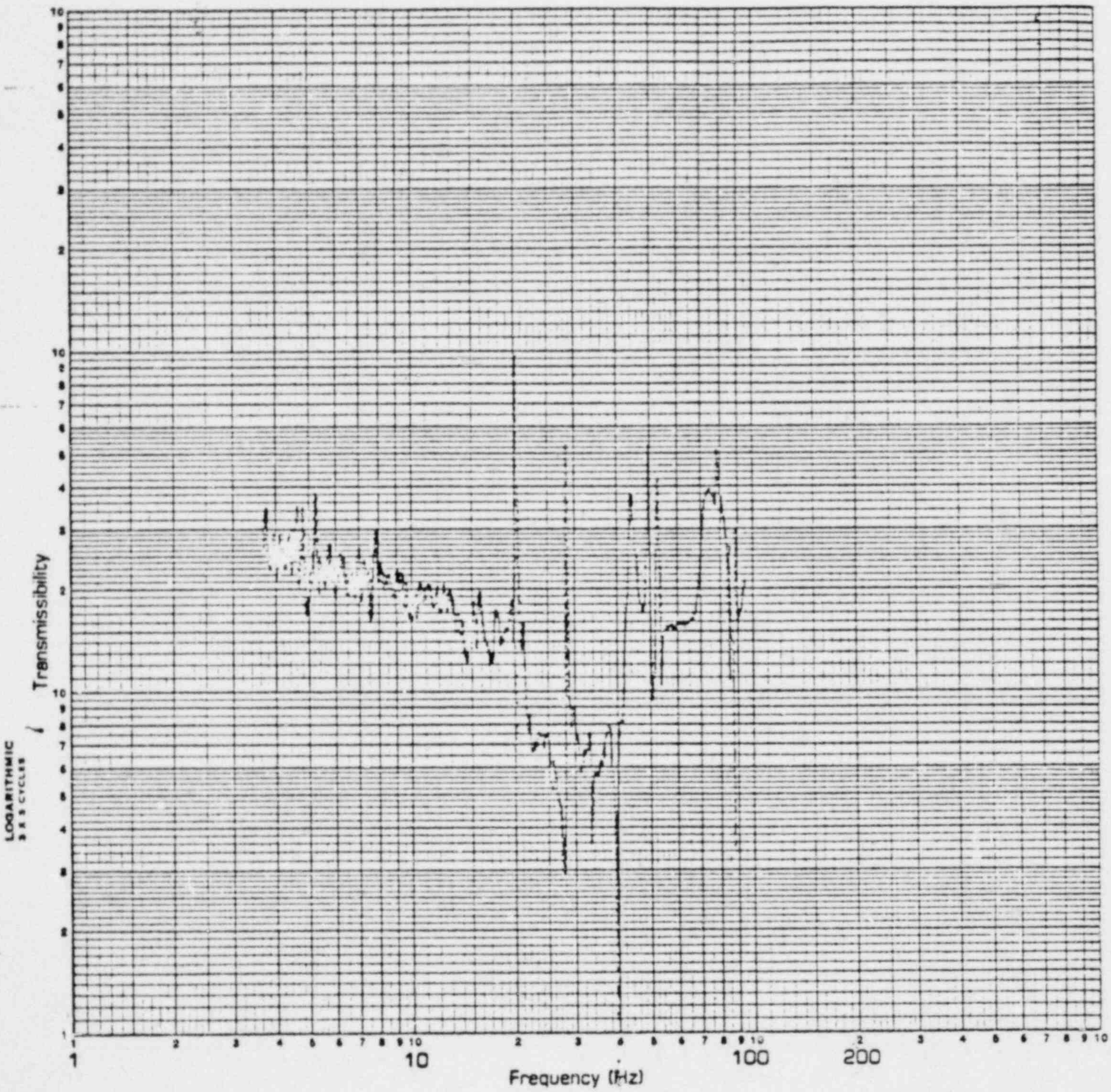
AXIS LONG

ACCEL NO. 4LONG NO. 1LONG

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

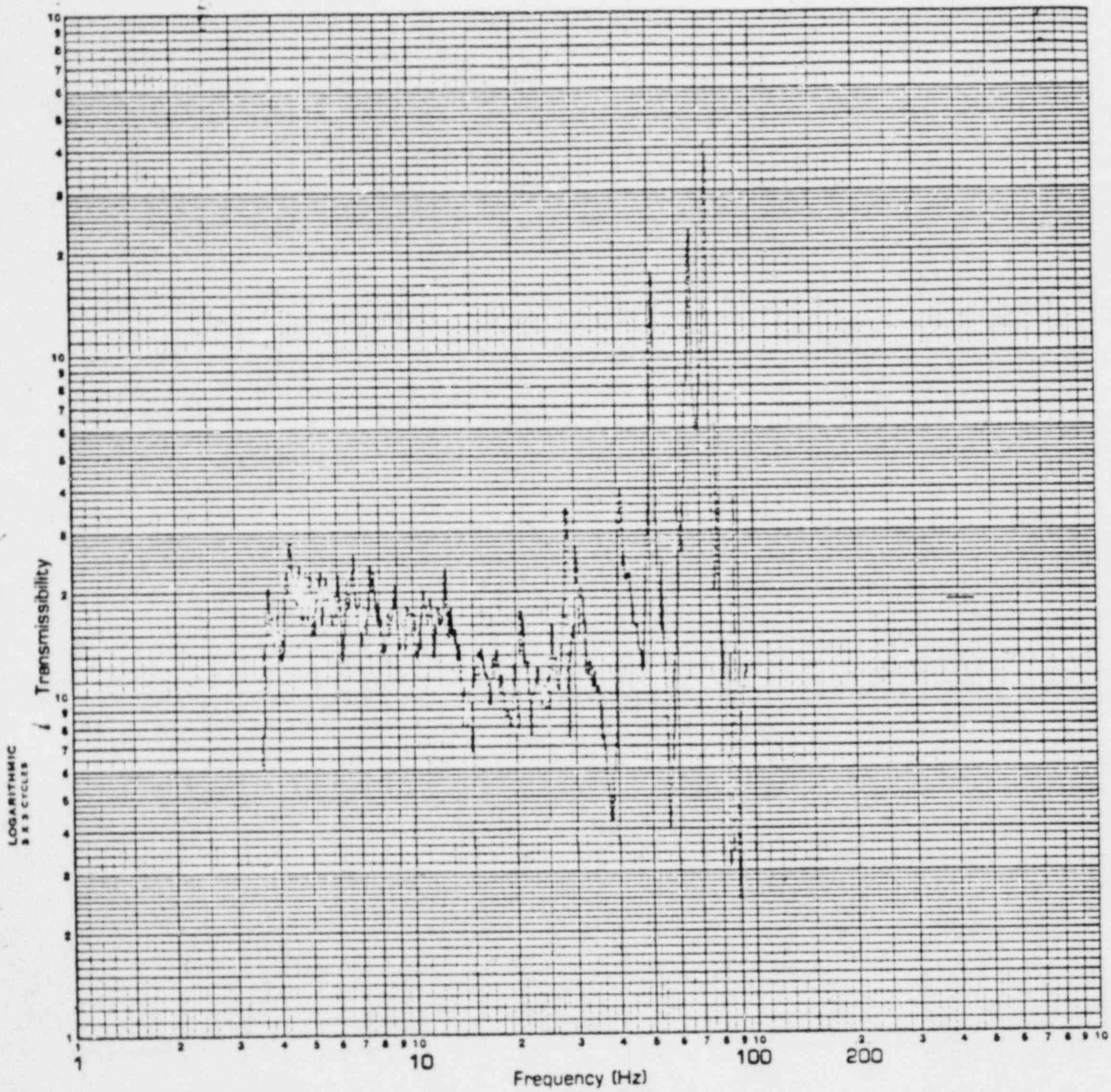
AXIS LONG

ACCEL NO. 5VERT NO. 2VERT

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

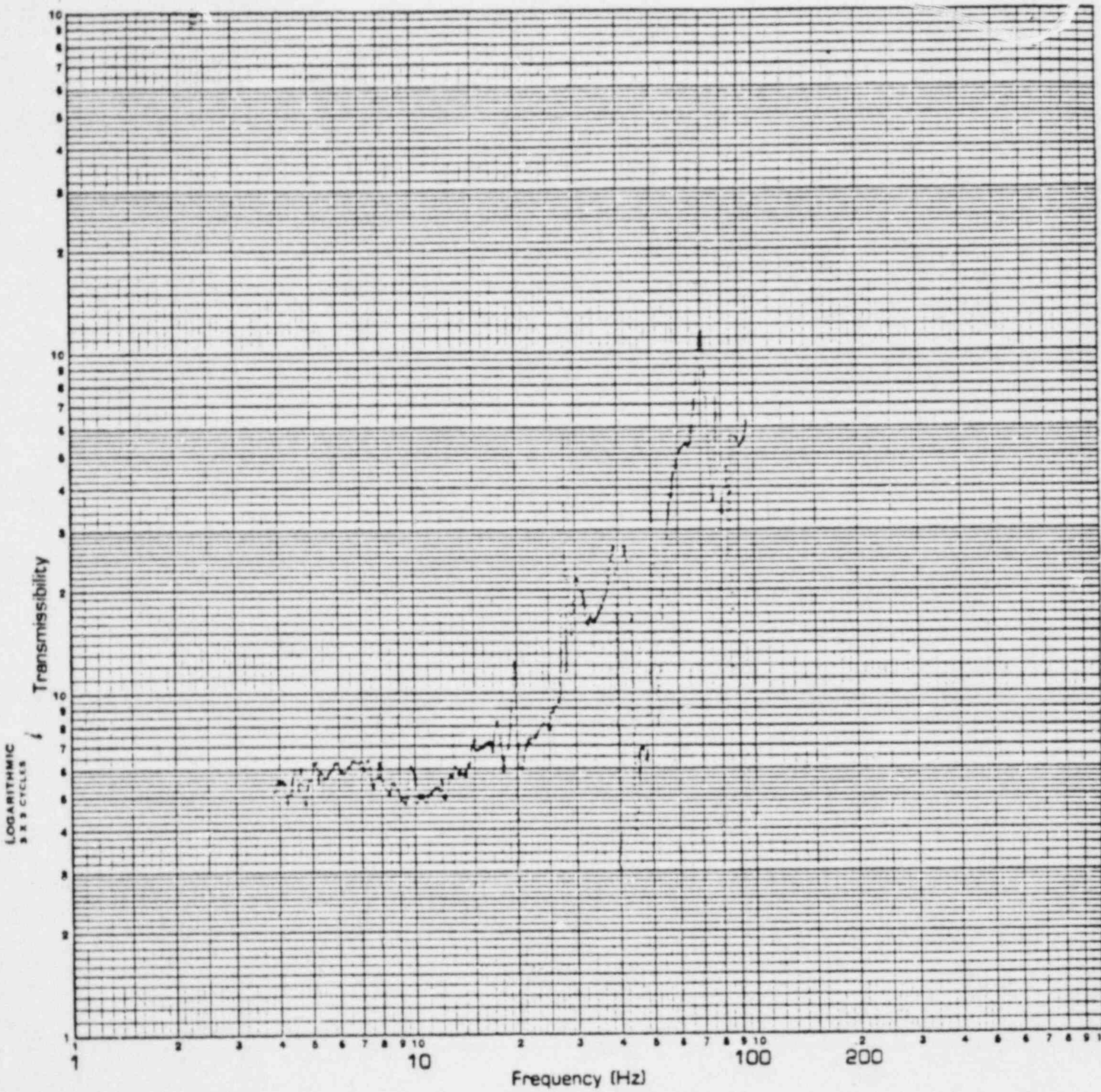
AXIS LONG

ACCEL NO. 6LAT NO. 3LAT

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 12"

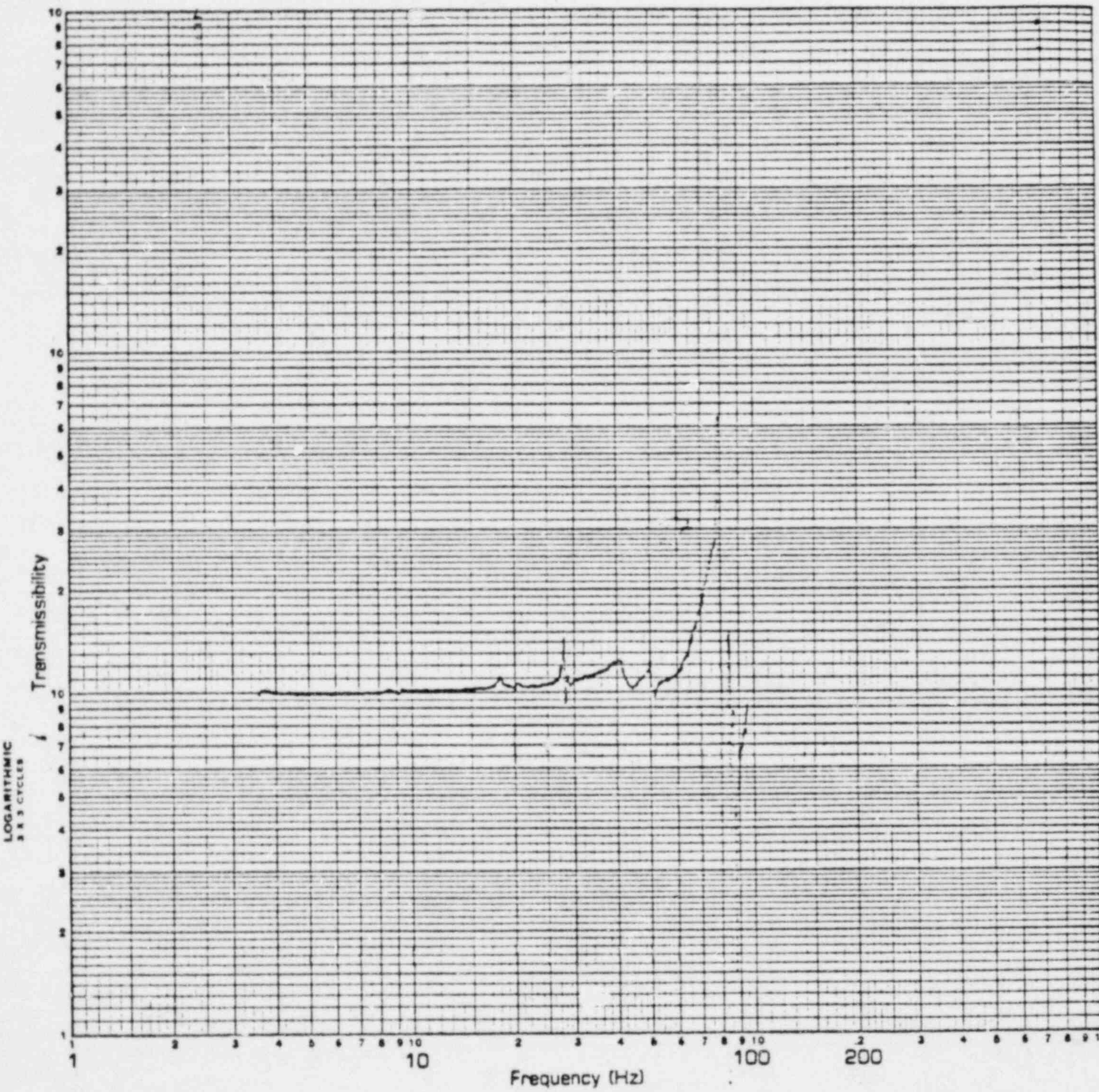
AXIS VERT

ACCEL NO. 1LONG NO. VCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

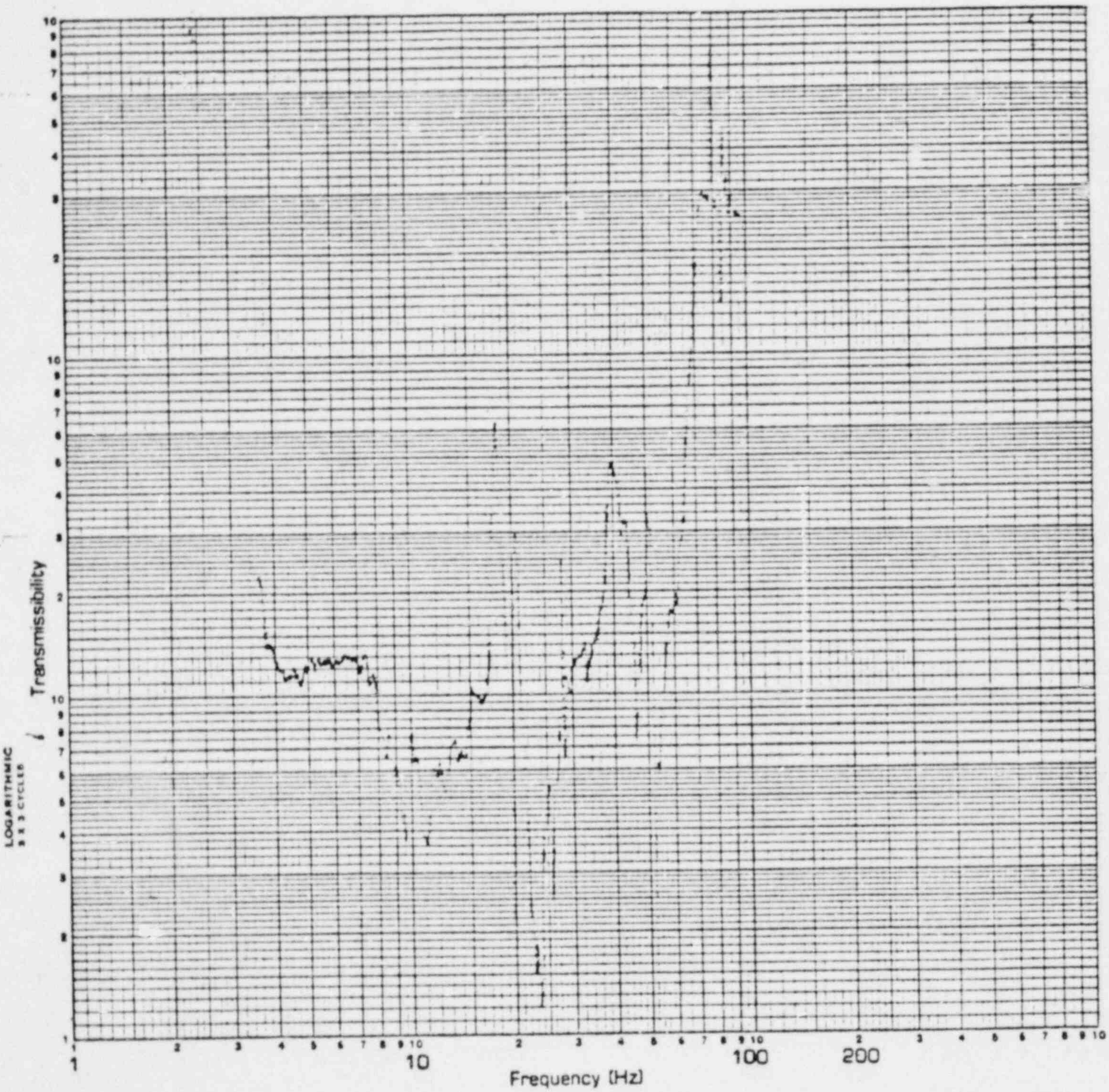
0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"
AXIS VERT
ACCEL NO. 2VERT NO. VCA
TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 12"

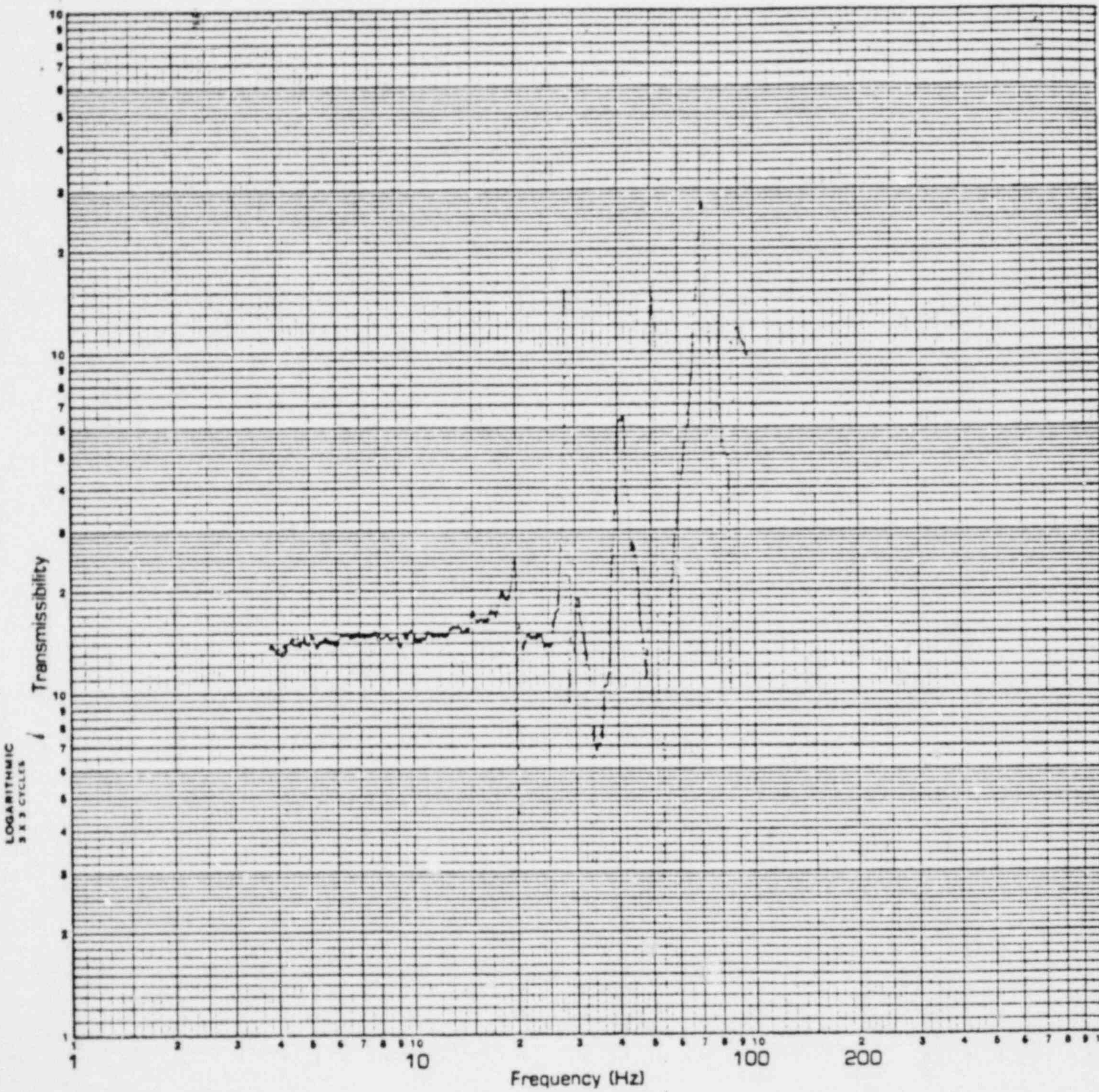
AXIS VERT

ACCEL NO. 3 LAT NO. VCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 12"

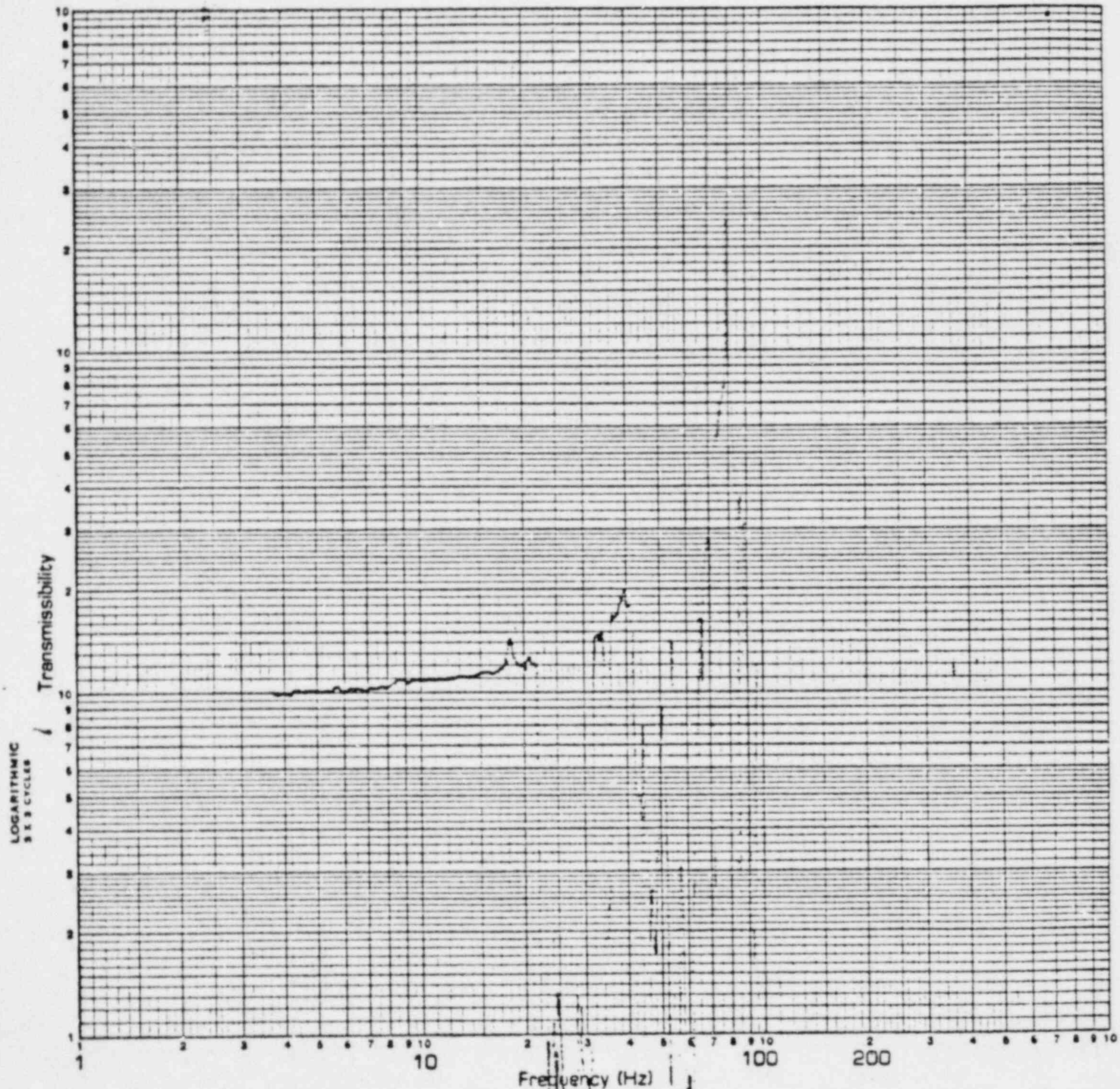
AXIS VERT

ACCEL NO. ALONG -NO. VCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

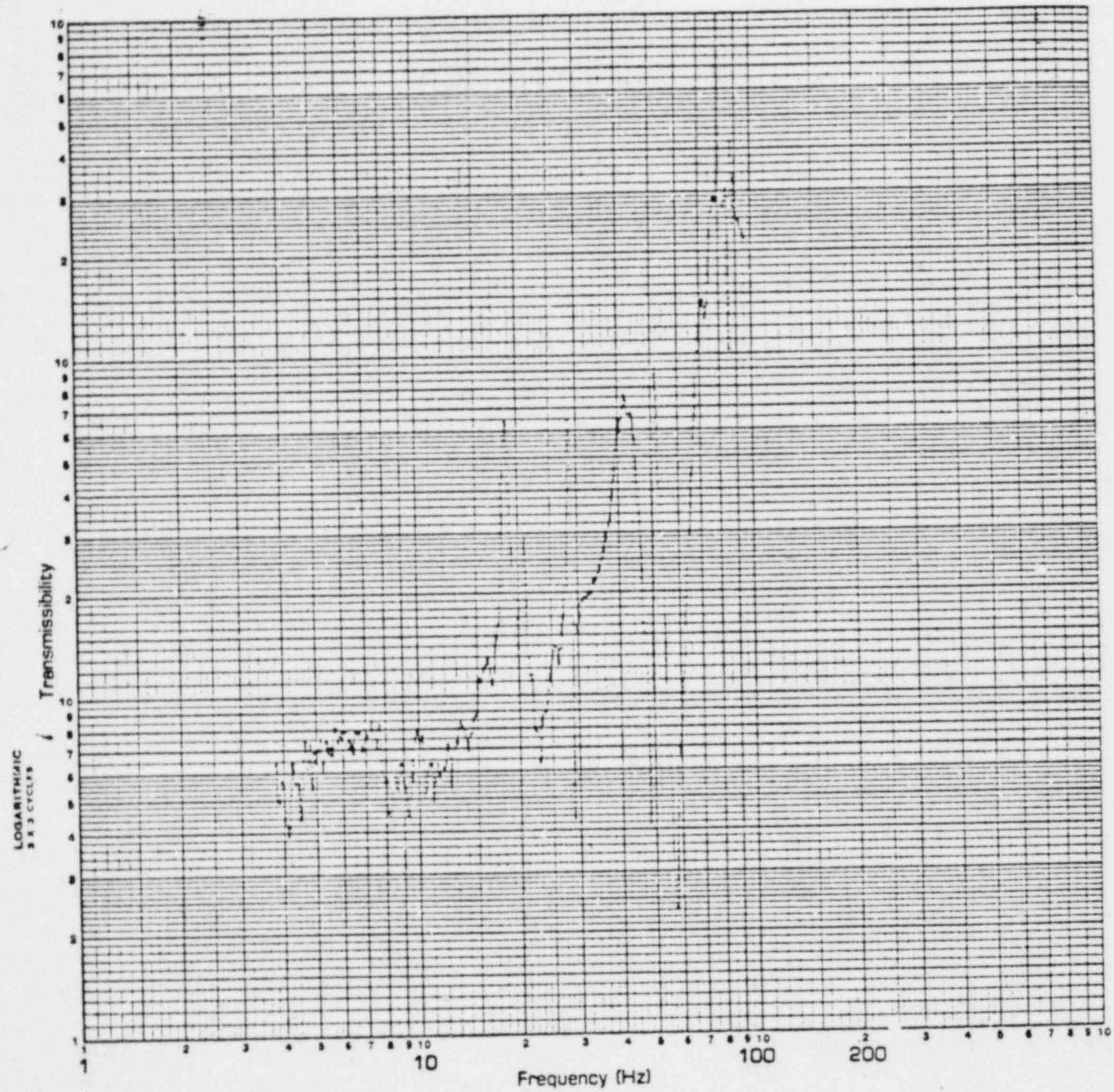
AXIS VERT

ACCEL NO. 5VERT NO. VCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 12"

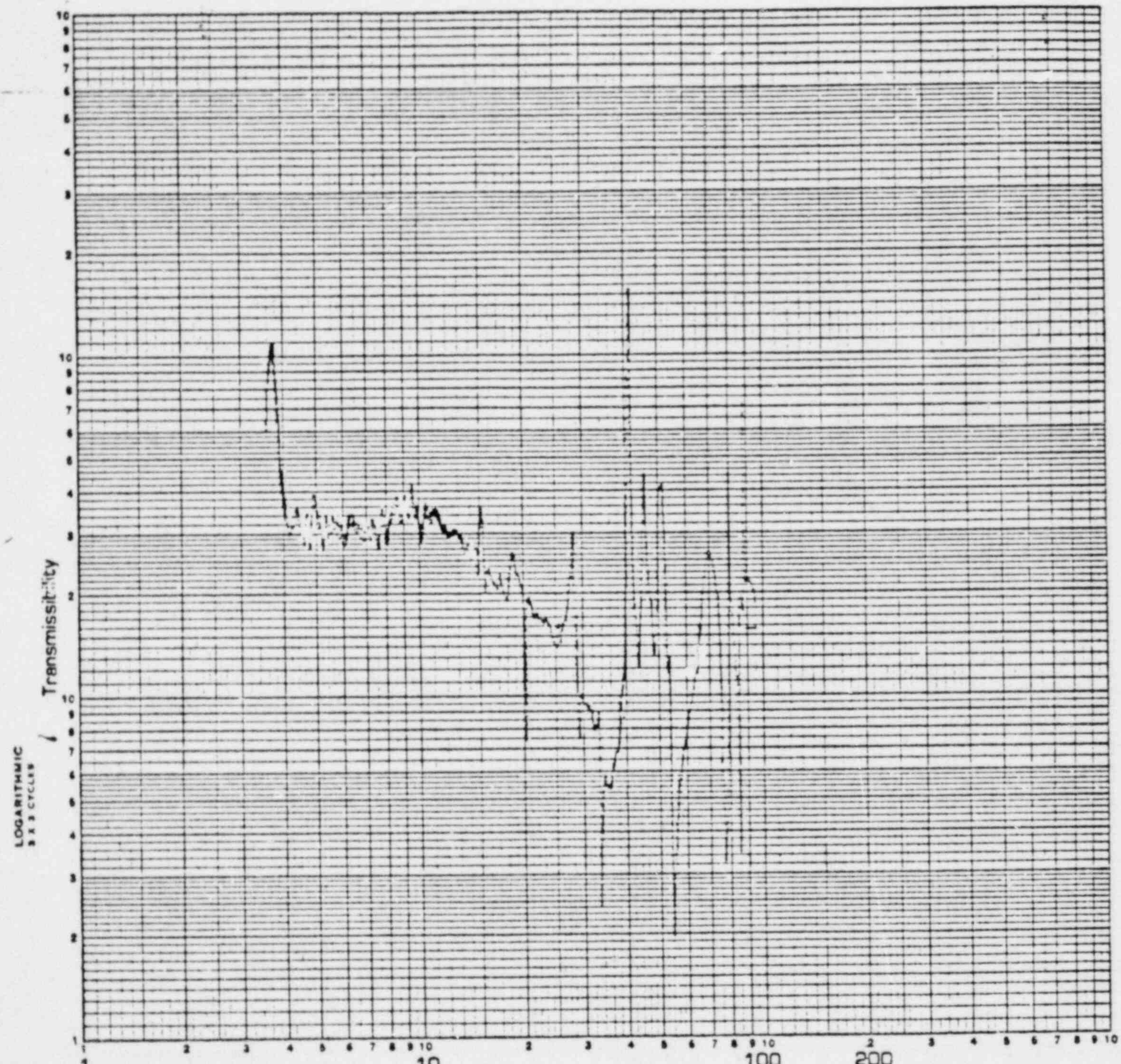
AXIS VERT

ACCEL NO. 6LAT NO. VCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

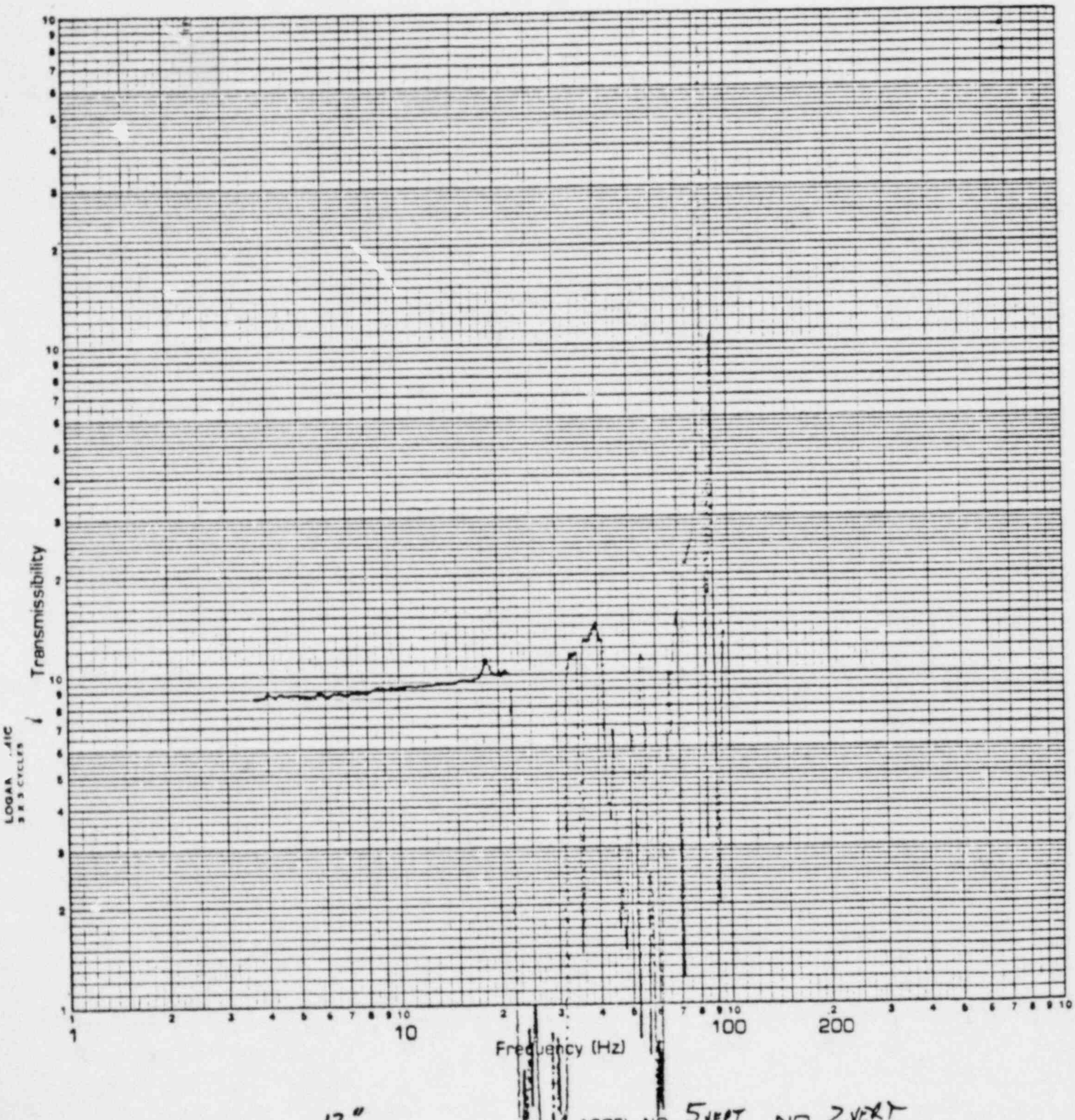
0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"
AXIS VERT
ACCEL NO. 4 LONG NO. 1 LONG
TEST RUN NO. 7

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

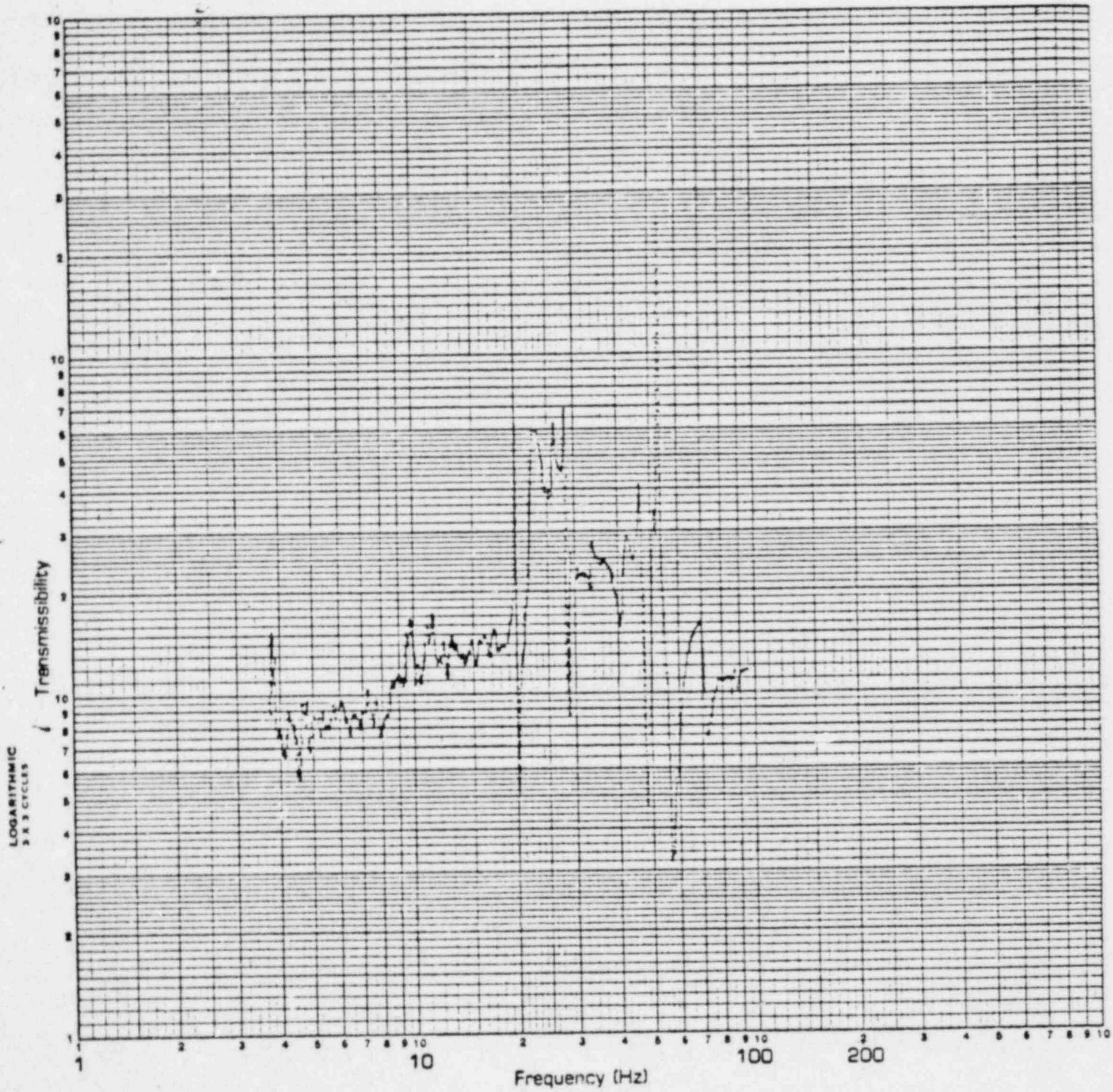
AXIS VERT

ACCEL NO. 5VERT NO. 2VERT

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

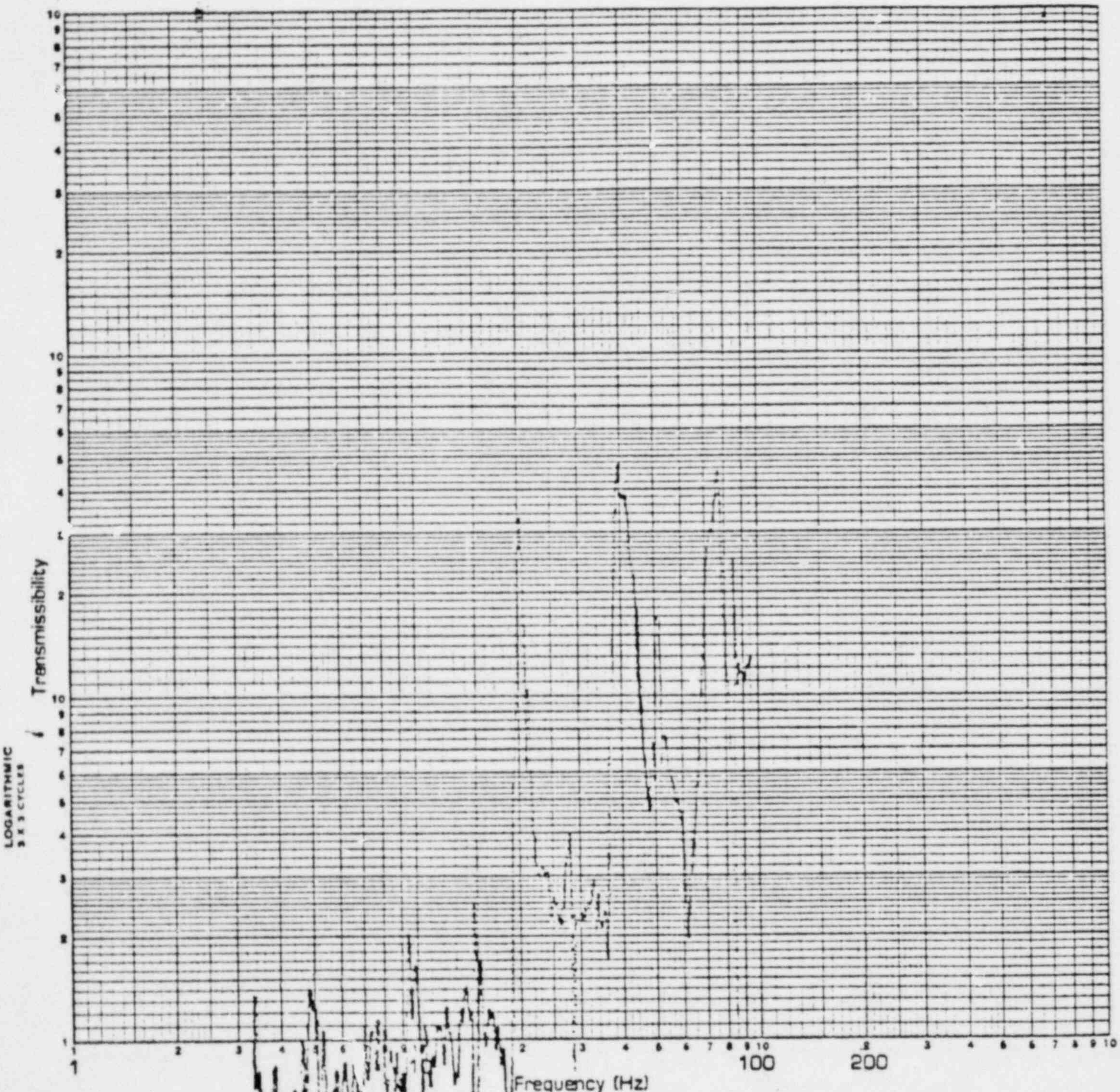
AXIS VERT

ACCEL NO. 6LAT NO. 3LAT

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☑ 100 ☐ 1000 ☐



SPECIMEN 72"

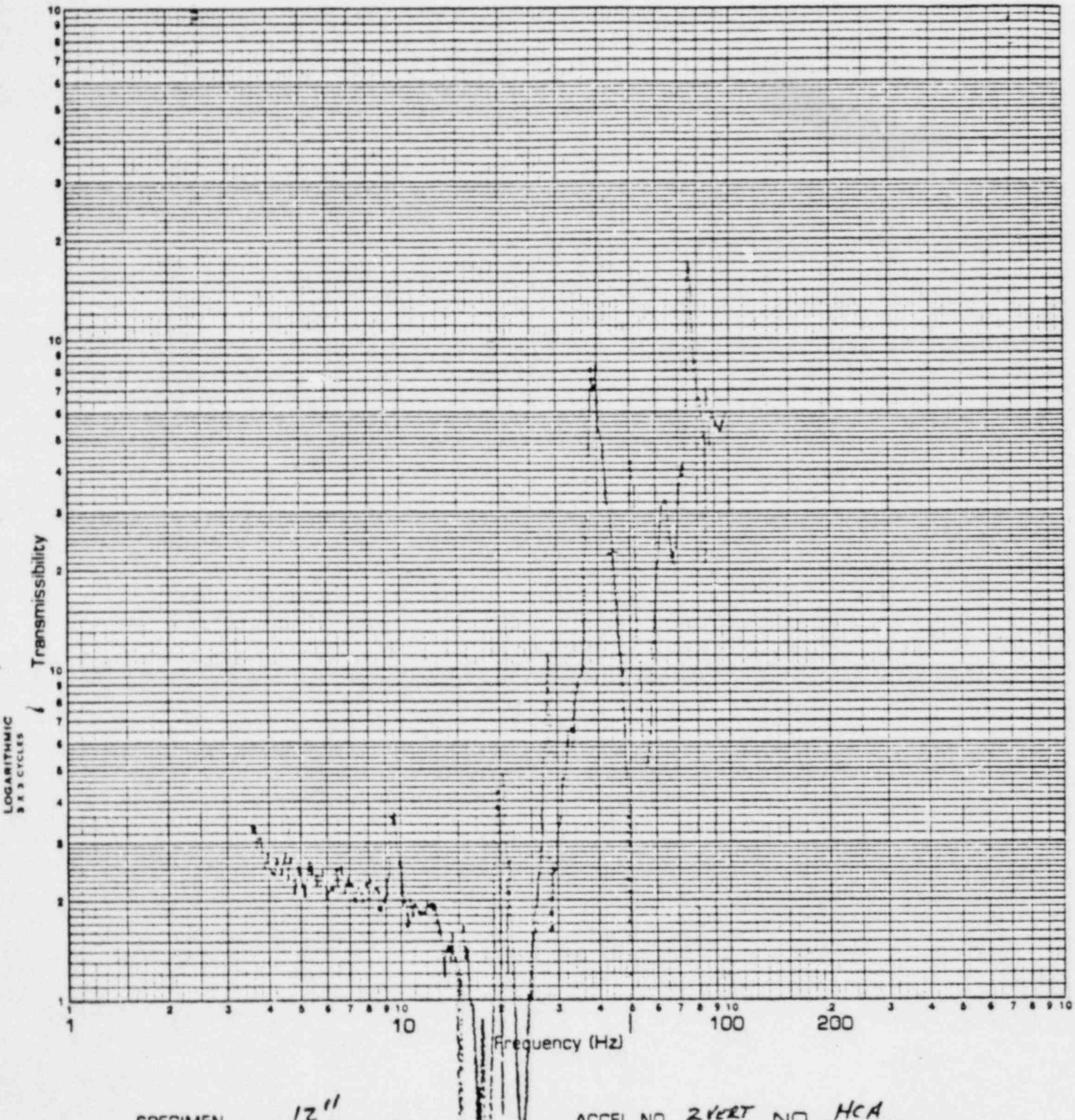
AXIS LAT

ACCEL NO 1 LONG NO. HCA

TEST RUN NO 33

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 12"

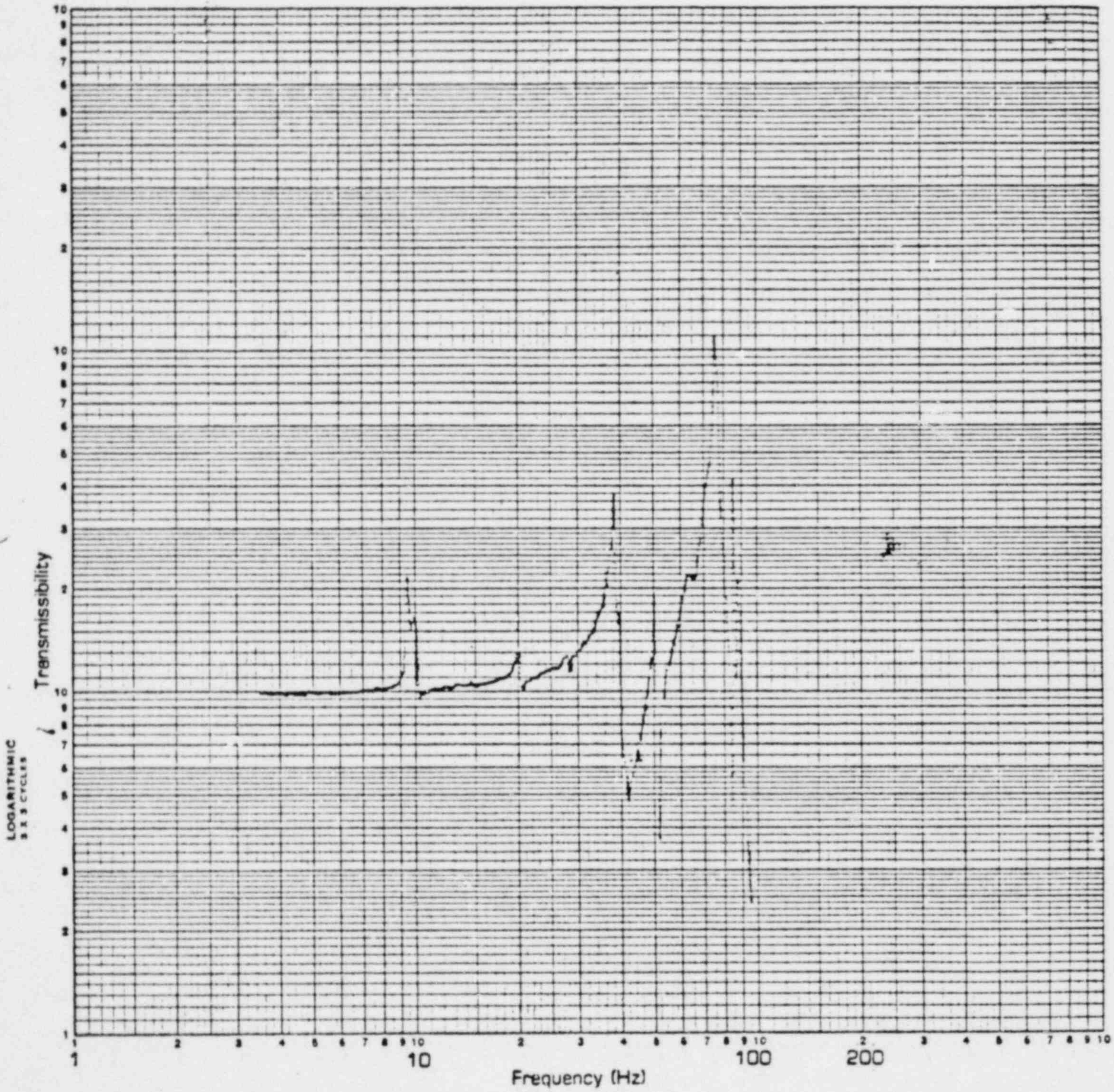
AXIS LAT

ACCEL NO. 2 VERT NO. HCA

TEST RUN NO. 33

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

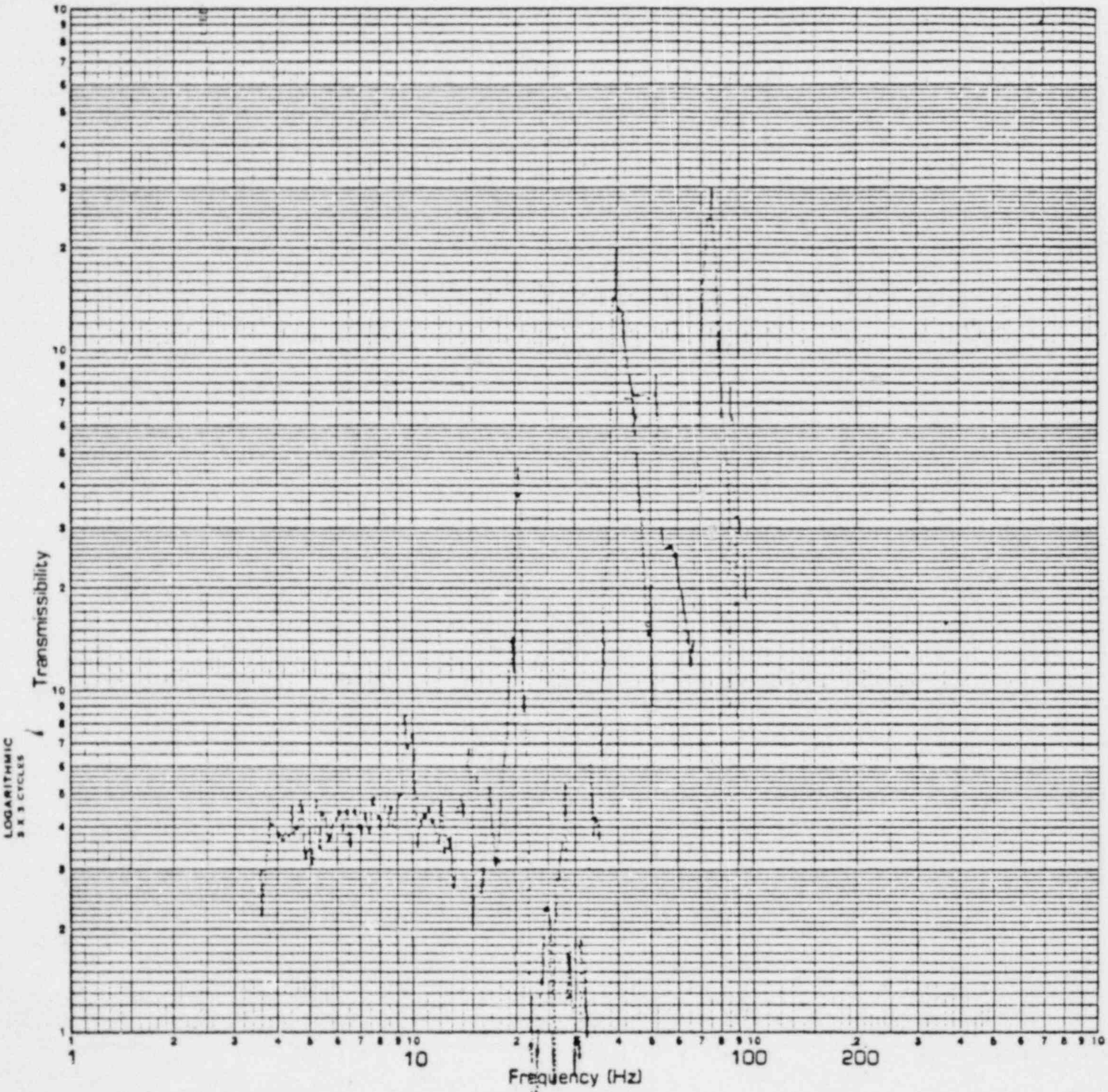
AXIS LAT

ACCEL NO. 3LAT NO. HCH

TEST RUN NO. 33

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 12"

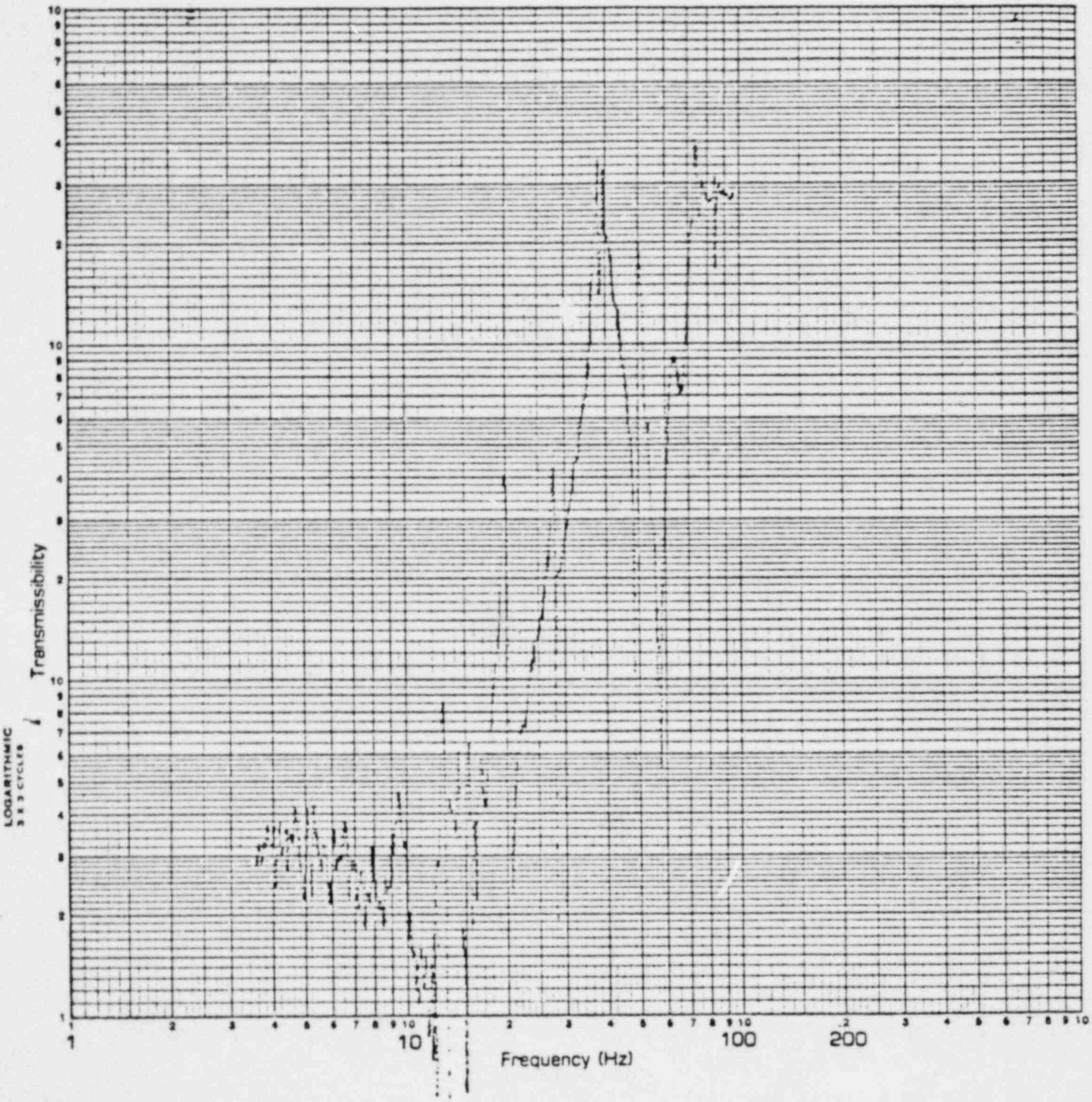
AXIS LAT

ACCEL NO. 4 Long NO. HCA

TEST RUN NO. 33

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☒ 100 ☐ 1000 ☐



SPECIMEN 12"

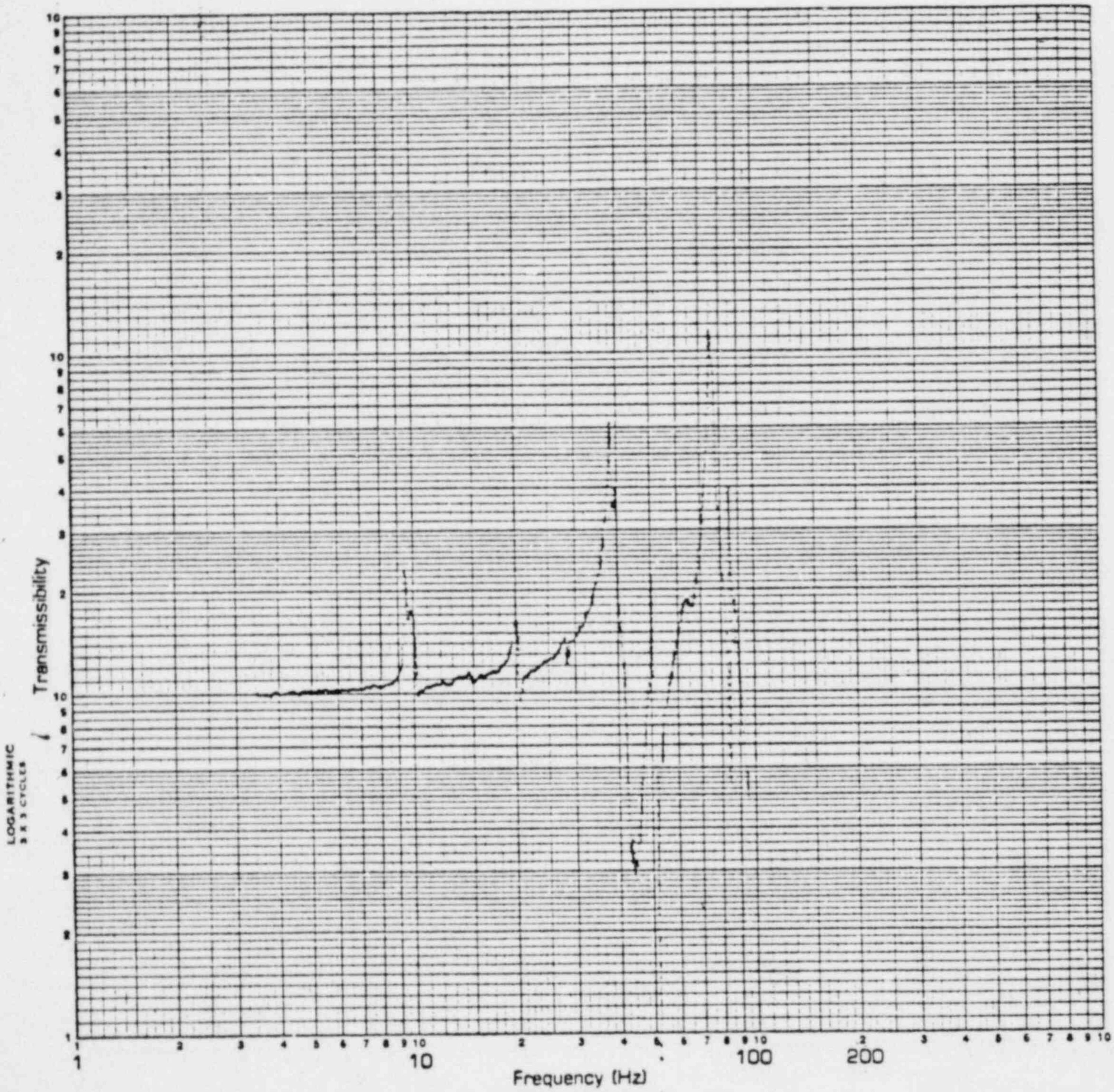
AXIS LAT

ACCEL NO. 5Y00J NO. HCA

TEST RUN NO. 33

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

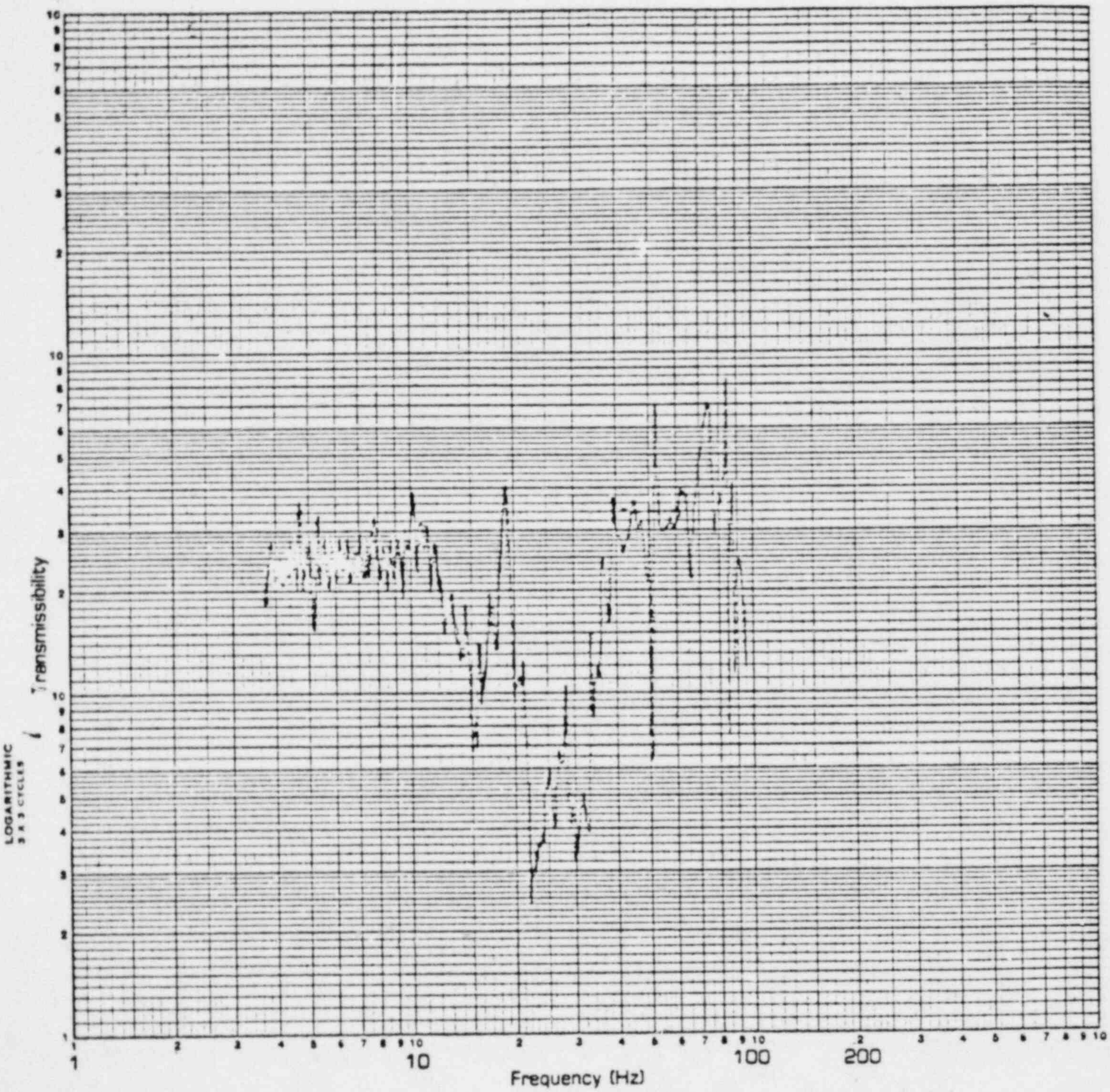
AXIS LAT

ACCEL NO. 6 LAT NO. HCA

TEST RUN NO. 33

FULL SCALE TRANSMISSIBILITY

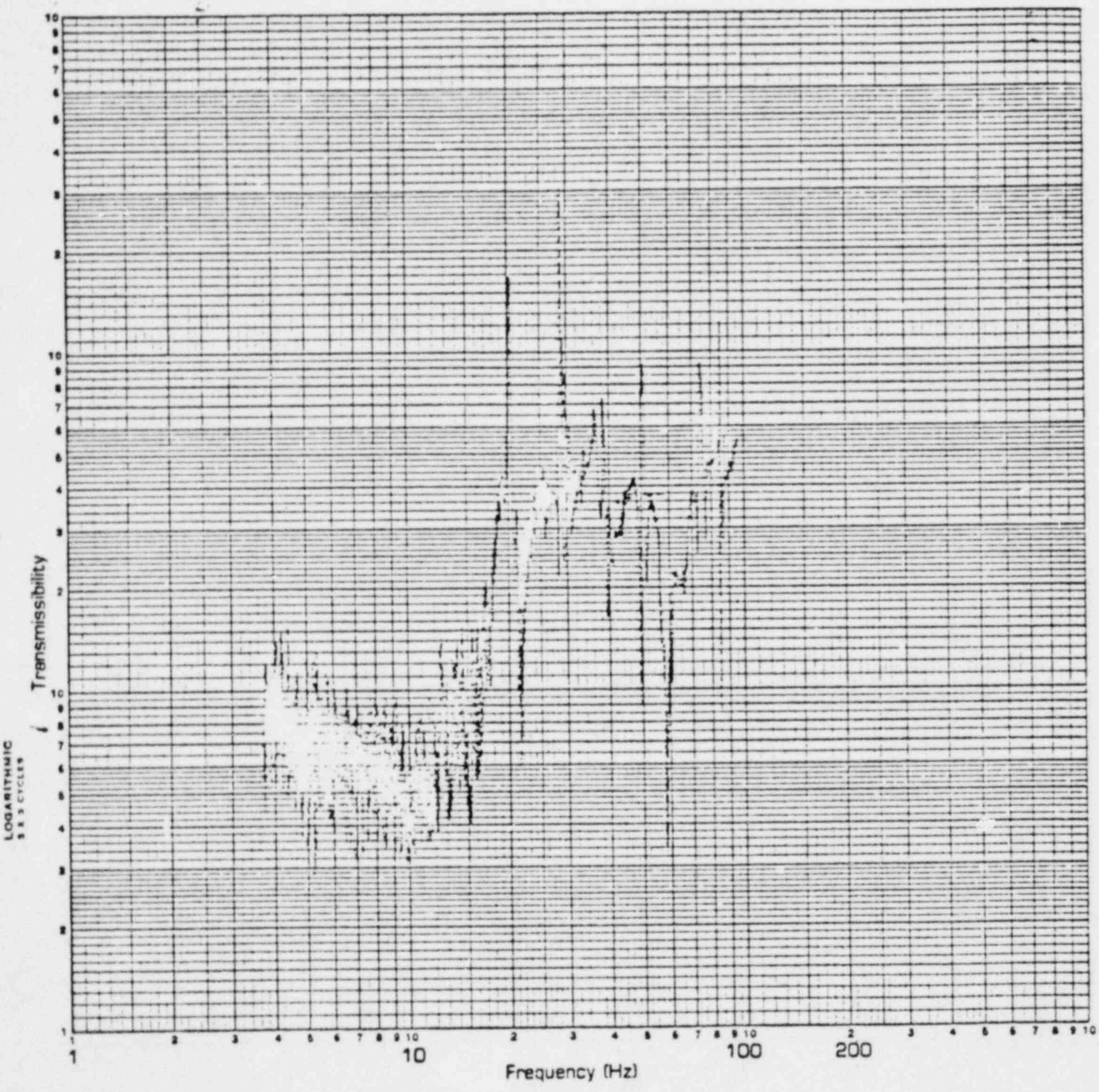
0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"
AXIS LAT
ACCEL NO. 4 LONG NO. 1 LONG
TEST RUN NO. 33

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN 12"

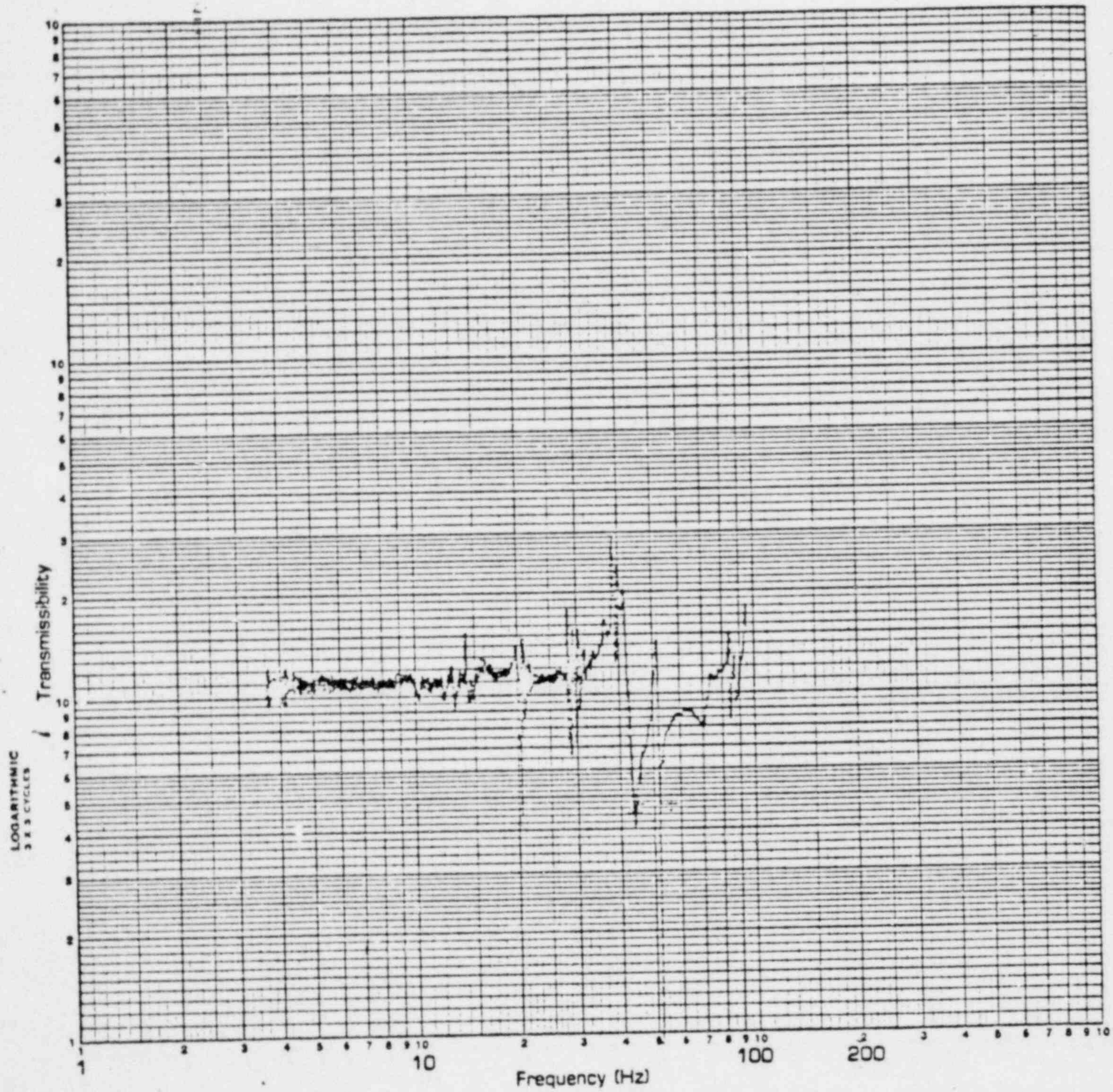
AXIS LAT

ACCEL NO. 5 VERT NO. 2 VERT

TEST RUN NO. 33

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN 12"

AXIS LAT

ACCEL NO. 6LAT NO. 3LAT

TEST RUN NO. 33

APPENDIX II

INSTRUMENTATION LOG SHEETS
AND
INSTRUMENTATION EQUIPMENT SHEETS

W 322

WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44679

CUSTOMER HENRY PRATT

LOG PAGE NO. 1 OF 9

TEST ENGINEER [signature]

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)
30 JULY 75		SET UP TO RECORD 2 CONTROL & 6 RESPONSE ACCELS
		ON TAPE AND O'GRAPH
		SET UP TO RECORD 2 ELECTRICAL MONITORS ON O'GRAPH
		RECORDED CAL SIGNAL OF 1VRMS 100HZ ON REEL # 2
		START 0000 STOP 0120'
		MOUNTED SPECIMEN IN LONG/VERT AXIS 12" VALVE
	1010	RUN # 1 SINE SWEEP 3.5 → 95 Hz 0.2g HORIZ LONG AXIS
		START 1320' STOP 1560'
	1032	RUN # 2 SINE SWEEP 3.5 → 95 Hz 0.2g VERT VERT AXIS
		START 1560' STOP 1795'
	1110	RUN # 3 SINE DWELL @ 3.5 Hz 0.5g LONG AXIS
		START 1795' STOP 1820'

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WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44679 | LOG PAGE NO. 2 OF 9

CUSTOMER HENRY PRATT | TEST ENGINEER [illegible]

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)
30 July 79	1112	Run #4 Sine Dwell @ 4.5 Hz 0.5g Long Axis Start 1820' Stop 1835'
	1116	Run #5 Sine Dwell @ 6.0 Hz 0.5g Long Axis Start 1835' Stop 1845'
	1118	Run #6 Sine Dwell @ 8.0 Hz 0.5g Long Axis Start 1845 Stop 1855'
	1120	Run #7 Sine Dwell @ 11.0 Hz 0.5g Long Axis Start 1855' Stop 1865'
	1121	Run #8 Sine Dwell @ 15.0 Hz 0.5g Long Axis Start 1865' Stop 1880'
	1123	Run #9 Sine Dwell @ 21.0 Hz 0.5g Long Axis Start 1880' Stop 1890'

W 322

WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44679

CUSTOMER HENRY PRATT

LOG PAGE NO. 3 OF 9

TEST ENGINEER [signature]

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)	
30 JULY 79	11:26	RUN # 10 SINE DWELL @ 29.0 Hz 0.5g	LONG. AXIS
		START 1890' STOP 1900'	
	11:27	RUN # 11 SINE DWELL @ 39.0 Hz 0.5g	LONG. AXIS
		START 1900' STOP 1910'	
	11:29	RUN # 12 SINE DWELL @ 53.0 Hz 0.5g	LONG. AXIS
		START 1910' STOP 1920'	
	11:33	RUN # 13 SINE DWELL @ 71.0 Hz 0.5g	LONG. AXIS
		START 1920' STOP 1930'	CHANGED CABLE ON ACCEL #5
	11:43	RUN # 14 SINE DWELL @ 95.0 Hz 0.5g	LONG. AXIS
		START 1930' STOP 1940'	
	11:48	RUN # 15 SINE DWELL @ [illegible] Hz 0.5g	VERT. AXIS
		START 1940' STOP 1950'	

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WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44679

CUSTOMER HENRY PRATT

TEST ENGINEER [signature]

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)	
30 JULY 79	1150	RUN 16 SINE DWELL @ 4.5Hz 0.5g	VERT AXIS
		START 1950' STOP 1960'	
	1152	RUN 17 SINE DWELL @ 6.0Hz 0.5g	VERT AXIS
		START 1960' STOP 1980'	
	1153	RUN 18 SINE DWELL @ 8.0Hz 0.5g	VERT AXIS
		START 1980' STOP 1990'	
	1155	RUN 19 SINE DWELL @ 11.0Hz 0.5g	VERT AXIS
		START 1990' STOP 2000'	
	1156	RUN 20 SINE DWELL @ 15.0Hz 0.5g	VERT AXIS
		START 2000' STOP 2010'	
	1157	RUN 21 SINE DWELL @ 21.0Hz 0.5g	VERT AXIS
		START 2010' STOP 2030'	

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WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44679 LOG PAGE NO. 5 OF 9

CUSTOMER HENRY PRATT TEST ENGINEER [signature]

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)
31 JUL 79	1158	Run 22 Sine Dwell @ 29.0 Hz 0.5g Vert Axis
		Start 2020' Stop 2030'
	1159	Run 23 Sine Dwell @ 39.0 Hz 0.5g Vert Axis
		Start 2030' Stop 2040'
	1201	Run 24 Sine Dwell @ 53.0 Hz 0.5g Vert Axis
		Start 2040' Stop 2050'
	1203	Run 25 Sine Dwell @ 71.0 Hz 0.5g Vert Axis
		Start 2050' Stop 2065'
	1205	Run 26 Sine Dwell @ 95.0 Hz 0.5g Vert Axis
		Start 2065' Stop 2075'
	1210	Run 27 Unidirectional @ 33 Hz 0.5g Long Axis
		Start 2075' Stop 2100'

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WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44679

LOG PAGE NO. 6 OF 9

CUSTOMER HENRY PRATT

TEST ENGINEER Bernard Fowler

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)
30 MAY 79	1215	RUN 28 ENDURANCE @ 41.0 Hz 0.5g LONG. AXIS
		START 2100' STOP 2120
	1220	RUN 29 ENDURANCE @ 52.0 Hz 0.5g LONG AXIS
		START 2120' STOP 2145'
	1227	RUN 30 ENDURANCE @ 33.0 Hz 0.5g VERT AXIS
		START 2145' STOP 2180'
	1233	RUN 31 ENDURANCE @ 83.0 Hz 0.5g VERT AXIS
		START 2180' STOP 2205'
	1237	RUN 32 ENDURANCE @ 88.0 Hz 0.5g VERT AXIS
		START 2205' STOP 2250'
		ROTATED SPECIMEN 90° TO THE LATERAL AXIS
		CHANGED TAPE [illegible] CAL [illegible] 100 Hz REEL [illegible] [illegible]

W 322

WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44679

CUSTOMER HENRY PRATT

LOG PAGE NO. 7 OF 9

TEST ENGINEER Bruce G. Fowler

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)
30 JULY 79	1410	RUN #33 SINE SWEEP 3.5 – 95 HZ 0.2g H LAT ONLY
		START 0100' STOP 0335'
	1435	RUN #34, SINE DWELL @ 3.5 HZ 0.5g H LAT ONLY
		START 0335' STOP 0345'
	1437	RUN #35, SINE DWELL @ 4.5 HZ 0.5g H LAT ONLY
		START 0345' STOP 0355'
	1442	RUN #36, SINE DWELL @ 6.0 HZ 0.5g H LAT ONLY
		START 0355' STOP 0365'
	1444	RUN #37, SINE DWELL @ 8.0 HZ 0.5g H LAT ONLY
		START 0365' STOP 0375'
	1445	RUN #38 SINE DWELL @ 11.0 HZ 0.5g H LAT ONLY
		START 0375' STOP 0385'

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WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44679

LOG PAGE NO. 8 OF 9

CUSTOMER HENRY PRATT

TEST ENGINEER [signature]

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)
30 JULY 79	1447	RUN 39, SINE DWELL @ 15 HZ 0.5g H LAT ONLY
		START 0385' STOP 0395'
	1449	RUN 40, SINE DWELL @ 21 HZ 0.5g H LAT ONLY
		START 0395' STOP 0405'
	1452	RUN 41, SINE DWELL @ 25 HZ 0.5g H LAT ONLY
		START 0405' STOP 0415'
	1454	RUN 42, SINE DWELL @ 35 HZ 0.5g H LAT ONLY
		START 0415' STOP 0425'
	1455	RUN 43, SINE DWELL @ 53.0 HZ 0.5g H LAT ONLY
		START 0425' STOP 0435'
	1459	RUN 44, SINE DWELL @ 71 HZ 0.5g H2
		START 0435' STOP 0450'

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WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44679

LOG PAGE NO. 9 OF 9

CUSTOMER HENRY PRATT

TEST ENGINEER [signature]

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)
30 JULY 79	1502	RUN 45, SINE DWELL @ 25 HZ 0.5 g H LAT ONLY
		START 0450' STOP 0460'
	1505	RUN 46, ENDURANCE @ 33 HZ 0.5 g H LAT ONLY
		START 0460' STOP 0480'
	1510	RUN 47, ENDURANCE @ 38 HZ 0.5 g H LAT ONLY
		START 0480' STOP 0505'
		END OF TEST

INSTRUMENTATION EQUIPMENT SHEET

Date 28 JULY 79 Job No. 44679 Test Area PIT #1

Technician W. MORROW Customer HENRY PRATT Type Test SEISMIC

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
1	ACCELEROMETER	ENDEVCO	2213E	CP59	96283	1000g	±5%	6-12-79	9-12-79
2	ACCELEROMETER	ENDEVCO	2213	DA44	95340	1000g	±5%	6-12-79	9-12-79
3	ACCELEROMETER	ENDEVCO	2272	NE89	96192	1000g	±5%	6-27-79	9-27-79
4	ACCELEROMETER	ENDEVCO	2272	NA62	F1437	1000g	±5%	5-17-79	8-17-79
5	ACCELEROMETER	ENDEVCO	2272	EP53	96147	1000g	±5%	6-28-79	9-28-79
6	ACCELEROMETER	ENDEVCO	2272	NA68	F1406	1000g	±5%	6-1-79	9-1-79
7	ACCELEROMETER	ENDEVCO	7701-100	AE80	11350	1000g	±5%	6-12-79	9-12-79
8	ACCELEROMETER	ENDEVCO	7701-100	AE53	11759	1000g	±5%	6-12-79	9-12-79
9	CHARGE AMP	DYNAMICS	7302	—	1656	500g	±2%	6-1-79	12-1-79
10	CHARGE AMP	DYNAMICS	7302	—	1551	500g	±2%	6-1-79	12-1-79
11	CHARGE AMP	DYNAMICS	7302	—	1566	500g	±2%	6-1-79	12-1-79
12	CHARGE AMP	DYNAMICS	7302	—	1556	500g	±2%	6-4-79	12-4-79
13	CHARGE AMP	DYNAMICS	7302	—	1631	500g	±2%	6-4-79	12-4-79
14	CHARGE AMP	DYNAMICS	7302	—	1593	500g	±2%	6-1-79	12-1-79
15	CHARGE AMP	DYNAMICS	2740-B	—	11212	50 KHZ	±1.5%	6-22-79	12-22-79
16	CHARGE AMP	DYNAMICS	2740-B	—	11213	50 KHZ	±1.5%	6-22-79	12-22-79
17	GALVO AMP	HONEYWELL	T6GA-500	—	96258	1:1	±2%	2-6-79	8-6-79
18	GALVO AMP	HONEYWELL	T6GA-500	—	96275	1:1	±2%	2-22-79	8-22-79

Page No. 51A
Report No. 44679-1

Instrument Test Engineer Wayne Kilgore Checked & Received By Bobby L. Quinn

INSTRUMENTATION EQUIPMENT SHEET

Date 30 JULY '79 Job No. 44679 Test Area PIT #1

Technician W. MORROW Customer HENRY PRATT Type Test SEISMIC

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
19	GALVO AMP	HONEYWELL	TEGA-500	—	96259	1:1	± 2%	4-4-79	10-4-79
20	VISICORDER	HONEYWELL	1508	—	11167	D.C. - 2.5KHZ	± 2%	5-7-79	11-7-79
21	VISICORDER	HONEYWELL	1508	—	96056	D.C. - 2.5KHZ	± 2%	3-8-79	9-8-79
22	TIMER/COUNTER	MONSANTO	101A	—	95371	D.C. - 99999HZ	± 1 COUNT	5-11-79	8-11-79
23	GALVO AMP	HONEYWELL	TEGA-500	—	96261	1:1	± 2%	2-28-79	8-28-79
24	TAPE RECORDER	Bell & Howell	CPR4010	—	72149	D.C. - 2.5KHZ	± 2%	7-5-79	10-5-79
25	SWEEP OSCILLATOR	SPEC. DYNAMICS	SD104	—	95360	.005HZ - 50KHZ	± 0.5%	7-30-79	10-30-79
26	SERVO MONITOR	SPEC. DYNAMICS	SD105	—	95358	1000g	± 4%	7-30-79	10-30-79
27	SERVO MONITOR	SPEC. DYNAMICS	SD105	—	95296	1000g	± 4%	7-30-79	10-30-79
28	X-Y RECORDER	H.P.	7004B	—	95202	10V/IN	± 0.2%	3-14-79	9-14-79
29	OSCILLOSCOPE	H.P.	122AR	—	80896	10V/IN	± 3%	7-2-79	10-2-79
30	VOLTMETER	B&K	2426	—	95492	300V	± 2%	7-18-79	10-18-79
31	LOG. FREQ. CONV.	SPEC. DYNAMICS	SD116	—	95123	5HZ - 50KHZ	± 2%	7-6-79	10-6-79
32	TRACKING FILTER	SPEC. DYNAMICS	SD131	—	11242	40db	± 0.5db	5-31-79	11-31-79
33	TRACKING FILTER	SPEC. DYNAMICS	SD131	—	11243	40db	± 0.5db	5-31-79	11-31-79
34	POWER SUPPLY	KEPCO	KS36-10	H50990	98723	0-50VDC		7-9-79	1-9-80
35	PRESSURE GAGE	ASHCROFT	AMP7322	—	97811	0-200PSI	± 1%	7-3-79	10-3-79
36	SWEEP OSCILLATOR	SPEC. DYNAMICS	SD104	—	95295	.005HZ - 50KHZ	± 2%	7-11-79	10-11-79

Instrument Test Engineer H.E. Gilliland Checked & Received By James W. Foreman

WI-1029

INSTRUMENTATION EQUIPMENT SHEET

Date 30 JULY 79 Job No. 44677 Test Area PIT #1

Technician C.R. FROST Customer HENRY PRATT Type Test SEISMIC

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
37	SERVO MONITOR	SPEC. DYNAMICS	SD105	—	95357	1000g	±4%	7-5-79	10-5-79

Instrument Test Engineer [signature] Checked & Received By Bobby L. Quinn

WH-1029

APPENDIX III

SEISMIC TEST PROCEDURE

TEST PROCEDURE

WYLE LABORATORIES
SCIENTIFIC SERVICES AND SYSTEMS GROUP
P. O. BOX 1008 • HUNTSVILLE, ALABAMA 35807
TWX (810) 726-2225 • TELEPHONE (205) 837-4411

TEST PROCEDURE NO. 541/2014/DK

DATE: June 26, 1979

SEISMIC TEST PROCEDURE

FOR

FOUR VALVE ASSEMBLIES

FOR

HENRY PRATT COMPANY
AURORA, ILLINOIS

APPROVED BY: ____________
FOR: ____________

APPROVED BY: ____________
FOR: ____________

APPROVED BY: ____________
FOR: ____________

APPROVED BY PROJECT MANAGER: *Herschel Gudan*

APPROVED BY QUALITY ENGINEER: *Mervin J. Kimbell*

PREPARED BY PROJECT ENGINEER: *James W. Forman*

REVISIONS

FORM 1054-1 Rev. 4/74

REV. NO.	DATE	PAGES AFFECTED	BY	APP'L.	DESCRIPTION OF CHANGES
A	7/26/79	3	BGF	*HD*	Para. 2.2.5 - Deleted "below 33 Hz".
					Changed "input" to "valve body".

1.0 PURPOSE

The purpose of this test plan is to describe the procedure to be used to seismically-qualify four (4) Valve Assemblies, hereinafter called the specimens, for Henry Pratt Company, Aurora, Illinois.

1.1 Specimen Description

Specimen	Size	Description	Part No.
1	12"	1200 with Bettis Actuator	D-0089-04
2	18"	1400 with Motor Operator	D-0115-10
3	24"	1200 with Motor Operator	D-0151-02
4	36"	1200 with Motor Operator	D-0114-14

2.0 SEISMIC QUALIFICATION TESTS

2.1 Mounting

2.1.1 Specimen Orientation

The specimens shall be installed separately on Wyle's Biaxial Seismic Simulator Table. The specimens shall be tested in the first horizontal axis and then rotated 90 degrees about their vertical centerlines for the second test orientation. Items 1 and 3 will be tested sequentially and Items 2 and 4 will be tested sequentially.

2.1.2 Specimen Tie-Down

The specimens will be premounted to a Wyle-furnished test fixture using commercially-available bolts, nuts and washers. The test fixtures will be welded to the test table. Figure 1 shows a typical test setup.

2.2 Excitation

2.2.1 Excitation Control

A control accelerometer shall be mounted on the test fixture.

2.2.2 Single-Axis Excitation

The specimens shall be subjected to single-axis sinusoidal excitation during the tests. Each of the three test axes shall be tested (two horizontal and one vertical).

2.2.3 Resonance Search

A sine sweep test (approximately 0.2 g) from 3.5 to 95 Hz shall be performed in each of the three orthogonal axes. The sweep rate shall be one octave per minute.

2.2.4 Variable Frequency Test

A variable frequency test shall be performed in each of the three orthogonal axes. The input test level shall be approximately 0.5 g (within the limitations of the test machine) at the following frequencies: 3.5, 4.5, 6, 8, 11, 15, 21, 29, 39, 53, 71, and 95 Hz. Duration of the test shall be sufficient to allow the specimens to cycle open to close to open. Motive power will be recorded at each half of operating time.

2.2.5 Endurance Test A

An endurance test shall be performed in each of the three orthogonal axes. The input test level shall be approximately 0.5 g (within the limitations of the test machine) at the resonant frequencies* found in Paragraph 2.2.3, and at 33 Hz. Duration of the test shall be at least three (3) minutes.

*Resonant frequencies are defined as a frequency at which the acceleration of the actuator center of gravity exceeds the valve body acceleration level by a factor of 3 or more.

At the conclusion of each three (3) minutes with the specimen still vibrating, a functional test will be performed as specified in Paragraph 3.0.

2.3 Instrumentation

2.3.1 Specimen Response Accelerometers

Six (6) specimen-mounted uniaxial piezo-electric accelerometers shall be provided for the specimens during the test. Placement of the accelerometers will be as directed by the Henry Pratt Technical Representative or the Wyle Test Engineer. The accelerometers will be recorded on FM tape and oscillograph recorders during the sine sweep test. Transmissibility plots of these accelerometers will be provided in the test report. Additional accelerometers are quoted as an option.

2.3.2 Electrical Monitoring

A potentiometer will be used to monitor the shaft position of the specimens. The output of the potentiometer will be recorded on an oscillograph recorder.

2.3.4 Electrical Powering

Standard electrical power of 460 VAC, 3-phase, will be provided for operation of the valve actuator.

3.0 FUNCTIONAL TESTS

Functional tests will be performed prior to and after the test program with the following parameters recorded:

Motive Power	VAC/PSI	Measured with volt meter/pressure gage
Operating Time		
Closed to Open		
Open to Closed.		

4.0 IN-PROCESS INSPECTION

The records will be checked for quality of performance after each test.

The specimens will be examined for possible damage following all violent tests such as at a severe structural resonance.

All important vibration effects will be logged.

Photographs will be taken of any noticeable physical damage that may occur.

5.0 REPORT

Five (5) copies of a certification-type report for each Valve will be issued within four (4) weeks after completion of testing. This report will be signed by a Registered Professional Engineer, and will summarize the test response, results and conclusions, details and recommendations concerning deficiencies and repairs, photographs of test setups, failures, test procedures, etc. The report will also contain a list of test equipment used, calibrations, and Instrumentation Log Sheets. A description of the test facility and instrumentation will also be included in the test report.

TABLE I

ORDER OF TESTS

1) Pre-Test Functional

2) Sine Sweep (1st horizontal axis)

3) Sine Sweep (vertical axis)

4) Variable Frequency Test (1st horizontal axis)

5) Variable Frequency Test (vertical axis)

6) Endurance Test (1st horizontal axis)

7) Endurance Test (vertical axis)

8) Post-Test Functional

9) Sine Sweep (2nd horizontal axis)

10) Variable Frequency Test (2nd horizontal axis)

11) Endurance Test (2nd horizontal axis)

12) Post-Test Functional

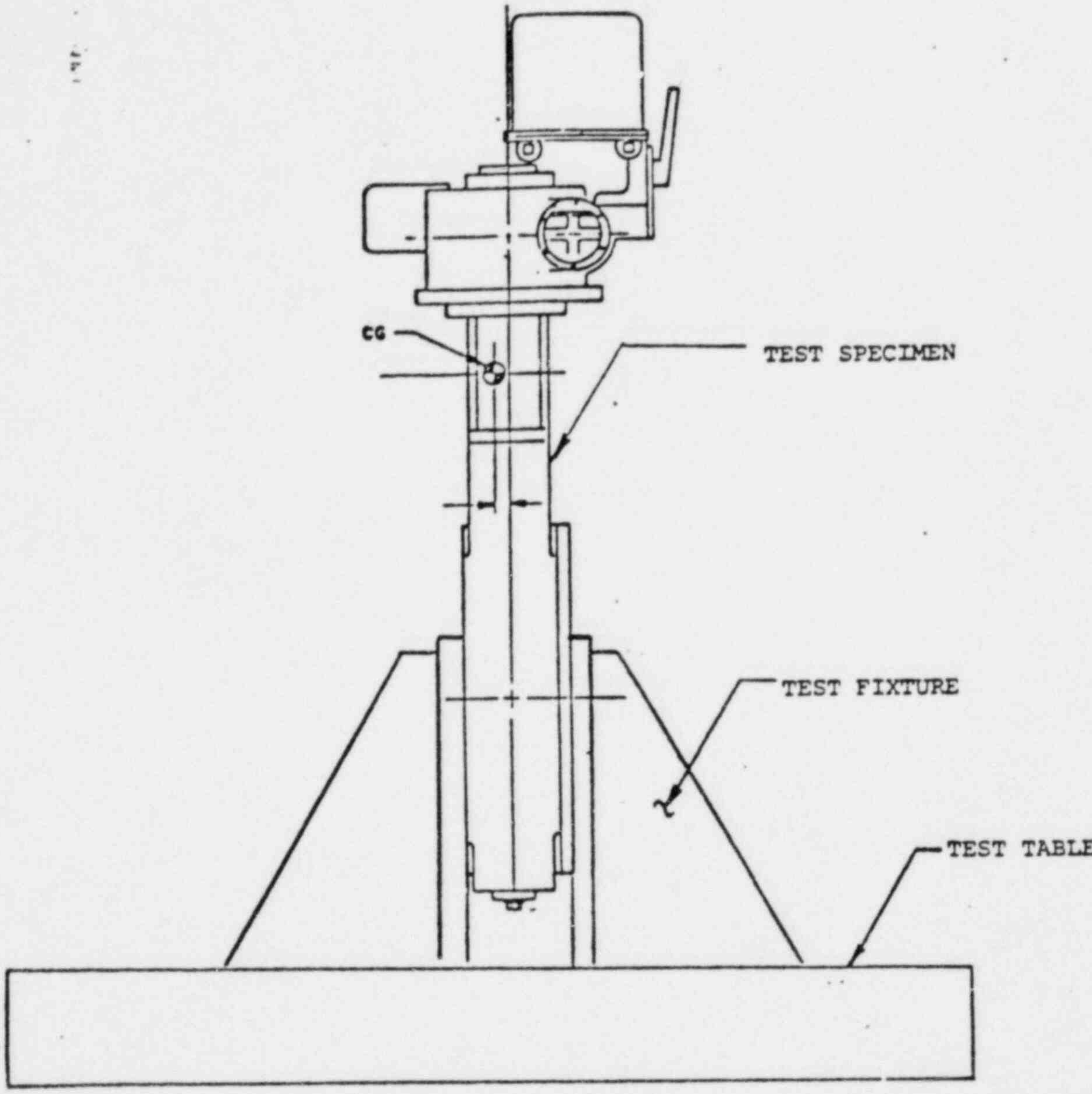
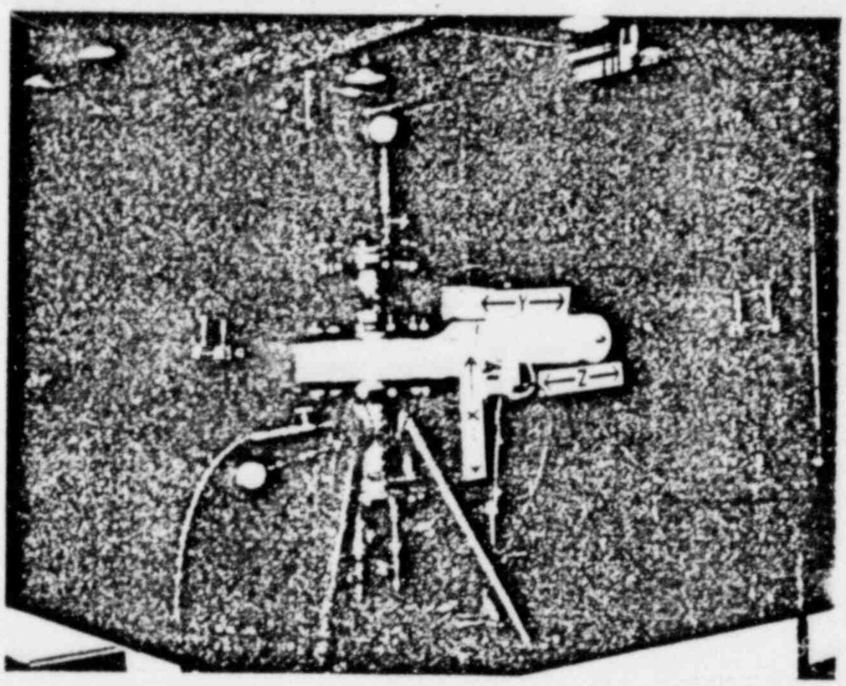


FIGURE 1. TYPICAL TEST SETUP

Job No. D-0089-4



FUNCTIONAL QUALIFICATION TEST FACILITY

HENRY PRATT COMPANY

AURORA, ILLINOIS

Job No. D-0089-4

DIMENSIONAL DATA QTVA

Valve Size 12" NXL (1100)

Operator Mounting TEE BONNET   Operator 721C-80-12

Minimum Cylinder Force Required to Equal Seismic Moments

F_1 = 846 lb. in x direction F_2 = 1058 lb. in y direction

F_3 = 1009 lb. in z direction

Actual Test Cylinder Force 1421.7 lb. in x, 1421.7 lb. in y, 1421.7 lb. in z

A_1	.142	J_2	.8125
A_2	.126	J_3	3.156
A_3	.142	J_4	1.656
A_4	.126	K_1	3.5
A_5	—	M_x	7030
A_6	—	M_y	21383
A_7	9.69	M_z	20254
B_1	4.5	$\overline{M}_x$	—
B_2	3.0	$\overline{M}_y$	—
F_x	1623.5	$\overline{\overline{M}}_x$	16982
F_y	1421.7	$\overline{\overline{M}}_y$	32843
F_z	1421.7	T_1	—
g_x	7.72	T_2	5000
g_y	6.72	V_1	—
g_z	7.05	V_2	—
H_1	4.25	V_3	—
H_2	3.188	V_4	—
H_3	3.188	W_1	201.75
H_4	7	W_2	27.5
I_1	157.63	W_3	—
I_2	22.57	X_0	11.82
J_1	.625	Y_0	2.125
		Z_0	2.82

PART II

SECTION 1 B

FUNCTIONAL QUALIFICATION REPORT

FOR

GENERIC FAMILY VALVE ASSEMBLY (GFVA)

Job No. D-0089-5

As qualified by QTVA form D-0089-4.

THIS GENERIC FAMILY VALVE ASSEMBLY SATISFIES ALL GENERIC QUALIFICATION RULES (PART I, PARAGRAPH 1.3) AND IT IS CONSIDERED A QUALIFIED GENERIC FAMILY VALVE ASSEMBLY.

Job No. D-0089-5

1. DESCRIPTION AND CHARACTERISTICS

Valve Size and Type			12" NXL (1100)
Standard Pressure Class			150
Cold Working Pressure			275 psi
Rated Differential Pressure			200 psi
Maximum Service Temperature			200 °F
Actuator Type	—	Electric Motor	✓ Air
Actuator Size	721C-80-12		
Normal Motive Power	—	Vac	100 psi
Minimum Motive Power	—	Vac	80 psi
Maximum Motive Power	—	Vac	110 psi

Job No. D-0089-5

2. BASE LINE DATA OF GFVA TO BE USED FOR GENERIC QUALIFICATION

Reference Paragraph		
1.3.1	Valve Size	12"NXL(1100)
1.3.2	Seat Taper Angle	15°
1.3.3	Disc/Seat Interference	.030
1.3.4	Seating Surface Materials	STAINLESS STEEL/EPT
1.3.5	Materials of Construction	
	Body	ASME SA-516 GR.70
	Disc	ASME SA-516 GR.70
	Shaft	ASME SA-564 T.630-H1150
	Bearing	ASTM B438 GR.1 TYPE 2
	Seat	EPT
	Retainer Segments	—
	Packing	EPT
	Thrust Collar	SAE 660 BRONZE
	Bottom Cover	ASME SA-516 GR.70
	Bonnet	ASTM A-36
	Bolts: Valve to Bonnet	SAE GR. 8
	Bonnet to Actuator	SAE GR. 8
1.3.6	Actuator Rated Torque @ 80 PSI	3420
	Calculated Operator Torque	2750
	Ratio = 1.24	
	Operating Time	
	Open to Close	4 Sec.
	Close to Open	4 Sec.

Job No. D-0089-5

RESULTS OF QUALIFICATION RULES 1.3.8 AND 1.3.9 FOR GFVA

Rule 1.3.8

a. S_1 = 36000 Yield strength of bonnet materail

S_2 = 3594 Calculated bonnet stress

S_1/S_2 = 10.02 > 1

b. S_3 = 120000 Yield strength (proof load) of bonnet to valve bolting

S_4 = 33167 Calculated stress of bonnet to valve bolting

S_3/S_4 = 3.55 > 1

c. S_5 = 120000 Yield strength (proof load) of actuator to bonnet bolting

S_6 = 26250 Calculated stress of actuator to bonnet bolting

S_5/S_6 = 4.57 > 1

Rule 1.3.9 Bonnet Body Deflections (ΔL)

ΔL of GFVA = .00071 Deflection family valve

ΔL of GFVA < .002"

Job No. D-0089-5

3. COPY OF FUNCTIONAL QUALIFICATION REPORT OF ACTUATOR TO SHOW COMPLETE TO IEEE 344 AND IEEE 382

Reference

Paragraph

1.3.7

Job No. D-0087-5

STATEMENT OF CERTIFICATION

QUALIFICATION TESTING

GH-BETTIS Actuator Model N-721C-SR80 is hereby certified to be of the same construction as Bettis Actuator Model N-732C-SR80 which was qualified to the requirements of ANSI 278.2.1, Draft 3, Rev. 0, Feb. 1977 (IEEE 382) with the exception of LOCA by testing at Southwest Research Institute, San Antonio, Texas. Applicable test margins as described in paragraph 6.3.1.5 of IEEE 323-1974 were utilized with the exception of (8). Refer to SWRI Test Report No. 02-4854-RPT-1 .

The LOCA testing required to complete the qualification program is scheduled to begin at Wyle Laboratories, Huntsville, Alabama on September 11. Upon successful completion of that testing a revised statement of certification will be issued referencing the applicable test report number.

SEISMIC ANALYSIS

In addition to the seismic test results obtained in the above referenced tests, Bettis Seismic Analysis Report No. R-1062-25 Rev.A is offered as further supportive evidence to the rigidity of this actuator.

Joel D. Page

JOEL D. PAGE
Senior Engineer
Nuclear Products

JP/ksy
8-31-78

Job No. D-0089-5

DIMENSIONAL DATA GFVA

Valve Size 12" NXL (1100)

Operator Mounting TEE BONNET

Operator 721C-80-12

A_1	.142	J_2	.8125
A_2	.126	J_3	3.156
A_3	.142	J_4	1.656
A_4	.126	K_1	3.5
A_5	—	M_x	4988
A_6	—	M_y	14768
A_7	9.69	M_z	14067
B_1	4.5	$\overline{M}_x$	—
B_2	3.0	$\overline{M}_y$	—
F_x	1009	$\overline{\overline{M}}_x$	12531
F_y	1009	$\overline{\overline{M}}_y$	22311
F_z	1009	T_1	—
g_x	5.0	T_2	5000
g_y	5.0	V_1	—
g_z	5.0	V_2	—
H_1	4.25	V_3	—
H_2	3.188	V_4	—
H_3	3.188	W_1	201.75
H_4	7	W_2	27.5
I_1	157.63	W_3	—
I_2	22.57	X_0	11.82
J_1	.625	Y_0	2.125
		Z_0	2.82

Addendum 1

This Addendum presents the equations and the calculations required to obtain the required test cylinder forces and the results of the Generic Qualification Rules 1.3.8 and 1.3.9 for the Operability Assurance Program for Active Nuclear Valves.

Table of Contents	Page No.

Forward to Addendum I

The following Addendum has been prepared utilizing a general case involving motor actuators.

This Addendum will also apply for the case involving pneumatic actuators if the adapter plate weight and thickness (W_3 & T_1) are taken to be zero. The "adapter plate" is assumed to be an integral part of the actuator and H_2 is the actuator square.

Then the equation for S_6 represents the actuator to bonnet bolt stress.

ANALYSIS NOMENCLATURE

A_1	Tensile area of trunnion bolt, in^2
A_2	Shear area of trunnion bolt, in^2
A_3	Tensile area of actuator bolt, in^2
A_4	Shear area of actuator bolt, in^2
A_5	Bonnet bolt tensile area, in^2
A_6	Bonnet bolt shear area, in^2
A_7	Bonnet body cross-sectional area, in^2
B_1	Distance to outer fiber of bonnet from shaft on y axis, in.
B_2	Distance to outer fiber of bonnet from shaft on x axis, in.
E	Modulus of elasticity, psi. For steel = 30×10^6
F_1	Required cylinder force in the x direction to equal seismic moments at body mounting surface, pounds
F_2	Required cylinder force in the y direction to equal seismic moments at body mounting surface, pounds
F_3	Required cylinder force in the z direction to equal seismic moments at body mounting surface, pounds
F_x	$W_1 g_x$ - Seismic force along x axis due to seismic acceleration acting on actuator extended mass, pounds
F_y	$W_1 g_y$ - Seismic force along y axis due to seismic acceleration acting on actuator extended mass, pounds
F_z	$W_1 g_z$ - Seismic force along z axis due to seismic acceleration acting on actuator extended mass, pounds
g_x	Seismic acceleration constant along x axis
g_y	Seismic acceleration constant along y axis
g_z	Seismic acceleration constant along z axis
H_1	Top trunnion bolt square, in.
H_2	Bonnet bolt square, in.
H_3	Actuator bolt circle, in.
H_4	Bonnet height, in.
I_1	Bonnet body moment of inertia means about x axis, in^4

I_2 Bonnet body moment of inertia means about y axis, in^4

J_1 Distance to neutral bending axis for top trunnion bolt pattern along x axis, in.

J_2 Distance to neutral bending axis for top trunnion bolt pattern along y axis, in.

J_3 Distance to neutral bending axis for bonnet bolt pattern along x axis, in.

J_4 Distance to neutral bending axis for bonnet bolt pattern along y axis, in.

K_1 Length along z axis to c.g. of bonnet plus adapter plate assembly, in.

M_x $W_1(g_y Z_0)$, actuator extended mass seismic bending moment about the y axis, acting at the base of the actuator, in-lbs.

M_y $W_1(g_x Z_0)$, actuator extended mass seismic bending moment about the y axis, acting at the base of the actuator, in-lbs.

M_z $W_1(g_x Y_0 + g_z X_0)$, actuator extended mass seismic bending moment about the z axis, in-lbs.

$\overline{M_x}$ $M_x + F_y T_1$, actuator extended mass seismic bending moment about the x axis, acting at the bottom of the adapter plate, in-lbs.

$\overline{M_y}$ $M_y + F_x T_1$, actuator extended mass seismic bending moment about the y axis, acting at the bottom of the adapter plate, in-lbs.

$\overline{\overline{M_x}}$ $M_x + F_y(T_1 + H_4) + g_y W_2 K_1$, actuator extended mass seismic bending moment about the x axis, acting at the base of the bonnet, in-lbs.

$\overline{\overline{M_y}}$ $M_y + F_x(T_1 + H_4) + g_x W_2 K_1$, actuator extended mass seismic bending moment about the y axis, acting at the base of the bonnet, in-lbs.

T_1 Adapter plate thickness, in.

T_2 Maximum required operating torque for valve, in-lbs.

V_1 Distances to bolts in bolt pattern on adapter plate, in.

V_2 Distances to bolts in bolt pattern on adapter plate, in.

V_3 Distances to bolts in bolt pattern on adapter plate, in.

V_4 Distances to bolts in bolt pattern on adapter plate, in.

ANALYSIS NOMENCLATURE

W_1 Actuator weight, pounds

W_2 Bonnet and adapter plate assembly weight, pounds

W_3 Adapter plate weight, pounds

X_0 Eccentricity of center of gravity of actuator extended mass along x axis, inches

Y_0 Eccentricity of center of gravity of actuator extended mass along y axis, inches

Z_0 Eccentricity of center of gravity of actuator extended mass along z axis, inches

ΔL_0 Combined deflection of bonnet body due to seismic loads, inches

ΔL_x Deflection of bonnet body in x direction due to seismic load, inches

ΔL_y Deflection of bonnet body in y direction due to seismic load, inches

Derivation of the Required Cylinder Force to Apply to the Actuator Center of Gravity for the QTVA

The actuator mounting and orientation is shown in Figure 1 for a standard valve assembly. The test loading configuration is shown in Figure 2. A cylinder force is applied through the center of gravity of the actuator along both the x,y, and z directions. The cylinder load applied has greater or equal moments about the valve body mounting surface than the actuator assembly at the specified g levels.

In the x direction, the bonnet and actuator are oriented so that the least rigid direction of bonnet and the largest actuator eccentricity combine to form the worst loading case. Since the test valve orientation has the actuator weight acting in the same direction as the cylinder force due to gravity, the test valve actuator weight reduces the required cylinder force. The determination of the cylinder force is shown below. The terms used are listed in the Nomenclature and shown on Figure 2.

Moments of Actuator Assembly at Specified Accelerations

About y axis = $W_1 g_x (H_4 + T_1 + Z_0) + W_2 g_x K_1$

About z axis = $W_1 g_x Y_0$

Moments of Actuator Assembly and Cylinder Load (F_1)

About y axis = $(W_1 + F_1)\ (H_4 + T_2 + Z_0) + W_2 K_1$

About z axis = $(W_1 + F_1)\ Y_0$

Setting the moments about each axis equal and solving for the cylinder load results in two values. The test valve loading shall be equal to or larger than the larger of the two values.

The cylinder load is determined from the following:

About y axis: $F_1 = \dfrac{W_1(g_x-1)(H_4+T_2+Z_0)+W_2K_1(g_x-1)}{H_4+T_1+Z_0}$

About z axis: $F_1 = W_1(g_x-1)$

In the y direction, the gravity effects are not involved and the cylinder load (F_2) is determined from the following equations:

Moments of Actuator Assembly at Specified Accelerations

About x axis $= W_1g_y(H_4+T_1+Z_0)+W_2g_yK_1$

About z axis $= W_1g_yX_0$

Moments of Cylinder Force with No Gravity Effect

About x axis - $F_2(H_4+T_2+Z_0)$

About z axis $= F_2X_0$

Setting the moments about each axis equal and solving for the cylinder load results in two values. The test valve loading shall be equal to or larger than the larger of the two values.

The cylinder load in the y direction is determined from the following:

About y axis: $F_2 = \dfrac{W_1g_y(H_4+T_1+Z_0)+W_2g_yK_1}{H_4+T_1+Z_0}$

About z axis: $F_2 = W_1g_y$

Moments Due to Acceleration in z Direction

About x axis = $W_1 g_z Y_0$

About y axis = $W_1 g_z X_0$

These moments will be directly represented during the test by a force F_3 applied at the c.g. of the operator.

$F_3 = W_1 g_z$

The values for Generic Rules 1.3.8 and 1.3.9 for the actual test valve QTVA are determined using the actual test force. The forces and moments are redefined by the following equations:

$F_x = W_1 + F_1$ $\qquad g_x = 1$

$F_y = F_2$ $\qquad g_y = 1$

$F_z = F_3$ $\qquad g_z = 1$

$M_x = F_2 Z_0 + F_3 Y_0$

$M_y = (W_1 + F_1) Z_0 + F_3 X_0$

$M_z = F_2 X_0 + (W_1 + F_1) Y_0$

$\overline{M_x} = F_2 (Z_0 + T_1) + F_3 Y_0$

$\overline{M_y} = (W_3 + F_2)(Z_0 + T_1) + W_3 T_1 / 2 + F_3 X_0$

$\overline{\overline{M_x}} = F_2 (H_4 + T_1 + Z_0) + F_3 Y_0$

$M_y = (W_1 + F_1)(H_4 + T_1 + Z_0) + W_2 K_1 + F_3 X_0$

The equations of 1.3.8 A through D can be used to determine values for S_2, S_4, S_6, and S_8.

The bonnet body deflections of Rule 1.3.9 for the QTVA are determined using the actual test force and are determined from the following equations:

$$\Delta L_x = \frac{(W_1 + W_2 + F_1) H_4^3}{3EI_2} + \frac{[(W_1 + F_1)(Z_0 + T_1) - W_2 (H_4 - K_1)] H_4^2}{2EI_2} + \frac{F_3 X_0 H_4^2}{2EI_2}$$

$$\Delta L_y = \frac{F_2 H_4^3}{3EI_1} + \frac{F_2 (Z_0 + T_1) H_4^2}{2EI_1} + \frac{F_3 Y_0 H_4^2}{2EI_1}$$

$$\Delta L_0 = (\Delta L_x^2 + \Delta L_y^2)^{1/2}$$

Derivation of the Values for the
Generic Rules 1.3.8 and 1.3.9

The actuator mounting consists of the top trunnion, the bonnet, the actuator housing, and the bolt connections. The elements of the assembly are shown in Figure 2. The following assumptions are used in the development of the equations:

A. Torsional, direct shear, and direct tensile loads are shared equally by all bolts in the pattern.

B. Moments across the bolt pattern are opposed in such a way that the load in each bolt is proportional to its distance from the neutral bending axis.

C. All loads are transferred through the bolt connections.

1.3.8 a. The maximum combined stress in the bonnet was calculated using the following formulas:

$$S_2 = \frac{S_{10}}{2} + \frac{(S_{10}^2 + 4(S_{11}+S_{12})^2)^{1/2}}{2}$$ = Combined stress in bonnet legs, psi

$$S_{10} = \frac{\overline{M}_x B_1}{I_1} + \frac{\overline{M}_y B_2}{I_2}$$ = Tensile stress due to bending moment, psi

$$S_{11} = \frac{(F_x^2+F_y^2)^{1/2} + W_2(g_x^2+g_y^2)^{1/2}}{A_7}$$ = Direct shear stress, psi

$$S_{12} = \frac{(M_z+T_2)(B_1^2+B_2^2)^{1/2}}{I_2 + I_1}$$ = Torsional shear stress, psi

1.3.8 b. Combined stress in bonnet to valve bolting. (See Figure 3)

$$S_4 = \frac{S_{13}}{2} + \frac{(S_{13}^2 + 4(S_{14}+S_{15})^2)^{1/2}}{2}$$

Where:

$$S_{13} = \frac{\dfrac{\overline{\overline{M}}_x(J_2+H_1)}{2J_2^2+2(J_2+H_1)^2} + \dfrac{\overline{\overline{M}}_y(J_1+H_1)}{2J_1^2+2(J_1+H_1)^2}}{A_1}$$ = Tensile stress due to extended mass bending moment, psi

$S_{14} = \dfrac{(F_x^2+F_y^2)^{1/2}+W_2(g_x^2+g_y^2)^{1/2}}{4A_2}$ = Direct shear stress, psi

$S_{15} = \dfrac{(M_z+T_2)}{(.707\ H_1)4\ A_2}$ = Shear stress due to torsional load, psi

1.3.8 c. Combined stress in adapter plate to bonnet bolting. (Figure 4)

$S_6 = \dfrac{S_{16}}{2} + \dfrac{(S_{16}^2+4(S_{17}+S_{18})^2)^{1/2}}{2}$

Where:

$S_{16} = \dfrac{\dfrac{\overline{M_x}(J_4+H_2)}{2J_4^2+2(J_4+H_2)^2} + \dfrac{\overline{M_y}(J_3+H_2)}{2J_3^2+2(J_3+H_2)^2}}{A_5}$ = Tensile stress due to bending, psi

$S_{17} = \dfrac{(F_x^2+F_y^2)^{1/2}}{4A_6}$ = Direct shear stress

$S_{18} = \dfrac{M_z+T_2}{(.707H_2)4\ A_6}$ = Shear stress due to torsion, psi

1.3.8 d. Combined stress in actuator to adapter plate bolting. (Figure 5)

$S_8 = \dfrac{S_{19}}{2} + \dfrac{(S_{19}^2+4(S_{20}+S_{21})^2)^{1/2}}{2}$

Where:

$S_{19} = \dfrac{(M_x+M_y)V_4}{2(V_1^2+V_2^2+V_3^2+V_4^2)A_3}$ = Tensile stress due to bending moment, psi

$S_{20} = \dfrac{(F_x^2+F_y^2)^{1/2}}{8A_4}$ = Direct shear stress, psi

$S_{21} = \dfrac{(M_z+T_2)}{.5\ H_3\ 8\ A_4}$ = Shear stress due to torsion, psi

1.3.9 Bonnet Body Deflections

The deflections of the bonnet body are determined in each direction and are summed vertorially for a combined deflection.

The deflection in each direction was calculated using the following equations:

$$\Delta L_x = \frac{(W_1+W_2)g_xH_4^3}{3EI_2} + \frac{\left[W_1(Z_0+T_1)-W_2(H_4-K_1)\right]g_xH_4^2}{2EI_2} + \frac{W_1g_zX_0H_4^2}{2EI_2}$$

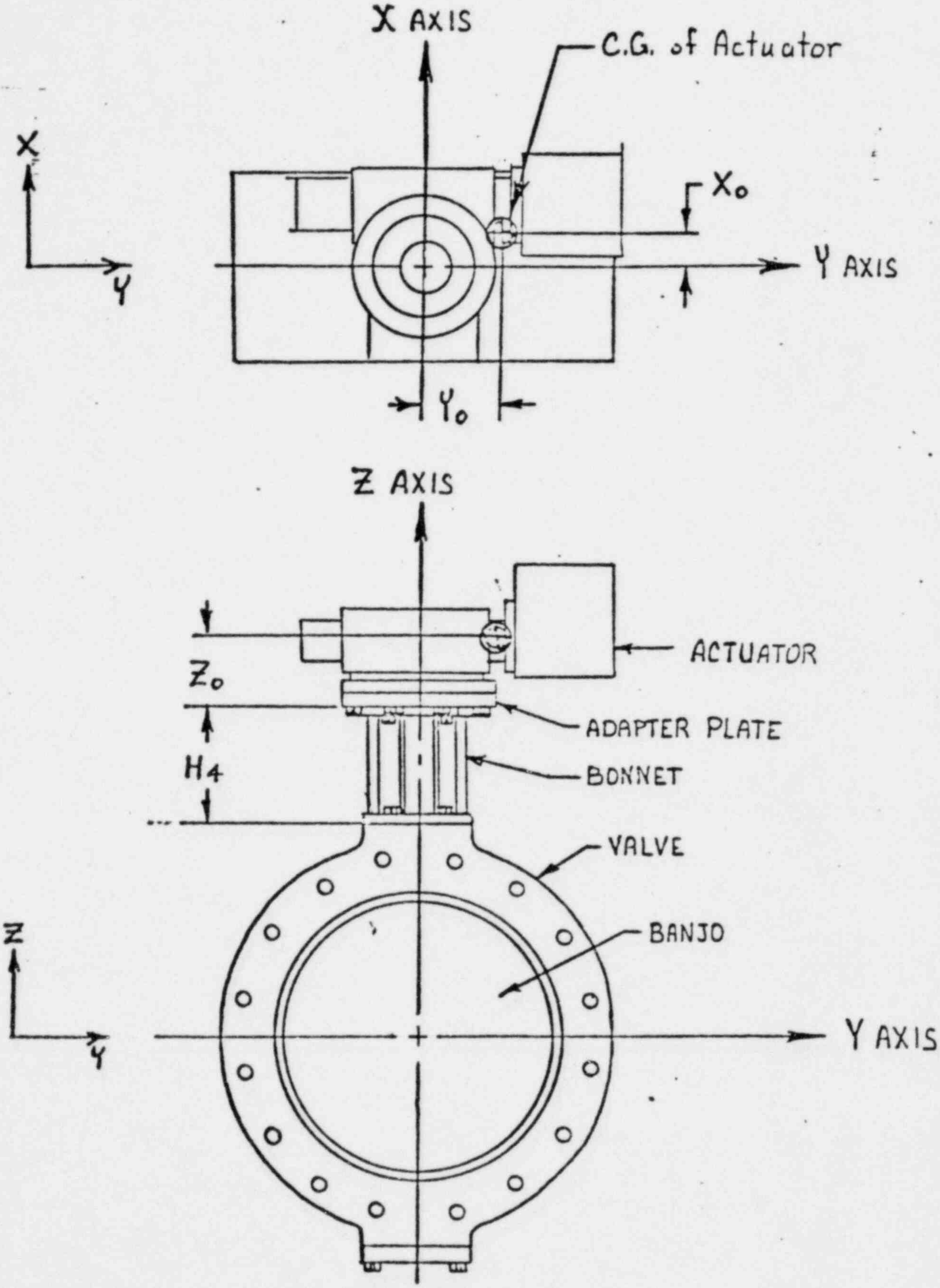
= deflection in the x direction, in.

$$\Delta L_y = \frac{(W_1+W_2)\ g_yH_4^3}{3EI_1} + \frac{\left[W_1(Z_0+T_1)-W_2(H_4-K_1)\right]g_yH_4^2}{2EI_1} + \frac{W_1g_zY_0H_4^2}{2EI_1}$$

= deflection in the y direction, in.

The combined deflection is found from the following equation:

$\Delta L_0 = (\Delta L_x^2 + \Delta L_y^2)^{1/2}$ = Total deflection, in.



Actuator Mounting Assembly
Figure 1

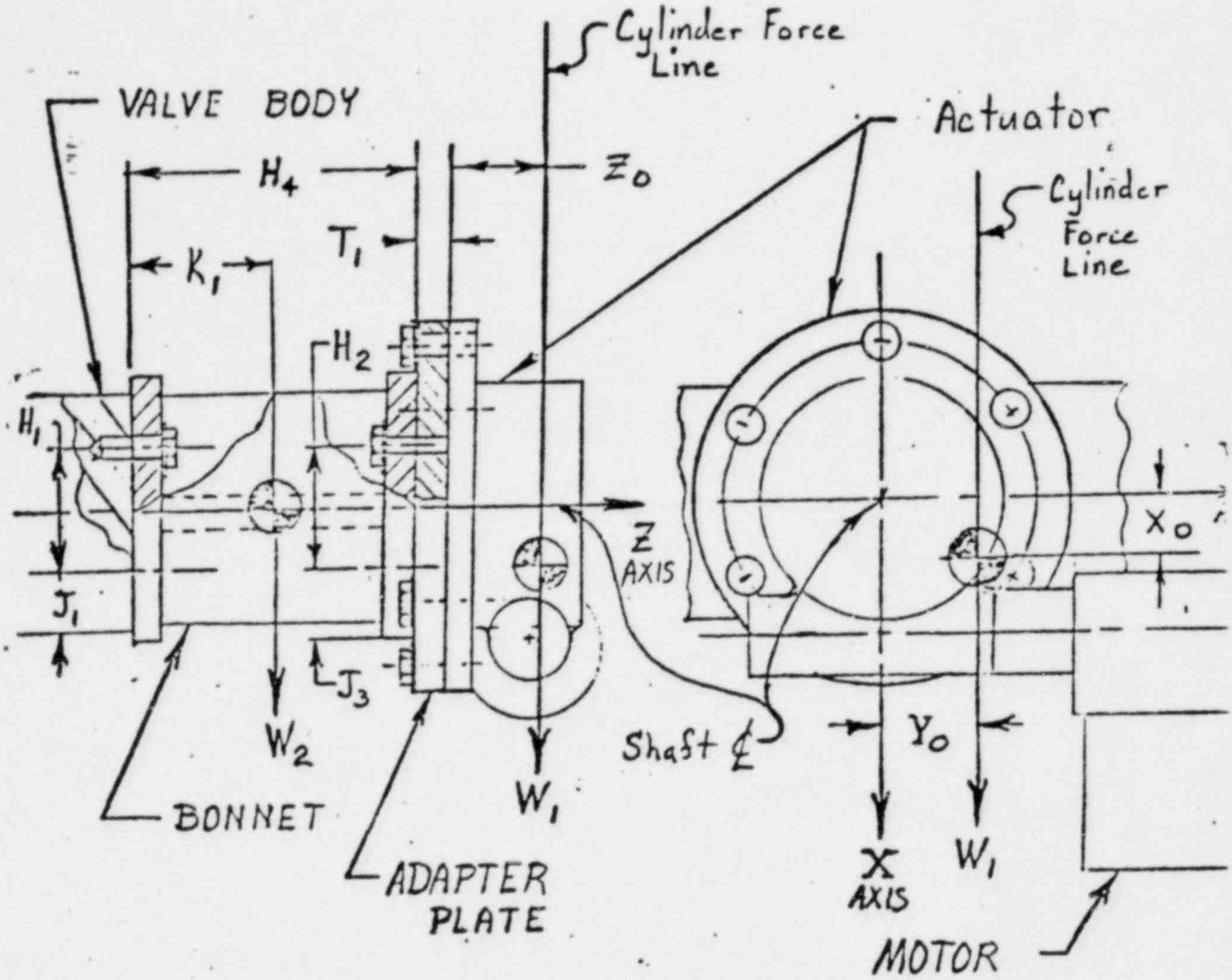
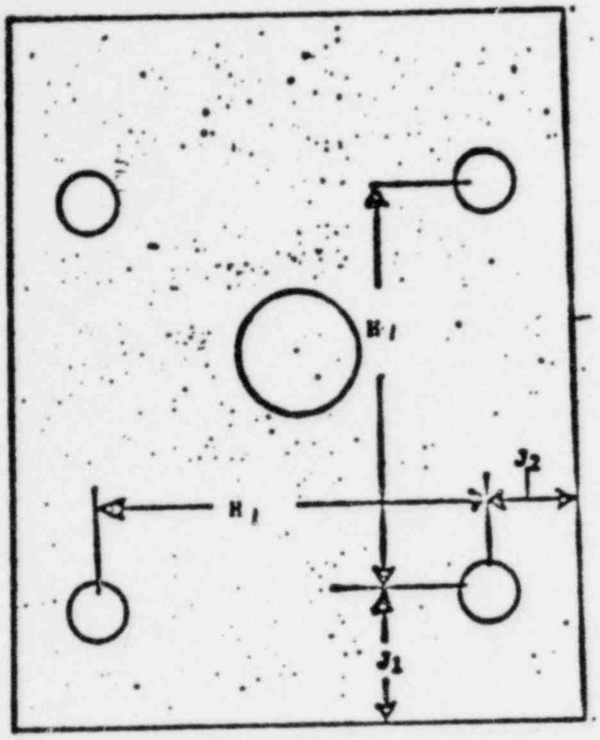


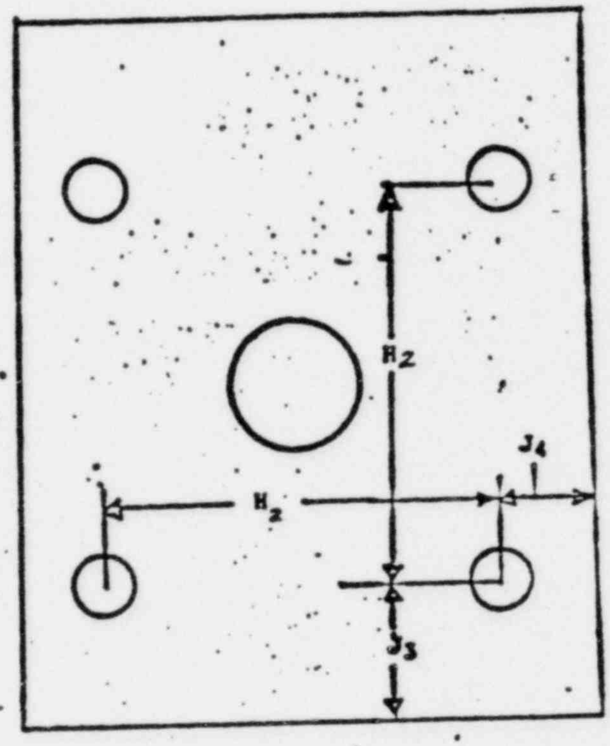
FIGURE 2

Actuator Mounting Configuration for Testing



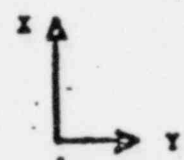
TOP TRUNNION BOLTING

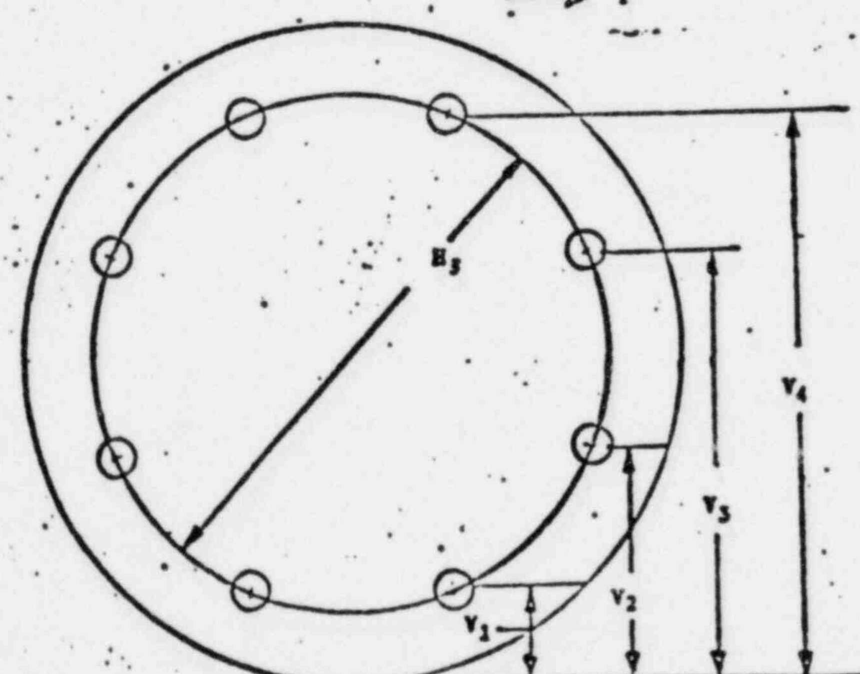
Figure 3



BONNET BOLT PATTERN

Figure 4





ADAPTER PLATE BOLT PATTERN

Figure 5

Job No. ________________

DIMENSIONAL DATA QTVA

Valve Size ____________

Operator Mounting ______________________ Operator ____________________

Minimum Cylinder Force Required to Equal Seismic Moments

F_1 = ______ lb. in x direction F_2 = ______ lb. in y direction

F_3 = ______ lb. in z direction

Actual Test Cylinder Force ______ lb. in x, ______ lb. in y, ______ lb. in z

A_1 ____________	J_2 ____________
A_2 ____________	J_3 ____________
A_3 ____________	J_4 ____________
A_4 ____________	K_1 ____________
A_5 ____________	M_x ____________
A_6 ____________	M_y ____________
A_7 ____________	M_z ____________
B_1 ____________	$\overline{M}_x$ ____________
B_2 ____________	$\overline{M}_y$ ____________
F_x ____________	$\overline{\overline{M}}_x$ ____________
F_y ____________	$\overline{\overline{M}}_y$ ____________
F_z ____________	T_1 ____________
g_x ____________	T_2 ____________
g_y ____________	V_1 ____________
g_z ____________	V_2 ____________
H_1 ____________	V_3 ____________
H_2 ____________	V_4 ____________
H_3 ____________	W_1 ____________
H_4 ____________	W_2 ____________
I_1 ____________	W_3 ____________
I_2 ____________	X_0 ____________
J_1 ____________	Y_0 ____________
	Z_0 ____________

M . Job No. ______________

RESULTS OF QUALIFICATION RULES 1.3.8 and 1.3.9 FOR QTVA

Rule 1.3.8

a. S_1 = ______________ Yield strength of bonnet material

S_2 = ______________ Calculated bonnet stress

S_1/S_2 = ______________ > 1

b. S_3 = ______________ Yield strength (proof load) of bonnet to valve bolting

S_4 = ______________ Calculated stress of bonnet to valve bolting

S_3/S_4 = ______________ > 1

c. S_5 = ______________ Yield strength (proof load) of adapter plate to bonnet bolting

S_6 = ______________ Calculated stress of adapter plate to bonnet bolting

S_5/S_6 = ______________ > 1

d. S_7 = ______________ Yield strength (proof load) of actuator to adapter plate bolting

S_8 = ______________ Calculated stress of actuator to adapter plate bolting

S_7/S_8 = ______________ > 1

Rule 1.3.9

Δ_L of QTVA = ______________ Deflection of test valve

Δ_L of QTVA .002"

Reference Addendum 1 & 2 for equations used to determine stresses and deflection for Rules 1.3.8 and 1.3.9.

Job No. ______________

DIMENSIONAL DATA GFVA

Valve Size ______________

Operator Mounting ______________________ Operator ______________________

A_1 ______________________

A_2 ______________________

A_3 ______________________

A_4 ______________________

A_5 ______________________

A_6 ______________________

A_7 ______________________

B_1 ______________________

B_2 ______________________

F_x ______________________

F_y ______________________

F_z ______________________

g_x ______________________

g_y ______________________

g_z ______________________

H_1 ______________________

H_2 ______________________

H_3 ______________________

H_4 ______________________

I_1 ______________________

I_2 ______________________

J_1 ______________________

J_2 ______________________

J_3 ______________________

J_4 ______________________

K_1 ______________________

M_x ______________________

M_y ______________________

M_z ______________________

$\overline{M_x}$ ______________________

$\overline{M_y}$ ______________________

$\overline{\overline{M_x}}$ ______________________

$\overline{\overline{M_y}}$ ______________________

T_1 ______________________

T_2 ______________________

V_1 ______________________

V_2 ______________________

V_3 ______________________

V_4 ______________________

W_1 ______________________

W_2 ______________________

W_3 ______________________

X_0 ______________________

Y_0 ______________________

Z_0 ______________________

M Job No. ______________

RESULTS OF QUALIFICATION RULES 1.3.8 AND 1.3.9 FOR GFVA

Rule 1.3.8

a. S_1 = ____________________ Yield strength of bonnet material

S_2 = ____________________ Calculated bonnet stress

S_1/S_2 = ________________ > 1

b. S_3 = ____________________ Yield strength (proof load) of bonnet to valve bolting

S_4 = ____________________ Calculated stress of bonnet to valve bolting

S_3/S_4 = ________________ > 1

c. S_5 = ____________________ Yield strength (proof load) of adaptor plate to bonnet bolting

S_6 = ____________________ Calculated stress of adaptor plate to bonnet bolting

S_5/S_6 = ________________ > 1

d. S_7 = ____________________ Yield strength (proof load) of actuator to adaptor plate bolting

S_8 = ____________________ Calculated stress of actuator to adaptor plate bolting

S_7/S_8 = ________________ > 1

Rule 1.3.9 Bonnet Body Deflections (ΔL)

ΔL of GFVA = ____________________ Deflection family valve

ΔL of GFVA < .002"

BECHTEL POWER CORP.
RECEIVED
OCT 1 1978
JOB NO. 9645

PART II

Section 6 A

FUNCTIONAL QUALIFICATION REPORT

FOR

QUALIFIED TEST VALVE ASSEMBLY (QTVA)

RECORD DOCUMENT

Pratt Job No. D-0038-3

BPC P.O. Item 2.03

VENDOR'S DOCUMENT REVIEW
1 [X] Approved - Mfg. may proceed
2 [ ] Approved - Submit final dwg. - Mfg. may proceed
3 [ ] Approved - except as noted - Make changes and submit final dwg. - Mfg. may proceed as approved
4 [ ] Not Approved - Correct and resubmit
5 [ ] Review not required - Mfg. may proceed
Approval of ... relieve supplier ... full compliance ...
By ... Date 9/29/78
JOB NO. 9645 | BECHTEL CORPORATION POWER & INDUSTRIAL DIVISION P.O. BOX 607 GAITHERSBURG, MD

Project Site: Grand Gulf Nuclear Station
Port Gibson, Mississippi

Customer: Mississippi Power & Light Company

Engineer: Bechtel Power Corporation

Specification: 9645-M-257.0

BPC P.O. Item: 9645-M-257.0

0 2 3 2 1 0 3 1 5

Prepared By: Robert C Sanson 9-11-78
Date

Babu m. Carl 9-11-78
Date

Reviewed By: Keith J. Selm 9-7-78
Date

Certified By: Istvan S. Hukeri 9-11-'78
Date

ISTVAN HUKERI 62-27... REGISTERED PROFESSIONAL ENGINEER OF ILLINOIS

9645-M257.0-QS-26.0-8-0

9645-M258.0-QS-26.0-8-0

Section 6A

PART II

Section 6 A

FUNCTIONAL QUALIFICATION REPORT

FOR

QUALIFIED TEST VALVE ASSEMBLY (QTVA)

Job No. D0038-3

THIS TEST VALVE ASSEMBLY WAS SUBJECTED TO ALL APPROPRIATE TEST REQUIREMENTS (PART I, PARAGRAPH 7.0) AND IT IS CONSIDERED A QUALIFIED TEST VALVE ASSEMBLY.

*Applicable for service temperature in excess of 200^{o}F.

Job No. D0038-3

1. DESCRIPTION AND CHARACTERISTICS

Valve Size and Type			36" 1100
Standard Pressure Class			150
Cold Working Pressure			275 psi
Rated Differential Pressure			75 psi
Maximum Service Temperature			200 °F
Actuator Type	—	Electric Motor	✓ Air
Actuator Size	T412-SR4		
Normal Motive Power	—	Vac	100 psi
Minimum Motive Power	—	Vac	80 psi
Maximum Motive Power	—	Vac	110 psi

Job No. D0038-3

2. BASE LINE DATA OF QTVA TO BE USED FOR GENERIC QUALIFICATION OF GFVA

Reference Paragraph		
1.3.1	Valve Size	36"
1.3.2	Seat Taper Angle	11°
1.3.3	Disc/Seat Interference	.030
1.3.4	Seating Surface Materials	ASME SA-240 TYPE 304
1.3.5	Materials of Construction	
	Body	ASME SA-516 GR. 55
	Disc	ASME SA-516 GR.70
	Shaft	ASME SA-564, TYPE 630 COND. H 1150
	Bearing	ASTM B-438 GR 1 TYPE 2
	Seat	E.P.T.
	Retainer Segments	—
	Packing	E.P.T
	Thrust Collar	SAE 660 BRONZE
	Bottom Cover	ASME SA-516 GR. 55
	Bonnet	ASME SA-36
	Bolts: Valve to bonnet	SA 193 GR. B7
	Bonnet to adaptor plate	SA 193 GR 7
	Adaptor plate to actuator	SA 193 GR.7
1.3.6	Actuator Rated Torque	20200
	Calculated Operator Torque	19440
	Ratio = 1.04	
	Operating Time	
	Open to Close	4 Sec.
	Close to Open	60 Sec.

02321 0319

Job No. D0038·3

RESULTS OF QUALIFICATION RULES 1.3.8 and 1.3.9 FOR QTVA

Rule 1.3.8

a. S_1 = 36,000 Yield strength of bonnet material

S_2 = 1419 Calculated bonnet stress

S_1/S_2 = 25·37 > 1

b. S_3 = 95,000 Yield strength (proof load) of bonnet to valve bolting

S_4 = 9750 Calculated stress of bonnet to valve bolting

S_3/S_4 = 9·74 > 1

c. S_5 = 95,000 Yield strength (proof load) of adapter plate to bonnet bolting

S_6 = 6185 Calculated stress of adapter plate to bonnet bolting

S_5/S_6 = 15·36 > 1

Rule 1.3.9

Δ_L of QTVA = ·00024 Deflection of test valve

Δ_L of QTVA .002"

Reference Addendum 1 & 2 for equations used to determine stresses and deflection for Rules 1.3.8 and 1.3.9.

Job No. D-0038-3

STATEMENT OF QUALIFICATION

QUALIFICATION TESTING

GH-BETTIS Actuator Model NT-412B-SR4 is hereby certified to be of the same construction as Bettis Actuator Model NT-420B-SR1 which was qualified to the requirements of ANSI 278.2.1, Draft 3, Rev.0, Feb. 1977 (IEEE 382) with the exception of LOCA by testing at Southwest Research Institute, San Antonio, Texas. Applicable test margins as described in paragraph 6.3.1.5 of IEEE 323-1974 were utilized with the exception of (8). Refer to SWRI Test Report No. 02-4854-RPT-1 .

The LOCA testing required to complete the qualification program is scheduled to begin at Wyle Laboratories, Huntsville, Alabama on September 11. Upon successful completion of that testing a revised statement of certification will be issued referencing the applicable test report number.

Supplementary seismic testing was performed on Bettis Actuator Model NT-520B-SR1 to the requirements of the above referenced ANSI document. Results of that testing are contained in the same report.

SEISMIC ANALYSIS

In addition to the seismic test results obtained in the above referenced tests, Bettis Seismic Analysis Report No. R-1062-40 is offered as further supportive evidence to the rigidity of this actuator.

Joel D. Page

JOEL D. PAGE
Senior Engineer
Nuclear Products

JDP/ksy
8-31-78

Job No. D0038-3 VALVE LEAKAGE TEST

4.1.0 To demonstrate valve shut-off capability and pressure boundary meeting applicable leakage tolerances (para. 3.1). Test valve assembly to be mounted on test stand with the valve shaft oriented horizontally as shown in Figure 1.

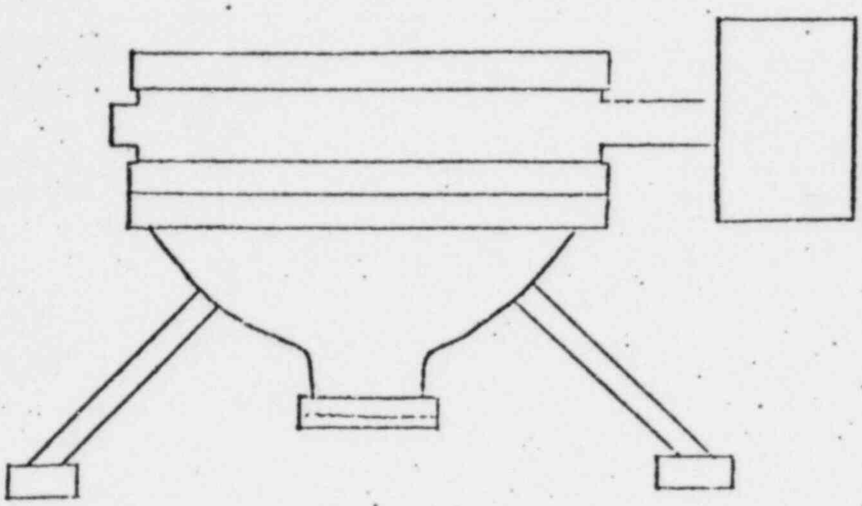


FIGURE 1

4.1.1 Pre-Test Inspection

4.1.2 Adjust limit switches for proper open and closed positions of valve disc.

4.1.3 Measure normal motive power to actuator.

— Vac. 100 psi

4.1.4 Measure required torque settings of fasteners. (Ft. Lb.)

Bonnet to trunnion	Required 430	Measured 430
Bonnet to ~~adaptor plate~~	Required NA	Measured NA
~~Adaptor plate to~~ actuator	Required 430	Measured 430
Adaptor plate to trunnion	Required NA	Measured NA
Bottom cover to trunnion	Required 30	Measured 30

4.1.5 Verify calibration of required test equipment.

Job No. *D0038-3*

4.1.6 Test Procedure (Appendix A)

a. With the test valve assembly in the most adverse position (as shown in Figure 1) operate the valve with normal motive power starting from full closed position three operating cycles.

Measure and Record:

Motive Power	*—* Vac.	*100* psi	
Operating Time	Cycle #1	Cycle #2	Cycle #3
Closed to Open	*11.8* sec.	*11.6* sec.	*11.8* sec.
Open to Closed	*3.1* sec.	*2.9* sec.	*2.8* sec.

b. Repeat Step a with minimum motive power.

Motive Power	*—* Vac.	*80* psi	
Operating Time	Cycle #1	Cycle #2	Cycle #3
Closed to Open	*16.3* sec.	*16.3* sec.	*16.3* sec.
Open to Closed	*2.5* sec.	*2.5* sec.	*2.7* sec.

c. With the valve disc in the closed position, cover the disc with a pool of water deep enough to submerge disc/seat interference line.

d. Using air as test fluid, pressurize valve assembly to *3* psi differential pressure across disc. Hold pressure for a minimum time of five minutes (A-3). Observe and record leakage (A-4). Bubble tight condition of valve seat is considered a successful qualification of the TVA.

Leakage *NONE* Bubble Tight *TO AT LEAST 3 PSIG*

e. Repeat steps c and d with pressure on opposite side of valve disc for bi-directional qualification

Leakage *NONE* Bubble Tight *TO AT LEAST 3 PSIG*

Job No. D0038-3

f. For the packing leak test the TVA is to be sandwiched in between two test heads as shown in Figure 2.

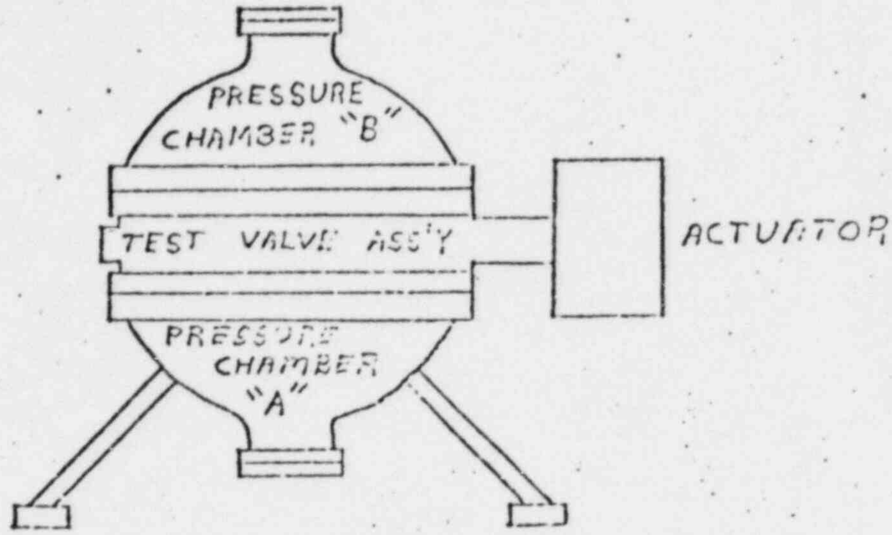


FIGURE 2

g. With normal motive power applied to the actuator, cycle the TVA 10 times. Record cycle time for the first and tenth cycles.

Record:

Motive power	— Vac.	100	psi
1st Cycle	Open to Close	2.9	sec.
	Close to Open	11.8	sec.
10th Cycle	Open to Close	2.8	sec.
	Close to Open	11.8	sec.

h. With the valve disc in the open position, pressurize test valve assembly to cold working pressure of 3 psi using air as test fluid. Hold cold working pressure for a time period of 5 minutes. Observe leakage by applying soap solution around packing. Soap bubble tight condition of packing is considered successful qualification of TVA.

Leakage Observed NONE Soap Bubble Tight TO AT LEAST 3 PSIG

Job No. D0038-3

4.2.0 Cold Cyclic Test

To demonstrate cyclic operability of the TVA (3.2) under the most adverse combination of motive power and system pressure. The test valve assembly is to be sandwiched between two test heads with the valve shaft oriented horizontally as shown in Figure 3.

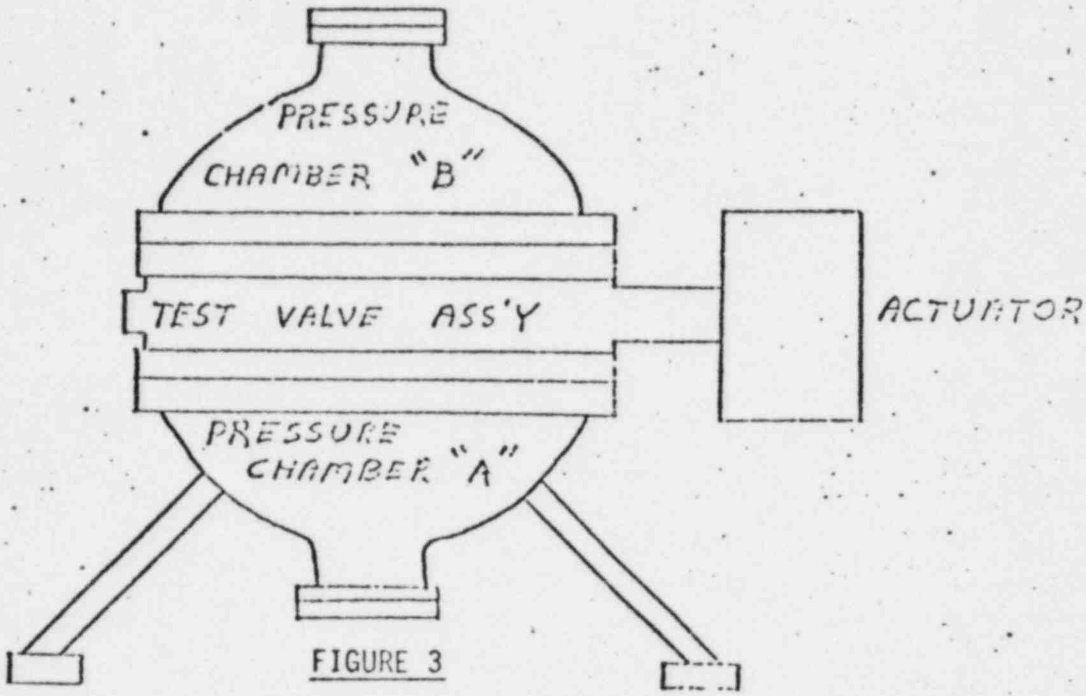


FIGURE 3

4.2.1 Pre-Test Inspection

4.2.2 Adjust limit switches for proper closed and open position of valve disc.

4.2.3 Measure motive power to actuator.

— Vac. 100 psi

4.2.4 Measure required torque settings of fasteners. (Ft. Lb.)

Bonnet to trunnion	Required	430	Measured	430
Bonnet to ~~adaptor plate~~	Required	NA	Measured	NA
~~Adaptor plate to~~ actuator	Required	430	Measured	430
Adaptor plate to trunnion	Required	NA	Measured	NA
Bottom cover to trunnion	Required	30	Measured	30

4.2.5 Verify calibration of required test equipment.

Job No. D 0038-3

4.2.6 Test Procedure (Appendix B)

a. With the valve disc in the full open position pressurize pressure chamber A & B (Figure 3) to cold working pressure of 3 psi using air as test fluid. With minimum motive power of — Vac or 80 psi applied to actuator operate valve disc to full closed position.

b. Reduce air pressure to 0 psi in pressure chamber B, and to 3 psi in pressure chamber A, to obtain a differential pressure of 3 psi across the closed valve disc.

c. With minimum motive power of — Vac or 80 psi applied to actuator, open valve disc.

d. Repeat steps a, b, and c twice.

e. Data to be Recorded.

In step "a"	1st Cycle	2nd Cycle	3rd Cycle
Pressure in Chamber A	3 psi	3 psi	3 psi
Pressure in Chamber B	3 psi	3 psi	3 psi
Motive Power	(— Vac	— Vac	— Vac
	(80 psi	80 psi	80 psi
Operating Time			
Open to Close	2.8 sec	2.6 sec	2.7 sec
In step "b"			
Pressure in Chamber A	3 psi	3 psi	3 psi
Pressure in Chamber B	0 psi	0 psi	0 psi
Motive Power	(— Vac	— Vac	— Vac
	(80 psi	80 psi	80 psi
Operating Time			
Close to Open	15.9 sec	16.1 sec	16.3 sec

Job No. D0038-3

f. Repeat steps a to d using nominal motive power of — Vac or 100 psi.

g. Data to be Recorded

Step f, a	1st Cycle	2nd Cycle	3rd Cycle
Pressure in Chamber A	3 psi	3 psi	3 psi
Pressure in Chamber B	3 psi	3 psi	3 psi
Motive	(— Vac	— Vac	— Vac
	(100 psi	100 psi	100 psi
Operating Time			
Open to Close	3.2 sec	3.0 sec	3.5 sec

Step f, b			
Pressure in Chamber A	3 psi	3 psi	3 psi
Pressure in Chamber B	0 psi	0 psi	0 psi
Motive	(— Vac	— Vac	— Vac
	(100 psi	100 psi	100 psi
Operating Time			
Close to Open	11.4 sec	11.4 sec	11.5 sec

h. With the test valve assembly depressurized and maximum power of — Vac or 110 psi applied to actuator, perform three operating cycles.

Data to be recorded:

Operating Time	1st Cycle	2nd Cycle	3rd Cycle
Open to Close	3.4 sec	3.1 sec	3.0 sec
Close to open	10.3 sec	10.2 sec	10.2 sec

i. Measured operating times within operating times specified in paragraph 1.3.6 are considered successful qualification of the test valve assembly.

4.3.0 To demonstrate cyclic operability of TVA under the most adverse combination of motive power, system pressure and loading representative of the maximum seismic incident, the test valve assembly is sandwiched between two test heads as shown in Figure 4.

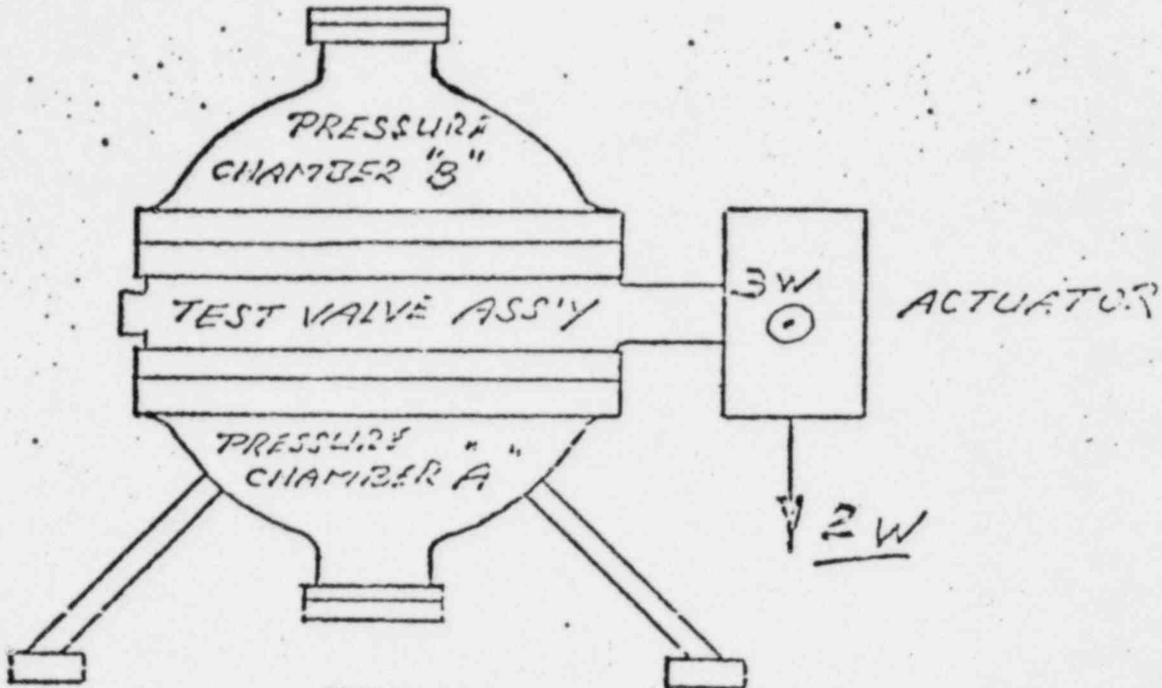


FIGURE 4

4.3.1 Pre-Test Inspection

4.3.2 Adjust limit switches for proper closed and open position of valve disc.

4.3.3 Measure motive power to actuator

— Vac   100 psi

4.3.4 Measure required torque settings of fasteners. (Ft. Lb.)

Bonnet to trunnion	Required	430	Measured	430
Bonnet to ~~adaptor plate~~	Required	NA	Measured	NA
~~Adaptor plate to~~ actuator	Required	430	Measured	430
Adaptor plate to trunnion	Required	NA	Measured	NA
Bottom cover to trunnion	Required	30	Measured	30

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4.3.5 Test Procedure (Appendix E)

a. A static load shall be applied in line with the center of gravity of the valve operator. The static load shall equal twice the operator weight applied in the vertical direction (downward) and three times the operator weight in a direction parallel to the valve nozzle centerline applied simultaneously. Ref. Addendum 1 & 2 for the determination of test loads to be applied.

b. With the static load applied as described in paragraph a and with the valve disc in the full open position, pressurize pressure chamber A and B to a cold working pressure of 3 psi. Use air as test fluid. With minimum motive power of — Vac or 80 psi applied to actuator, operate valve disc to full closed position.

c. Reduce air pressure to 0 psi in pressure chamber B and 3 psi in pressure chamber A to obtain a differential pressure of 3 psi across valve disc.

d. With minimum motive power of — Vac or 80 psi applied to actuator, open valve disc.

e. Repeat steps a, b, and c twice.

f. Data to be Recorded:

In step A	1st Cycle	2nd Cycle	3rd Cycle
Pressure in Chamber A	3 psi	3 psi	3 psi
Pressure in Chamber B	3 psi	3 psi	3 psi
Motive Power	(— Vac	— Vac	— Vac
	(80 psi	80 psi	80 psi
Operating Time			
Open to Close	2.7 sec	3.0 sec	2.8 sec

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In step b	1st Cycle	2nd Cycle	3rd Cycle
Pressure in Chamber A	3 psi	3 psi	3 psi
Pressure in Chamber B	0 psi	0 psi	0 psi
Motive Power	(— Vac	— Vac	— Vac
	(80 psi	80 psi	80 psi
Operating Time			
Close to Open	15.9 sec	15.9 sec	16.1 sec

g. Repeat steps a to d using normal motive power of — Vac or 100 psi.

h. Data to be Recorded

Step g, b			
Pressure in Chamber A	3 psi	3 psi	3 psi
Pressure in Chamber B	3 psi	3 psi	3 psi
Motive Power	(— Vac	— Vac	— Vac
	(100 psi	100 psi	100 psi
Operating Time			
Open to Close	3.0 sec	3.0 sec	3.0 sec
Step g, c			
Pressure in Chamber A	3 psi	3 psi	3 psi
Pressure in Chamber B	0 psi	0 psi	0 psi
Motive Power	(— Vac	— Vac	— Vac
	(100 psi	100 psi	100 psi
Operating Time			
Close to Open	11.5 sec	11.5 sec	11.6 sec

i. With the test valve assembly depressurized and maximum motive power of — Vac or 110 psi applied to actuator, perform three operating cycles.

Job No. D0038-3

Data to be recorded:

Operating time	1st Cycle	2nd Cycle	3rd Cycle
Open to Close	2.9 sec	3.0 sec	3.1 sec
Close to Open	10.3 sec	10.3 sec	10.3 sec

j. Measured operating times within operating times specified in paragraph 1.3.6 are considered successful qualification of the test valve assembly.

4.3.6 Valve Leakage Test

To demonstrate that the test valve is capable of meeting seat and shaft packing sealing requirements after exposure to the most adverse combination of motive power, system pressure and seismic loading tests, the test valve assembly is mounted on test stand with the valve shaft oriented horizontally as shown in Figure 5.

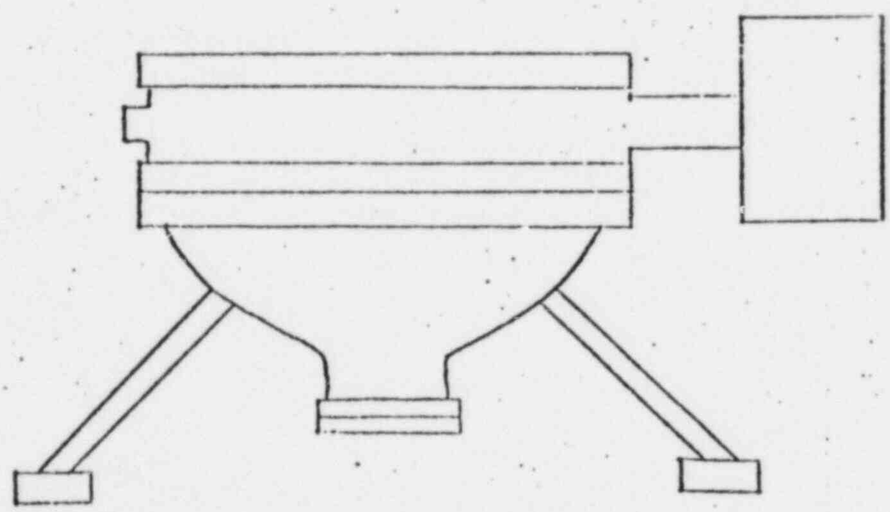

FIGURE 5

4.3.7 Pre-Test Inspection

4.3.8 Adjust limit switches for proper open and closed positions of valve disc.

4.3.9 Measure normal motive power to actuator.

— Vac 100 psi

Job No. D0038-3

4.3.10 Measure required torque setting of fasteners. (Ft. Lb.)

Bonnet to trunnion	Required 430	Measured 430
Bonnet to ~~adaptor plate~~	Required NA	Measured NA
~~Adaptor plate to~~ actuator	Required 430	Measured 430
Adaptor plate to trunnion	Required NA	Measured NA
Bottom cover to trunnion	Required 30	Measured 30

4.3.11 Verify calibration of required test equipment.

4.3.12 Test Procedure (Appendix A)

a. With the test valve assembly in the most adverse position (as shown in Figure 1) operate the valve with normal motive power starting from full closed position three cperating cycles.

Data to be Recorded

Motive Power — Vac 100 psi

Operating Time	1st Cycle	2nd Cycle	3rd Cycle
Closed to Open	12.0 sec	11.6 sec	11.5 sec
Open to Closed	3.0 sec	3.0 sec	3.1 sec

b. Repeat step a with minimum motive power.

Motive Power — Vac 80 psi

Operating Time	1st Cycle	2nd Cycle	3rd Cycle
Closed to Open	15.9 sec	15.8 sec	15.7 sec
Open to Closed	2.7 sec	2.7 sec	2.8 sec

c. With the valve disc in the closed position, cover the disc with a pool of water deep enough to submerge disc/seat interference line.

d. Using air as test fluid, pressurize valve assembly to 3 psi differential pressure across disc. Hold pressure for a time period of five minutes (A-3). Observe and record leakage (A-4). Bubble tight condition of valve seat is considered a successful qualification of TVA.

Leakage Observed NONE Bubble Tight TO AT LEAST 3 PSIG

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e. Repeat steps c and d with pressure on opposite side of valve disc for bi-directional qualification.

Leakage Observed NONE Bubble Tight TO AT LEAST 3 PSIG

f. For the packing leak test the TVA is to be sandwiched between two test heads as shown in Figure 6.

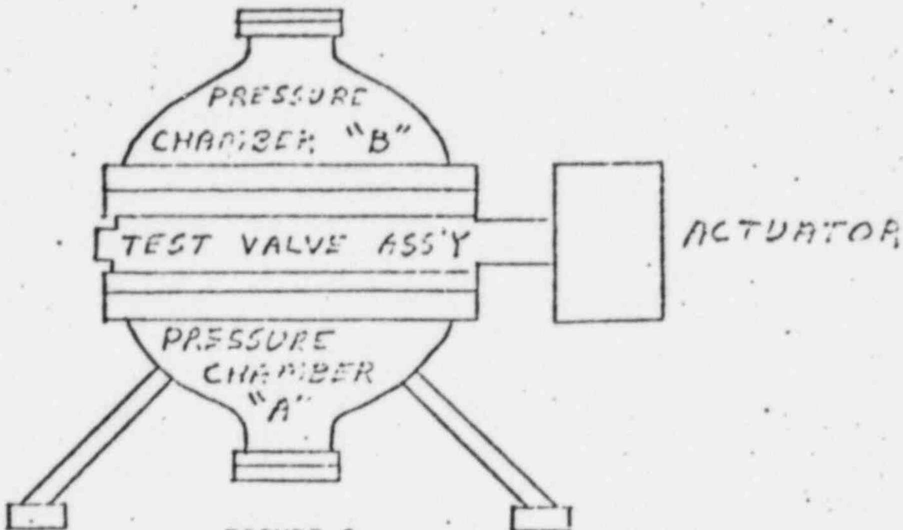

FIGURE 6

g. With normal motive power applied to the actuator, cycle the TVA 10 times. Record cycle time for the first and tenth cycles.

Data to be Recorded

Motive Power	– Vac	100 psi
1st Cycle	Open to Close	3.0 sec
	Close to Open	11.6 sec
10th Cycle	Open to Close	3.0 sec
	Close to Open	11.6 sec

h. With the valve disc in the open position, pressurize test valve assembly to cold working pressure of 3 psi using air as test fluid. Hold cold working pressure for a time period of 5 minutes. Observe leakage by applying soap solution around packing. Soap bubble tight condition of packing is considered successful qualification of TVA.

Leakage Observed NONE Soap Bubble Tight TO AT LEAST 3 PSIG

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Section 6A Part 2

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Job No. D-0038-3

4.5.0 Vibration Test

To demonstrate operability of the test valve assembly during and after vibratory disturbances, and to establish the validity of natural frequency calculations the test valve assembly is to be mounted on a seismic test machine with the valve shaft oriented horizontally. (Para. 5.2 of Qualification Requirements)

4.5.1 Pre-Test Inspection

a. Receiving inspection - Identification and visual inspection of TVA for evidence of damage due to shipping. To be performed in the presence of HPCo. representative.

b. Description of test valve assembly mounting to seismic test machine - photograph of test apparatus to be included.

c. Adjust limit switches for proper open and closed position of valve disc.

d. Measure motive power to actuator.

— Vac 90 psi

e. Describe test equipment and calibration methods including location and number of control and response accelerometers.

4.5.2 Test Procedure

a. With the test valve assembly mounted to the seismic test machine in the most adverse position (para. 5.2 of Qualification Requirements) operate valve with nominal motive power starting from full closed position.

Measure and record:

Motive power — Vac 90 psi

Operating time

Closed to open 12 sec

Open to closed 3 sec

b. Resonance search - A steady state sinusoidal resonant search to be performed in each of the three mutually perpendicular axis. Input test level amplitude to be at least 0.2g (zero to peak). The frequency range of 3.5 to 95 Hz to be covered with a sweep rate not exceeding one octave per minute. For the purpose of this test resonance is defined as a frequency at which acceleration of the actuator at the plane of the center of gravity perpendicular to the shaft centerline exceeds the input acceleration level by a factor of 3 or more.

c. Variable frequency test - A variable frequency test to be performed with a minimum input test level of 0.5 g (zero to peak) in the mutually perpendicular axis of the following frequencies. 3.5, 4.5, 6, 8, 11, 15, 21, 29, 39, 53, 71, and 95 Hz. At each of the above frequencies repeat step a and record motive power and each helf of operating time.

d. Endurance test - The test valve assembly to be vibrated with a minimum input of 0.5g (zero to peak) in the three mutually perpendicular axis at resonant frequencies found in step b and at 33 Hz, for a time period of three minutes. At the conclusion of each of the three minute vibration test with the test assembly still vibrating, operability of the test valve assembly to be demonstrated by performing step a.

e. Measured operating times within operating time specified in paragraph 1.3.6 and rechecked in para. a are considered successful qualification of test valve assembly.

FOR TEST RESULTS SEE ATTACHED AERO-NAV LAB. REPORT DATED MAY-9-1978

0232103339

AERO NAV

LABORATORIES, INC.

14-29 112TH STREET • COLLEGE POINT, N.Y. 11356 • (212) 939-4422

(UNCLASSIFIED)

REPORT OF SEISMIC TEST ON 36-INCH VALVE WITH ROBOTARM OPERATOR FOR HENRY PRATT COMPANY AURORA, ILLINOIS

TESTED BY	[signature]	ETL REPORT	7-6534-7
CHECKED BY	[signature]	AERO NAV SALES ORDER	7-6534
APPROVED BY	[signature]	CUSTOMER P.O.	B-58030
DATE	9 MAY 1978	P.O. ITEM NO. - 4	
GOVERNMENT QAR	NONE	TEST VALVE NO. - 6 PRATT JOB NO. - D-0038-3	

(UNCLASSIFIED)

ADMINISTRATIVE DATA

DATE
9 May 1978

PURPOSE OF TEST: To determine the effects of Seismic Vibration on the physical and operational characteristics of the submitted specimen.

MANUFACTURER: HENRY PRATT COMPANY
401 S. Highland Avenue
Aurora, Illinois 60507

MANUFACTURER TYPE AND SERIAL NUMBER: As specified on Purchase Order, the following nomenclature applies:
36-inch Valve with Robotarm Operator
See Paragraph 2.0 for nameplate data.

DRAWINGS SPECIFICATIONS OR EXHIBIT: Tested in accordance with Henry Pratt Company Test Procedure

QUANTITY OF ITEMS TESTED: One (1) only

EQUIPMENT: Unclassified
REPORT: Unclassified

DATE TEST COMPLETED: 21 March 1978

TEST CONDUCTED BY: **AERO NAV LABORATORIES, INC.**
14-29 112th STREET
COLLEGE POINT, NEW YORK 11356

DISPOSITION OF SPECIMEN: Returned to client

ABSTRACT: It is the function of the Aero Nav Laboratories, Inc., as an impartial testing agency in performing this test to subject the specimen to seismic vibration of magnitude and direction as specified in the detailed specifications.

FACTUAL DATA

1.0 DESCRIPTION OF TEST APPARATUS:

1.1 Accelerometers, Model No. 2213E, Serial Nos. CP36, CP37, CP43, CP47 & CP48, manufactured by Endevco Corporation.
Calibration Due: 13 July 1978.

1.2 Amplifier, Model No. 2616, Serial No. CA-13, manufactured by Endevco Corporation.
Calibration Due: 13 July 1978.

1.3 Amplifier, Model No. 2616B, Serial No. KA-07, manufactured by Endevco Corporation.
Calibration Due: 13 July 1978.

1.4 Power Supply, Model No. 2621, Serial No. 9026, manufactured by Endevco Corporation.
Calibration Due: 13 July 1978.

1.5 Power Supply, Model No. 2622, Serial No. CA-24, manufactured by Krohn-Hite Corporation.
Calibration Due: 13 July 1978.

1.6 Band Pass Filter, Model No. 330M, Serial No. 2116, manufactured by Ballantine Labs.
Calibration Due: 12 September 1978.

1.7 True R.M.S. VTVM, Model No. 320A, Serial No. 8400, manufactured by Ballantine Labs.
Calibration Due: 4 May 1978.

1.8 Vibration Test Stand, Model 72-5000, Serial No. 51402, manufactured by L.A.B. Corporation.
Calibration Due: 13 July 1978.

FACTUAL DATA

2.0 NAMEPLATE DATA:

Nameplate Data (valve)
Nuclear Class 3
3 PSI at 150°F
Valve S/N D-0038-3-4
Tag No. SQ-36-HBC-AO-F020-OWY
Body Mat. SA516 GR55
Year 1976
P.O. 9645-M-257.0
Job 9645 Item 2-2.03B

Nameplate Data (actuator)
Robotarm
Model No. 7412-SR-4
Serial No. 50929-4
Nominal Working Press. 91 PSI
Maximum Working Press. 220 PSI
Maximum Test Press. 220 PSI

FACTUAL DATA

3.0 METHOD OF TEST:

The submitted valve, mounted so as to simulate installed conditions, was affixed to the table of the seismic simulator and was subjected to the following:

3.1 Resonance Frequency Search:

The specimen was subjected to a resonant frequency search from 3.5 to 95 Hz. The input acceleration was in accordance with Table I.

TABLE I

Frequency	Acceleration
3.5 to 95 Hz	0.2 g's

The frequency was increased in steps of 1 Hz and vibration was maintained at each frequency for a period of approximately twenty (20) seconds.

The above test was performed in each of the three (3) mutually perpendicular axes independently.

For the purpose of this test, resonance is defined as a frequency at which acceleration of the actuator at the plane of the center of gravity perpendicular to the shaft centerline exceeds the input acceleration level by a factor of three (3) or more.

3.2 Variable Frequency Test:

Upon completion of resonant frequency search in each of the three (3) mutually perpendicular axes, the specimen was subjected to a dwell test at the following frequencies:

3.5, 4.5, 6, 8, 11, 15, 21, 29, 39, 53, 71 and 95 Hz. The acceleration level was 0.5 g's. Vibration was maintained at each frequency for a sufficient length of time in order to determine the following valve/actuator parameters:

(1) Input Air - 90 psig shop air nominal

(2) Operating Time (a) Closed to open
(b) Open to closed

The above test was accomplished in each of the three (3) mutually perpendicular axes.

METHOD OF TEST (continued)

3.3 Endurance Test:

The specimen was subjected to vibration at an amplitude of 0.5g at each of the resonant frequencies encountered during the resonant search and at 33 Hz for a time period of three (3) minutes at each frequency.

At the conclusion of each of the three (3) minute vibration test the following valve/actuator parameters were determined.

(1) Input Air - 90 psig shop air nominal

(2) Operating Time (a) Closed to open
(b) Open to closed

The above test was accomplished in each of the three (3) mutually perpnedicular axes.

FACTUAL DATA

4.0 RESULTS OF TESTS:

4.1 Horizontal (along the valve stem) Axis (H2)

4.1.1 Resonance Frequency Search:

Accelerometer Locations:

Input accelerometers are located on the valve side of the bonnet on the valve.

Output accelerometers are located on the actuator side of the bonnet on the actuator.

Inputs A - Horizontal across stem (H1)
B - Horizontal with stem (H2)
C - Vertical (V)

Outputs D - Horizontal across stem (H1)
E - Horizontal with stem (H2)
F - Vertical (V)

RESULTS OF TESTS:

Horizontal (along the valve stem) Axis (H2)

Resonance Frequency Search (continued)

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F
5	.010	.090	.012	.010	.080	.056
6	.012	.15	.026	.010	.14	.060
7	.014	.22	.048	.012	.22	.070
8	.019	.30	.065	.014	.30	.084
9	.011	.11	.028	.010	.10	.030
10	.014	.15	.037	.010	.15	.040
11	.018	.20	.050	.010	.20	.050
12	.020	.23	.055	.010	.23	.054
13	.028	.30	.072	.010	.30	.070
14	.011	.10	.028	.010	.10	.025
15	.013	.12	.032	.010	.12	.029
16	.014	.14	.037	.010	.14	.032
17	.016	.16	.042	.010	.16	.034
18	.018	.18	.049	.010	.18	.039
19	.019	.20	.055	.010	.20	.044
20	.021	.23	.060	.010	.23	.045
21	.024	.25	.066	.010	.25	.050
22	.029	.29	.076	.010	.29	.050
23	.033	.30	.08	.010	.30	.054
24	.016	.096	.040	.028	.096	.032
25	.017	.099	.042	.031	.099	.024
26	.017	.11	.047	.020	.11	.040
27	.016	.115	.050	.022	.115	.040
28	.015	.12	.054	.047	.115	.070
29	.028	.14	.062	.033	.14	.080
30	.026	.145	.062	.020	.145	.042
31	.024	.155	.066	.024	.155	.040
32	.020	.17	.070	.022	.17	.045
33	.021	.18	.073	.024	.18	.046
34	.019	.185	.076	.020	.185	.049
35	.023	.19	.078	.0225	.19	.054
36	.025	.20	.086	.025	.20	.060
37	.024	.22	.096	.030	.22	.040
38	.025	.23	.11	.040	.23	.036
39	.028	.24	.115	.035	.25	.080
40	.036	.25	.14	.046	.27	.068

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FACTUAL DATA

RESULTS OF TESTS:

Horizontal (along the valve stem) Axis (H2)

Resonance Frequency Search (continued)

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F
41	.2	.081	.2	.10	.44	.16
42	.2	.080	.19	.088	.42	.15
43	.2	.080	.19	.10	.35	.15
44	.2	.092	.17	.11	.42	.17
45	.2	.10	.18	.12	.47	.16
46	.2	.12	.18	.14	.70	.22
47	.2	.115	.18	.14	.71	.22
48	.2	.13	.46	.19	1.0	.30
49	.2	.10	.20	.14	1.2	.39
50	.2	.09	.38	.13	1.15	.38
51	.2	.061	.084	.085	1.0	.34
52	.2	.051	.078	.078	1.0	.34
53	.2	.033	.084	.061	.92	.33
54	.2	.031	.099	.051	.89	.31
55	.2	.040	.11	.070	.81	.26
56	.2	.060	.15	.095	.70	.23
57	.2	.085	.30	.13	.90	.28
58	.2	.079	.40	.15	.78	.26
59	.2	.074	.32	.11	.72	.25
60	.2	.13	.26	.16	.78	.26
61	.2	.14	.30	.15	.84	.27
62	.2	.15	.25	.16	1.1	.35
63	.2	.14	.28	.15	1.4	.42
64	.2	.13	.40	.16	1.4	.39
65	.2	.12	.47	.17	.88	.25
66	.2	.13	.45	.19	.62	.15
67	.2	.084	.22	.12	.9	.28
68	.2	.11	.4	.17	.9	.28
69	.2	.075	.3	.11	.33	.075
70	.2	.076	.36	.12	.52	.12
71	.2	.085	.42	.18	.8	.2
72	.2	.17	.5	.28	.9	.25
73	.2	.12	.4	.15	.32	.3
74	.2	.09	.34	.12	.4	.25
75	.2	.10	.38	.14	.48	.26
76	.2	.15	.44	.26	.69	.32
77	.2	.2	.5	.3	.86	.35
78	.2	.087	.34	.13	.45	.21
79	.2	.16	.4	.28	.58	.25
80	.2	.22	.45	.29	.88	.28

FACTUAL DATA

RESULTS OF TESTS:

Horizontal (along the valve stem) Axis (H2)

Resonance Frequency Search (continued)

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F
81	.2	.14	.4	.23	.5	.21
82	.2	.25	.44	.29	.67	.3
83	.2	.21	.4	.26	.56	.25
84	.2	.29	.46	.27	.3	.2
85	.2	.28	.47	.28	.41	.24
86	.2	.28	.5	.27	.46	.25
87	.2	.26	.47	.26	.42	.24
88	.2	.25	.43	.23	.44	.24
89	.2	.2	.42	.22	.41	.23
90	.2	.18	.37	.2	.3	.22
91	.2	.16	.34	.17	.28	.22
92	.2	.10	.26	.12	.23	.2
93	.2	.039	.17	.05	.23	.2
94	.2	.018	.12	.035	.24	.19
95	.2	.017	.10	.020	.25	.20

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RESULTS OF TESTS:

Horizontal (along the valve stem) Axis (H2) (continued)

4.1.2 Variable Frequency Test:

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F	Operating Time Open Seconds	Close
4.5	.11	.11	.11	.05	.08	.05	12	3
6	.18	.11	.11	.08	.14	.08	12	3
8	.35	.14	.16	.11	.35	.10	12	3
11	.5	.14	.22	.05	.5	.08	12	3
15	.5	.11	.2	.07	.5	.1	12	3
21	.5	.12	.27	.14	1.5	.54	12	2.8
29	.5	.16	.55	.24	1.7	.45	12	3
39	.5	.17	.32	.18	1.2	.44	12	3
53	.5	.10	.11	.16	2.1	.72	12	2.7
71	.5	.065	.27	.078	.75	.18	12	2.7
95	.5	.090	.24	.086	.19	.24	12.1	2.7

There was no evidence of external physical damage, pneumatic or electrical malfunctions as a result of this test.

RESULTS OF TESTS:

Horizontal (along the valve stem) Axis (H2) (continued)

4.1.2 Endurance Vibration Test:

The endurance vibration test was performed at the following frequency for a time period of three (3) minutes.

Frequency (Hz)	Inputs (G's) A	Inputs (G's) B	Inputs (G's) C	Outputs (G's) D	Outputs (G's) E	Outputs (G's) F	Operating Time Open (Seconds)	Operating Time Close (Seconds)
33	.50	.24	.51	.31	2.2	.58	12.0	2.8
49	.50	.22	.35	.30	2.2	.69	12.0	2.8
57	.50	.11	.41	.18	1.55	.49	12.0	2.8
64	.50	.32	1.1	.48	3.3	.68	12.0	2.8
67	.50	.52	2.0	.86	7.6	1.3	12.0	2.8
72	.50	.50	2.0	.72	6.4	1.2	12.0	2.7
77	.50	.40	1.6	.75	2.9	.75	12.0	2.7
80	.50	.55	.9	.57	2.4	.84	12.0	2.8
82	.50	.54	.75	.51	1.6	.65	12.0	2.7

There was no evidence of external physical damage, pneumatic or electrical malfunctions as a result of this test.

RESULTS OF TESTS (continued)

4.2 Vertical Axis:

4.2.1 Resonance Frequency Search:

Accelerometer Locations:

Input accelerometers are located on the valve side of the bonnet on the valve.

Output accelerometers are located on the actuator side of the bonnet on the actuator.

Inputs A - Horizontal across stem (H1)
B - Horizontal with stem (H2)
C - Vertical (V)

Outputs D - Horizontal across stem (H1)
E - Horizontal with stem (H2)
F - Vertical (V)

FACTUAL DATA

RESULTS OF TESTS:

Vertical Axis:

Resonance Frequency Search (continued)

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F
5	.040	.010	.11	.010	.010	.11
6	.056	.013	.17	.010	.010	.17
7	.080	.018	.24	.010	.010	.25
8	.036	.010	.10	.010	.010	.11
9	.044	.011	.13	.010	.010	.13
10	.055	.013	.15	.010	.010	.16
11	.068	.017	.20	.010	.010	.22
12	.080	.021	.25	.010	.010	.26
13	.094	.024	.30	.012	.010	.30
14	.036	.014	.12	.015	.010	.12
15	.040	.014	.13	.012	.010	.14
16	.046	.017	.15	.012	.010	.16
17	.052	.019	.17	.014	.010	.18
18	.057	.023	.19	.013	.011	.20
19	.065	.024	.21	.013	.011	.22
20	.071	.26	.23	.014	.010	.26
21	.080	.028	.27	.017	.010	.29
22	.090	.031	.30	.021	.010	.32
23	.025	.020	.096	.013	.012	.10
24	.028	.021	.10	.018	.013	.11
25	.027	.024	.11	.019	.012	.11
26	.028	.026	.12	.019	.011	.12
27	.030	.026	.135	.028	.012	.135
28	.038	.030	.14	.050	.014	.165
29	.036	.034	.15	.028	.020	.18
30	.038	.035	.16	.020	.019	.20
31	.040	.031	.18	.020	.020	.21
32	.045	.040	.19	.015	.022	.225
33	.048	.043	.20	.019	.023	.24
34	.050	.046	.205	.020	.030	.26
35	.056	.045	.22	.018	.030	.23
36	.060	.047	.25	.018	.025	.30
37	.064	.050	.27	.020	.027	.31
38	.070	.057	.28	.026	.023	.315
39	.078	.059	.29	.022	.025	.33
40	.10	.061	.30	.045	.025	.33

0232 1 0353

FACTUAL DATA

RESULTS OF TESTS:

Vertical Axis:

Resonance Frequency Search (continued)

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F
41	.034	.025	.2	.52	.028	.2
42	.032	.023	.2	.55	.031	.16
43	.038	.042	.2	.63	.057	.19
44	.033	.033	.2	.56	.043	.2
45	.032	.027	.2	.63	.034	.2
46	.031	.024	.2	.56	.028	.185
47	.033	.025	.2	.56	.024	.19
48	.03	.044	.2	.6	.035	.21
49	.071	.093	.2	.63	.096	.18
50	.072	.1	.2	.66	.11	.18
51	.033	.04	.2	.56	.05	.13
52	.029	.025	.2	.58	.055	.15
53	.023	.022	.2	.61	.023	.17
54	.021	.021	.2	.64	.027	.17
55	.02	.029	.2	.57	.03	.16
56	.041	.068	.2	.65	.041	.17
57	.050	.078	.2	.88	.070	.24
58	.057	.084	.2	.92	.060	.25
59	.058	.11	.2	.9	.065	.24
60	.060	.065	.2	.8	.055	.25
61	.065	.070	.2	.8	.1	.23
62	.046	.064	.2	.68	.070	.2
63	.033	.063	.2	.7	.068	.121
64	.037	.047	.2	.72	.042	.21
65	.042	.032	.2	.68	.050	.22
66	.043	.040	.2	.61	.035	.19
67	.038	.050	.2	.6	.047	.2
68	.045	.033	.2	.46	.035	.16
69	.045	.028	.2	.47	.40	.15
70	.037	.037	.2	.47	.026	.15
71	.040	.039	.2	.45	.034	.14
72	.058	.027	.2	.4	.039	.14
73	.055	.020	.2	.4	.032	.15
74	.053	.023	.2	.41	.031	.145
75	.050	.015	.2	.36	.026	.14
76	.054	.035	.2	.34	.025	.13
77	.063	.028	.2	.23	.034	.12
78	.066	.028	.2	.22	.028	.12
79	.07	.03	.2	.23	.021	.12
80	.066	.027	.2	.27	.04	.12

FACTUAL DATA

RESULTS OF TESTS:

Vertical Axis:

Resonance Frequency Search (continued)

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F
81	.12	.032	.2	.54	.041	.1
82	.11	.041	.2	.6	.057	.11
83	.080	.042	.2	.58	.065	.13
84	.055	.045	.2	.55	.057	.12
85	.048	.047	.2	.36	.051	.1
86	.051	.056	.2	.33	.066	.1
87	.071	.060	.2	.45	.085	.11
88	.085	.047	.2	.8	.056	.17
89	.043	.045	.2	.5	.044	.12
90	.046	.066	.2	.38	.070	.085
91	.033	.074	.2	.33	.076	.070
92	.024	.082	.2	.26	.086	.057
93	.019	.094	.2	.23	.1	.05
94	.013	.115	.2	.18	.12	.057
95	.064	.16	.2	.34	.16	.13

RESULTS OF TESTS:

Vertical Axis (continued)

4.2.2 Variable Frequency Test:

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F	Operating Time Open (Seconds)	Close (Seconds)
3.5	.06	-	.1	.04	.02	.09	12	2
4.5	.02	.02	.13	.02	.02	.13	12	3
6	.02	.04	.19	.02	.02	.18	12	3
8	.02	.07	.31	.02	.02	.31	12	3
11	.07	.11	.5	.02	.04	.5	12	3
15	.03	.05	.5	.02	.05	.5	12	3
21	.06	.02	.5	.04	.02	.5	12	3
29	.09	.04	.5	.04	.04	.53	12	3
39	.078	.042	.5	1.5	.074	.48	12	3
53	.048	.063	.5	1.3	.064	.37	12	3
71	.12	.056	.5	2.6	.4	.7	12	3
95	.14	.38	.5	2.6	.4	.7	12	3

There was no evidence of external physical damage, pneumatic or electrical malfunctions as a result of this test.

4.2.3 Endurance Vibration Test:

The endurance vibration test was performed at the following frequency for a time period of three (3) minutes.

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F	Operating Time Open (Seconds)	Close (Seconds)
33	.13	.18	.5	.54	.19	.54	12	3

There was no evidence of external physical damage, pneumatic or electrical malfunctions as a result of this test.

RESULTS OF TESTS (continued)

4.3 Horizontal (perpendicular to the valve stem) Axis (H1)

4.3.1 Resonance Frequency Search:

Accelerometer Locations:

Input accelerometers are located on the valve side of the bonnet on the valve.

Output accelerometers are located on the actuator side of the bonnet on the actuator.

Inputs A - Horizontal across stem (H1)
B - Horizontal with stem (H2)
C - Vertical (V)

Outputs D - Horizontal across stem (H1)
E - Horizontal with stem (H2)
F - Vertical (V)

FACTUAL DATA

RESULTS OF TESTS:

Horizontal (perpendicular to the valve stem) Axis (H1)

Resonance Frequency Search (continued)

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F
5	.090	.01	.03	.090	.01	.01
6	.15	.01	.03	.15	.01	.01
7	.22	.01	.03	.22	.01	.02
8	.096	.01	.03	.098	.01	.02
9	.11	.02	.04	.11	.01	.02
10	.15	.02	.05	.15	.01	.03
11	.18	.03	.07	.19	.01	.03
12	.21	.03	.08	.21	.01	.04
13	.26	.05	.11	.26	.02	.06
14	.30	.06	.12	.31	.03	.06
15	.096	.07	.12	.097	.03	.08
16	.10	.01	.04	.10	.03	.10
17	.12	.02	.05	.12	.01	.03
18	.13	.02	.05	.13	.01	.04
19	.15	.02	.05	.15	.01	.05
20	.096	.03	.04	.10	.01	.04
21	.10	.03	.04	.11	.01	.04
22	.12	.03	.03	.12	.01	.04
23	.13	.03	.04	.14	.01	.05
24	.14	.04	.04	.15	.016	.07
25	.16	.04	.05	.17	.025	.11
26	.17	.04	.06	.19	.01	.07
27	.19	.05	.06	.2	.016	.07
28	.2	.05	.06	.21	.01	.05
29	.22	.05	.07	.24	.01	.08
30	.24	.06	.08	.26	.01	.10
31	.25	.06	.08	.27	.01	.10
32	.26	.06	.08	.29	.01	.10
33	.28	.06	.10	.31	.01	.11
34	.3	.07	.09	.34	.01	.13
35	.13	.01	.02	.12	.03	.09
36	.14	.01	.02	.13	.04	.10
37	.14	.01	.07	.14	.04	.12
38	.16	.01	.03	.14	.03	.12
39	.17	.01	.03	.14	.02	.10
40	.18	.02	.03	.16	.02	.06

FACTUAL DATA

RESULTS OF TESTS:

Horizontal (perpendicular to the valve stem) Axis (H1)

Resonance Frequency Search (continued)

Frequency (Hz)	Inputs (G's) A	B	C	D	Outputs (G's) E	F
41	.13	.2	.37	.21	.78	.25
42	.11	.2	.37	.20	.77	.25
43	.12	.2	.43	.26	.76	.26
44	.105	.2	.39	.24	.73	.24
45	.10	.2	.36	.21	.76	.25
46	.087	.2	.42	.21	.80	.26
47	.12	.2	.54	.22	.96	.31
48	.11	.2	.54	.20	.84	.28
49	.10	.2	.50	.21	.80	.27
50	.11	.2	.52	.21	.81	.26
51	.086	.2	.54	.19	.74	.25
52	.086	.2	.55	.21	.74	.25
53	.081	.2	.53	.20	.60	.21
54	.076	.2	.47	.20	.52	.17
55	.074	.2	.44	.18	.49	.18
56	.072	.2	.41	.18	.47	.17
57	.057	.2	.38	.16	.45	.15
58	.055	.2	.37	.16	.52	.13
59	.068	.2	.30	.17	.66	.18
60	.088	.2	.30	.20	.99	.28
61	.086	.2	.33	.20	1.2	.38
62	.080	.2	.33	.19	.86	.27
63	.084	.2	.32	.18	.88	.29
64	.12	.2	.40	.20	1.2	.38
65	.12	.2	.46	.21	1.4	.43
66	.15	.2	.67	.28	1.6	.55
67	.17	.2	.72	.27	1.6	.55
68	.17	.2	.20	.28	1.4	.48
69	.13	.2	.63	.25	1.2	.41
70	.16	.2	.66	.27	1.2	.41
71	.15	.2	.65	.27	1.1	.40
72	.16	.2	.68	.28	1.2	.40
73	.15	.2	.59	.28	.97	.33
74	.21	.2	.72	.28	1.7	.52
75	.23	.2	.70	.27	1.4	.48
76	.19	.2	.50	.26	.77	.58
77	.17	.2	.44	.27	.62	.24
78	.17	.2	.41	.22	.60	.22
79	.15	.2	.36	.20	.43	.16
80	.16	.2	.35	.19	.46	.15

FACTUAL DATA

RESULTS OF TESTS:

Horizontal (perpendicular to the valve stem) Axis (H1)

Resonance Frequency Search (continued)

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F
81	.19	.2	.31	.24	.84	.24
82	.18	.2	.50	.20	.76	.17
83	.19	.2	.46	.24	.47	.39
84	.16	.2	.70	.25	2.4	.64
85	.094	.2	.18	.13	1.1	.34
86	.090	.2	.16	.15	.75	.26
87	.094	.2	.21	.18	.49	.18
88	.088	.2	.27	.17	.47	.13
89	.13	.2	.28	.22	.55	.14
90	.13	.2	.45	.23	.99	.22
91	.12	.2	.45	.20	.95	.21
92	.11	.2	.50	.21	1.2	.28
93	.11	.2	.52	.25	1.3	.25
94	.10	.2	.48	.25	1.2	.30
95	.074	.2	.45	.19	1.0	.27

RESULTS OF TESTS:

Horizontal (perpendicular to the valve stem) Axis (H1) (continued)

4.3.2 Variable Frequency Test:

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F	Operating Time Open (Seconds)	Close (Seconds)
4.5	.23	.05	.16	.23	.03	.06	12	3
6	.34	.07	.23	.32	.06	.06	12	3
8	.3	.10	.46	.22	.07	.14	12	3
11	.5	.14	.8	.44	.12	.22	12	3
15	.45	.2	.8	.46	.13	.4	12	3
21	.5	.30	.8	.50	1.4	.4	12.1	2.8
29	.5	.28	.8	.48	1.6	.45	12.1	2.8
39	.5	.35	1.0	.53	1.7	.55	12.1	2.8
53	.5	.16	.86	.56	.9	.35	12.1	2.7
71	.5	.40	1.5	.65	2.9	.92	12.0	2.8
95	.5	.27	1.2	.55	3.0	.76	12.0	2.8

There was no evidence of external physical damage, pneumatic or electrical malfunctions as a result of this test.

4.3.3 Endurance Vibration Test:

The endurance vibration test was performed at the following frequency for a time period of three (3) minutes.

Frequency (Hz)	Inputs (G's) A	B	C	Outputs (G's) D	E	F	Operating Time Open (Seconds)	Close (Seconds)
33	.5	.40	.76	.53	1.4	.46	12.0	2.8

There was no evidence of external physical damage, pneumatic or electrical malfunctions as a result of this test.

5.0 VISUAL POST TEST EXAMINATION:

Visual post test examination revealed no evidence of external physical damage as a result of the stress of this test.

6.0 RECOMMENDATIONS:

None, data merely submitted.

7.0 CONCLUSIONS:

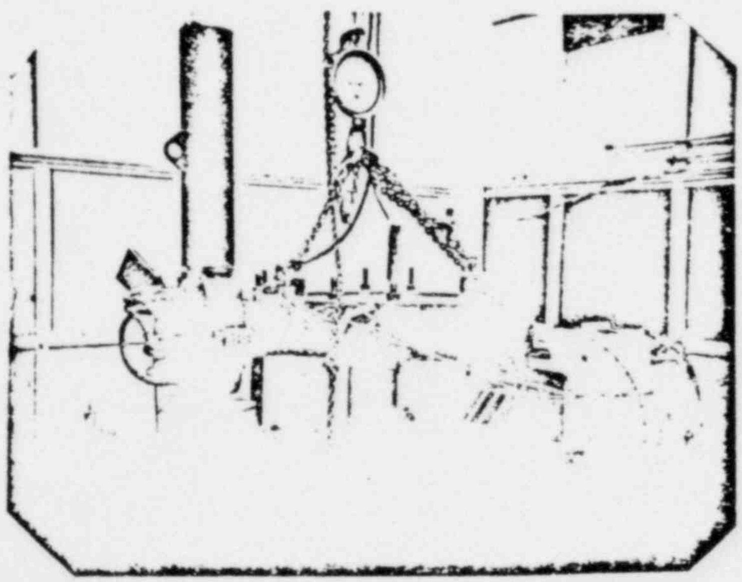
Final evaluation of the submitted specimen for conformance to the requirements of the detailed specifications will be accomplished by the Henry Pratt Company upon review of results reported herein and further examination as required.

HENRY PRATT COMPANY

AURORA, ILLINOIS

36-INCH VALVE

WITH ROBOTARM OPERATOR



Seismic Test Setup

0 2 3 2 1 0 3 6 4

Job No. D0038-3

DIMENSIONAL DATA QTVA

Valve Size 36"

Operator Mounting ANGLE BONNET Operator T412-SR4

Minimum Cylinder Force Required to Equal Seismic Moments

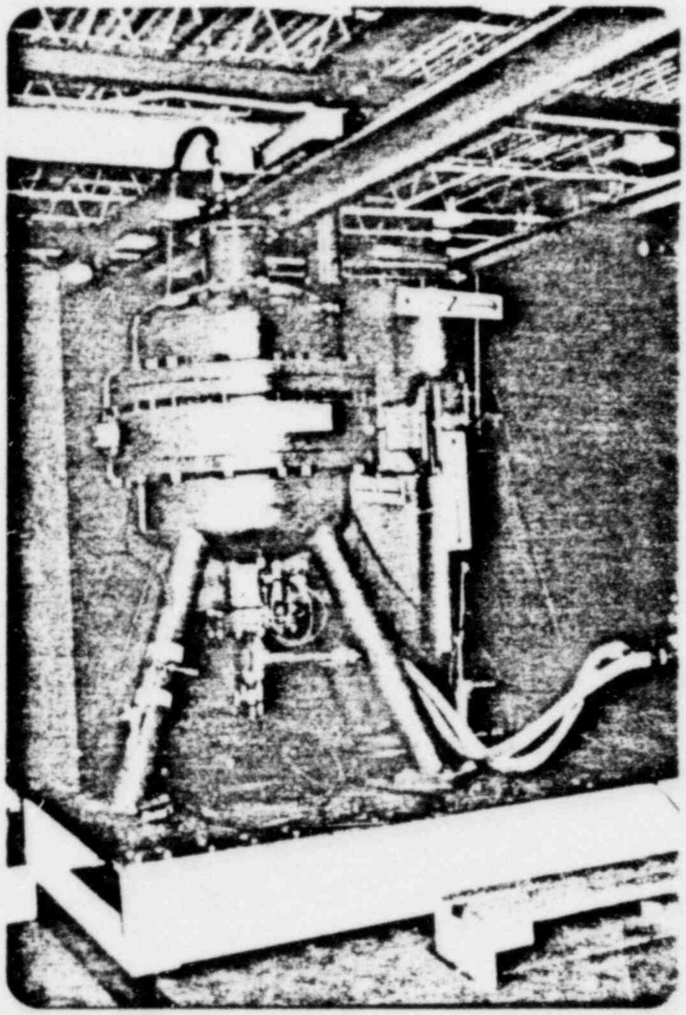
Along x axis:		Along y axis:	
From Y: F_1 =	835 #	From X: F_2 =	1252 #
From Z: F_1 =	774#	From Z: F_2 =	1161#

Actual Test Cylinder Force = 1003# in. x and 1504 in. y

A_1	.462	J_1	1.25
A_2	.419	J_2	3.25
A_3	.462	J_3	NA
A_4	.419	J_4	NA
A_5	15	K_1	4.8
B_1	6.25	M_x	6436
B_2	3	M_y	10879
F_x	1161	M_z	5584
F_y	1161	$\overline{M}_x$	17471
g_x	3	$\overline{M}_y$	21913
g_y	3	T_2	20,000
H_1	5	W_1	387
H_2	7	W_2	81
H_4	8.5	X_0	3.84
I_1	497.2	Y_0	.97
I_2	70.3	Z_0	4.25

Job No. D-0038-3

0 2 3 2 1   0 3 6 6



FUNCTIONAL QUALIFICATION TEST FACILITY

HENRY PRATT COMPANY

AURORA, ILLINOIS

Section 6B

PART II

SECTION 6 B

FUNCTIONAL QUALIFICATION REPORT

FOR

GENERIC FAMILY VALVE ASSEMBLY (GFVA)

Job No. D-0038-4

As qualified by QTVA form D-0038-3

THIS GENERIC FAMILY VALVE ASSEMBLY SATISFIES ALL GENERIC QUALIFICATION RULES (PART I, PARAGRAPH 1.3) AND IT IS CONSIDERED A QUALIFIED GENERIC FAMILY VALVE ASSEMBLY.

Job No. D 0038-4

1. DESCRIPTION AND CHARACTERISTICS

Valve Size and Type			44" 1100	
Standard Pressure Class			150	
Cold Working Pressure			275	psi
Rated Differential Pressure			200	psi
Maximum Service Temperature			200	°F
Actuator Type		Electric Motor	✓	Air
Actuator Size	T420-SR1			
Normal Motive Power	–	Vac	100	psi
Minimum Motive Power	–	Vac	80	psi
Maximum Motive Power	–	Vac	110	psi

02321 0369

Job No. D0038-4

2. BASE LINE DATA OF GFVA TO BE USED FOR GENERIC QUALIFICATION

Reference Paragraph		
1.3.1	Valve Size	44"
1.3.2	Seat Taper Angle	11°
1.3.3	Disc/Seat Interference	.030"
1.3.4	Seating Surface Materials	ASME SA-240 TYPE 304
1.3.5	Materials of Construction	
	Body	ASME SA-516 GR. 55
	Disc	ASME SA-516 GR. 70
	Shaft	ASME SA-564 TYPE 630 COND. H115
	Bearing	ASTM B 438 GR. 1 TYPE 2
	Seat	E.P.T
	Retainer Segments	—
	Packing	E.P.T
	Thrust Collar	SAE 660 BRONZE
	Bottom Cover	ASME SA-516 GR. 55
	Bonnet	ASME SA-36
	Bolts: Valve to Bonnet	SA-193 GR. B7
	Bonnet to Actuator	SA-193 GR. B7
1.3.6	Actuator Rated Torque	48500
	Calculated Operator Torque	29040

Ratio = 1.67

Operating Time

Open to Close	4 Sec.
Close to Open	60 Sec.

Job No. D0038-4

RESULTS OF QUALIFICATION RULES 1.3.8 AND 1.3.9 FOR GFVA

Rule 1.3.8

a. S_1 = 36,000 Yield strength of bonnet materail

S_2 = 2819 Calculated bonnet stress

S_1/S_2 = 12.8 > 1

b. S_3 = 95,000 Yield strength (proof load) of bonnet to valve bolting

S_4 = 19671 Calculated stress of bonnet to valve bolting

S_3/S_4 = 4.8 > 1

c. S_5 = 95,000 Yield strength (proof load) of actuator to bonnet bolting

S_6 = 13565 Calculated stress of actuator to bonnet bolting

S_5/S_6 = 7.0 > 1

Rule 1.3.9 Bonnet Body Deflections (ΔL)

ΔL of GFVA = .00039 Deflection family valve

ΔL of GFVA < .002"

Job No. D0038-4

DIMENSIONAL DATA GFVA

Valve Size 44"

Actuator Mounting ANGLE BONNET Actuator T420-SR1

A_1	.462	J_1	1.25
A_2	.419	J_2	3.25
A_3	.462	J_3	NA
A_4	.419	J_4	NA
A_5	15	K_1	4.8
B_1	6.25	M_x	25409
B_2	3	M_y	21101
F_x	2244	M_z	20914
F_y	2244	$\overline{M_x}$	45650
g_x	3	$\overline{M_y}$	41341
g_y	3	T_2	30,000
H_1	5	W_1	748
H_2	7	W_2	81
H_4	8.5	X_0	3.94
I_1	497.2	Y_0	5.38
I_2	70.3	Z_0	4.15

Job No. D-0038-4

STATEMENT OF QUALIFICATION

QUALIFICATION TESTING

GH-BETTIS Actuator Model NT-420B-SR1 is hereby certified to be of the same construction as Bettis Actuator Model NT-420B-SR1 which was qualified to the requirements of ANSI 278.2.1, Draft 3, Rev.0, Feb. 1977 (IEEE 382) with the exception of LOCA by testing at Southwest Research Institute, San Antonio, Texas. Applicable test margins as described in paragraph 6.3.1.5 of IEEE 323-1974 were utilized with the exception of (8). Refer to SWRI Test Report No. 02-4854-RPT-1 .

The LOCA testing required to complete the qualification program is scheduled to begin at Wyle Laboratories, Huntsville, Alabama on September 11. Upon successful completion of that testing a revised statement of certification will be issued referencing the applicable test report number.

Supplementary seismic testing was performed on Bettis Actuator Model NT-520B-SR1 to the requirements of the above referenced ANSI document. Results of that testing are contained in the same report.

SEISMIC ANALYSIS

In addition to the seismic test results obtained in the above referenced tests, Bettis Seismic Analysis Report No. R-1062-29 Rev. A, is offered as further supportive evidence to the rigidity of this actuator.

Joel D. Page

JOEL D. PAGE
Senior Engineer
Nuclear Products

JDP/ksy
8-31-78

ATTACHMENT NO. 6

Safety Relief Valve
M-141.1

BECHTEL POWER CORP.
RECEIVED
APR 29 1981
JOB NO. 9645

SEISMIC CALCULATIONS

SAFETY AND RELIEF VALVES

FOR

MISSISSIPPI POWER & LIGHT

GRAND GULF POWER STATION

PORT GIBSON, MISSISSIPPI

UNIT NO. 1 & 2

RECO... ...MENT

VENDOR'S DOCUMENT REVIEW
B. ... 5/15/81
JOB NO 9645 | BECHTEL POWER CORPORATION 15740 SHADY GROVE ROAD GAITHERSBURG, MD

BECHTEL P.O. NO. 9645-M-141.1

LONERGAN NO. 500320-1

500320-2

8	4/7/81	BTK	ALG	SEE SDRN-QS-7.0-1-8	[signature]	[signature]
REV	DATE	RE	CHK	DESCRIPTION	GRP SUP	PE
BECHTEL REVISION						
DOC. 9645-M-141.1-QS-7.0-1-8						

APPROVED BY
J. E. LONERGAN COMPANY

A. J. Schmidt 3/6/75
A. J. SCHMIDT, CHIEF ENGINEER

9645-M-141.1-QS-7.0-1-8

REV.	DATE	APPROVED
1	5/19/75	[signature]
2	7/11/75	[signature]
3	1/12/76	[signature]
4	9/23/76	[signature]
5	12/19/80	[signature]

1197

J. E. LONERGAN COMPANY
POST OFFICE BOX 6167
PHILADELPHIA, PA. 19115

REVISION RECORD

REV. NO.	PAGE NO.	DESCRIPTION OF CHANGE	APPROVED BY
5	ii	Added New	1. Engineering Departmen Prepared by: J. T 12/19/1980
	ic	Added New Item NO., Tag NO., and Page NO.	Checked by: [signature] 12/19/80
	4	Revised Seismic Acceleration 6.0g Horizontal and 6.0g Vertical.	
	21	Added Item NO. 37.	Approved by: [signature]
	29-31	Added Item NO. 38, 39, Seismic Calculations.	
	35	Revised "Y" Dimension. "Y" = 14.9 Was "Y" = 29.8".	

U520103/31

SEISMIC CALCULATIONS

REVISION RECORD

REV. NO.	PAGE NO.	DESCRIPTION OF CHANGE	APPROVED BY
6	iii	Added New	1. Engineering Department Prepared by: Jen Tang 3/5/1981 Checked by: [signature] 3/5/81 Approved by: [signature]
	1b.	Revised Item NO. 31 Tag NO. HBC-PSV-F300A HBC-PSV-F300B Item NO. 33, 34 Tag No. HCC-PSV-F125J HCC-PSV-SPARE	
	11.	Revised 3. Combined Stresses Acting at Base. C. Bending Stress Due to 1a, 2d, 2e. "S_b = 583.44 psi" was "S_b = 501.25 psi" d. Combined Stress Due to 3a, 3b, 3c, 1c. "S = 1329.86 psi" was "S = 1248 psi"	

Lonergan

MANUFACTURERS OF SAFETY-RELIEF VALVES

SEISMIC CALCULATIONS

REVISION RECORD

REV. NO.	PAGE NO.	DESCRIPTION OF CHANGE	APPROVED BY:
7	IV.	ADDED NEW	Engineering Department
	5.	Added Symbol: "W_c = Valve Capacity - S.C.F.M."	1. PREPARED BY: [signature] 4/27/81
	6.	Added Formula: "(Gases) $F_r = 0.0405\ W_c$"	CHECKED BY: [signature] 4/27/81
	8.	Revised Item No. 4 Tag. No. "PSV-F031A" was "PSV-F031"	APPROVED BY: [signature]
		Revised Item No. 6 Tag. No. PSV-F041 Set Pressure. "150 PSIG" was "185 PSIG"	
		Revised Item No. 7 Tag No. "PSV-F084 A,B" was "PSV-F094 A,B."	
		Revised Item No. 25 Tag No. PSV-F017-A,B,C. Set Pressure "166 PSIG" was "200 PSIG".	
		Revised Item No. 31, Tag No. "PSV-F300 A,B." was "PSV-F197A,B." Set Pressure "100 PSIG" was "155 PSIG".	
	13.	Revised Item No. 18, Tag No. PSV-F029-A,B. Valve Capacity "Q = 66.7 GPM" was "Q = 67 GPM"	
	19.	Revise Item No. 33 Tag No. "PSV-F125J" was "PSV-F122" Set Pressure "190 PSIG" was "175 PSIG"	
	21.	Revised Item No. 23, Tag No. PSV-F035 Set Pressure and Valve Capacity. "1560 PSIG" was "1575 PSIG" and "Q" = 36.5 GPM" was "Q = 38.8 GPM"	
	24	Revised Item No. 23, Tag No. PSV-F014 Set Pressure "100 PSIG" was "95 PSIG"	
	27	Revised Item No. 29, Tag No. PSV-F018. Set Pressure and Valve Capacity, "510 PSIG" was "600 PSIG" and "Q = 163 GPM" was "Q = 176 GPM"	

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INDEX

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16	HBC-PSV-F061	8, 9, 10, 11
17	HBC-PSV-F046	8, 9, 10, 11
18	DCB-PSV-F029 A DCB-PSV-F029 B	12, 13, 14
19	GBB-PSV-F055 A GBB-PSV-F055 B	15, 16, 17, 18
20	HBB-PSV-F017	23, 24, 25
21	HBB-PSV-F018	29, 30, 31
22	HBB-PSV-F014	23, 24, 25
23	DBB-PSV-F035	9, 21, 22
24	GBB-PSV-F005	8, 9, 10, 11
25	GBB-PSV-F017 A GBB-PSV-F017 B GBB-PSV-F017 C	8, 9, 10, 11
26	GBB-PSV-F025 A GBB-PSV-F025 B GBB-PSV-F025 C	8, 9, 10, 11
27	HBB-PSV-F036	32, 33, 34
28	HBB-PSV-F031	23, 24, 25
29	GBB-PSV-F018	26, 27, 28
30	HBC-PSV-F194 A HBC-PSV-F194 B	8, 9, 10, 11
31	HBC-PSV-F300 A HBC-PSV-F300 B	8, 9, 10, 11
32	HBC-PSV-F031 B	8, 9, 10, 11
33	HCC-PSV-F125 J	9, 19, 20
8 34	HBC-PSV-F293 A, B	9, 19, 20
35	HCC-PSV-F124 A HCC-PSV-F124 B HCC-PSV-F124 C HCC-PSV-F124 D HCC-PSV-F124 E HCC-PSV-F124 F HCC-PSV-F124 G HCC-PSV-F124 H	9, 19, 20
36	HCC-PSV-F125 A HCC-PSV-F125 B HCC-PSV-F125 C HCC-PSV-F125 D HCC-PSV-F125 E HCC-PSV-F125 F HCC-PSV-F125 G HCC-PSV-F125 H	9, 19, 20

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SEISMIC REQUIREMENTS

Bechtel Spec. No. 9645-M-141.1 para. 5.2.4 requires that valves be capable of withstanding a seismic load of 6.0 g horizontal and 6.0 g vertical. Forces will be considered to act simultaneously.

The stresses due to horizontal and vertical seismic forces shall be considered to act simultaneously in the most disadvantageous manner and shall be added directly. The stresses in the valve components due to seismic loads shall be combined with the stresses due to other live, dead, and operating loads. The combined stress levels must not exceed those allowable in ASME Code, Section III, 1971 Edition.

BASIS OF CALCULATIONS

Critical stress areas will be areas where bending moments due to Seismic acceleration and reaction forces are the greatest. These areas will be at the valve inlet and, in the case of bolted bonnet valves, the bonnet bolts. The section of highest stress at the valve inlet is taken in the inlet nipple at the point where it enters the socket on weld end valves, and at the inlet neck at the back of the flange for flanged end valves.

For determination of stress at the section of highest stress at the valve inlet, the center of gravity is taken; vertically, one-half the distance from the face of the inlet to the top of the valve and horizontally, one-third the distance from the center line to the face of the outlet.

In determining stress in bonnet bolting due to Seismic acceleration, the weight of the bonnet section of the valve is taken as one-half the weight of the valve. The center of gravity of the bonnet section is taken on the vertical center line at one half the distance from the face of the bonnet flange to the top of the valve. These assumptions will yield conservative results.

Shear stress in the bonnet bolting is not considered since the bonnet is held in firm alignment with the body by the guide which is recessed into both the bonnet and the body.

The moment due to the reaction force of the discharge jet at the valve outlet is included in the stress calculations. The reaction force is taken at the highest pressure setting for each type of valve. Valves set at lower pressures will have lower reaction forces.

Stress due to inlet pressure based on the highest pressure setting plus 10% overpressure is included where inlet pressure acts on the inlet neck. In full nozzle valves, the inlet pressure is retained in the nozzle, not the body neck; therefore, stress due to pressure is not included in the calculations. However, in the case of full nozzle valves, the spring force is acting in tension on both the bonnet bolting and the section of highest stress at the valve inlet. The maximum spring force at the rated lift of the valve is used in the stress calculations.

ALLOWABLE STRESSES

Allowable stresses based upon ASME CODE, Section III, are listed below:

MATERIAL	SPEC.	ALLOWABLE STRESS AT TEMP.	
Stainless Steel	ASME A-351 GR CF 8	(.8 x 13,900) 11,121 psi	@ 400° F.
Alloy Bolting	ASME SA-320 GR B 8	12,600 psi	@ 400° F.
Stainless Steel Bar	ASME SA-479 TP 304	16,000 psi	@ 400° F.
Seamless Pipe	ASME SA-106 GRB	16,500 psi	@ 400° F.

CONCLUSION

The summation of stresses due to maximum acceleration forces and maximum operating forces combined with maximum pressures are well within those permitted by ASME CODE, Section III, 1971 Edition, with all addenda including Summer 1973.

SYMBOLS:

A	=	Area of inlet section (at O), sq. in.
A_b	=	Effective area of bolt at root of thread, sq. in.
A_i	=	Area of inlet, sq. in.
A_n	=	Area of Nozzle, sq. in.
A_o	=	Area of outlet, sq. in.
A_s	=	Area of valve seat, sq. in.
D	=	Outside diameter of section, inches.
d	=	Inside diameter of section, inches.
F_o	=	Maximum force in bonnet bolting due to horizontal acceleration, LBS.
F_p	=	Force due to inlet pressure, lbs.
F_r	=	Reaction force, lbs.
F_s	=	Horizontal shear due to horizontal acceleration, lbs.
F_{sp}	=	Spring force, lbs.
F_v	=	Vertical force due to vertical acceleration, lbs.
g_h	=	Horizontal acceleration = 6.0 g
g_v	=	Vertical acceleration = 6.0 g
I/c	=	Section Modulus, Inches^3
J/c	=	Polar Section Modulus, inches^3
L	=	Valve lift, inches.
M_{bh}	=	Moment in bonnet bolting due to horizontal acceleration, in. lbs.
M_h	=	Bending moment due to horizontal acceleration, in. lbs.
M_v	=	Bending moment due to vertical acceleration, in. lbs.
n	=	Number of bolts.
O	=	Section of highestress (at inlet).
P	=	Pressure, PSIG.

SYMBOLS: (Continued)

Q = Valve capacity, GPM

R = Spring Deflection rate, lbs./in.

r = Distance from centerline to bonnet bolts, inches.

S = Numerically combined stress (S_t + S_s + S_b + S_p), PSI

S_b = Stress due to bending, PSI

S_{bc} = Combined stress in bonnet bolt due to S_{bm} + S_{bt}, PSI

S_{bm} = Stress in bonnet bolt due to horizontal acceleration, PSI

S_{bt} = Bonnet bolt tensile stress, PSI

S = Stress due to internal pressure, PSI

S_s = Stress in shear, PSI

S_t = Stress in tension, PSI

T = Torsion due to horizontal acceleration, in. lbs.

t = Wall thickness, inches

u = Distance from face of bonnet flange to center of gravity of bonnet section, inches.

vo = Specific Volume (from steam tables)

V_o = Velocity - Ft/sec.

W = Total weight of valve, lbs.

w = Steam capacity - #/sec.

W_b = Weight of bonnet section of valve. lbs.

W_c = Valve capacity - s.c.f.m.

W_p = Valve capacity - lbs/hr. steam.

x = Horizontal distance from centerline of valve to center of gravity, inches.

y = Vertical distance from section of highest stress at inlet to center of gravity, inches.

z = Vertical distance from section of highest stress at inlet to centerline of outlet, inches.

REACTION FORCES

1 (Liquid) $F_r = 0.00139 \frac{Q^2}{A_o}$

2 (Air) $F_r = .0405\, W_c$

3 (Steam) $F_r = \frac{w V_o}{g} + (P_o - 15) A_o$

3a $P_o = .58 \left(\frac{A_n}{A_o}\right)(1.10\, P + 15)$

3b $V_o = \frac{v_o\, w\, 144}{A_o}$

FORCE FORMULAS

4 $F_p = A_i \times P \times 1.10$

5 $F_o = \frac{M_{bh}\, r_2}{2\,(r_1^2 + r_2^2)}$

6 $F_s = g_h \times W$

7 $F_{sp} = PA_s + L\, R$

8 $F_v = g_v \times W - W$

MOMENT FORMULAS

9 $M_{bh} = g_h \times W_b \times u$

10 $M_h = y\,(g_h \times W)$

11 $M_v = x\,(g_v \times W + W)$

12 $T = g_h \times W \times (x)$

13 $I/c = \frac{\pi}{32} \frac{(D^4 - d^4)}{D}$

14 $J/c = \frac{\pi}{16} \frac{(D^4 - d^4)}{D}$

STRESS FORMULAS

15 $S_p = \frac{1.1\, P\, d}{2\, t}$

16 $S_t = \frac{F_p + F_v}{A}$

17 $S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c}$

18 $S_b = \frac{(F_r \times z) + M_v + M_h}{I/c}$

19 $S = S_t + S_s + S_b + S_p$

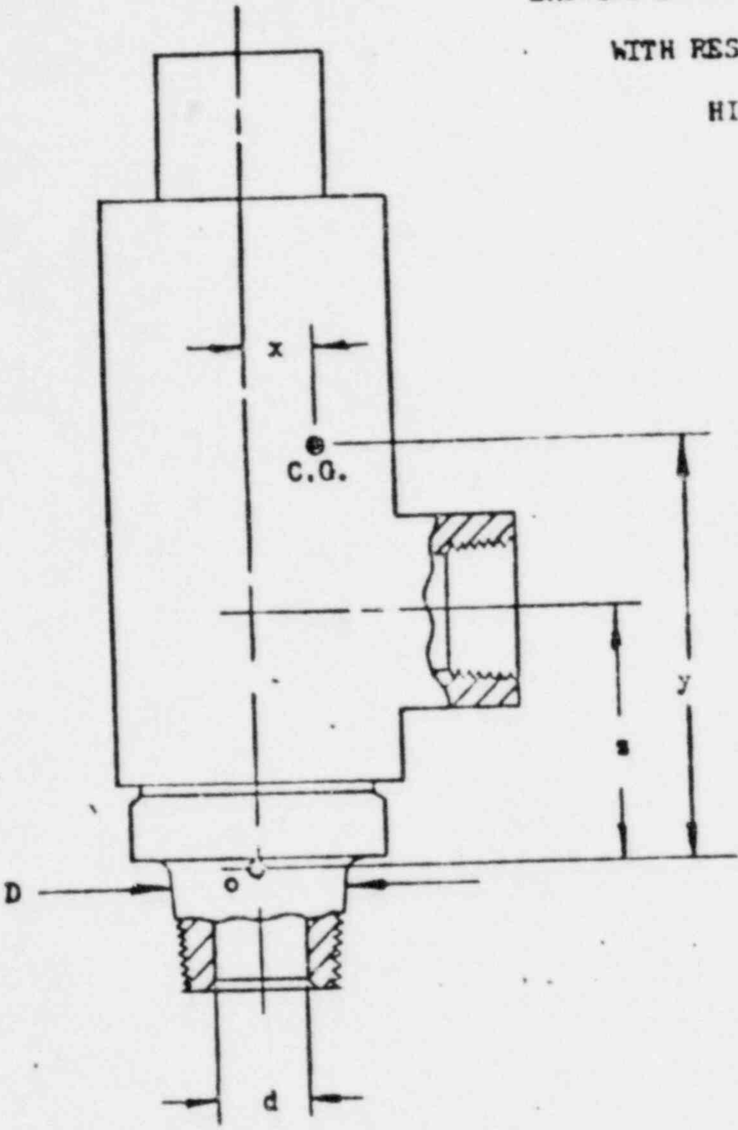
STRESS FORMULAS (BONNET)

20 $S_{bt} = \frac{\frac{F_{sp}}{n} + F_v}{A_b}$

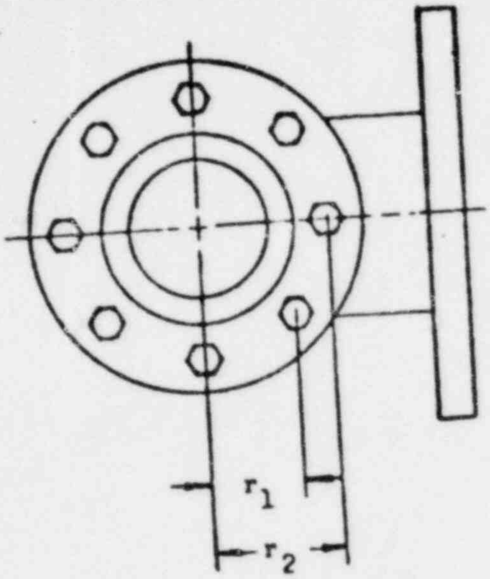
21 $S_{bn} = \frac{F_o}{A_b}$ or $\frac{M_{bh}}{r \times 2\, A_b}$

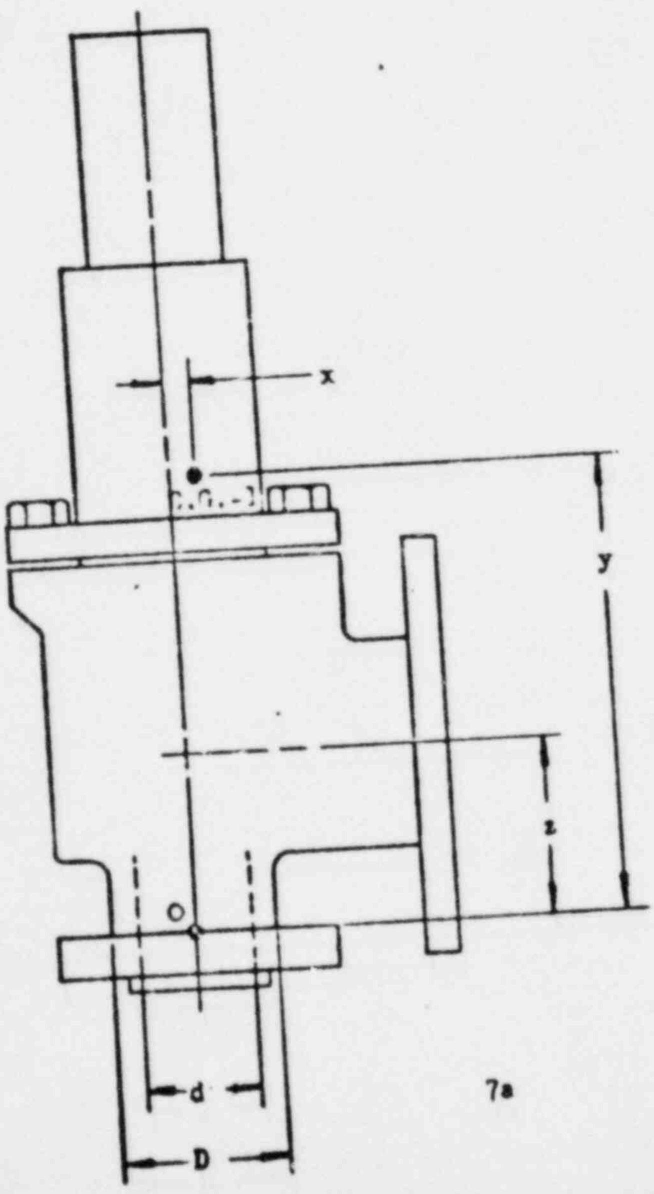
22 $S_{bc} = S_{bt} + S_{bn}$

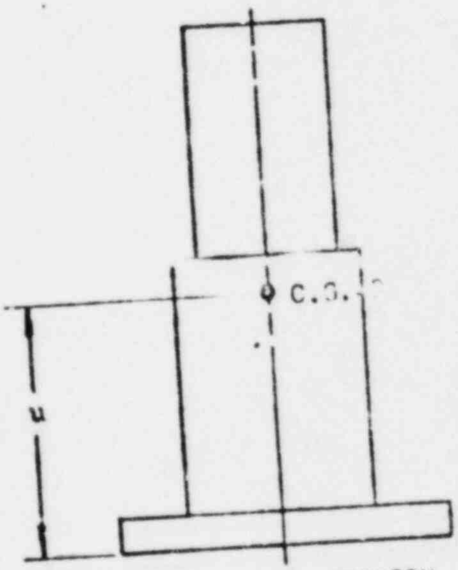
SKETCHES OF TYPICAL VALVE ARRANGEMENTS SHOWING LOCATION OF CENTER OF GRAVITY WITH RESPECT TO SECTION OF HIGHEST STRESS.



SKETCHES OF TYPICAL VALVE ARRANGEMENTS SHOWING LOCATION OF CENTER OF GRAVITY WITH RESPECT TO SECTION OF HIGHEST STRESS.

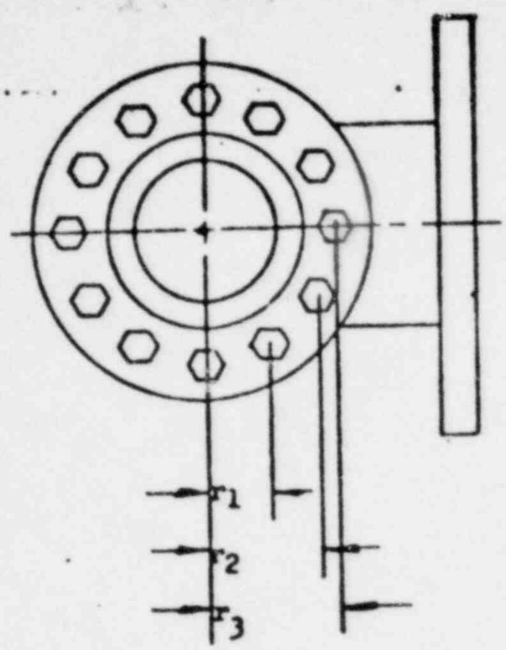


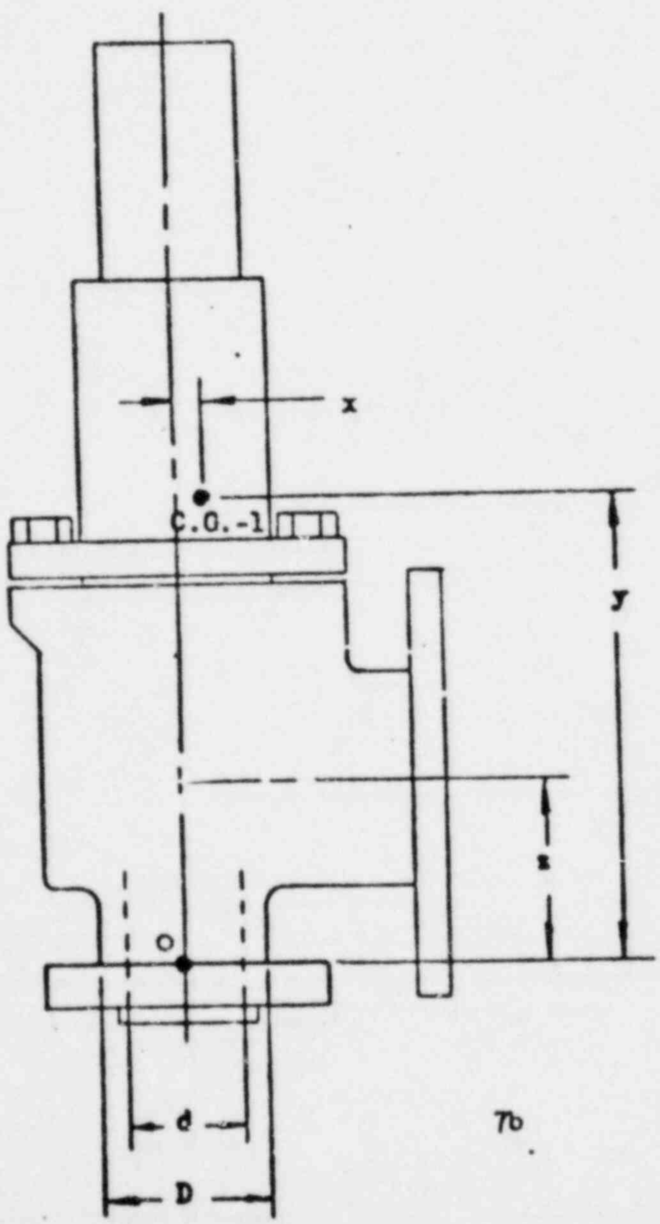


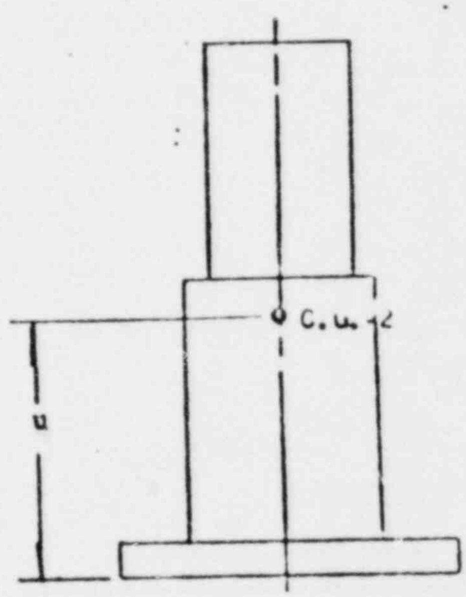


BONNET SECTION

SKETCHES OF TYPICAL VALVE ARRANGEMENTS SHOWING LOCATION OF CENTER OF GRAVITY WITH RESPECT TO SECTION OF HIGHEST STRESS.

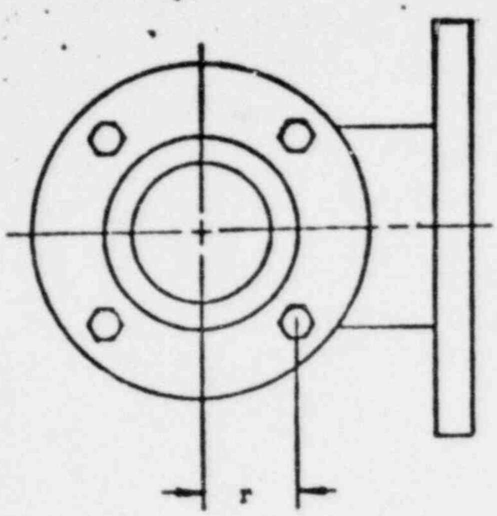


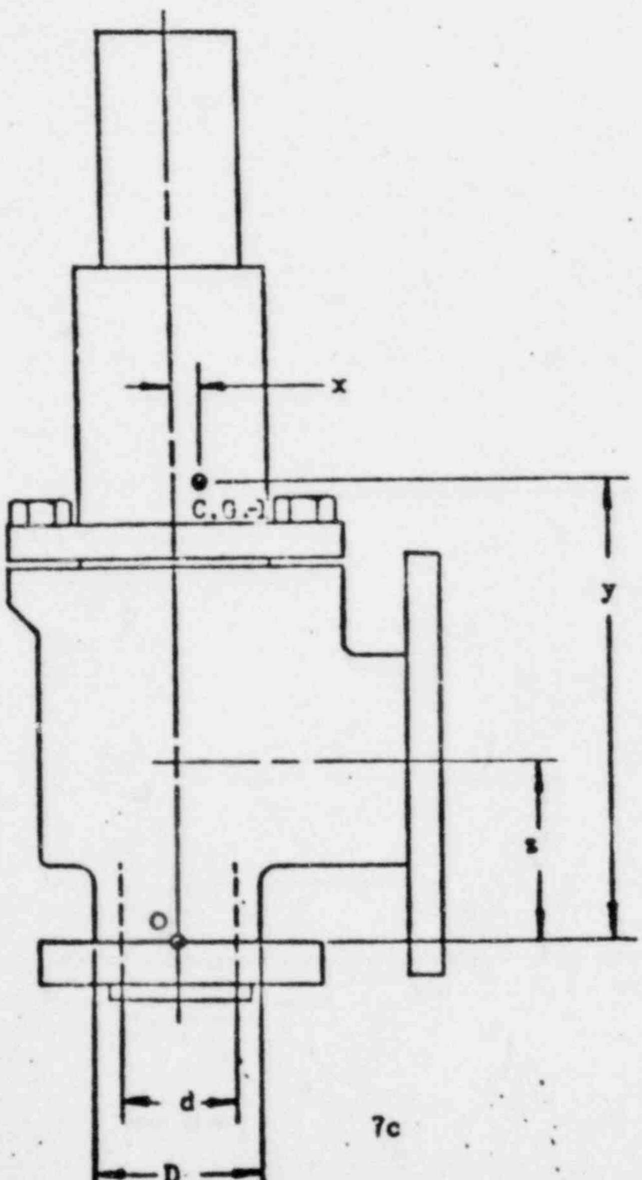


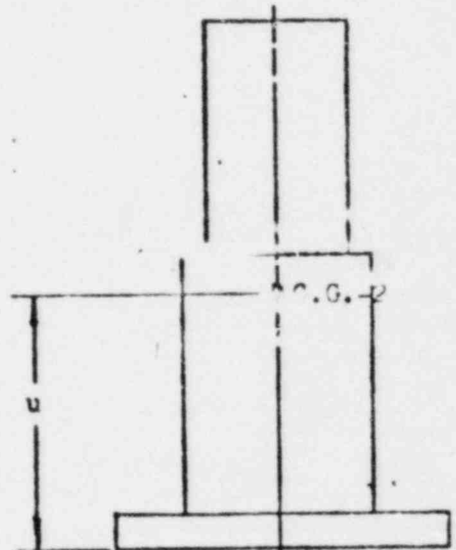


BONNET SECTION

SKETCHES OF TYPICAL VALVE ARRANGEMENTS SHOWING LOCATION OF CENTER OF GRAVITY WITH RESPECT TO SECTION OF HIGHEST STRESS.

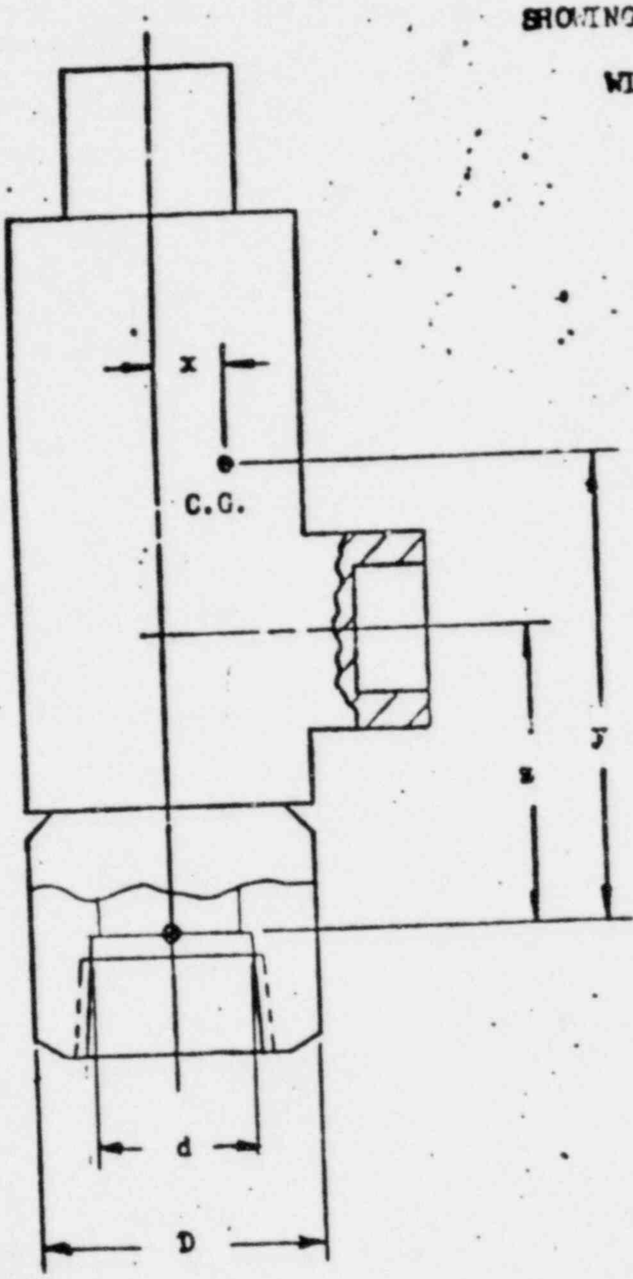






BONNET SECTION

SKETCHES OF TYPICAL VALVE ARRANGEMENTS
SHOWING LOCATION OF CENTER OF GRAVITY
WITH RESPECT TO SECTION OF
HIGHEST STRESS.



J. E. LONERGAN COMPANY

1/2" x 1"
3/4" x 1"
1" x 1"

LCT-11 MALE x FEMALE DWG. NO. A-2587

ITEM NO.	TAG NO.	SET PRESSURE
1	PSV-F 100 A, B	185 PSIG
3	PSV-F 024 A, B	170 PSIG
4	PSV-F 031 A	150 PSIG
5	PSV-F 036	180 PSIG
6	PSV-F 041	150 PSIG
7	PSV-F 084 A, B	185 PSIG
8	PSV-F 097 A, B	175 PSIG
9	PSV-F 104	185 PSIG
10	PSV-F 127 A, B	175 PSIG
11	PSV-F 138 A, B	175 PSIG
12	PSV-F 157 A, B	175 PSIG
13	PSV-F 151 A, B	175 PSIG
14	PSV-F 049	185 PSIG
15	PSV-F 055	150 PSIG
16	PSV-F 061	150 PSIG
17	PSV-F 046	180 PSIG
24	PSV-F005	20[illegible] PSIG
25	PSV-F017 A, B, C	166 PSIG
* 26	PSV-F025 A, B, C	500 PSIG
30	PSV-F194 A, B	175 PSIG
31	PSV-F300 A, B	100 PSIG
32	PSV-F031 B	150 PSIG

* This item used for calculations.

J. E. LONERGAN COMPANY

MISSISSIPPI POWER & LIGHT . (BECHTEL)

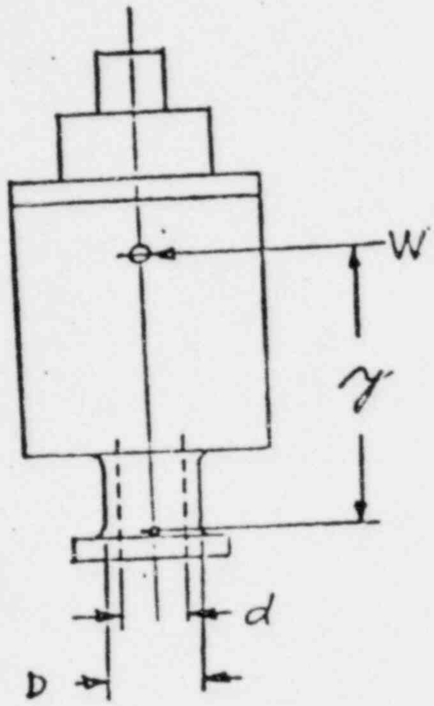
P. O. NO. 9645-M-141.1

LONERGAN No. 500320-1 & 2

1" x 1" - LCT-11 MALE x FEMALE

Natural Frequency Calculations

ITEM PSV-F025 A, B, C



W = 4.25 LBS.

y = 4.06 in.

D = 1.050 in.

d = .625 in.

E = 30×10^6

g = 386 in/sec^2

$$\text{ncps} = \frac{1.73}{2\pi}\sqrt{\frac{g\,E\,I}{W\,y^3}}$$

$$I = \frac{\pi\,(D^4 - d^4)}{64}$$

$$I = \frac{\pi}{64}(1.05^4 - .625^4) = .052$$

$$\text{ncps} = \frac{1.73}{2\pi}\sqrt{\frac{386 \times 30 \times 10^6 \times .052}{4.25 \times 4.06^3}}$$

$$= .275\sqrt{2{,}117{,}109} = 400 \text{ c.p.s.}$$

$A = 1.05 \text{ in.}^2$	$P = 500$ PSIG	$x = .58$ in.
$A_i = .307 \text{ in.}^2$	$Q = 21.9$ GPM	$y = 4.06$ in.
$A_o = .864 \text{ in.}^2$	$W = 4.25$ LBS.	$z = 2.25$ in.
$D = 1.315$ in.	$t = .34$ in.	$J/c = .42 \text{ in.}^3$
$d = .625$ in.		$I/c = .21 \text{ in.}^3$

1. OPERATING FORCES

a. Reaction force of discharge jet acting horizontally along centerline of outlet.

$$F_r = \frac{.00139\, Q^2}{A_o} = \frac{.00139 \times \overline{21.9}^2}{.864} = .77 \text{ LBS.}$$

b. Vertical force acting on valve centerline due to inlet pressure.

$$F_p = A_i \times P \times 1.10 = .307 \times 1.1 \times 500 = 169 \text{ LBS.}$$

c. Stress in base due to internal pressure.

$$S_p = \frac{1.10\, P\, d}{2\, t} = \frac{1.1 \times 500 \times .625}{2 \times .34} = 505 \text{ PSI}$$

2. SEISMIC FORCES

a. Vertical tension due to vertical acceleration.

$$F_v = g_v \times W - W = 6.0 \times 4.25 - 4.25 = 21.25 \text{ LBS.}$$

b. Horizontal shear due to horizontal acceleration.

$$F_s = g_h \times W = 6.0 \times 4.25 = 25.5 \text{ LBS.}$$

c. Torison about vertical centerline due to horizontal acceleration.

$$T = g_h \times W \times (x) = 6.0 \times 4.25 \times .58 = 14.79 \text{ IN. LBS.}$$

d. Bending moment due to vertical acceleration.

$$M_v = x\,(g_v \times W + W) = .58\,(6.0 \times 4.25 + 4.25) = 17.26 \text{ IN. LBS.}$$

e. Bending moment due to horizontal acceleration.

$$M_h = y\,(g_h \times W) = 4.06 \times 6.0 \times 4.25 = 103.53 \text{ IN. LBS.}$$

3. COMBINED STRESSES ACTING AT BASE

a. Tensile stress due to 1b, 2a.

$$S_t = \frac{F_p + F_y}{A} = \frac{169 + 21.25}{1.05} = 181.19 \text{ PSI}$$

b. Shear stress due to 1a, 2b, 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{.77 + 25.5}{1.05} + \frac{14.79}{\frac{\pi}{16}\left(\frac{1.315^4 - .625^4}{1.315}\right)}$$

$$= \frac{26.27}{1.05} + \frac{14.79}{.42} = 60.23 \text{ PSI}$$

c. Bending stress due to 1a, 2d, 2e.

$$S_b = \frac{(F_r \times z) + M_v + M_h}{I/c} = \frac{(.77 \times 2.25) + 17.26 + 103.53}{.21} = 583.44 \text{ PSI}$$

d. Combined stress due to 3a, 3b, 3c, 1c.

$$S = S_t + S_s + S_b + S_p = 181.19 + 60.23 + 583.44 + 505 = 1329.86 \text{ PSI}$$

J. E. LONERGAN COMPANY

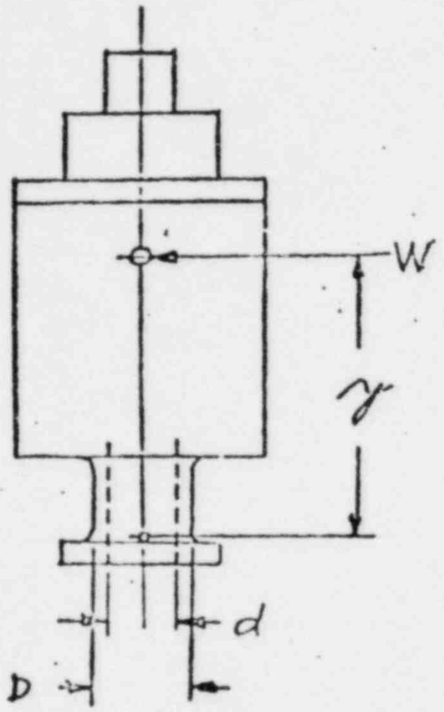
MISSISSIPPI POWER & LIGHT (BECHTEL)

P.O. NO. 9645-M-141.1 LONERGAN NO. 500320 1 & 2

1-1/2" x 2" D-70 D / L3

Natural Frequency Calculations

ITEM PSV-F 029 A & B



W = 58 LBS.

y = 8.625 in.

D = 2.50 in.

d = 1.755 in.

E = 30×10^6

g = 386 in/sec^2

$$\text{ncps} = \frac{1.73}{2\pi}\sqrt{\frac{g\,E\,I}{W\,y^3}}$$

$$I = \pi\,\frac{(D^4 - d^4)}{64}$$

$$= \frac{\pi}{64}(2.5^4 - 1.755^4) = 1.45 \text{ in.}^4$$

$$\text{ncps} = \frac{1.73}{2\pi}\sqrt{\frac{386 \times 30 \times 10^6 \times 1.45}{58 \times 8.625^3}}$$

$$= .275\sqrt{451{,}186} = 185 \text{ cps}$$

J. E. LONERGAN COMPANY

1-1/2" x 2" D-70 D / L3 900# L.O. x 150# R.F. DWG. NO. A-2687

ITEM NO.	TAG NO.	SET PRESSURE
18	PSV-F 029 A, B.	1386 PSIG

A = 2.49 in.^{2}	L = .132 in.	r_1 = 1.68 in.	x = 1.833 in.
A_b = .126 in.^{2}	n = 8	r_2 = 2.375 in.	y = 8.625 in.
A_o = 3.14 in.^{2}	P = 1386 PSIG	u = 5.94 in.	z = 2.125 in.
A_s = .307 in.^{2}	Q = 66.7 GPM	W = 58 LBS.	J/c = 2.32 in.^{3}
D = 2.50 in.	R = 2085#/in.	W_b = 29 LBS.	I/c = 1.16 in.^{3}
d = 1.755 in.			

1. OPERATING FORCES

   a. Reaction force of discharge jet acting horizontally along centerline of outlet.

   $$F_r = \frac{.00139\ Q^2}{A_o} = \frac{.00139 \times (66.7^2)}{3.14}\quad 1.97 \text{ LBS.}$$

   b. Vertical force acting on centerline due to spring compression.

   $F_{sp} = P \times A_s + L \times R$ = 1386 x .307 + .132 x 2085 [illegible]5 + 275 = 700 LBS.

2. SEISMIC FORCES

   a. Vertical tension due to vertical acceleration.

   $F_v = g_v \times W - W$ = 6.0 x 58 - 58 = 290 LBS.

   b. Horizontal shear due to horizontal acceleration.

   $F_s = g_h \times W$ = 6.0 x 58 = 348.0 LBS.

   c. Torsion about vertical centerline due to horizontal acceleration.

   $T = g_h \times W \times (x)$ = 6.0 x 58 x 1.833 = 637.9 IN. LBS.

   d. Bending moment due to vertical acceleration.

   $M_v = x\ (g_v \times W + W)$ = 1.833 (6.0 x 58 + 58) = 744.2 IN. LBS.

   e. Bending moment due to horizontal acceleration.

   $M_h = y\ (g_h \times W)$ = 8.625 x 6.0 x 58 = 3001.5 IN. LBS.

3. COMBINED STRESSES ACTING AT POINT "O"

a. Tensile stress due to 1b, 2a.

$$S_t = \frac{F_{sp} + F_v}{A} = \frac{700 + 290}{2.49} = 397.6$$

b. Shear stress due to 1a, 2b, 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{1.97 + 348}{2.49} + \frac{637.9}{\frac{\frac{\pi}{16}(2.50^4 \quad 1.755^4)}{2.50}}$$

$$= \frac{349.97}{2.49} + \frac{637.9}{2.32} = 415.51 \text{ PSI}$$

c. Bending stress due to 1a, 2d, 2e.

$$S_b = \frac{(F_r \times z) + M_v + M_h}{I/c} = \frac{(1.97 \times 2.125) + 744.2 + 3001.5}{1.16} = 3232.66 \text{ PSI}$$

d. Combined stress due to 3a, 3b, 3c.

$$S = S_t + S_s + S_b = 397.6 + 415.51 + 3232.66 = 4045.77 \text{ PSI}$$

4. COMBINED STRESSES ACTING AT BOLTING

a. Tensile stress due to 1b, 2a.

$$S_{bt} = \frac{F_{sp} + F_v}{n \times A_b} = \frac{700 + 290}{8 \times .126} = 982 \text{ PSI}$$

b. Bending stress due to horizontal acceleration (Bonnet only).

$$M_{bh} = g_h \times W_b \times u = 6.0 \times 29 \times 5.94 = 1034 \text{ IN. LBS.}$$

$$F_o = \frac{M_{bh} \quad r_2}{2\,(r_2^2 + r_1^2)} = \frac{1034 \times 2.375}{2\,(2.375^2 + 1.6?^2)} = 145.05$$

$$S_{bm} = \frac{F_o}{A_b} = \frac{145.05}{.126} = 1151 \text{ PSI}$$

(NOTE: Use number of bolts in plane of maximum stress)

c. Combined stress due to 4a, 4b.

$$S_{bc} = S_{bt} + S_{bm} = 982 + 1151 = 2133 \text{ PSI}$$

J. E. LONERGAN COMPANY

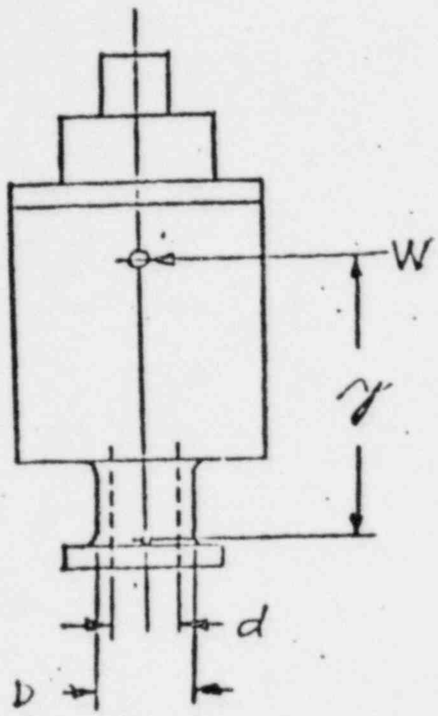
MISSISSIPPI POWER & LIGHT - (BECHTEL)

P.O. NO. 9645-M-141.1 LONERGAN NO. 500320-1 & 2

6" x Q x 8" D-52 Q

Natural Frequency Calculations

ITEM PSV-F 055 A, B.



W = 630 LBS.

y = 22.75 in.

D = 7.562 in.

d = 6.445 in.

E = 30×10^6

g = 386 in/sec^2

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{g E I}{W y^3}}$$

$$I = \frac{\pi (D^4 - d^4)}{64}$$

$$\frac{\pi}{64}(7.562^4 - 6.445^4) = 75.84 \text{ in.}^4$$

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{386 \times 30 \times 10^6 \times 75.84}{630 \times 22.75^3}}$$

$$= .275 \sqrt{118351} = 95 \text{ cps.}$$

J. E. LONERGAN COMPANY

6" x 8" D-52 Q 600# RF x 150# RF FLANGED DWG. NO. A-2369

ITEM NO.	TAG NO.	SET PRESSURE
19	PSV-F 055 A PSV-F 055 B	500 PSIG

A = 12.28 in.^{2}	L = .985 in.	r_1 = 3.17 in.	x = 3.17 in.
A_b = .302 in.^{2}	n = 12	r_2 = 5.49 in.	y = 22.75 in.
A_n = 12.18 in.^{2}	P = 500 PSIG	r_3 = 6.34 in.	z = 6.75 in.
A_o = 50 in.^{2}	P_o = 80 PSIA	u = 15.19 in.	J/c = 40.11 in.^{3}
A_s = 13.7 in.^{2}	R = 5200#/in.	W = 630 LBS.	I/c = 20.06 in.^{3}
D = 7.562 in.		W_b = 315 LBS.	
d = 6.445 in.		W_p = 311,997#/hr.	

1. OPERATING FORCES

a. Reaction force of discharge jet acting horizontally along the centerline of the outlet.

$$P_o = .58\left(\frac{A_n}{A_o}\right)(1.10\,P + 14.7) = .58\,\left(\frac{12.18}{50}\right)(1.10 \times 500 + 14.7) = 80 \text{ PSIA}$$

$$v_o = 5.472 \text{ ft.}^3/\# \text{ (from steam tables)}$$

$$w\#/\text{sec.} = \frac{311997}{3600} = 86.67\#/\text{sec.}$$

$$V_o = \frac{v_o\ w\ 144}{A_o} = \frac{5.472 \times 86.67}{50} \times 144 = 1366 \text{ ft/sec.}$$

$$F_r = \frac{w\ V_o}{g} + (P_o - 14.7)\ A_o = \frac{86.67 \times 1366}{32.2} + (80 - 14.7)\ 50$$

$$= 3677 + 3265 = 6942 \text{ LBS.}$$

b. Vertical force acting on centerline due to spring compression.

$$F_{sp} = P \times A_s + L \times R = 500 \times 13.7 + .985 \times 5200$$

$$= 6850 + 5122 = 11972 \text{ LBS.}$$

2. SEISMIC FORCES

a. Vertical tension due to vertical acceleration.

$$F_v = g_v \times W - W = 6.0 \times 630 - 630 = 3150 \text{ LBS.}$$

b. Horizontal shear due to horizontal acceleration.

$$F_s = g_h \times W = 6.0 \times 630 = 3780 \text{ LBS.}$$

c. Torsion about bertical cenerline due to horizontal acceleration.

$$T = g_h \times W \times (x) = 6.0 \times 630 \times 3.17 = 11983 \text{ IN. LBS.}$$

d. Bending moment due to vertical acceleration.

$$M_v = x\,(g_v \times W + W) = 3.17\,(6.0 \times 630 + 630) = 13980$$

e. Bending moment due to horizontal acceleration.

$$M_h = y\,(g_h \times W) = 22.75 \times 6.0 \times 630 = 85995 \text{ IN. LBS.}$$

3. COMBINED STRESSES ACTING AT POINT "O".

a. Tensile stress due to 1b., 2a.

$$S_t = \frac{F_{sp} + F_v}{A} = \frac{11972 + 3150}{.785\,(7.562^2 - 6.445^2)} = \frac{15122}{12.28} = 1231 \text{ PSI}$$

b. Shear stress due to 1a, 2a, 2b., 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{6942 + 3780}{12.28} + \frac{11983}{\frac{\pi}{16}\left(\frac{7.562^4 - 6.445^4}{7.562}\right)}$$

$$= \frac{10722}{12.28} + \frac{11983}{40.11} = 1172 \text{ PSI}$$

c. Bending stress due to 1a, 2d., 2e.

$$S_b = \frac{(F_r \times z) + M_v + M_h}{I/c} = \frac{(6942 \times 6.75) + 13980 + 85995}{20.06} = 7320 \text{ PSI}$$

d. Combined stress due to 3a, 3b, 3c.

$$S = S_t + S_s + S_b = 1231 + 1172 + 7320 = 9723 \text{ PSI}$$

J. E. LONERGAN COMPANY

4. COMBINED STRESSES ACTING ON BOLTING

a. Tensile stress due to 1b, 2a.

$$S_{bt} = \frac{F_{sp} + F_v}{n \times A_b} = \frac{11972 + 3150}{12 \times .302} = 4173 \text{ PSI}$$

b. Bending stress due to horizontal acceleration (bonnet only).

$$M_{bh} = g_h \times W_b \times u = 6.5 \times 315 \times 15.19 = 31102 \text{ IN. LBS.}$$

$$F_o = \frac{M_{bh} \quad r_3}{2(r_3^2 + r_2^2 + r_1^2)} = \frac{31102 \times 6.34}{2(6.34^2 + 5.49^2 + 3.17^2)}$$

$$= \frac{21532 \times 6.34}{161} = 1225 \text{ LBS.}$$

$$S_{bm} = \frac{F_o}{A_b} = \frac{1225}{.302} = 4056 \text{ PSI}$$

(NOTE: Use number of bolts in plane of maximum stress).

c. Combined stress due to 4a, 4b.

$$S_{bc} = S_{bt} + S_{bm} = 4173 + 4056 = 8229 \text{ PSI}$$

J. E. LONERGAN COMPANY

1" x 1" LCT-11 MALE x FEMALE DWG. No. A-2587

ITEM NO.	TAG NO.	SET PRESSURE
* 33	PSV-F125J	190 PSIG
34	PSV-F293A,B (B)	175 PSIG
35	PSV-F124 A-H	190 PSIG
36	PSV-F125 A-H	190 PSIG

$A = 1.05$ in^2

$A_1 = .307$ in^2

$D = 1.315$ in

$d = .625$ in

P = 190 PSIG

W = 4.25 LBS.

W_c = 221 SCFM

t = .34 in

x = .58 in.

y = 4.06 in

z = 2.25 in.

$J/c = .42$ in^3

$I/c = .21$ in^3

* NOTE: THIS ITEM USED FOR CALCULATION.

1. OPERATING FORCES

a. Reaction force due to discharge jet acting horizontally along centerline of outlet.

$F_r = .0405\ W_c = .0405 \times 221 = 8.95$ LBS.

b. Vertical force acting on valve centerline due to inlet pressure.

$F_p = A_1 \times P \times 1.10 = .307 \times 190 \times 1.1 = 64.16$ LBS.

c. Stress in base due to internal pressure.

$S_p = \frac{1.1 \times P \times d}{2\ t} = \frac{1.1 \times 190 \times .625}{2 \times .34} = 192.1$ PSI

2. SEISMIC FORCES

a. Vertical tension due to vertical acceleration.

$F_v = g_v \times W - W = 6.0 \times 4.25 - 4.25 = 21.3$ LBS.

b. Horizontal shear due to horizontal acceleration.

$F_s = g_h \times W = 6.0 \times 4.25 = 25.50$ LBS.

c. Torsion about vertical centerline due to horizontal acceleration.

$T = g_h \times W \times (x) = 6.0 \times 4.25 \times .58 = 14.8$ IN.LBS.

d. Bending moment due to vertical acceleration.

$M_v = x(g_v \times W + W) = .58(6.0 \times 4.25 + 4.25) = 17.3$ IN.LBS.

e. Bending moment due to horizontal acceleration.

$M_h = y\ (g_h \times W) = 4.06 \times 6.0 \times 4.25 = 103.5$ IN. LBS.

3. COMBINED STRESSES ACTING AT BASE

a. Tensile stress due to 1b, 2a.

$$S_t = \frac{F_p + F_v}{A} = \frac{64.16 + 21.3}{1.05} = 81.39 \text{ PSI.}$$

b. Shear stress due to 1a, 2b, 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{8.95 + 25.5}{1.05} + \frac{14.8}{\frac{\pi}{16}\left(\frac{1.315^4 - .625^4}{1.315}\right)}$$

$$= \frac{34.45}{1.05} + \frac{14.8}{.42} = 68 \text{ PSI}$$

c. Bending stress due to 1a, 2d, 2e.

$$S_b = \frac{(F_r \times z) + M_v + M_h}{I/c} = \frac{(8.95 \times 2.25) + 17.3 + 103.5}{.21} = 671 \text{ PSI}$$

d. Combined stress due to 3a, 3b, 3c, 1c.

$$S = S_t + S_s + S_b + S_p = 81.39 + 68 + 671 + 192.1 = 1012.49 \text{ PSI.}$$

1" x 1" LCT-11 1500#L.G. x 150#R.F. FLANGED DWG. NO.

ITEM NO.	TAG NO.	SET PRESSURE
* 23	PSV-F035	1560 PSIG
37	PSV-F090	1500 PSIG

* NOTE:--This Item used for calculation.

$A = 1.05\ in^2$ $P = 1560$ PSIG $x = 1.00$ in

$A_i = .307\ in^2$ $Q = 38.6$ GPM $y = 8.00$ in

$A_o = .78\ in^2$ $W = 10$ LBS. $z = 2.56$ in

$D = 1.315$ in $t = .34$ in $J/c = .42\ in^3$

$d = .625$ in $I/c = .21\ in^3$

1. OPERATING FORCES

a. Reaction force of discharge jet acting horizontally along centerline of outlet.

$$F_r = \frac{.00139\ Q^2}{A_o} = \frac{.00139 \times \overline{38.6}^2}{.78} = 2.65 \text{ LBS.}$$

b. Vertical force acting on valve centerline due to inlet pres

$$F_p = A_i \times P \times 1.10 = .307 \times 1560 \times 1.1 = 527 \text{ LBS.}$$

c. Stress in base due to internal pressure.

$$S_p = \frac{1.10\ P\ d}{2\ t} = \frac{1.1 \times 1560 \times .625}{2 \times .34} = 1577 \text{ PSI}$$

2. SEISMIC FORCES

a. Vertical tension due to vertical acceleration.

$$F_v = g_v \times W - W = 6.0 \times 10 - 10 = 50 \text{ LBS.}$$

b. Horizontal shear due to horizontal acceleration.

$$F_s = g_h \times W = 6.0 \times 10 = 60 \text{ LBS.}$$

c. Torsion about vertical centerline due to horizontal acceleration.

$$T = g_h \times W \times (x) = 6.0 \times 10 \times 1.0 = 60 \text{ IN.LBS.}$$

d. Bending moment due to vertical acceleration.

$$M_v = x\ (g_v \times W + W) = 1.0\ (6.0 \times 10 + 10) = 70 \text{ IN.LBS.}$$

e. Bending moment due to horizontal acceleration.

$$M_h = y\ (g_h \times W) = 8.0 \times 6.0 \times 10 = 480 \text{ IN.LBS.}$$

COMBINED STRESSES ACTING AT BASE

a. Tensile stress due to 1b, 2a.

$$S_t = \frac{F_p + F_v}{A} = \frac{527 + 60}{1.05} = 550 \text{ PSI}$$

b. Shear stress due to 1a, 2b, 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{2.65 + 60}{1.05} + \frac{60}{\frac{\pi}{16}\left(\frac{1.315^4 - .625^4}{1.315}\right)}$$

$$= \frac{62.65}{1.05} + \frac{60}{.42} = 202.53 \text{ PSI}$$

c. Bending stress due to 1a, 2d, 2e.

$$S_b = \frac{(F_r \times z) + M_v + M_h}{I/c} = \frac{(2.65 \times 2.56) + 70 + 480}{.21} = 2651.35 \text{ PSI}$$

d. Combined stress due to 3a, 3b, 3c, 1c.

$$S = S_t + S_s + S_b + S_p = 550 + 202.53 + 2651.35 + 1577 = 4980.88 \text{ PSI}$$

J. E. LONERGAN COMPANY

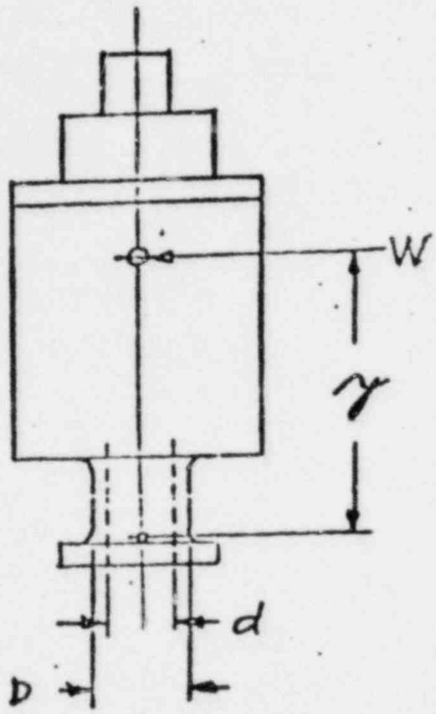
MISSISSIPPI POWER & LIGHT (Bechtel)

P.O. No. 9645-M-141.1 LONERGAN NO. 500320

3/4" x 1" LCT-20 Female x Female

Natural Frequency Calculations

ITEM PSV-F031



$W = 22$ LBS

$y = 7.56$ in.

$D = 2.656$ in.

$d = .92$ in

$E = 30 \times 10^6$

$g = 386$ in/sec^2

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{g E I}{W y^3}}$$

$$I = \pi \left(\frac{D^4 - d^4}{64}\right)$$

$$= \frac{\pi}{64}(2.656^4 - .92^4) = 2.41 \text{ in}^4$$

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{386 \times 30 \times 10^6 \times 2.41}{22 \times 7.56^3}}$$

$$= .275\sqrt{2,935,774} = 471 \text{ cps}$$

J. E. LONERGAN COMPANY

3/4" x 1" LCT-20 FEMALE x FEMALE DWG. No. A-2624

ITEM NO.	TAG NO.	SET PRESSURE
20	PSV-F017	75 PSIG
22	PSV-F014	100 PSIG
• 28	PSV-F031	100 PSIG

*This item used for calculations.

$A = 4.87\ in^2$	$P = 100$ PSIG	$x = .96$ in
$A_1 = .66\ in^2$	$Q = 17.9$ GPM	$y = 7.56$ in
$A_o = .72\ in^2$	$W = 22$ LBS	$z = 2.62$ in.
$D = 2.656$ in	$t = .87$ in	$J/c = 3.62\ in^3$
$d = .92$ in		$I/c = 1.81\ in^3$

1. OPERATING FORCES

a. Reaction force of discharge jet acting horizontally along centerline of outlet.

$$F_r = \frac{.00139\ Q^2}{A_o} = \frac{.00139 \times \overline{17.9}^2}{.72} = .62 \text{ LBS.}$$

b. Vertical force acting on valve centerline due to inlet pressure.

$$F_p = A_1 \times P \times 1.10 = .66 \times 100 \times 1.1 = 7[illegible] \text{ LBS}$$

c. Stress in base due to internal pressure.

$$S_p = \frac{1.10\ P\ d}{2\ t} = \frac{1.1 \times 100 \times .92}{2 \times .87} = 58 \text{ PSI}$$

2. SEISMIC FORCES

a. Vertical tension due to vertical acceleration.

$$F_v = g_v \times W - W = 6.0 \times 22 - 22 = 110 \text{ LBS.}$$

b. Horizontal shear due to horizontal acceleration.

$$F_s = g_h \times W = 6.0 \times 22 = 132 \text{ LBS.}$$

c. Torsion about vertical centerline due to horizontal acceleration.

$$T = g_h \times W \times (x) = 6.0 \times 22 \times .96 = 127 \text{ IN. LBS.}$$

d. Bending moment due to vertical acceleration.

$$M_v = x\ (g_v \times W + W) = .96\ (6.0 \times 22 + 22) = 148 \text{ IN. LBS.}$$

e. Bending moment due to horizontal acceleration.

$$M_h = y\ (g_h \times W) = 7.56 \times 6.0 \times 22 = 998 \text{ IN.LBS.}$$

3. COMBINED STRESSES ACTING AT BASE

a. Tensile stress due to 1b, 2a.

$$S_t = \frac{F_p + F_v}{A} = \frac{72.6 + 110}{4.87} = 38 \text{ PSI}$$

b. Shear stress due to 1a, 2b, 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{.62 + 132}{4.87} + \frac{127}{\frac{\pi}{16}\left(\frac{2.656^4 - .92^4}{2.656}\right)}$$

$$= \frac{132.62}{4.87} + \frac{127}{3.62} = 62 \text{ PSI}$$

c. Bending stress due to 1a, 2d, 2e.

$$S_b = \frac{(F_r \times z) + M_v + M_h}{I/c} = \frac{(.62 \times 2.62) + 148 + 998}{1.81} = 634 \text{ PSI}$$

d. Combined stress due to 3a, 3b, 3c, 1c.

$$S = S_t + S_s + S_b + S_p = 38 + 62 + 634 + 58 = 792 \text{ PSI}$$

J. E. LONERGAN COMPANY

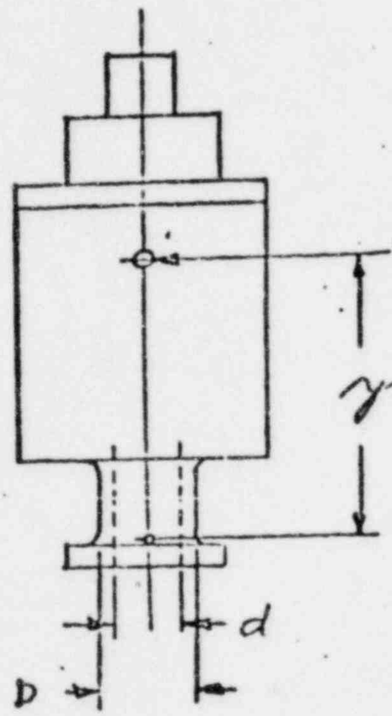
MISSISSIPPI POWER & LIGHT (Bechtel)

P.O. No. 9645-M-141.1 LONERGAN NO. 500320

1½" x 2" LCT-20 Female x Female

Natural Frequency Calculations

ITEM PSV-F018



W = [illegible] LBS.

y = 8.06 IN.

D = 3.275 in.

d = 1.73 in

E = 30×10^6

g = 386 in/sec^2

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{g\,E\,I}{W\,y^3}}$$

$$I = \frac{\pi}{64}(D^4 - d^4)$$

$$= \frac{\pi}{64}(3.275^4 - 1.73^4) = 5.21\ in^4$$

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{386 \times 30 \times 10^6 \times 5.21}{33 \times 8.06^3}}$$

$$= .275\sqrt{3491565} = 514\ cps$$

1-1/2" x 2" LCT-20 FEMALE x FEMALE DWG. No. A2624

ITEM NO.	TAG NO.	SET PRESSURE
29	PSV-F018	510 PSIG
$A = 6.86\ in^2$	$P = 510$ PSIG	$x = .96$ in
$A_i = 2.35\ in^2$	$Q = 163$ GPM	$y = 8.06$ in
$A_o = 2.95\ in^2$	$W = 33$ LBS	$z = 3.00$ in
$D = 3.275$ in	$t = .77$ in	$J/c = 6.36\ in^3$
$d = 1.73$ in		$I/c = 3.18\ in^3$

1. OPERATING FORCES

a. Reaction force of discharge jet acting horizontally along centerline of outlet.

$$F_r = \frac{.00139\ Q^2}{A_o} = \frac{.00139 \times \overline{163}^2}{2.95} = 12.52 \text{ LBS.}$$

b. Vertical force acting on valve centerline due to inlet pressure.

$$F_p = A_i \times P \times 1.10 = 2.35 \times 510 \times 1.1 = 1318.35 \text{ LBS}$$

c. Stress in base due to internal pressure.

$$S_p = \frac{1.10\ P\ d}{2\ t} = \frac{1.1 \times 510 \times 1.73}{2 \times .77} = 630.21 \text{ PSI}$$

2. SEISMIC FORCES

a. Vertical tension due to vertical acceleration.

$$F_v = g_v \times W - W = 6.0 \times 33 - 33 = 165 \text{ LBS.}$$

b. Horizontal shear due to horizontal acceleration.

$$F_s = g_h \times W = 6.0 \times 33 = 198 \text{ LBS.}$$

c. Torsion about vertical centerline due to horizontal acceleration.

$$T = g_h \times W \times (x) = 6.0 \times 33 \times .96 = 190 \text{ IN.LBS.}$$

d. Bending moment due to vertical acceleration.

$$M_v = x\ (g_v \times W + W) = .96(6.0 \times 33 + 33) = 222 \text{ IN.LBS.}$$

e. Bending moment due to horizontal acceleration.

$$M_h = y\ (g_h \times W) = 8.06 \times 6.0 \times 33 = 1596 \text{ IN.LBS.}$$

3. COMBINED STRESSES ACTING AT BASE

a. Tensile stress due to 1b, 2a.

$$S_t = \frac{F_p + F_Y}{A} = \frac{1318.35 + 165}{6.86} = 216.23 \text{ PSI}$$

b. Shear stress due to 1a, 2b, 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{12.52 + 198}{6.86} + \frac{190}{\frac{\pi}{16}\left(\frac{3.275^4 - 1.73^4}{3.275}\right)}$$

$$= \frac{210.52}{6.86} + \frac{190}{6.36} = 60.56 \text{ PSI}$$

c. Bending stress due to 1a, 2d, 2e.

$$S_b = \frac{(F_r \times z) + M_V + M_h}{I/c} = \frac{(12.52 \times 3) + 222 + 1596}{3.18} = 583.51 \text{ PSI}$$

d. Combined stress due to 3a, 3b, 3c, 1c.

$$S = S_t + S_s + S_b + S_p = 216.23 + 60.56 + 583.51 + 630.21 = 1490.51 \text{ PSI.}$$

MISSISSIPPI POWER AND LIGHT (Bechtel)

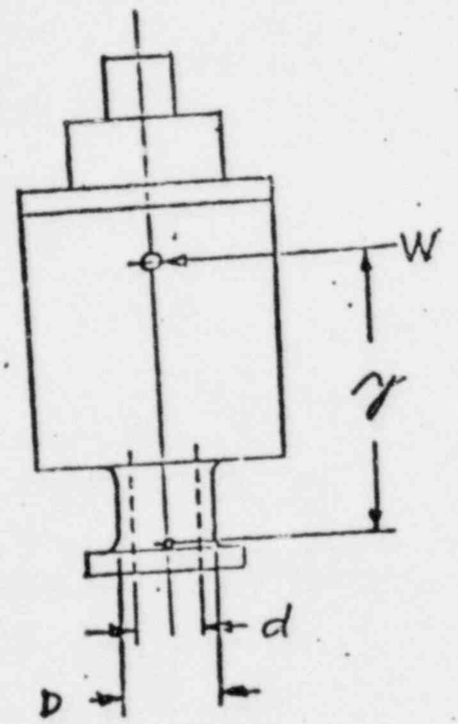
P. O. No. 9645-M-141.1 LONERGAN NO. 500320-1 & 2

$1\frac{1}{2}$" x 2" - LCT-20 150 # R.F. x 150 # R.F.

Natural Frequency Calculations

Item No. 1-1.06A
1-1.06B

Tag No. SQ-$1\frac{1}{2}$ HBC-PSV-F026A
SQ-$1\frac{1}{2}$ HBC-PSV-F026B



W = 41 LBS.

y = 9.16 INS.

D = 1.90 INS.

d = 1.50 INS.

E = 30×10^6

g = $386\ in/sec^2$

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{g E I}{W y^3}}$$

$$I = \pi \left(\frac{D^4 - d^4}{64}\right)$$

$$I = \frac{\pi}{64}\left(1.90^4 - 1.50^4\right) = 0.39$$

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{386 \times 30 \times 10^6}{41 \times 9.16^3}}$$

$$= .275\sqrt{367484}$$

$$= 167\ CPS.$$

Lonergan

MANUFACTURERS OF SAFETY-RELIEF VALVES

SEISMIC CALCULATIONS

1½" x 2" LCT-20 150 # R.F. x 150 # R.F. DWG. No. A-2371

ITEM NO.	TAG NO.	SET PRESSURE
38	SQ-1½HBC-PSV-F026A	40 PSIG
39	SQ-1½HBC-PSV-F026B	40 PSIG

A = 1.07 IN.^{2}		P = 40 PSIG		x = 1.88 INS.	
A_i = 1.767 IN.^{2}		Q = 43.2 GPM.		y = 9.16 INS.	
A_o = 2.95 IN.^{2}		W = 41 LBS.		z = 5.19 INS.	
D = 1.90 IN.^{2}		t = 0.20 INS.		J/c = .82 IN.^{3}	
d = 1.50 IN.^{2}				I/c = .41 IN.^{3}	

1. OPERATING FORCES

a. Reaction force of discharge jet horizontally along centerline of outlet.

$$F_r = \frac{.00139\ Q^2}{A_o} = \frac{0.00139\ (43.2)^2}{2.95} = 0.88 \text{ LBS.}$$

b. Vertical force acting on valve centerline due to inlet pressure.

$$F_p = A_i \times P \times 1.10 = (1.767) \times 40 \times 1.10 = 77.8 \text{ LBS.}$$

c. Stress in base due to internal pressure.

$$S_p = \frac{1.10\ P\ d}{2\ t} = \frac{(1.10)\ (40)\ (1.50)}{2\ (0.20)} = 165 \text{ psi.}$$

2. SEISMIC FORCES

a. Vertical tension due to vertical acceleration.

$$F_v = g_v \times W - W = 6.0 \times 41 - 41 = 205 \text{ LBS.}$$

b. Horizontal shear due to horizontal acceleration.

$$F_s = g_h \times W = 246 \text{ LBS.}$$

c. Torsion about vertical centerline due to horizontal acceleration.

$$T = g_h \times W \times (x) = 6.0 \times 41 \times (1.88) = 463 \text{ IN.-LBS.}$$

d. Bending moment due to vertical acceleration.

$$M_v = x\ (g_v\ W + W) = (1.88) \times (6.0 \times 41 + 41) = 540 \text{ IN.-LBS.}$$

e. Bending moment due to horizontal acceleration.

$$M_h = y\ (g_h \times W) = 9.16 \times (6.0 \times 41) = 2253 \text{ IN.-LBS.}$$

Conergan MANUFACTURERS OF SAFETY-RELIEF VALVES

SEISMIC CALCULATIONS

COMBINED STRESSES ACTING AT BASE

a. Tensile stress due to 1b, 2a.

$$S_t = \frac{F_p + F_v}{A} = \frac{77.8 + 205}{1.07} = 264 \text{ psi.}$$

b. Shear stress due to 1a, 2b, 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{0.88 + 246}{1.07} + \frac{463}{0.82} = 795 \text{ psi.}$$

c. Bending stress due to 1a, 2d, 2e.

$$S_b = \frac{(F_r \times z) + M_v + M_h}{I/c} = \frac{(0.88 \times 5.19) + 540 + 2253}{0.41} = 6823 \text{ psi}$$

d. Combined stress due to 3a, 3b, 3c, 1c.

$$S = S_t + S_s + S_b + S_p = 264 + 795 + 6823 + 165 = 8047 \text{ psi.}$$

J. E. LONERGAN COMPANY

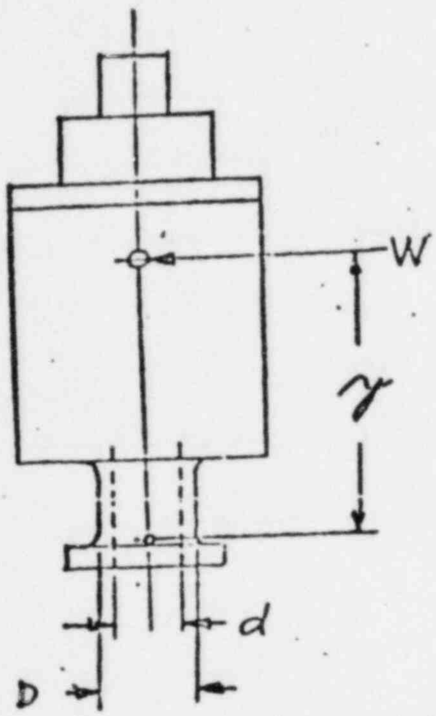
MISSISSIPPI POWER & LIGHT (Bechtel)

P.O. No. 9645-M-141.1 LONERGAN NO. 500320

1½" x 3" D-10H 150#RF x 150#RF FLANGED

Natural Frequency Calculations

ITEM PSV-F018



W = 50 LBS.

y = 9.47 in.

D = 2.62 in.

d = 2.00 in.

E = 30×10^6

g = 386 in/sec^2

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{g E I}{W y^3}}$$

$$I = \frac{\pi (D^4 - d^4)}{64}$$

$$= \frac{\pi}{64}(\overline{2.62}^4 - \overline{2.0}^4) = 1.53 \text{ in}^4$$

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{386 \times 30 \times 10^6 \times 1.53}{50 \times \overline{9.47}^3}}$$

$$.275\sqrt{417209} = 178 \text{ cps}$$

J. E. LONERGAN COMPANY

1-1/2" x 3" D-10H 150#RF x 150#RF FLANGED DWG. No. A-2370

ITEM NO.	TAG NO.	SET PRESSURE
21	PSV-F018	75 PSIG

$A = 2.25\ in^2$	$L = .263\ in$	$r_1 = 1.68\ in.$	$x = 1.62\ in$
$A_b = .126\ in^2$	$n = 4$		$y = 9.47\ in$
$A_o = 7.0\ in^2$	$P = 75\ PSIG$	$u = 5.81\ in$	$z = 3.87\ in$
$A_s = .992\ in^2$	$Q = 111\ GPM$	$W = 50\ LBS$	$J/c = 2.33\ in^3$
$D = 2.62\ in$	$R = 196\#/inch$	$W_b = 25\ LBS.$	$I/c = 1.16\ in^3$
$d = 2.00\ in$			

1. OPERATING FORCES

   a. Reaction force of discharge jet acting horizontally along centerline of outlet.

   $$F_r = \frac{.00139\ Q^2}{A_o} = \frac{.00139 \times \overline{111}^2}{7.0} = 2.45\ LBS.$$

   b. Vertical force acting on centerline due to spring compression.

   $$F_{sp} = P \times A_s + L \times R = 75 \times .992 + .263 \times 196$$

   $$= 74.4 + 51.5 = 126\ LBS.$$

2. SEISMIC FORCES

   a. Vertical tension due to vertical acceleration.

   $$F_v = g_v \times W - W = 6.0 \times 50 - 50 = 250\ LBS.$$

   b. Horizontal shear due to horizontal acceleration.

   $$F_s = g_h \times W = 6.0 \times 50 = 300\ LBS.$$

   c. Torsion about vertical centerline due to horizontal acceleration.

   $$T = g_h \times W \times (x) = 6.0 \times 50 \times 1.62 = 486\ IN.LBS.$$

   d. Bending moment due to vertical acceleration.

   $$M_v = x\ (g_v \times W + W) = 1.62\ (6.0 \times 50 + 50) = 567\ IN.LBS.$$

   e. Bending moment due to horizontal acceleration.

   $$M_h = y\ (g_h \times W) = 9.47 \times 6.0 \times 50 = 2841\ IN.LBS.$$

3. COMBINED STRESSES ACTING AT POINT "O"

a. Tensile stress due to 1b, 2a.

$$S_t = \frac{F_{sp} + F_v}{A} = \frac{126 + 250}{2.25} = 167 \text{ PSI}$$

b. Shear stress due to 1a, 2b, 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{2.45 + 300}{2.25} + \frac{486}{\frac{\pi}{16}\left(\frac{2.62^4 - 2.0^4}{2.62}\right)}$$

$$= \frac{302.45}{2.25} + \frac{486}{2.33} = 343 \text{ PSI}$$

c. Bending stress due to 1a, 2d, 2e.

$$S_b = \frac{(F_r \times z) + M_v + M_h}{I/c} = \frac{(2.45 \times 3.87) + 567 + 2841}{1.16} = 2946 \text{ PSI}$$

d. Combined stress due to 3a, 3b, 3c.

$$S = S_t + S_s + S_b = 167 + 343 + 2946 = 3456 \text{ PSI}$$

4. COMBINED STRESSES ACTING ON BOLTING

a. Tensile stress due to 1b, 2a.

$$S_{bt} = \frac{F_{sp} + F_v}{n \times A_b} = \frac{126 + 250}{4 \times .126} = 746 \text{ PSI}$$

b. Bending stress due to horizontal acceleration (bonnet only).

$$M_{bh} = g_h \times W_b \times u = 6.0 \times 25 \times 5.81 = 872 \text{ IN.LBS.}$$

$$S_{bm} = \frac{M_{bh}}{r \times 2\, A_b} = \frac{872}{1.68 \times 2 \times .126} = 2059 \text{ PSI}$$

c. Combined stress due to 4a, 4b.

$$S_{bc} = S_{bt} + S_{bm} = 746 + 2059 = 2805 \text{ PSI}$$

J. E. LONERGAN COMPANY

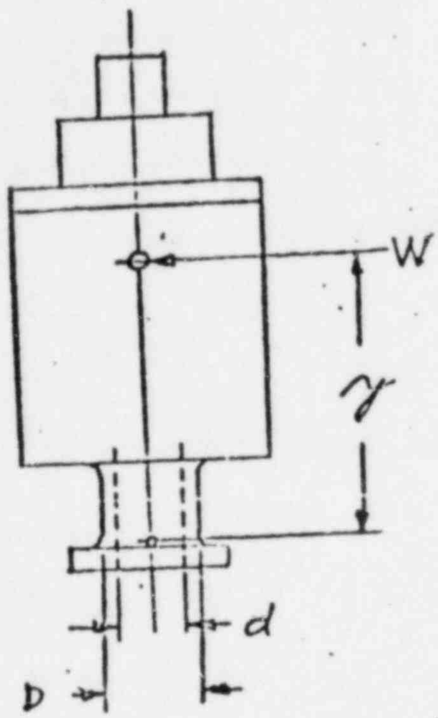
MISSISSIPPI POWER AND LIGHT (Bechtel)

P.O. No. 9645-M-141.1 LONERGAN No. 500320

4" x 6" D-10K 150#RF x 150#RF FLANGED

Natural Frequency Calculations

ITEM PSV-F036



$W = 200$ LBS.

$y = 14.9$ in

$D = 5.75$ in.

$d = 4.63$ in

$E = 30 \times 10^6$

$g = 386$ in/sec^2

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{g E I}{W y^3}}$$

$$I = \pi \left(\frac{D^4 - d^4}{64}\right)$$

$$= \frac{\pi}{64}(5.75^4 - 4.63^4) = 31.1 \text{ in}^4$$

$$ncps = \frac{1.73}{2\pi}\sqrt{\frac{386 \times 30 \times 10^6 \times 31.1}{200 \times 14.9^3}}$$

$$= .275 \sqrt{67886} = 203 \text{ cps}$$

J. E. LONERGAN COMPANY

4" x 6" D-10N 150#RF x 150#RF FLANGED DWG. NO. A-2370

ITEM NO.	TAG NO.	SET PRESSURE
27	PSV-F036	75 PSIG

$A = 9.12\ in^2$	$L = .62$	$r_1 = 2.78$ in	$x = 2.75$ in
$A_b = .202\ in^2$	$n = 8$	$r_2 = 3.94$ in	$y = 14.9$ in
$A_o = 28\ in^2$	$P = 75$ PSIG	$u = 9.1$ in	$z = 6.125$ in
$A_s = 5.40\ in^2$	$Q = 613$ GPM	$W = 200$ LBS.	$J/c = 21.6\ in^3$
$D = 5.75$ in	$R = 400\#/inch$	$W_b = 100$ LBS	$I/c = 10.8\ in^3$
$d_1 = 4.630$ in			

1. OPERATING FORCES

a. Reaction force of discharge jet acting horizontally along centerline of outlet.

$$F_r = \frac{.00139\ Q^2}{A_o} = \frac{.00139 \times \overline{613}^2}{28} = 18.6 \text{ LBS.}$$

b. Vertical force acting on centerline due to spring compression

$F_{sp} = P \times A_s + L + R = 75 \times 5.4 + .62 \times 400$

$= 405 + 248 = 653$ LBS.

2. SEISMIC FORCES

a. Vertical tension due to vertical acceleration.

$F_v = g_v \times W - W = 6.0 \times 200 - 200 = 1000$ LBS.

b. Horizontal shear due to horizontal acceleration.

$F_s = g_h \times W = 6.0 \times 200 = 1200$ LBS.

c. Torsion about vertical centerline due to horizontal acceleration.

$T = g_h \times W \times (x) = 6.0 \times 200 \times 2.75 = 3300$ IN.LBS.

d. Bending moment due to vertical acceleration.

$M_v = x\ (g_v \times W + W) = 2.75\ (6.0 \times 200 + 200) = 3850$ IN.LBS.

e. Bending moment due to horizontal acceleration.

$M_h = y\ (g_h \times W) = 14.9 \times 6.0 \times 200 = 17880$ IN.LBS.

3. COMBINED STRESSES ACTING AT POINT "O"

a. Tensile stress due to 1b, 2a.

$$S_t = \frac{F_{sp} + F_v}{A} = \frac{653 + 1000}{9.12} = 181 \text{ PSI}$$

b. Shear stress due to 1a, 2b, 2c.

$$S_s = \frac{F_r + F_s}{A} + \frac{T}{J/c} = \frac{18.6 + 1200}{9.12} + \frac{3300}{\frac{\pi}{16}\left(\frac{5.75^4 - 4.63^4}{5.75}\right)}$$

$$= \frac{1218.6}{9.12} + \frac{3300}{21.6} = 286 \text{ PSI}$$

c. Bending stress due to 1a, 2d, 2e.

$$S_b = \frac{(F_r \times z) + M_v + M_h}{I/c} = \frac{(18.6 \times 6.125) + 3850 + 17880}{10.8} = 2023 \text{ PSI}$$

d. Combined stress due to 3a, 3b, 3c.

$$S = S_t + S_s + S_b = 181 + 286 + 2023 = 2490 \text{ PSI}$$

4. COMBINED STRESSES ACTING AT BOLTING

a. Tensile stress due to 1b, 2a.

$$S_{bt} = \frac{F_{sp} + F_v}{n \times A_b} = \frac{653 + 1000}{8 \times .202} = 1023 \text{ PSI}$$

b. Bending stress due to horizontal acceleration (Bonnet only).

$$M_{bh} = g_h \times W_b \times u = 6.0 \times 100 \times 9.1 = 5460 \text{ IN.LBS.}$$

$$F_o = \frac{M_{bh}\, r_2}{2(r_2^2 + r_1^2)} = \frac{5460 \times 3.94}{2(3.94^2 + 2.78^2)} = 463 \text{ LBS.}$$

$$S_{bm} = \frac{F_o}{A_b} = \frac{463}{.202} = 2292 \text{ PSI}$$

(NOTE: Use number of bolts in plane of maximum stress.)

c. Combined stress due to 4a, 4b.

$$S_{bc} = S_{bt} + S_{bm} = 1023 + 229 = 3315 \text{ PSI}$$

BECHTEL MPL

SUPPLIER DRAWING REVISION NOTICE

JOB NO.	DRAWING NO	REV NO
9645	9645-M-141.1 QS-7.0-1	8

RN NO. 8 PAGE 1 OF 1

BY B. KHUC DATE 8/7/81

REASON FOR CHANGE CHANGE TAG NO. OF ITEM NO. 34.
CORRECT CALCULATION.

DESCRIPTION OF CHANGE	ZONE LOCATION
1) CHANGED TAG NO. OF ITEM NO. 34. WAS: HCC-PSV-SPARE NOW: HBC-PSV-F293A,B	PAGES 16,19
2) CORRECTED NUMBER 59.67 TO 62.65	PAGE 22

8/7/81

B Kochis 8/7/81
GROUP SUPV /DATE

[signature] 8/7/81
P.E./A.P.E./DATE

ATTACHMENT NO. 7

Refurbishment Schedule
E22-F004

TARGET SCHEDULE FOR MODIFICATION

OF THE GRAND GULF

E22-F004 LIMITORQUE ACTUATOR

1.	Removal of Unit 2 F004 Limitorque Actuator and Ship to Limitorque for Refurbishment	Mid-May 1982
2.	Completion of Refurbishing Valve New stem and stem nut New self-locking worm gear New motor Remove brake	Mid-Dec 1982
3.	Ship to Grand Gulf site ready for installation	Mid-Jan 1983