ELECTRO-MECHANICS, INC.
New Britain, Connecticut

BISTABLE/AUXILIARY TRIP UNITS

SEISMIC QUALIFICATION TEST REPORT

FLORIDA POWER & LIGHT
St. Lucie Unit 2

Test Report TS 6575-2
Rev. A

M.O. #9873295

Prepared By:	S. Bransfield	Date:	7-2-82
Reviewed By:	[signature]	Date:	8-3-82
Approved By:	A.D. Kulkarni (Eng.)	Date:	8-4-82
Approved By:	A.J. Wayland (QA)	Date:	8/5/82

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RECORD OF REVISIONS

Revision		Sign-Offs
A	Extensively revised - refer to historical copy ECO #15145	ADX 10/21/82 ECW 10-22-82

BISTABLE/AUXILIARY TRIP UNITS
Seismic Qualification Test Report

1.0 ABSTRACT

The Bistable/Auxiliary Trip Units (BTU/ATU), Electro-Mechanics, Inc., Assembly #34860 and Assembly #34880, respectively, operate as intended by Reference 2.1, during and after exposure to the seismic environment defined in Appendix IV, Figures 1 and 2, fulfilling all safety requirements and are considered to be seismically qualified.

Testing of the BTU/ATU was performed by American Environments Company, Inc. at their test facility in West Babylon, NY. The test was completed on January 19, 1982.

2.0 REFERENCES

2.1 Combustion Engineering, Inc., 00000-ICE-3003, Rev. 01, (BTU/ATU Specification)

2.2 CE "Criteria No. SYS80-ICE-0506 for Seismic Qualification", Rev. 01

2.3 IEEE STD 344-1975, "Guide for Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations"

2.4 IEEE STD 323-1974, "General Guide for Qualifying Class I Electric Equipment for Nuclear Power Generating Stations"

2.5 EM Dwg. #34860, Rev. C, BTU Assembly

2.6 EM Dwg. #34880, Rev. C, ATU Assembly

2.7 EM TP 6575-4, Rev. C, Potentiometer Component Cycling Test Procedure

2.8 EM TP 6575-5, Rev. C, Relay Component Cycling Test Procedure

2.9 EM CA 6575-1, Rev. B, Bistable Trip Unit Error Analysis

2.10 EM TS 6575-1, Rev. A, Environmental Qualification Test Report

2.11 <u>Machinery's Handbook, 20th Edition</u>, Industrial Press, Inc., 1978

2.12 EM TS 6534-2, Rev. A, RPS Seismic Qualification Test Report

3.0 SCOPE

The objective of this test was to demonstrate the ability of the BTU and ATU assemblies to fulfill their safety requirements as stated in Ref. 2.1 during and after the seismic environment of the SSE without compromise of their functional accuracy or structural integrity.

4.0 TEST REQUIREMENTS

4.1 MOUNTING

4.1.1 The BTU and ATU were installed into the TE-271N (Appendix V) Test Bin Assembly which simulated both mechanically and electrically the actual Trip Unit Bin Assembly of the Reactor Protective System (RPS). The BTU was installed in position 1 and the ATU was installed in position 8 of the TE-271N (refer to photographs in Appendix IV). Positions 2 thru 7 and 9 of the TE-271N had dummy BTU assemblies installed. These dummy assemblies comprised actual trip unit frame structures which were mechanically weighted to represent the mass and center of gravity of an actual BTU assembly. Positions 10 and 11 of the TE-271N had dummy ATU assemblies installed. These dummy assemblies were similarly constructed to represent an actual ATU assembly.

4.2 PRECONDITIONING

4.2.1 Electromechanical Component Aging -Electromechanical components performing Class 1E safety functions were subjected to cycling aging procedures (see references 2.7 and 2.8) to place the components in an end of life condition. Locations of the cycled components were as follows: BTU - COARSE and FINE adjust Trip Setpoint potentiometers; Douglas-Randall, P/N 378907, relays K1, K2 and K3. ATU - Douglas-Randall, P/N 378907 relays K1 and K2 only.

During refurbishment of the assemblies, after completion of testing, ALL cycled components were removed and replaced with new components.

4.2.2 Environment Qualification Testing - Both the BTU and ATU assemblies have successfully undergone environmental testing (see Ref. 2.10) prior to Seismic Qualification.

4.3 MONITORING - FUNCTIONAL PERFORMANCE CRITERIA

(The following is a synopsis. Refer to Appendix I for a detailed description of the monitoring setups and acceptance criteria.)

4.3.1 Cycled Components - Continuously monitored during all seismic events on an oscillographic recorder. All cycled relays were serially monitored (i.e., contacts daisy chained) and displayed on the recorder as TRIP STATUS of the particular assembly.

4.3.2 Bistable Trip Unit Setpoint Stability - Continuously monitored during all seismic events on an oscillographic recorder at a deflection factor of 1mV = 0.1". Any variations to the waveform must be evaluated to determine their effect on the performance of the assembly.

4.3.3 Bistable Trip Unit Tripping Accuracy - During each monitored event, the BTU was forced to trip. Refer to Appendix I, Section 5.1, for operation of this test. The required accuracy was ±5mV of the set-point. Monitoring was accomplished with a 5-1/2 digit DMM.

4.3.4 Visual - Any other visual indication of malfunction (such as a change in indicator status) during a seismic event must be analyzed for its cause and reported.

4.4 MONITORING - SEISMIC

4.4.1 Accelerometers - A total of eight (8) accelerometers were used: 2 control (mounted on seismic table) and 6 response accelerometers (see Appendix I, Table I for locations and polarizations). The equipment deflection (maximum deflection of the equipment exterior relative to its mounting points) calculations are provided. Acceptance criteria was that the deflection of the equipment exterior during the SSE does not affect the design function.

4.4.2 Strain Gages - A total of two (2) strain gages were used located at positions of maximum strain (see Appendix IV, Table I for specific locations). Calculations (Appendix IV, Calculation I) are provided to indicate the apparent stress the equipment experienced during each SSE. The apparent stress must have been considerably less than the typical yield stress for steel, 30×10^3 PSI (refer to Reference 2.11, Table I on page 452).

4.4.3 Visual - Thorough preseismic and post seismic inspections were made to assure the physical integrity of each assembly was not compromised. These inspections typically entailed checking for loose mounting hardware and checking for any damage to structure of each assembly.

5.0 SEISMIC TESTING

5.1 EXACT SEQUENCE OF TESTS

5.1.1 Preseismic Visual

5.1.2 Preseismic Data

*5.1.3 2nd Pair Out-Of-Phase Resonance Search

*5.1.4 2nd Pair Out-Of-Phase OBE 1-5, SSE

5.1.4.1 Start recorder five (5) seconds prior to event

5.1.4.2 Start seismic motions (30 seconds duration)

5.1.4.3 Response Time test at 10-15 seconds

5.1.4.4 Stop recorder five (5) seconds after event

5.1.4.5 Examine recorder charts

5.1.5 Post SSE Visual Inspection

*5.1.6 2nd Pair In-Phase Resonance Search

*5.1.7 2nd Pair In-Phase OBE 1-5, SSE
(Same sequence as 5.1.4.1 thru 5.1.5 above)

*Refer to Appendix IV, Figure 2, for pictorial representation of each biaxial pair.

*5.1.8 1st Pair Out-Of-Phase Resonance Search

*5.1.9 1st Pair Out-Of-Phase OBE 1-5, SSE
(Same as sequence as 5.1.4.1 thru 5.1.5 above)

*5.1.10 1st Pair In-Phase Resonance Search

*5.1.11 1st Pair In-Phase OBE 1-5, SSE
(Same as sequence as 5.1.4.1 thru 5.1.5 above)

5.1.12 Post Seismic Data and Visual

*Refer to Appendix IV, Figure 2, for pictorial representation of each biaxial pair.

6.0 TEST RESULTS

6.1 RESONANCE SEARCHES

6.1.1 Appendix IV, paragrpahs 4.2, 4.3, 4.4 and 4.5 reported no significant structural resonances being observed during any of the biaxial pair resonance searches.

6.2 2ND BIAXIAL PAIR OUT-OF-PHASE

6.2.1 BTU Half Level Test (OBE)

6.2.1.1 While Reference 2.3 states that no functional testing/monitoring is required during OBE events, the BTU and ATU assemblies were functionally tested/monitored during all seismic events.

6.2.1.2 During four of the five OBE's, the trip setpoint channel of the visicorder indicated bursts of deflections, approximately 2mVDC or less in amplitude and duration of less than 1mSec, occurring at random intervals during the event. These deflections can be attributed to the wiper of the trip setpoint potentiometer shifting which causes making/breaking contact of adjacent surfaces of the wirewound element. This variation did not affect the tripping accuracy of the unit and is within the ±5mVDC acceptance criteria.

6.2.1.3 All other electrical data was compared with preseismic data and was found acceptable.

6.2.2 ATU Half Level Test (OBE)

6.2.2.1 All electrical data was compared with the preseismic data and was found acceptable.

6.2.3 BTU Full Level Test (SSE)

6.2.3.1 The same wiper shifting of the Trip Setpoint potentiometer was observed during the SSE as was observed during the OBEs. The amplitude was approximately 2mVDC and duration of less than 1mSec. The frequency of the deflections were at an increased level when compared with the OBEs. All variations were within the acceptance criteria.

6.2.3.2 All other electrical data was compared with preseismic data and was found acceptable.

6.2.3.3 Visual examination of the BTU assembly revealed no physical damage sustained.

6.2.3.4 The equipment deflection was 0.068 inches. It should be noted that since no resonances were observed, the maximum required frequency (33Hz) was used in all the calculations in order to yield the greatest (most conservative) deflection possible for the equipment within the earthquake frequency domain. The apparent stress the equipment experienced was 538 PSI. Refer to Appendix IV, Calculations I and II.

6.2.3.5 The maximum accelerations of the response accelerometers monitoring the Bin Assembly, during SSE event in the RPS Seismic Qualification Test, were compared to the modular curve (RRS) for the BTU/ATU assemblies. The accelerations of the Bin Assembly in the RPS did not exceed the BTU/ATU RRS, refer to Ref. 2.12 for data. Since all response accelerometers on the BTU assembly exceeded the RRS, the results of this test are considered valid and acceptable.

6.2.4 <u>ATU Full Level Test (SSE)</u>

6.2.4.1 All electrical data was compared with the preseismic data and was found acceptable.

6.2.4.2 Visual examination of the ATU assembly revealed no physical damage sustained.

6.2.4.3 Equipment deflection and apparent stress are the same as for the BTU assembly discussed in Section 6.2.3.4.

6.2.4.4 All response accelerometers on the ATU assembly exceeded the modular curve (RRS). Refer to Section 6.2.3.5 for discussion of comparison of the RPS Bin Assembly accelerations and the BTU/ATU modular curve.

6.3 2ND BIAXIAL PAIR IN-PHASE

6.3.1 BTU Half Level Test (OBE)

6.3.1.1 During all of the OBE events, the Trip Setpoint channel of the visicorder indicated potentiometer wiper shift burst deflections of less than 2mVDC. This anomaly was previously discussed in Section 6.2.1.2.

6.3.1.2 During OBE #4, after resetting of the assembly, a 4mVDC level shift of the Trip Setpoint occurred. The shift level was within the ±5mVDC acceptance criteria.

6.3.1.3 The tripping accuracy test performed during OBE #5 indicated that the BTU Assembly was tripping at 5.009 VDC. The Trip Setpoint was found to be at -5.009 VDC.

Previous to this seismic event, the cumulative variations of the Trip Setpoint potentiometer and its affect on the tripping accuracy had been acceptable within the defined limits of the BTU Error Analysis. During OBE #4, a 4mVDC level shift was observed just prior to completion of the event. This 4mVDC shift was sufficient to cause the tripping accuracy of OBE #5 to be in excess of the acceptable limits. The Trip Setpoint potentiometer variations for any single OBE or SSE prior to and including this event have been within the acceptable limits. Therefore, it is concluded that the variation of the Trip Setpoint potentiometer is acceptable because no

cumulative variations could occur from seismic events due to periodic calibration where the Trip Setpoint is readjusted. The worst case Trip Setpoint potentiometer shift for any seismic event was determined to be 5mVDC which has been added to the CA 6575-1 BTU Error Analysis.

The Trip Setpoint was readjusted to -5.000 VDC prior to any further seismic testing.

6.3.1.4 All other electrical data was compared with preseismic data and was found acceptable.

6.3.2 ATU Half Level Test (OBE)

6.3.2.1 All electrical data was compared with the preseismic data and was found acceptable.

6.3.3 BTU Full Level Test (SSE)

6.3.3.1 The same wiper shifting of the Trip Setpoint potentiometer was observed during the SSE as previously discussed in Section 6.2.3.1. All variations were within the acceptable criteria.

6.3.3.2 All other electrical data was compared with preseismic data and was found acceptable.

6.3.3.3 Visual examination of the BTU assembly revealed no physical damage sustained.

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6.3.3.4 The equipment deflection was 0.0684 inches. The apparent stress the equipment experienced was 475 PSI per Calculations I and II of Appendix IV.

6.3.3.5 All response accelerations on the BTU assembly exceeded the modular curve (RRS).

6.3.4 <u>ATU Full Level Test (SSE)</u>

6.3.4.1 All electrical data was compared with preseismic data and was found acceptable.

6.3.4.2 Visual examination of the ATU assembly revealed no physical damage sustained.

6.3.4.3 Equipment deflection and apparent stress are the same as for the BTU assembly discussed in Section 6.3.3.4.

6.3.4.4 All response accelerations on the ATU assembly exceeded the modular curve (RRS).

6.4 1ST BIAXIAL PAIR OUT-OF-PHASE

6.4.1 <u>BTU Half Level Tests (OBE)</u>

6.4.1.1 During OBE #1, after pretrip condition, a 30mVDC spike of less than 1mSec duration was observed on the Trip Setpoint. The spike was nonrepetitive. This anomaly was caused by the wiper of the potentiometer lifting off the wire wound element momentarily and then re-establishing contact. This anomaly is considered acceptable because the trip setpoint level

returned to the same value after the spike as it was prior to the spike, indicating no rotational motion of the wiper had occurred. The specification for the potentiometer indicates a wiper bounce of 0.1mSec maximum is possible. The BTU circuitry is designed to ignore any level change in which the duration is less than the adjustable delay of 50mSec to 150mSec. Therefore, this spike was not considered a failure.

6.4.1.2 During OBE's 2 and 3, the same wiper shifting of the Trip Setpoint potentiometer was observed as previously discussed in Section 6.2.3.1. All variations were within the acceptance criteria.

6.4.1.3 All other electrical data was compared with the preseismic data and was found acceptable.

6.4.2 ATU Half Level Test (OBE)

6.4.2.1 All electrical data was compared with the preseismic data and was found acceptable.

6.4.3.2 Visual examination of the BTU assembly revealed no physical damage sustained.

6.4.3.3 The equipment deflection was 0.0684 inches. The apparent stress the equipment experienced was 102 PSI per Calculations I and II of Appendix IV. Calculation I in Appendix IV has a math error in the performance of the calculation. It erroneously indicates the apparent stress as 108 PSI.

6.4.3.4 All response accelerations on the BTU assembly exceeded the modular curve (RRS).

6.4.4 ATU Full Level Test (SSE)

6.4.4.1 All electrical data was compared with the preseismic data and was found acceptable.

6.4.4.2 Visual examination of the ATU assembly revealed no physical damage sustained.

6.4.4.3 Equipment deflection and apparent stress are the same as for the BTU assembly discussed in Section 6.4.3.3.

6.4.4.4 All response accelerations on the ATU assembly exceeded the modular curve (RRS).

6.5 1ST BIAXIAL PAIR IN-PHASE

6.5.1 BTU Half Level Tests (OBE)

6.5.1.1 During OBE #2, prior to pretrip condition, a 12mVDC spike of less than 1mSec duration was observed on the Trip Setpoint. This anomaly is similar to the previous discussion in Section 6.4.1.1.

6.5.1.2 During all the OBEs, the same wiper shifting of the Trip Setpoint potentiometer was observed as previously discussed in Section 6.2.3.1.

6.5.1.3 All other electrical data was compared with the preseismic data and found acceptable.

6.5.2 ATU Half Level Tests (OBE)

6.5.2.1 All electrical data was compared with the preseismic data and found acceptable.

6.5.3 BTU Full Level Test (SSE)

6.5.3.1 All electrical data was compared with the preseismic data and found acceptable.

6.5.3.2 Visual examination of the BTU assembly revealed no physical damage sustained.

6.5.3.3 The equipment deflection was 0.0677 inches. The apparent stress the equipment experienced was 97 PSI per Calculations I and II of Appendix IV.

6.4.3.4 All response accelerations on the BTU assembly exceeded the modular curve (RRS).

6.5.4 ATU Full Level Test (SSE)

6.5.4.1 All electrical data was compared with the preseismic data and found acceptable.

6.5.4.2 Visual examination of the ATU assembly revealed no physical damage sustained.

6.5.4.3 Equipment deflection and apparent stress are the same as for the BTU assembly discussed in Section 6.5.3.3.

6.5.4.4 All response accelerations on the ATU assembly exceeded the modular curve (RRS).

6.6 POST SEISMIC TESTING

6.6.1 All data was within prescribed limits relative to preseismic data.

7.0 CONCLUSION

The Bistable/Auxiliary Trip Units are seismically qualified to the requirements of Reference 2.1.

APPENDIX I

to

TS 6575-2

Bistable/Auxiliary Trip Units

Seismic Qualification Report

ELECTRO-MECHANICS, INC.
New Britain, Connecticut

BISTABLE/AUX. TRIP QUALIFICATION UNITS

Seismic Test Procedure

(BTU Ass'y. 34680 & ATU Ass'y. 34880)

Test Procedure TP 6575-7

Prepared by: B Johnson Date 9-25-80
Reviewed by: R. J. [illegible] Date 9-25-80
Approved by: A.D. Kulkarni (Engineer) Date 9-25-80.
Approved by: E.C. Wein (QA) Date 9-25-80

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	Engineer		QA		ECO #	
	Date	Initial	Date	Initial	Date	ECO #
Rev. A	10-27-80	ADK	10/28/80	[illegible]	10/24/80	12113
Rev. B	12-5-80	ADK	12/8/80	[illegible]	12/4/80	12483
Rev. C						
Rev. D						
Rev. E						

BISTABLE AUX. TRIP QUALIFICATION UNITS
Seismic Test Procedure
(BTU Ass'y. 34680 & ATU Ass'y. 34880)

1.0 SCOPE

This procedure will demonstrate that the Bistable Trip Unit (BTU) and the Auxiliary Trip Unit (ATU) are capable of withstanding, without malfunction or physical degradation, the effects of the OBE and SSE as defined in Item 2.5. The units will be functionally tested before and after seismic exposure and will be monitored and recorded during exposure to assure setpoint stability, resistance to false tripping and trip voltage accuracy. The ATU contact closure inputs are provided by the BTU relay outputs. In general, the acceptance criteria is that trip voltage does not vary more than ±5mV and no disturbance occurs to chart waveforms. However, actual results will be evaluated by analysis and their effect on performance given in the test report.

The facility implementing this procedure must provide a detailed test plan and report including test equipment used and results obtained, as well as hardware for mounting on seismic table, accelerometers and strain gages as required.

The RRS will be provided to test facility with purchase order.

EM personnel will be responsible for functional testing.

2.0 REFERENCES

2.1 EM Ass'y. 34860, BTU

2.2 EM Ass'y. 34880, ATU

2.3 EM Test Set Schematic TE-291N

2.4 EM Test Bin Ass'y. TE-271N (Includes P/S Ass'y. and Dummy Modules)

2.5 IEEE STD 344-1975

2.6 CE Criteria SYS80-ICE-0506

2.7 American Environments Test Plan STP-145380-!

3.0 TEST EQUIPMENT (Record S/N's and Cal. Dates in TR)

3.1 EM Test Set TE-291N

3.2 EM Test Bin Ass'y. TE-271N (Includes Cables and P/S Ass'y.)

3.3 DVM, 5 1/2 Digit, Fluke 8800A or equivalent (EM)

3.4 DC P/S (2), 15 Volts @ 2 Amps (Alt: ±15Vdc Supply - EM)

3.5 Oscilloscope, Tektronix 453 or equivalent (EM)

3.6 Voltage Ref., Digitec 3110 or equivalent (EM)

3.7 Optical Oscillographic Recorder, capable of resolving 1ms transients, Honeywell 1858 (EM)

3.8 Seismic Simulator and Related Instrumentation (Including Strain Gages and Accelerometers) to be provided by Testing Facility

3.9 Fixture to Mount TE-271N on Seismic Table (By Testing Facility)

3.10 Isolation Transformer, Topaz Type 91005-2

4.0 TEST SET-UP

4.1 On Bistable Trip Qualification Unit, Ass'y. 34860, connect a temporary jumper wire from J1, pin H, to turret terminal 31. On Auxiliary Trip Qualification Unit, Ass'y. 34880, connect temporary jumper wires from J1, pins A and B, to turret terminals 2 and 25, respectively. These connections are to allow for remote lamp reset.

4.2 Visually examine BTU and ATU to assure that all hardware, electrical connections and components are in place, secured and undamaged. Check Item 4.2 in TR 6575-7.

4.3 Install BTU, ATU and all dummy modules in their respective positions in TE-271N. Mount TE-271N in Item 3.9 and install on seismic table. Connect cables and power supply to TE-271N connectors, supporting cables as required. Cables are 25 ft. long. P/S assembly to derive 120Vac thru Item 3.10.

4.4 Adjust Test Set power supplies to ±15±0.1Vdc and connect to TE-291N.

4.5 Set TE-291N controls as follows:

S1, Auc. Switch to OFF
S2, Meter Select Switch to Pos. 2
Signal Adj. Pots to Min., Fully CCW
Auc. Adj. Pot to Min., Fully CCW
S4, Signal Select Switch to INT

4.6 Connect DVM to the BTU pretrip setpoint jack and adjust BTU front panel coarse and fine pretrip setpoint pots to +4.500±0.001Vdc. Connect DVM to BTU trip setpoint jack and adjust BTU front panel coarse and fine setpoint pots to +5.000±0.001Vdc. Connect DVM to the signal jack and adjust Auc. Adj. on TE-291N to +4.250±0.001Vdc. Set Auc. Sw. S1 to "ON".

4.6.1 Reset (momentarily actuate reset switch on TE-291N - this is a normal toggle and must be returned to its original position). Indicators L_1 thru L_4 on TE-291N should be extinguished. The BTU and ATU pretrip and trip indicators should be extinguished. Check Item 4.6 in TR 6575-7.

4.7 Set S2 to position 1. Slowly increase TE-291N coarse and fine signal adjust pots till the L_1 and L_2 indicators on TE-291N just light. The BTU and ATU pretrip indicators should also be lit. Record the actual signal voltage in Item 4.7 of TR 6575-7.

4.8 Continue increasing the signal adjust pots till L_3 and L_4 just light. BTU and ATU trip indicators should also be lit. Record actual signal voltage in Item 4.8 of TR 6575-7.

4.9 Slowly reduce signal voltage till L_3 and L_4 just extinguish. L_1, L_2 and all BTU and ATU indicators should remain lit. Record actual signal voltage in Item 4.9 of TR 6575-7.

4.10 Continue reducing signal voltage till L_1 and L_2 just extinguish. All BTU and ATU indicators should remain lit. Record actual signal voltage in Item 4.10 of TR 6575-7.

4.11 Reduce signal adjust pots fully CCW. Reset. All TE-291N, BTU and ATU indicators should be extinguished. Check Item 4.11 in TR 6575-7.

4.12 Set up, calibrate (using Digitec 3110) and connect recorder as shown in Figure 1.

5.0 SEISMIC TEST

Accelerometers should be mounted on the seismic table and the front panels of the BTU and ATU. A strain gage should be mounted on the side panel of TE-291N. Perform resonance survey according to test facility plan with equipment energized but not monitored.

5.1 Mount equipment for first biaxial pair in phase test. Vibrate equipment as detailed in seismic test plan. The recorder should run during each seismic event. (5 OBE's followed by an SSE). Record maximum chart deflection of Ch. 1 wave-

form throughout each event and any change in Ch. 2 or Ch. 3 waveforms. During each event, the actual trip voltage must be determined by increasing TE-291N signal adjust pots and monitoring L_2 and L_4. (Note: At trip point, a small change in setpoint voltage may occur due to indicator current voltage drop in Test Set wiring and should not be considered in determining setpoint variation.) After SSE, examine TE-271N assembly and both trip units for damage or loosened hardware. Record results in TR 6575-7, Item 5.1. Tighten any loosened hardware and reassemble TE-271N.

5.2 Repeat 5.1 except mount equipment for first bi-axial pair out of phase test. Record results in TR 6575-7, Item 5.2.

5.3 Repeat 5.1 except mount equipment for second bi-axial pair in-phase test. Record results in TR 6575-7, Item 5.3.

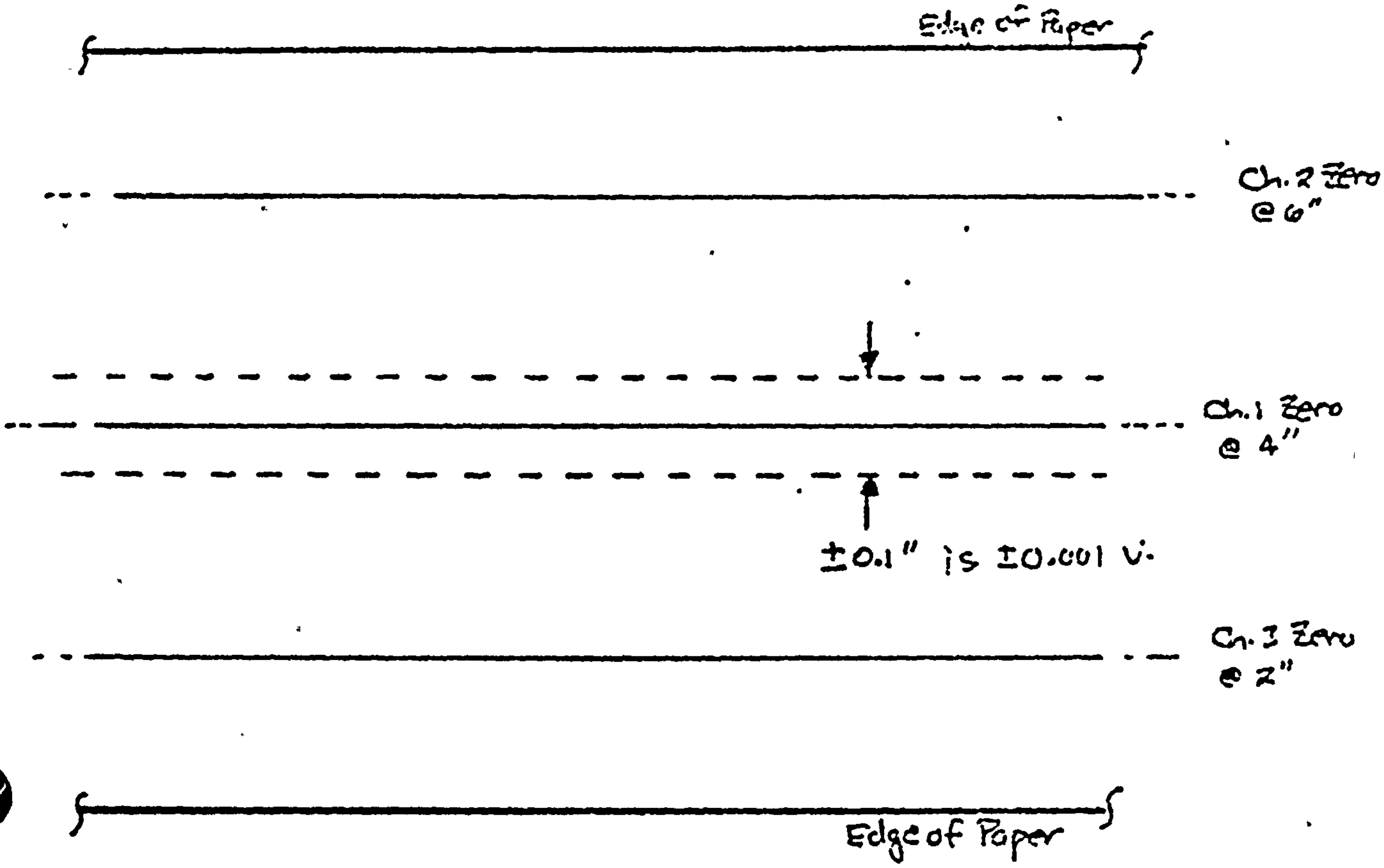
5.4 Repeat 5.1 except mount equipment for second bi-axial pair out of phase test. Record results in TR 6575-7, Item 5.4.

6.0 POST SEISMIC TEST

6.1 Repeat Items 4.6.1 thru 4.11, recording results in TR 6575-7, Item 6.6.1 thru 6.11.

Figure 1

RECORDER SET-UP

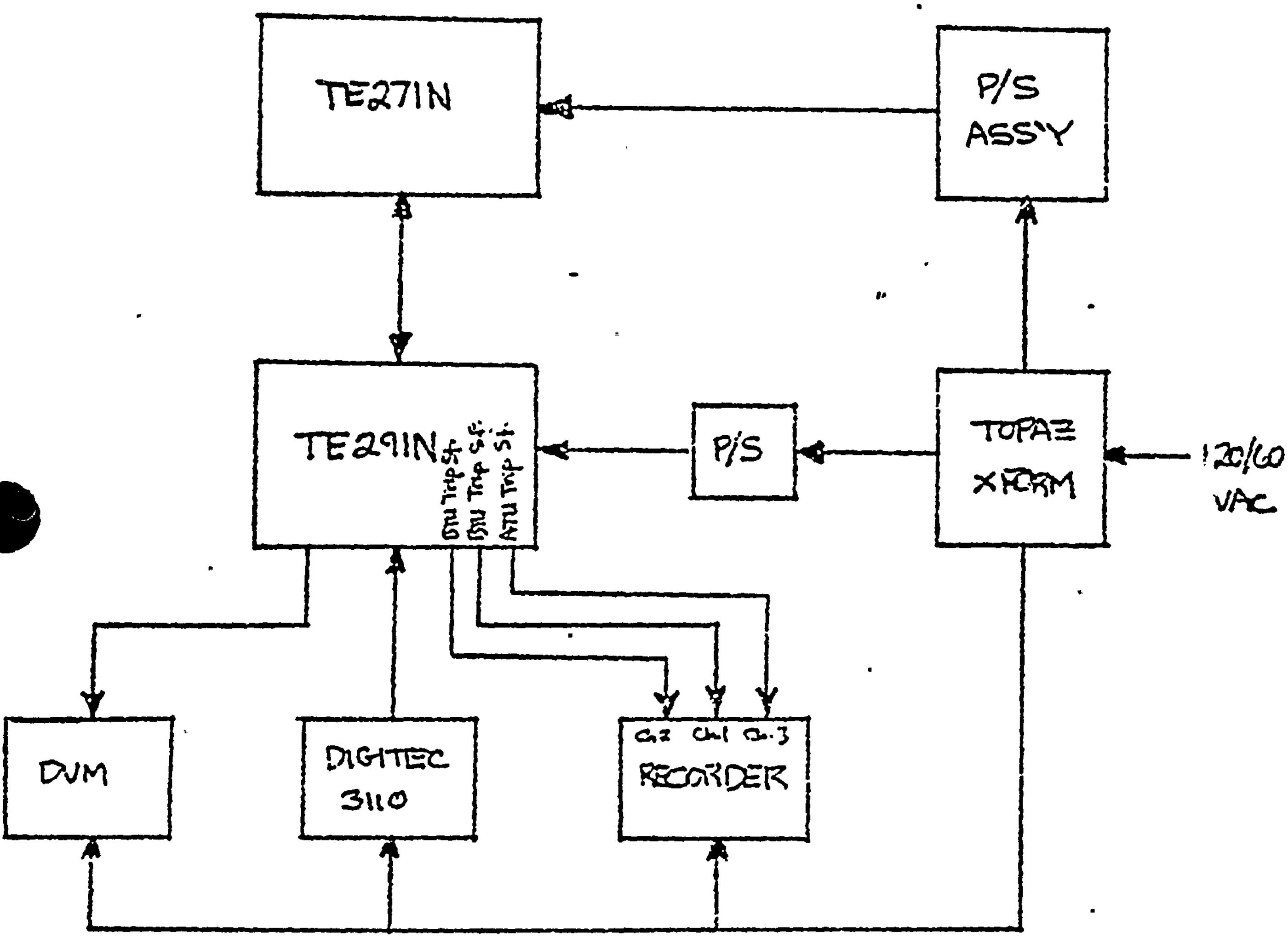


Recorder calibration and set-up:

1. Program Ch. 1, Ch. 2 and Ch. 3 for front panel BNC input.
2. Use Digitec 3110 and calibrate Ch. 1 for 0.050 volt per inch. TE-291N has 5X gain for net deflection of 0.010 V/in.
3. Set Ch. 1 zero line at approx. midpoint of chart, Ch. 2 zeroline at 6" and Ch. 3 zeroline to 2".
4. Connect Ch. 1 input to visicorder trip setpoint jack, Ch. 2 to BTU Trip Status jack and Ch. 3 to ATU Trip Status jack, all on TE-291N.
5. Connect Digitec 3110 to Digitec Input jack on TE-291N and set for -5.000Vdc.
6. Set chart speed to 2 in/sec.
7. Calibrate Ch. 2 and Ch. 3 to 0.5 volt/in. using Digitec 3110; TE-291N has 30:1 attenuators for net deflection of approximately 15 V/in.

Figure 2

TEST SET-UP



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APPENDIX II

to

TS 6575-2

Bistable/Auxiliary Trip Units

Seismic Qualification Report

ELECTRO-MECHANICS, INC.
New Britain, Connecticut

Test Record TR 6575-7

Description: Bistable/Aux. Trip Qualification Units
Part No. 34860 / 34880

Serial No. E 36893 / E 36929
Job No. 6575

Tested Per TP 6575-7 Rev. B
W.O. ~~or PDR No.~~ 12443/12444

Tested by: [signature]
Date 1-19-82 Acc ✓ Rej ___

Test Record Review by: [signature]
Date 6-3-82 Acc ✓ Rej ___

QA Test Review by: [signature]
Date 7/15/82 Acc ✓ Rej ___

List Test Equipment Used:
TE 291 N Test Set NCR
TE 271 N Test Set NCR
P 2404 N DMM 10-8-81. TEP 2469 N Visicorder 10-15-81
P 2393 N Source 10-31-81. TE 401 N Transformer NCR
TE 388 N Power Supply NCR

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	Engineer		QA		ECO #	
	Date	Initial	Date	Initial	Date	ECO #
Original Issue	9-25-80	ANX	9-25-80	ECW	—	N/A
Rev. A	10-22-80	ANX	10/28/80	[illegible]	10/24/80	12113
Rev. B						
Rev. C						
Rev. D						

TEST RECORD

Item	Observation/Measurement	Pass (Or Reading)	Fail
4.2	Visual Examination	✓	
4.6.1	Lamp Status	✓	
4.7	Lamp Status	✓	
	Pretrip Voltage	4.503	
4.8	Lamp Status	✓	
	Trip Voltage	5.001	
4.9	Lamp Status	✓	
	Untrip Voltage	4.895	
4.10	Lamp Status	✓	
	Unpretrip Voltage	4.408	
	Lamp Status	✓	
5.1	First Biaxial Pair In Phase		
5.1.1	First OBE		
5.1.1.1	Recorder Trace - Ch. 1 Deflection	3 mV	
	- Ch. 2/Ch. 3 Waveform	No Change	
5.1.1.2	Trip Voltage	5.004	
5.1.2	Second OBE		
5.1.2.1	Recorder Trace - Ch. 1 Deflection	12 mV	
	- Ch. 2/Ch. 3 Waveform	No Change	
5.1.2.2	Trip Voltage	5.004	
5.1.3	Third OBE		

Item	Observation/Measurement	Pass / Fail (Or Reading)
5.1.3.1	Recorder Trace - Ch. 1 Deflection	2 mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.1.3.2	Trip Voltage	5.005
5.1.4	Fourth OBE	
5.1.4.1	Recorder Trace - Ch. 1 Deflection	2 mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.1.4.2	Trip Voltage	5.004
5.1.5	Fifth OBE	
5.1.5.1	Recorder Trace - Ch. 1 Deflection	1 mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.1.5.2	Trip Voltage	5.003
5.1.6	SSE	
5.1.6.1	Recorder Trace - Ch. 1 Deflection	0 mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.1.6.2	Trip Voltage	5.005
5.1.7	Record any remarks for visual exam.	

NONE

Item	Observation/Measurement	Pass Fail (Or Reading)
5.2	First Biaxial Pair Out of Phase	
5.2.1	First OBE	
5.2.1.1	Recorder Trace - Ch. 1 Deflection	30 mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.2.1.2	Trip Voltage	5.000
5.2.2	Second OBE	
5.2.2.1	Recorder Trace - Ch. 1 Deflection	4 mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.2.2.2	Trip Voltage	5.003
5.2.3	Third OBE	
5.2.3.1	Recorder Trace - Ch. 1 Deflection	4 mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.2.3.2	Trip Voltage	5.004
5.2.4	Fourth OBE	
5.2.4.1	Recorder Trace - Ch. 1 Deflection	~~Ø~~ 2 mV SB 6-5-82
	- Ch. 2/Ch. 3 Waveform	No Change
5.2.4.2	Trip Voltage	5.004
5.2.5	Fifth OBE	
5.2.5.2	Recorder Trace - Ch. 1 Deflection	0 mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.2.5.2	Trip Voltage	5.004
5.2.6	SSE	

Item	Observation/Measurement	Pass Fail (Or Reading)
5.2.6.1	Recorder Trace - Ch. 1 Deflection	0mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.2.6.2	Trip Voltage	5.00V

5.2.7 Record any remarks for visual exam.

NONE

Item	Observation/Measurement	Pass	Fail (Or Reading)
5.3	Second Biaxial Pair In Phase		
5.3.1	First OBE		
5.3.1.1	Recorder Trace - Ch. 1 Deflection	2 mV	
	- Ch. 2/Ch. 3 Waveform	No Change	
5.3.1.2	Trip Voltage	5.003	
5.3.2	Second OBE		
5.3.2.1	Recorder Trace - Ch. 1 Deflection	2 mV	
	- Ch. 2/Ch. 3 Waveform	No Change	
5.3.2.2	Trip Voltage	5.003	
5.3.3	Third OBE		
5.3.3.1	Recorder Trace - Ch. 1 Deflection	1 mV	
	- Ch. 2/Ch. 3 Waveform	No Change	
5.3.3.2	Trip Voltage	5.003	
5.3.4	Fourth OBE		
5.3.4.1	Recorder Trace - Ch. 1 Deflection	4 mV	
	- Ch. 2/Ch. 3 Waveform	No Change	
5.3.4.2	Trip Voltage	5.004	
5.3.5	Fifth OBE		
5.3.5.3	Recorder Trace - Ch. 1 Deflection	2 mV	
	- Ch. 2/Ch. 3 Waveform	No Change	
5.3.5.3	Trip Voltage	5.009	
5.3.6	SSE		

Item	Observation/Measurement	Pass Fail (Or Reading)
5.3.6.1	Recorder Trace - Ch. 1 Deflection	2mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.3.6.2	Trip Voltage	5.008

5.3.7 Record any remarks for visual exam. NONE

Item	Observation/Measurement	Pass Fail (Or Reading)
5.4	Second Biaxial Pair Out Of Phase	
5.4.1	First OBE	
5.4.1.1	Recorder Trace - Ch. 1 Deflection	.1 mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.4.1.2	Trip Voltage	5.003
5.4.2	Second OBE	
5.4.2.1	Recorder Trace - Ch. 1 Deflection	2mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.4.2.2	Trip Voltage	5.002
5.4.3	Third OBE	
5.4.3.1	Recorder Trace - Ch. 1 Deflection	2mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.4.3.2	Trip Voltage	5.002
5.4.4	Fourth OBE	
5.4.4.1	Recorder Trace - Ch. 1 Deflection	2mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.4.4.2	Trip Voltage	5.001
5.4.5	Fifth OBE	
5.4.5.1	Recorder Trace - Ch. 1 Deflection	2mV
	- Ch. 2/Ch. 3 Waveform	No Change
5.4.5.2	Trip Voltage	5.001
5.4.6	SSE	

Item	Observation/Measurement	Pass (Or Reading)	Fail
5.4.6.1	Recorder Trace - Ch. 1 Deflection	2mV	
	- Ch. 2/Ch. 3 Waveform	No Change	
5.4.6.2	Trip Voltage	5.001	

5.4.7 Record any remarks for visual exam. NONE

Item	Observation/Measurement	Pass (Or Reading)	Fail
6.6.1	Lamp Status	✓	
6.7	Lamp Status	✓	
	Pretrip Voltage	4.506	
6.8	Lamp Status	✓	
	Trip Voltage	5.003	
6.9	Lamp Status	✓	
	Untrip Voltage	4.897	
6.10	Lamp Status	✓	
	Unpretrip Voltage	4.413	
6.11	Lamp Status	✓	

 cont. on P 11

ELECTRO-MECHANICS, INC.

New Britain, Connecticut

REJECTION OR REMARKS SHEET

Description Bistable/Aux trip Units
Part No. 34860 / 34880
Tested Per TP 6575-7

Job No. 6575
WO ~~or PDR No.~~ 12443/12444
Serial No. E36893/ E36929

Ref. TR Sht.	REJECTIONS OR REMARKS	Entered By/Date	Retest Acc	Retest Rej	Retest By/Date
1-9	Steps 5.1 thru 5.4 were done in reverse order	RGP 1-19-82			
6	Step 5.3.5.3 setpoint was checked and found to be 5.009	RGP 1-19-82			
	Previous to Step 5.2 Setpoint readjusted to 5.000	RGP 1-19-82			
	The above comments are remarks and described/analyzed in detail in TS6575-2 Seismic Test Report. S. Bransfield 10-22-82				

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TR 6575-7 Sht. 11 Cont. on F

APPENDIX III

to

TS 6575-2

Bistable/Auxiliary Trip Units
Seismic Qualification Report

AMERICAN ENVIRONMENTS COMPANY INC., 166D CABOT STREET, WEST BABYLON, N.Y. 11704 (516) 752-0989

SEISMIC QUALIFICATION TEST PLAN

FOR

BISTABLE-AUXILIARY TRIP UNITS

FOR

ELECTRO-MECHANICS INCORPORATED

NEW BRITAIN, CONNECTICUT

NUMBER	BY	DATE
STP-145380-1	AMERICAN ENVIRONMENTS COMPANY	09/22/80
REVISION A		03/17/81
REVISION B	PAGES 1, 3, 5, 7, 8, 9 & 12	12/10/81

PREPARED BY: [signature]

QUALITY ASSURANCE BY: [signature]

APPROVAL CERTIFICATION BY: [signature]

CUSTOMER REVIEW BY: [signature] 12-21-81

CUSTOMER APPROVAL BY: [signature] 12-21-81

DATE: 22 September 1980

PURPOSE OF TEST: To determine the effects of Seismic Qualification Testing on the physical and operational characteristics of the submitted test specimen.

MANUFACTURER: Electro-Mechanics Inc.
150 John Downey Drive
New Britain, Conn. 06051

MANUFACTURER TYPE AND SERIAL NUMBER: Bistable Trip Unit Assembly No. 34860.
Auxiliary Trip Unit Assembly No. 34880.

DRAWINGS SPECIFICATIONS OR EXHIBITS: A) Electro-Mechanics Test Procudure No. TP 6575-7.
B) IEEE-STD-344 1975.

QUANTITY OF ITEMS TO BE TESTED: One (1) assembly.

DISPOSITION OF TEST SPECIMEN: To be returned to client.

TEST COMPLETED ON: Record Test Date Here.

ARCHITECT / ENGINEER: N/A

NUCLEAR UNIT(S): N/A

TEST CONDUCTED BY: AMERICAN ENVIRONMENTS COMPANY, INC.
Division of: East-West Technology
119 Cabot Street
West Babylon, N.Y. 11704

ABSTRACT: It is the function of American Environments Company, Inc., as an impartial testing agency in performing this test, to subject the test specimen to seismic vibrations of magnitude and direction as specified in the RRS Curves, page 11 and orientation as shown on page 12.

1.0 DESCRIPTION OF TEST APPARATUS

1.1 Function Generator, Model No. 202A Serial No. 11638, manufactured by Hewlett-Packard.

1.2 DC Servo Controller, Model No. 82B300, Serial No. 193, manufactured by Moog, Inc. Calibration not required.

1.3 Actuator, Model No. DN-65, Serial No. 70552, manufactured by Miller Fluid Power Company. Calibration not required.

1.4 Servo Valve, Model No. 72-103, Serial No. 68 manufactured by Moog, Inc. Calibration not required.

1.5 Hydraulic Power Pack, Model No. 180/3000-5606, Serial No. 1, manufactured by East-West Technology Corp. Calibration not required.

1.6 Linear Displacement Potentiometer, Model No. RP-04-01-01-1, Serial No. 2662, manufactured by Pacific Scientific Company. Calibrate immediately prior to test.

1.7 Signal Amplifiers (3), Model No. 607-RMG-3A, Serial Nos. 135, 137 and 155, manufactured by Unholtz-Dicke.

1.8 Accelerometers (7), Model No. 330, Serial Nos. 279, 283, 297, 371, 359, 371 and 409, manufactured by Columbia Research Laboratories.

1.9 Storage oscilloscope, Model No. 564, Serial No. 000971, manufactured by Tektronix.

1.10 X-Y Recorder, Model No. 136A, Serial No. 1877, manufactured by F. L. Moesely Company.

1.11 FM Tape Recorder, Model No. 5600, manufactured by The Honeywell Corporation.

1.12 Spectrum Analyzer, Model No. N 982-30, Serial No. 28219, manufactured by M-Rad Corporation.

1.0 DESCRIPTION OF TEST APPARATUS (CON'T):

1.13 Spectrum Synthesizer, Model No. N 284, Serial No. 197-22, manufactured by M-Rad Corporation.

1.14 Noise Generator, Model No. 108, Serial No. 1081, manufactured by M-Rad Corporation. Calibration not required.

Note: The above equipment is to be used in the performance of this Seismic Qualification Test. Equipment calibration takes place on a continuous basis and would be current for equipment used at the time of test performance. In-house quality control and calibration procedures conform to the intent of 10 CFR 50 Appendix B, Mil-C- 45662 and are traceable to the NBS.

2.0 DESCRIPTION OF TEST SPECIMEN

Bistable Trip Unit, Assembly No. 34680, Serial No. (Record at time of Test).
Auxiliary Trip Unit, Assembly No. 34880, Serial No. (Record at time of Test).

3.0 METHOD OF TEST

The following test procedure shall be employed during the progress of the Qualification Test program.

3.1 TEST SEQUENCE

The test sequence, as stated below, shall be followed during the execution of the qualification program:

3.1.1 Pre-test Inspection and Electrical Tests.
3.1.2 Resonant Frequency Search Test (Phase I).
3.1.3 Seismic Random Test (Phase II).
3.1.4 Post Seismic Inspection and Electrical Tests.

3.2 TEST SET-UP

The test specimen shall be secured to a test fixture which is securely mounted to the seismic vibration table. The test fixture shall be rigid when subject to the seismic simulation. The front panel mounting screws will be provided by Electro-Mechanics. (Four (4) flatheat screws, 1/4"-20 x 1/2" long, number 8FX). The test cable connections to the unit, shall be typical of in-service connections and shall be supported for a span of approximately one (1) foot.

3.3 ELECTRICAL INSPECTION AND OPERATIONAL TESTS

Prior to and following the Seismic Qualification test the specimen shall be subjected to visual and electrical tests in order to determine it's ability to operate in a normal manner.

The specific operational test method shall be in accordance with Electro-Mechanics procedures as follows:

3.3.1 Pre-test Inspection

The pre-test inspection shall consist of visually examining the specimen for evidence of physical or other damage that may have been caused by shipment to the test site or in mounting the specimen. Points of particular interest shall be:

- Overall appearance and condition of metal surfaces
- Circuit boards and components
- Cables
- Connectors

3.3.2 Electrical Tests - Seismic

All Electrical tests shall be performed by Electro-Mechanics personnel, in accordance with the requirements of Test Procedure No. TP 6575-7 prior to, during, and at the conclusion of the Seismic Test Program. All test data shall be retained by Electro-Mechanics personnel.

3.3.3 Post-test Inspection

The post-test inspection shall consist of visually examining the specimen for evidence of physical or other damage that may have been caused by the stresses of the seismic qualification test. Points of particular interest shall be:

- Structural areas that may have experienced high stress
- Circuit boards and components
- Cables
- Connectors

3.4 SEISMIC QUALIFICATION TESTS

3.4.1 PHASE I - RESONANT FREQUENCY SEARCH

A resonant frequency search shall be performed in the frequency range of 1.0 to 35 Hz at an input excitation level of approximately 0.2 g peak. The input acceleration shall be controlled at all times by means of a piezoelectric accelerometer and displacement potentiometer. Six (6) response accelerometers shall be used to monitor specimen response and to determine specimen resonant frequencies, if any. Accelerometers shall be located on the front panels of the BTU and ATU assemblies and near the mounting screws of the BIN Assembly. Additionally, two (2) strain gages shall be secured to the test specimen. The strain gage locations will be selected at the time of test and the location noted in the test results portion of the test report.

The frequency range from 1.0 to 35 Hz shall be searched by sweeping the input frequency at a rate of approximately one half octave per minute and remaining at each discrete frequency for a period of approximately fifteen (15) seconds in order to record specimen response data.

Phase I testing shall be performed in each of three (3) mutually perpendicular axes. The resonant frequency survey shall be performed in all four (4) test directions.

The specimen shall be energized for all resonant search testing. Performance shall not be monitored.

3.4.2 PHASE II - SEISMIC RANDOM TEST (MULTI-FREQUENCY)

Upon completion of Phase I testing in the first biaxial pair (minor horizontal and vertical axes), the test specimen shall be subjected to seismic (random) event tests. The input motion shall be phase coherent, random multi-frequency in waveform and equalized in 1/3 octave segments from 1.0 to 200 Hz. The input acceleration response levels shall be sufficient to envelope the Required Response Spectrum shown in Figure 1 of Appendix A, contained herein.

3.4.2 SEISMIC QUALIFICATION TESTS CONTINUED

Analysis shall be performed in 1/6 octave segments, in the frequency range of 1.0 to 200 Hz, utilizing 1% of critical damping for the OBE and SSE Seismic loadings. The input accelerations shall be applied simultaneously, in-phase and at an angle of 45 degrees from the horizontal axis. Each seismic event shall be repeated with the inputs simultaneous but 180 degrees out-of-phase (ie., specimen and fixture shall be rotated 180 degrees about the vertical axis on the vibration table). The duration of each seismic event shall be a minimum of thirty (30) seconds, uninterrupted. The ZPA shall be monitored and recorded during each seismic event. There shall be a total of six (6) seismic events for each of the in-phase and out-of-phase conditions (ie., twelve (12) events for each biaxial pair) as follows:

FIVE TIMES IN-PHASE & FIVE TIMES OUT-OF-PHASE.

Operating Basis Earthquake (OBE) - Equipment energized.

ONE TIME IN-PHASE AND ONE TIME OUT-OF-PHASE

Safe Shutdown Earthquake (SSE) - Equipment energized.

At the conclusion of testing for the first biaxial pair the specimen shall be rotated 90 degrees on the seismic table, about the vertical, resulting in the second mutually perpendicular horizontal axis. Phase I testing shall be then repeated, in it's entirety, for the second horizontal (major) and vertical axes combination. Phase II testing shall be then repeated (in it's entirety) for the second biaxial pair (major horizontal and vertical axes). There shall be a total of six (6) seismic events for each of the in-phase and out-of-phase conditions (ie., twelve (12) events for each biaxial pair) as follows:

FIVE TIMES IN-PHASE & FIVE TIMES OUT-OF-PHASE

Operating Basis Earthquake (OBE) - Equipment energized.

ONE TIME IN-PHASE AND ONE TIME OUT-OF-PHASE

Safe Shutdown Earthquake (SSE) - Equipment energized.

Functional testing shall be performed during each Seismic Event by Electro-Mechanics personnel and all data retained by them.

4.0 TEST RESULTS

The observed test results and test data shall be included in a final detailed test report.

5.0 TEST REPORT

The final test report shall be submitted to Electro-Mechanics Inc. and shall include all transmissibility plots for each survey, typical test response spectra for the major test axes (ie., vertical and horizontal), all SSE plots and the last OBE plot per test orientation (with a statement of consistency for other OBE runs), for each direction of input motion and for each accelerometer location, stress calculations, from strain gauge data, photographs, a list of equipment used and calibration data, and all observations made.

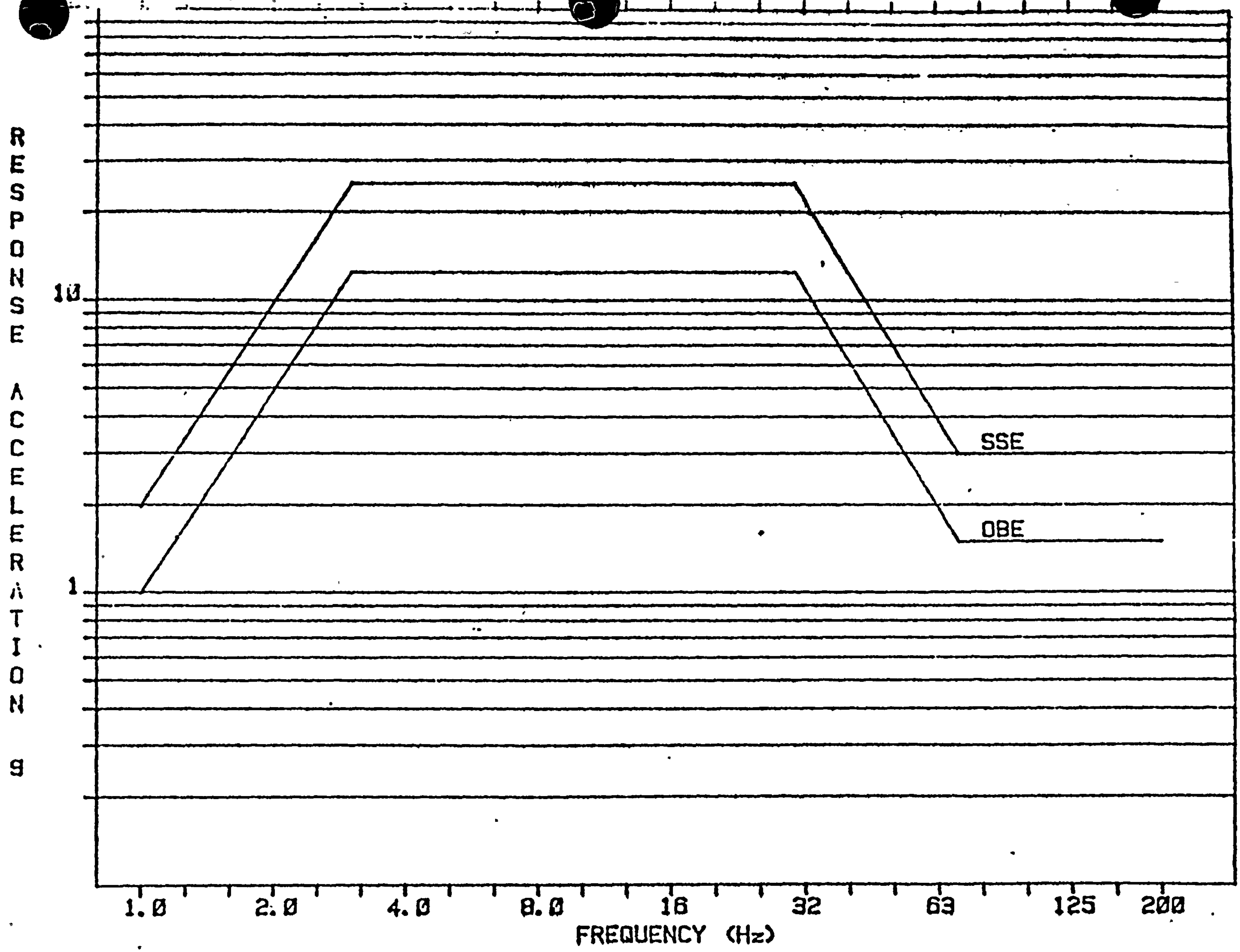
APPENDIX A

FIGURES

FOR

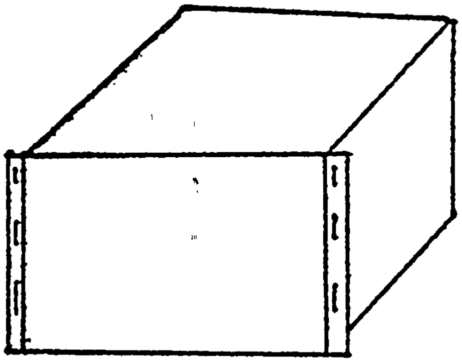
ELECTRO-MECHANICS INC.

BISTABLE-AUXILIARY TRIP UNITS



HORIZONTAL & VERTICAL REQUIRED RESPONSE SPECTRA
1.0 % OF CRITICAL DAMPING

BIAXIAL PAIR ONE



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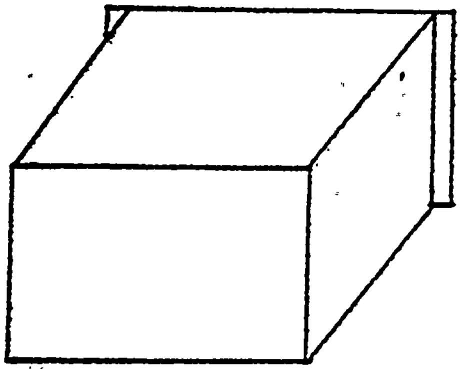
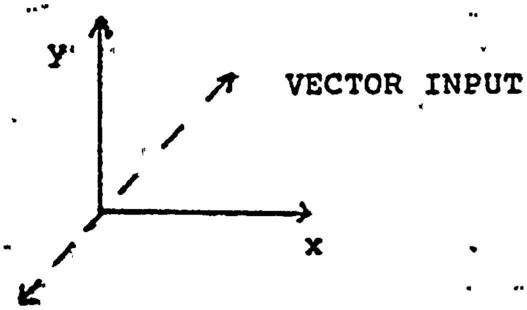
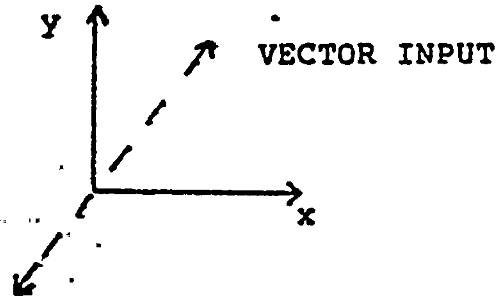
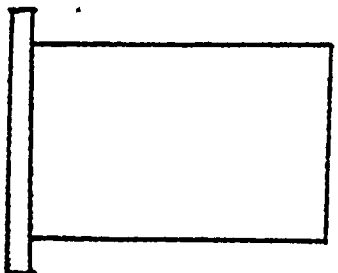


OUT-OF-PHASE

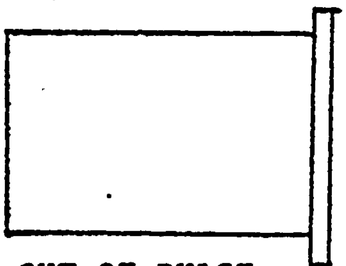




BIAXIAL PAIR TWO



IN-PHASE



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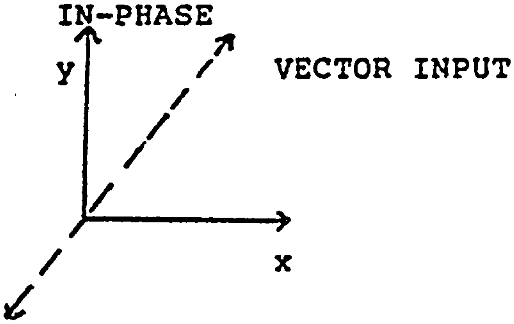
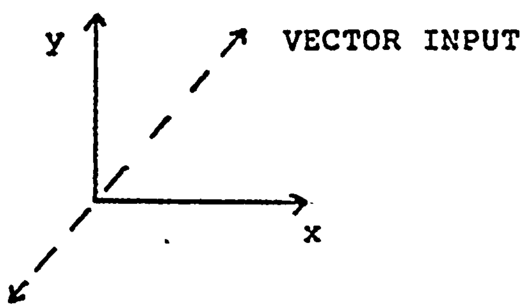




APPENDIX IV

to

TS 6575-2

Bistable/Auxiliary Trip Units Seismic Qualification Report

AMERICAN ENVIRONMENTS COMPANY INC., 166D CABOT STREET, WEST BABYLON, N.Y. 11704 (516) 752-0989

SEISMIC QUALIFICATION TEST REPORT

ON

BISTABLE-AUXILIARY TRIP UNITS

FOR

ELECTRO-MECHANICS INCORPORATED

NEW BRITAIN, CONNECTICUT

NUMBER	BY	DATE
STR-145380-1	AMERICAN ENVIRONMENTS COMPANY	01/29/82
REVISION "A"	AMERICAN ENVIRONMENTS COMPANY	09/08/82

PREPARED BY: Paul Bauer

QUALITY ASSURANCE BY: [signature]

APPROVAL CERTIFICATION BY: [signature]

CUSTOMER REVIEW BY:

CUSTOMER APPROVAL BY:

REVISION RECORD

DATE	REVISION NUMBER	PAGE NUMBER	PARAGRAPH NUMBER	CHANGES OR ADDITIONS	APPROVED BY
01/29/82	N/C	-	-	-	[signature]
09/08/82	A	3	-	Added Serial Numbers Added Rev. B to E-M Test Procedure No. TP6757-7 Clarified Quantity of items tested as One (1) of each Assembly	[signature]
09/08/82	A	5	2.0	Added clarification of test specimen as one (1) of each assembly.	[signature]
09/08/82	A	6	3.2	Added clarification of test set up. Added statement concerning additional brackets & padding	[signature]
09/08/82	A	7	3.4.1	Changed for clarification	[signature]
09/08/82	A	18	-	Changed Location to "E-M test fixture"	[signature]
09/08/82	A	23	-	Corrected typo from mico to micro-inches/inch"	[signature]

REVISION RECORD

DATE	REVISION NUMBER	PAGE NUMBER	PARAGRAPH NUMBER	CHANGES OR ADDITIONS	APPROVED BY
09/08/82	A	25	-	Changed location for clarification	[illegible]
09/08/82	A	28	-	Corrected Typo on equation Added Notation justifying use of 33 Hz in lieu of resonant frequency not available Changed definition of "g" from cabinet to test specimen	[illegible]
09/08/82	A	30	-	Changed location for clarification	[illegible]
09/08/82	A	31 - 45	-	Identification of plots	[illegible]
09/08/82	A	50	-	Added notation to justify one data point below the RRS Curve	[illegible]

TABLE OF CONTENTS

PARAGRAPH	PAGE

DATE: 29 January 1982

PURPOSE OF TEST:	To determine the effects of Seismic Qualification Testing on the physical and operational characteristics of the submitted test specimen.
MANUFACTURER:	Electro-Mechanics Inc. 150 John Downey Drive New Britain, Conn. 06051
MANUFACTURER TYPE AND SERIAL NUMBER:	Bistable Trip Unit Assembly No. 34860, S/N E36893. Auxiliary Trip Unit Assembly No. 34880, S/N E36929.
DRAWINGS SPECIFICATIONS OR EXHIBITS:	A) Electro-Mechanics Test Procedure No. TP/TR-6575-7, Rev. B. B) IEEE-STD-344 1975. C) American Environments Test Plan No. STP-145380-1, Rev.B.
QUANTITY OF ITEMS TESTED:	One (1) of each assembly.
DISPOSITION OF TEST SPECIMEN:	Returned to client.
TEST COMPLETED ON:	19 January 1982
ARCHITECT / ENGINEER:	N/A
NUCLEAR UNIT(S):	N/A
TEST CONDUCTED BY:	AMERICAN ENVIRONMENTS COMPANY, INC. Division of: East-West Technology 119 Cabot Street West Babylon, N.Y. 11704
ABSTRACT:	It is the function of American Environments Company, Inc., as an impartial testing agency in performing this test, to subject the test specimen to seismic vibrations of magnitude and direction as specified in the RRS Curves, Figure 1 and orientations as shown in Figure 2, herein.

1.0 DESCRIPTION OF TEST APPARATUS

1.1 Function Generator, Model No. 202A, Serial No. 11638, manufactured by Hewlett Packard. Calibration Due: 10 May 1982.

1.2 DC Servo Controller, Model No. 82B300, Serial No. 193, manufactured by Moog, Inc. Calibration not required.

1.3 Actuator, Model No. DN-65, Serial No. 70552, manufactured by Miller Fluid Power Company. Calibration not required.

1.4 Servo Valve, Model No. 72-103, Serial No. 68, manufactured by Moog, Inc. Calibration not required.

1.5 Hydraulic Power Pack, Model No. 240/3000-5606, Serial No. 03, manufactured by East West Technology Corp. Calibration not required.

1.6 Displacement Tranducer, Model No. 7312-V4-A0, Serial No. 036, manufactured by Pickering and Company. Calibrated immediately prior to test.

1.7 Signal Amplifier (1), Model No. 914, Serial No. 145, manufactured by Technology for Energy Corporation. Calibration Due: 16 February 1982.

1.8 Signal Charge Amplifiers (8), Model No. 500LF, Serial Nos. 01167 through 01174, manufactured by Technology for Energy Corporation. Calibration Due: 16 February 1982.

1.9 DC Servo Controller, Model No. 710, Serial No. 001, manufactured by CGS System, Inc. Calibration not required.

1.10 Accelerometers (8), Model No. 320, Serial Nos. 675 through 678 and 680 through 683, manufactured by Columbia Research Laboratories. Calibration Due: 16 February 1982.

1.0 DESCRIPTION OF TEST APPARATUS CONTINUED

1.11 Oscilloscope, Model No. 453, Serial No. 028412, manufactured by Tektronix. Calibration Due: 6 April 1982.

1.12 Digital Plotter, Model No. 7225A/17603A, Serial No. 1823A00171, manufactured by Hewlett Packard. Calibrated immediately prior to use.

1.13 X-Y Recorder, Model 7035B, Serial No. 2007818582, manufactured by Hewlett Packard. Calibration Due: 9 April 1982.

1.14 FM Tape Recorder (1), Model No. 5600C, Serial No. 081117, manufactured by The Honeywell Corporation. Calibration Due: 19 November 1982.

1.15 Spectrum Analyzer, Model No. 505N2, Serial No. 505-10, manufactured by M-Rad Corporation. Calibration Due: 15 March 1982.

1.16 Spectrum Synthesizer, Model No. N284, Serial No. 197-22, manufactured by M-Rad Corporation. Calibration Due: 10 June 1982.

1.17 Spectrum Analyzer, Model No. 3582A, Serial No. 1809A03066, manufactured by Hewlett-Packard. Calibration Due: 9 April 1982.

1.18 Strain Gage Conditioners (2), Model No. 3502-08A/08-0049, Serial Nos. 10229 (2010) and 10230 (2011), manufactured by Jay Controls Company. Calibration Due: 16 February 1982.

2.0. DESCRIPTION OF TEST SPECIMEN

The test specimen consisted of one (1) each of the following assemblies:

Bistable Trip Unit, Assembly No. 34860, Serial No. E36893
Auxiliary Trip Unit, Assembly No. 34880, Serial No. E36929

3.0 METHOD OF TEST

The following test procedure was employed during the progress of the Qualification Test program.

3.1 TEST SEQUENCE

The test sequence, as state below, was followed during the execution of the qualification program:

3.1.1 Pre-test Inspection and Electrical Tests.
3.1.2 Resonant Frequency Search Test (Phase I).
3.1.3 Seismic Random Test (Phase II).
3.1.4 Post Seismic Inspection and Electrical Tests.

3.2 TEST SET-UP

The test specimen was installed in the Electro-Mechanics test fixture which was secured to the American Environments test fixture which was securely mounted to the seismic vibration table. The front panel mounting screws for securing the Electro-Mechanics test fixture to the American Environments test fixture were provided by Electro-Mechanics (four (4) flathead screws, 1/4"-20 x 1/2" long, number 8FX). Additionly, the E-M Test fixture was supported in the rear by two (2) "L" brackets (1/16" steel) and below by padding placed between the E-M fixture and the AECO fixture. These fixture modifications were made prior to test to insure a rigid noise free test set up. The test cable connections to the unit were typical of in-service connections and were unsupported for a span of approximately one (1) foot.

3.3 ELECTRICAL INSPECTION AND OPERATIONAL TESTS

Prior to and following the Seismic Qualification test the specimen was subjected to visual and electrical tests in order to determine it's ability to operate in a normal manner.

The specific operational test method was in accordance with Electro-Mechanics procedures as follows:

3.3.1 Pre-test Inspection

The pre-test inspection consisted of visually examining the specimen for evidence of physical or other damage that may have been caused by shipment to the test site or in mounting the specimen. Points of particular interest were:

- Overall appearance and condition of metal surfaces
- Circuit boards and components
- Cables
- Connectors

3.3 ELECTRICAL INSPECTION AND OPERATIONAL TESTS (CON'T)

3.3.2 Electrical Tests - Seismic

All Electrical tests were performed by Electro-Mechanics personnel, in accordance with the requirements of Test Procedure No. TP 6575-7 prior to, during, and at the conclusion of the Seismic Test Program, All test data was retained by Electro-Mechanics personnel.

3.3.3 Post-test Inspection

The post-test inspection consisted of visually examining the specimen for evidence of physical or other damage that may have been caused by the stresses of the seismic qualification test. Points of particular interest were:

- Structural areas that may have experienced high stress
- Circuit boards and components
- Cables
- Connectors

3.4 SEISMIC QUALIFICATION TESTS

3.4.1 Phase I - Resonant Frequency Search

A resonant frequency search was performed in the frequency range of 1.0 to 35 Hz at an input excitation level of approximately 0.2 g peak. The input acceleration was controlled at all times by means of a piezoelectric accelerometer and displacement potentiometer. Six (6) response accelerometers were used to monitor the specimen and Electro-Mechanics test fixture responses and to determine the specimen resonant frequencies, if any. Accelerometers were located on the front panels of the BTU and ATU assemblies and near the mounting screws of the Electro-Mechanics test fixture. Additionally, two (2) strain gages were secured to the Electro-Mechanics test fixture. The accelerometer and strain gage locations are noted in the test results portion of the test report.

The frequency range from 1.0 to 35 Hz was searched by sweeping the input frequency at a rate of approximately one half octave per minute and remaining at each discrete frequency for a period of approximately fifteen (15) seconds in order to record specimen response data.

3.4 SEISMIC QUALIFICATION TESTS (CON'T)

3.4.1 Phase I - Resonant Frequency Search (Con't)

Phase I testing was performed in each of three (3) mutually perpendicular axes. The resonant frequency survey was performed in all four (4) test directions.

The specimen was energized for all resonant search testing. Performance was not monitored.

3.4.2 Phase II - Seismic Random Test (Multi-Frequency)

Upon completion of Phase I testing in the first biaxial pair (minor horizontal and vertical axes), the test specimen was subjected to seismic (random) event tests. The input motion was phase coherent, random multi-frequency in waveform and equalized in 1/3 octave segments from 1.0 to 100 Hz. The input acceleration response levels were sufficient to envelope the Required Response Spectrum shown in Figure 1 of Appendix A, contained herein.

Analysis was performed in 1/6 octave segments, in the frequency range of 1.0 to 200 Hz, utilizing 1% of critical damping for the OBE and SSE Seismic loadings. The input accelerations were applied simultaneously, in-phase and at an angle of 45 degrees from the horizontal axis. Each seismic event was repeated with the inputs simultaneous but 180 degrees out-of-phase (ie., specimen and fixture were rotated 180 degrees about the vertical axis on the vibration table). The duration of each seismic event was a minimum of thirty (30) seconds, uninterrupted. The ZPA was monitored and recorded during each seismic event. There were a total of six (6) seismic events for each of the in-phase and out-of-phase conditions (ie., twelve (12) events for each biaxial pair) as follows:

FIVE TIMES IN-PHASE & FIVE TIMES OUT-OF-PHASE

Operating Basis Earthquake (OBE) - Equipment energized.

ONE TIME IN-PHASE AND ONE TIME OUT-OF-PHASE

Safe Shutdown Earthquake (SSE) - Equipment energized.

3.4.2 Phase II - Seismic Random Test (Multi-Frequency) (Con't)

At the conclusion of testing for the first biaxial pair the specimen was rotated 90 degrees on the seismic table, about the vertical, resulting in the second mutually perpendicular horizontal axis. Phase I testing was then repeated, in it's entirety, for the second horizontal (major) and vertical axes combination. Phase II testing was then repeated (in it's entirety) for the second biaxial pair (major horizontal and vertical axes). There were a total of six (6) seismic events for each of the in-phase and out-of-phase conditions (ie., twelve (12) events for each biaxial pair) as follows:

FIVE TIMES IN-PHASE & FIVE TIMES OUT-OF-PHASE

Operating Basis Earthquake (OBE) - Equipment energized.

ONE TIME IN-PHASE AND ONE TIME OUT-OF-PHASE

Safe Shutdown Earthquake (SSE) - Equipment energized.

Functional testing was performed during each Seismic Event by Electro-Mechanics personnel and all data retained by them.

4.0 TEST RESULTS:

The following information was observed and recorded before, during and after exposure to the stresses of the Seismic Qualification Test.

4.1 PRE-TEST INSPECTION

The following information was observed and recorded during the Pre-Test Inspection and Electrical Tests.

Visual Inspection - There was no evidence of physical damage to the test specimen as a result of shipment to the test site or subsequent to it's installation on the test table.

Electrical Test - Electrical performance data was obtained and retained by Electro-Mechanics personnel.

4.2 PHASE I RESONANCE SEARCH TEST

BIAXIAL PAIR NO. 1
IN-PHASE

(See Appendix D for Transmissibility Data Plots)

There were no significant structural resonances observed.

4.3 PHASE I RESONANCE SEARCH TEST

BIAXIAL PAIR NO. 1
OUT-OF-PHASE

(See Appendix D for Transmissibility Data Plots)

There were no significant structural resonances observed.

4.4 PHASE I RESONANCE SEARCH TEST

BIAXIAL PAIR NO. 2
IN-PHASE

(See Appendix D for Transmissibility Data Plots)

There were no significant structural resonances observed.

4.5 PHASE I RESONANCE SEARCH TEST

BIAXIAL PAIR NO. 2
OUT-OF-PHASE

(See Appendix D for Transmissibility Data Plots)

There were no significant structural resonances observed.

4.6 SEISMIC RANDOM EVENT TESTS - PHASE II

BIAXIAL PAIR NO. 2
OUT-OF-PHASE

RUN NO.	EVENT	DURATION
1	OBE	30 SEC.
2	OBE	30 SEC.
3	OBE	30 SEC.
4	OBE	30 SEC.
5	OBE	30 SEC.
*6A	SSE	30 SEC.
6	SSE	30 SEC.

There was no evidence of physical damage observed as a result of the stresses of these events. All electrical performance data was obtained and retained by Electro-Mechanics personnel. See Appendix E for Test Response Spectra and Appendix F for Equipment Response Spectra. Note: Typical OBE response data is presented in these appendices and response data not shown was verified to be consistent with those presented.

* NOTE: The attained levels were not sufficient to satisfy the requirements.

4.7 SEISMIC RANDOM EVENT TESTS - PHASE II

BIAXIAL PAIR NO. 2
IN-PHASE

RUN NO.	EVENT	DURATION
7	OBE	30 SEC.
8	OBE	30 SEC.
9	OBE	30 SEC.
10	OBE	30 SEC.
11	OBE	30 SEC.
12	SSE	30 SEC.

There was no evidence of physical damage observed as a result of the stresses of these events. All electrical performance data was obtained and retained by Electro-Mechanics personnel. See Appendix E for Test Response Spectra and Appendix F for Equipment Response Spectra. Note: Typical OBE response data is presented in these appendices and response data not shown was verified to be consistent with those presented.

4.8 SEISMIC RANDOM EVENT TESTS - PHASE II

BIAXIAL PAIR NO. 1
OUT-OF-PHASE

RUN NO.	EVENT	DURATION
13	OBE	30 SEC.
14	OBE	30 SEC.
15	OBE	30 SEC.
16	OBE	30 SEC.
17	OBE	30 SEC.
18	SSE	30 SEC.

There was no evidence of physical damage observed as a result of the stresses of these events. All electrical performance data was obtained and retained by Electro-Mechanics personnel. See Appendix E for Test Response Spectra and Appendix F for Equipment Response Spectra. Note: Typical OBE response data is presented in these appendices and response data not shown was verified to be consistent with those presented.

4.9 SEISMIC RANDOM EVENT TESTS - PHASE II

BIAXIAL PAIR NO. 2
IN-PHASE

RUN NO.	EVENT	DURATION
19	OBE	30 SEC.
20	OBE	30 SEC.
21	OBE	30 SEC.
22	OBE	30 SEC.
23	OBE	30 SEC.
24	SSE	30 SEC.

There was no evidence of physical damage observed as a result of the stresses of these events. All electrical performance data was obtained and retained by Electro-Mechanics personnel. See Appendix E for Test Response Spectra and Appendix F for Equipment Response Spectra. Note: Typical OBE response data is presented in these appendices and response data not shown was verified to be consistent with those presented.

4.10 POST-TEST INSPECTION

The following information was observed and recorded during the Post-Test Inspection.

Visual Inspection - There was no evidence of physical damage observed as a result of the stresses of this Qualification test program.

Electrical Tests - All electrical performance data was obtained and retained by Electro-Mechanics personnel.

5.0 SUMMARY OF STRUCTURAL CONDITION

There was no evidence of physical damage observed as a result of the stresses of this test program.

6.0 RECOMMENDATIONS

None, data merely submitted.

7.0 CONCLUSIONS

It is the function of AMERICAN ENVIRONMENTS COMPANY, INC., to report the test data as observed. Final evaluation of the test results shall be accomplished by Electro-Mechanics Incorporated.

APPENDIX A

FIGURES

FOR

ELECTRO-MECHANICS INC.

BISTABLE-AUXILIARY TRIP UNITS

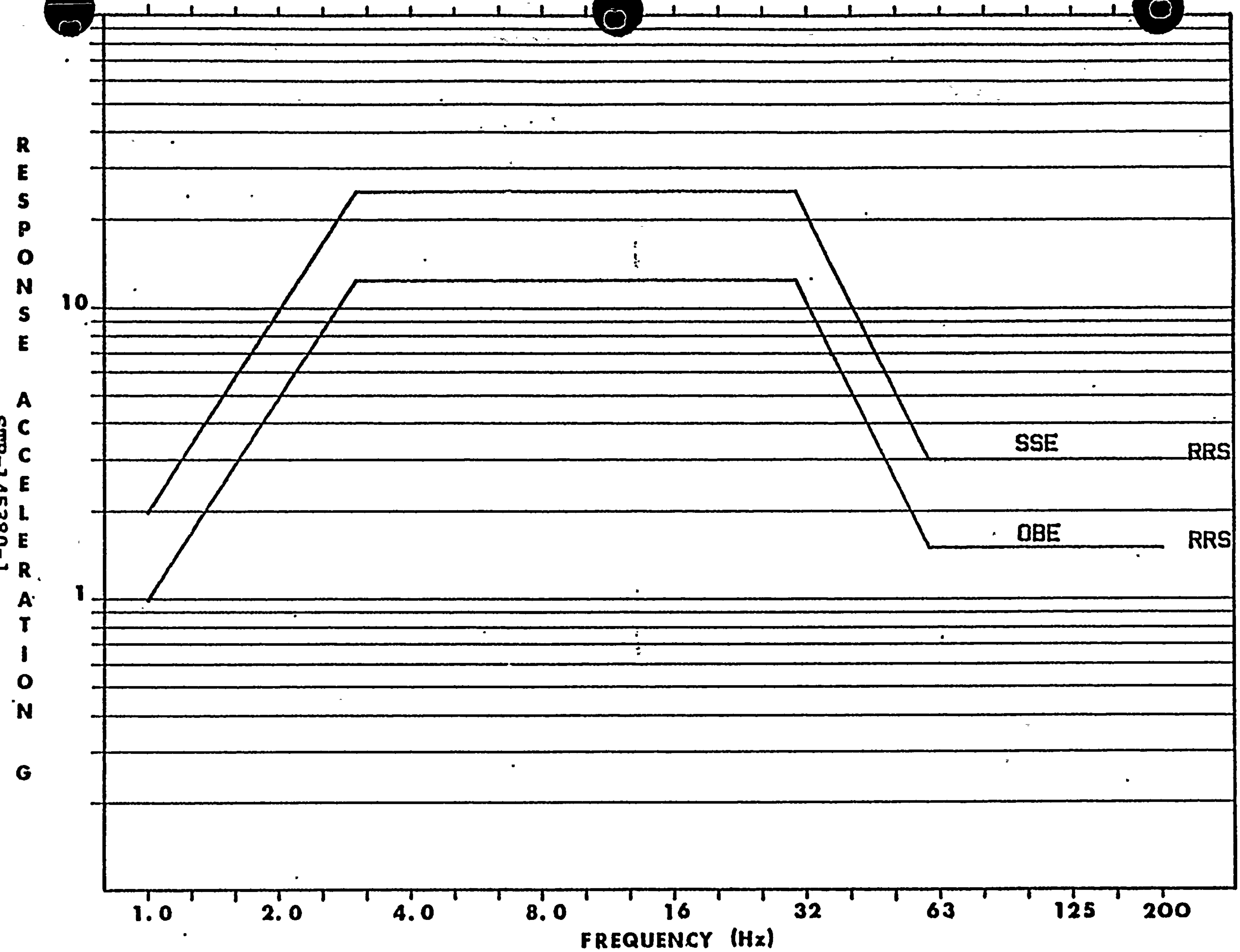
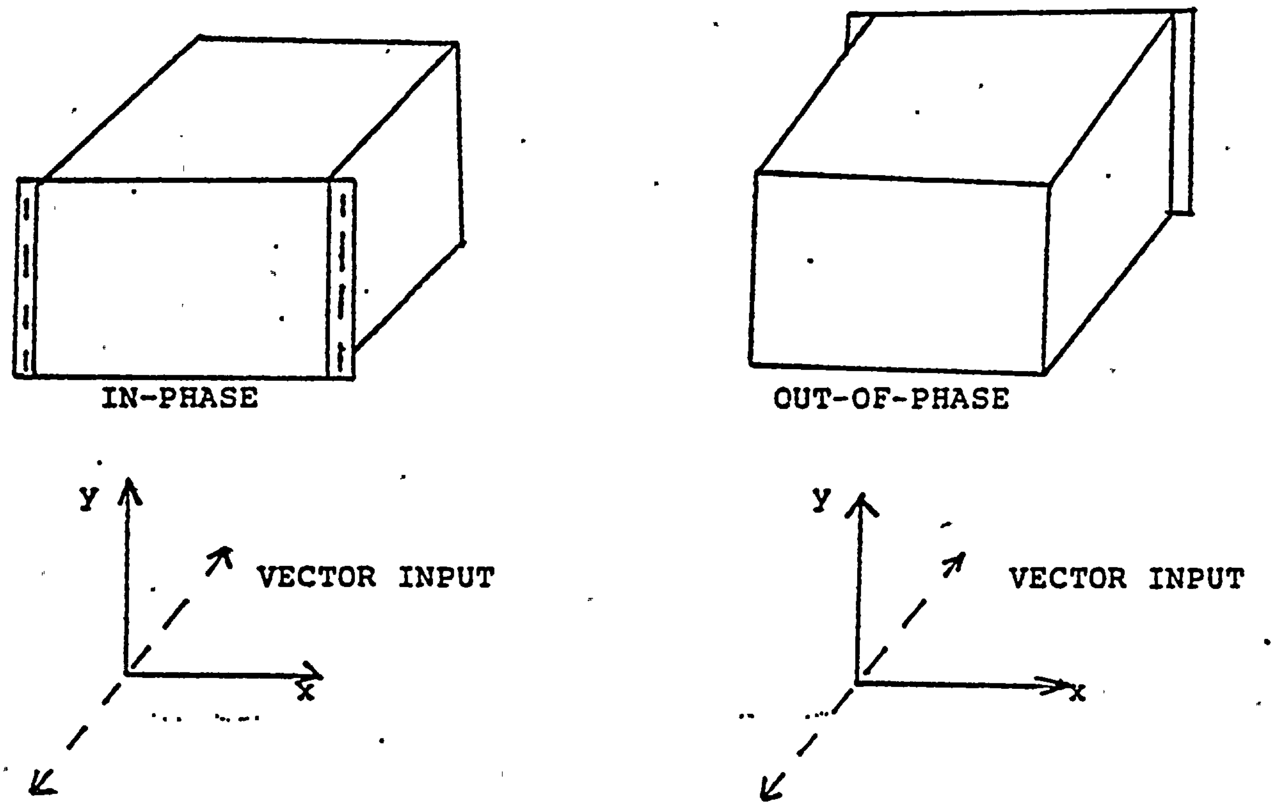


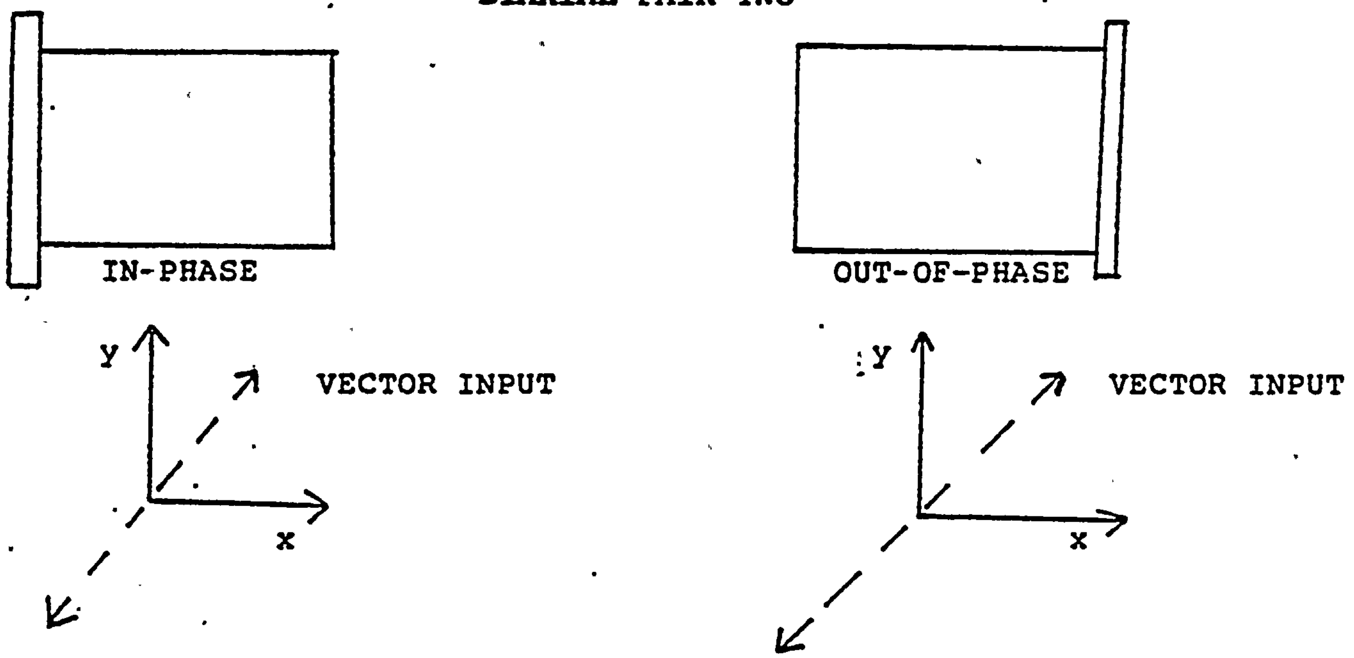
FIGURE 1 - HORIZONTAL & VERTICAL REQUIRED RESPONSE SPECTRA
1.0 % OF CRITICAL DAMPING

FIGURE 2

BIAXIAL PAIR ONE



BIAXIAL PAIR TWO



APPENDIX B

STRAIN GAUGE RECORDINGS & STRESS CALCULATIONS

FOR

ELECTRO-MECHANICS INC.

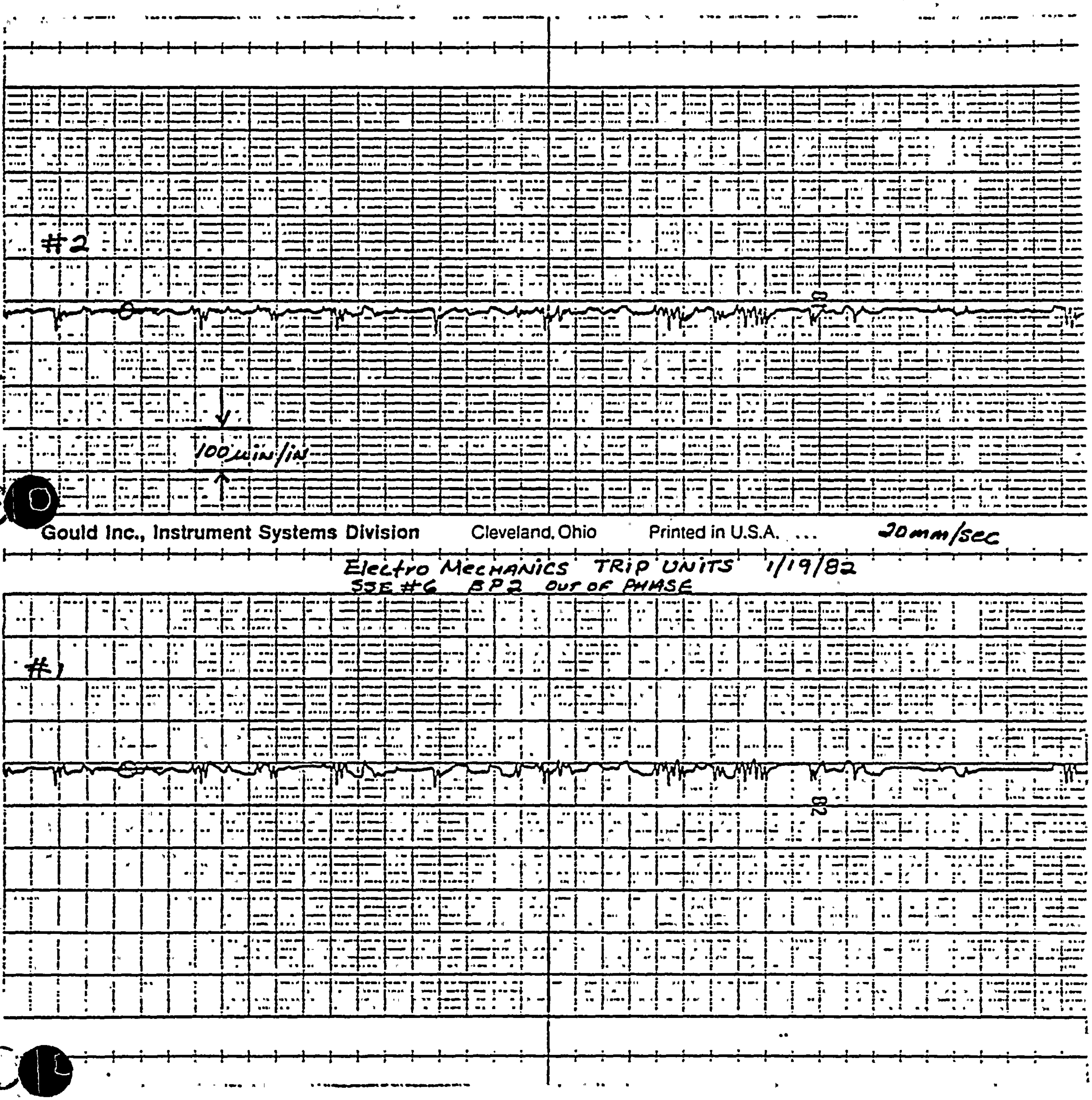
BISTABLE-AUXILIARY TRIP UNITS

STR-145380-1

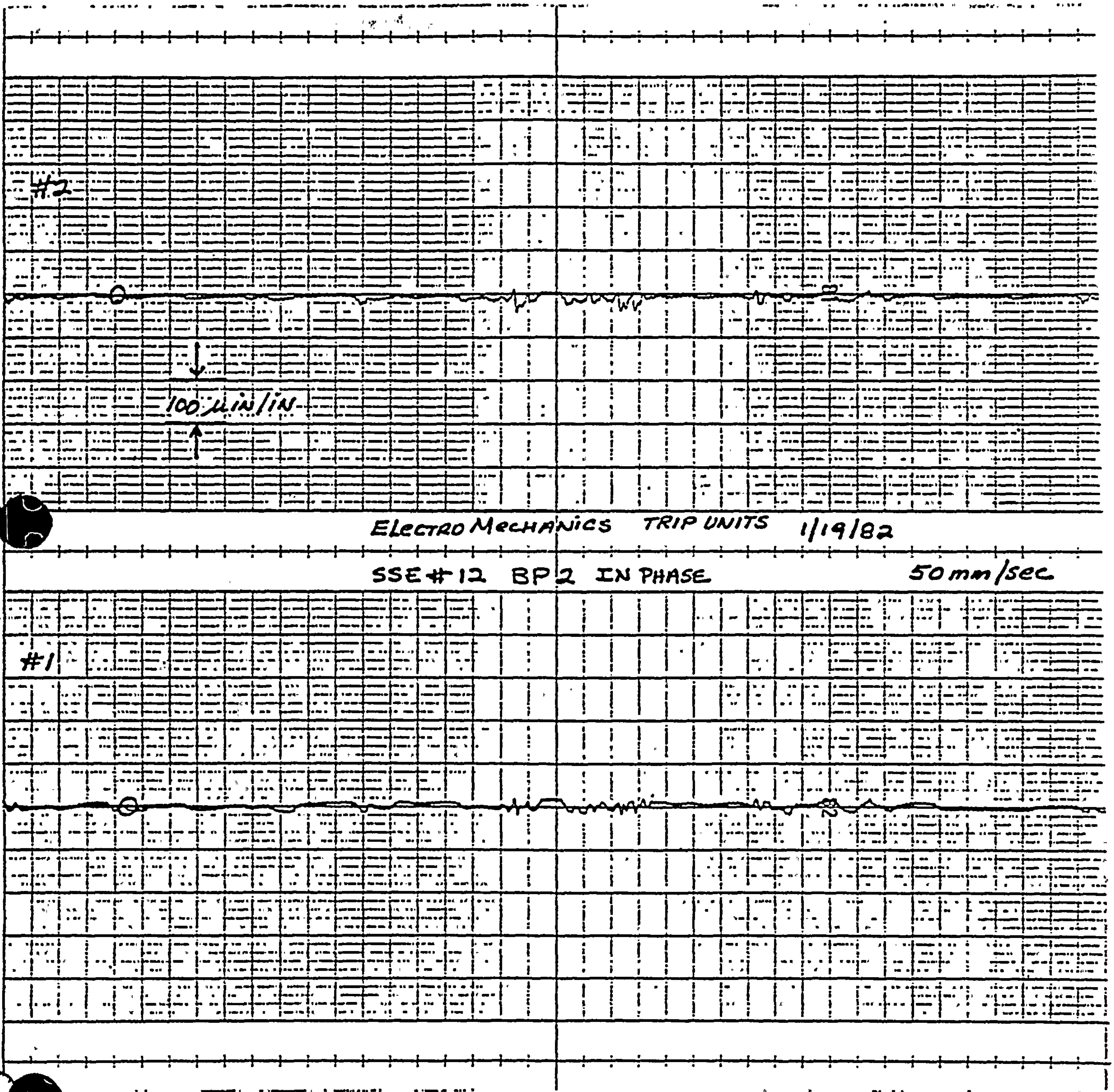
TABLE I

STRAIN GAUGE MOUNTING LOCATIONS

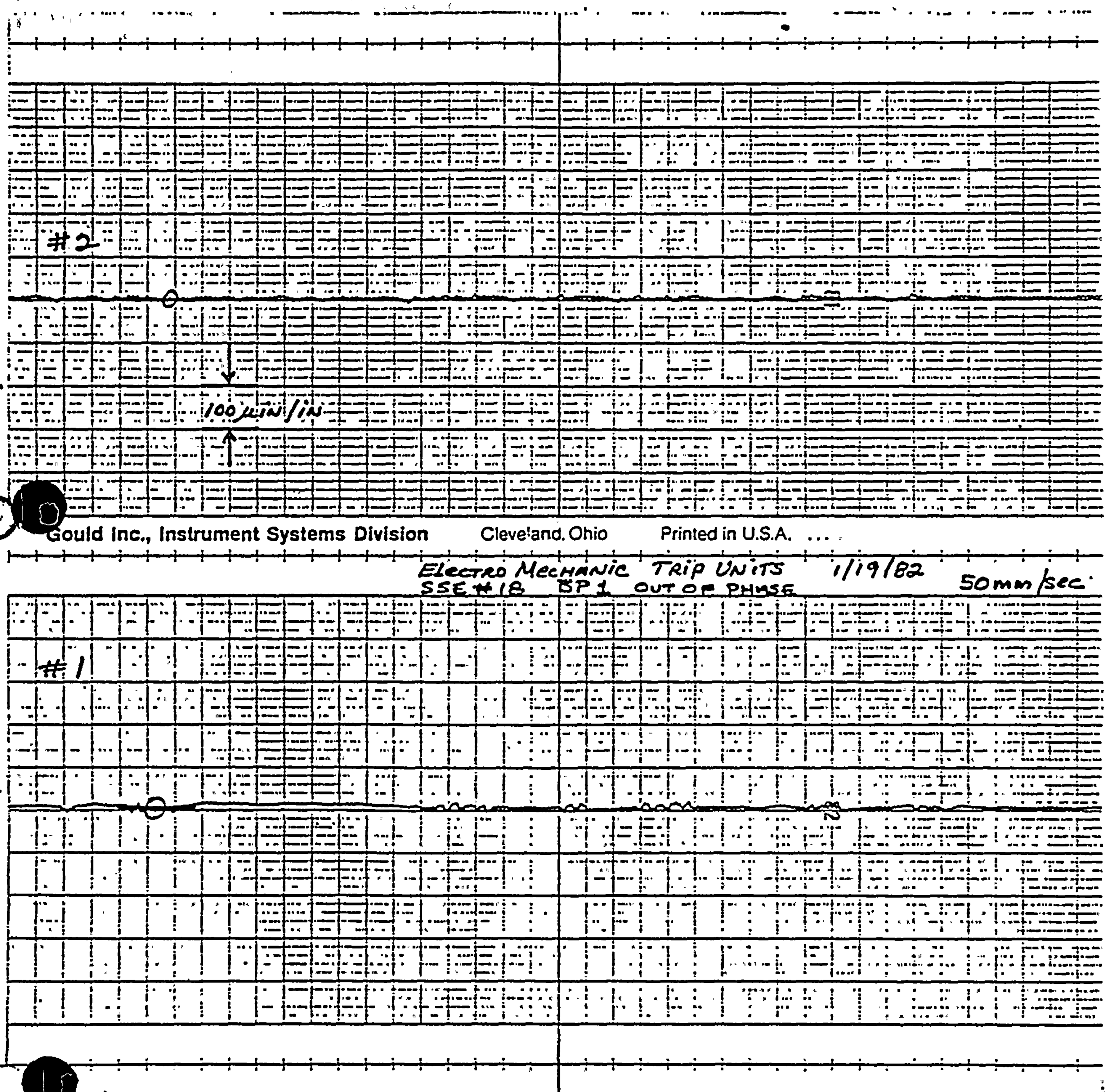
Gauge Number	Motion Axis Monitored	Location
1	Vertical	Right Rear Side of E-M Test Fixture
2	Horizontal (F/B)	



STRAIN GAUGE RECORDINGS
SSE #6
BIAXIAL PAIR NO. 2 OUT-OF-PHASE



STRAIN GAUGE RECORDINGS
SSE #12
BIAXIAL PAIR NO. 2 IN-PHASE



STRAIN GAUGE RECORDINGS
SSE #18
BIAXIAL PAIR NO. 1 OUT-OF-PHASE

CALCULATION I

The maximum observed strain for the Biaxial Pair No. 2 (Out-of-Phase) Test (SSE #6) was 53.8 micro-inches/inch, peak.

The maximum observed strain for the Biaxial Pair No. 2 (In-Phase) test (SSE #12) was 47.5 micro-inches/inch, peak.

delta L/L = e ; S = E*e

Where: delta L = Change in length of gauge

L = Length of gauge

e = Apparent strain

E = Young's modulus (10 x 10^6 aluminum)

S = Apparent stress (psi)

For SSE #6, Biaxial Pair No. 2 - Out-of-Phase:

delta L/L (peak) = 53.8 x 10^-6 inches/inch
S = 10 x 10^6 * 53.8 x 10^-6
S = 538 psi

For SSE #12, Biaxial Pair No. 2 - In-Phase:

delta L/L (peak) = 47.5 x 10^-6 inches/inch
S = 10 x 10^6 * 47.5 x 10^-6
S = 475 psi

For SSE #18, Biaxial Pair No. 1 - Out-of-Phase:

delta L/L (peak) = 10.2 x 10^-6 inches/inch
S = 10 x 10^6 * 10.2 x 10^-6
S = ~~108~~ psi
102

For SSE #24, Biaxial Pair No. 1 - In-Phase:

delta L/L (peak) = 9.7 x 10^-6 inches/inch
S = 10 x 10^6 * 9.7 x 10^-6
S = 97 psi

APPENDIX C

ZPA TEST DATA & DEFLECTION CALCULATIONS

FOR

ELECTRO-MECHANICS INC.

BISTABLE-AUXILIARY TRIP UNITS

STR-145380-1

TABLE I

ACCELEROMETER MOUNTING LOCATIONS

Accelerometer Number	Motion Axis Monitored	Location
1	Horizontal	Control - on Seismic Table
2	Vertical	Control - on Seismic Table
3	Horizontal	Top of the BTU Assembly
4	Vertical	
5	Horizontal	Top of the ATU Assembly
6	Vertical	
7	Horizontal	Top Left Corner of E-M Test fixture near mounting screw
8	Vertical	

RECORDED ZPA VALUES
BIAXIAL PAIR NO. 2 OUT-OF-PHASE
RUN - SSE NUMBER 6

Accelerometer Number	Value (g)
1	7.59 - Horizontal Control
2	7.68 - Vertical Control
3	7.34
4	7.57
5	7.44
6	7.42
7	7.57
8	7.39

RECORDED ZPA VALUES
BIAXIAL PAIR NO. 2 IN-PHASE
RUN - SSE NUMBER 12

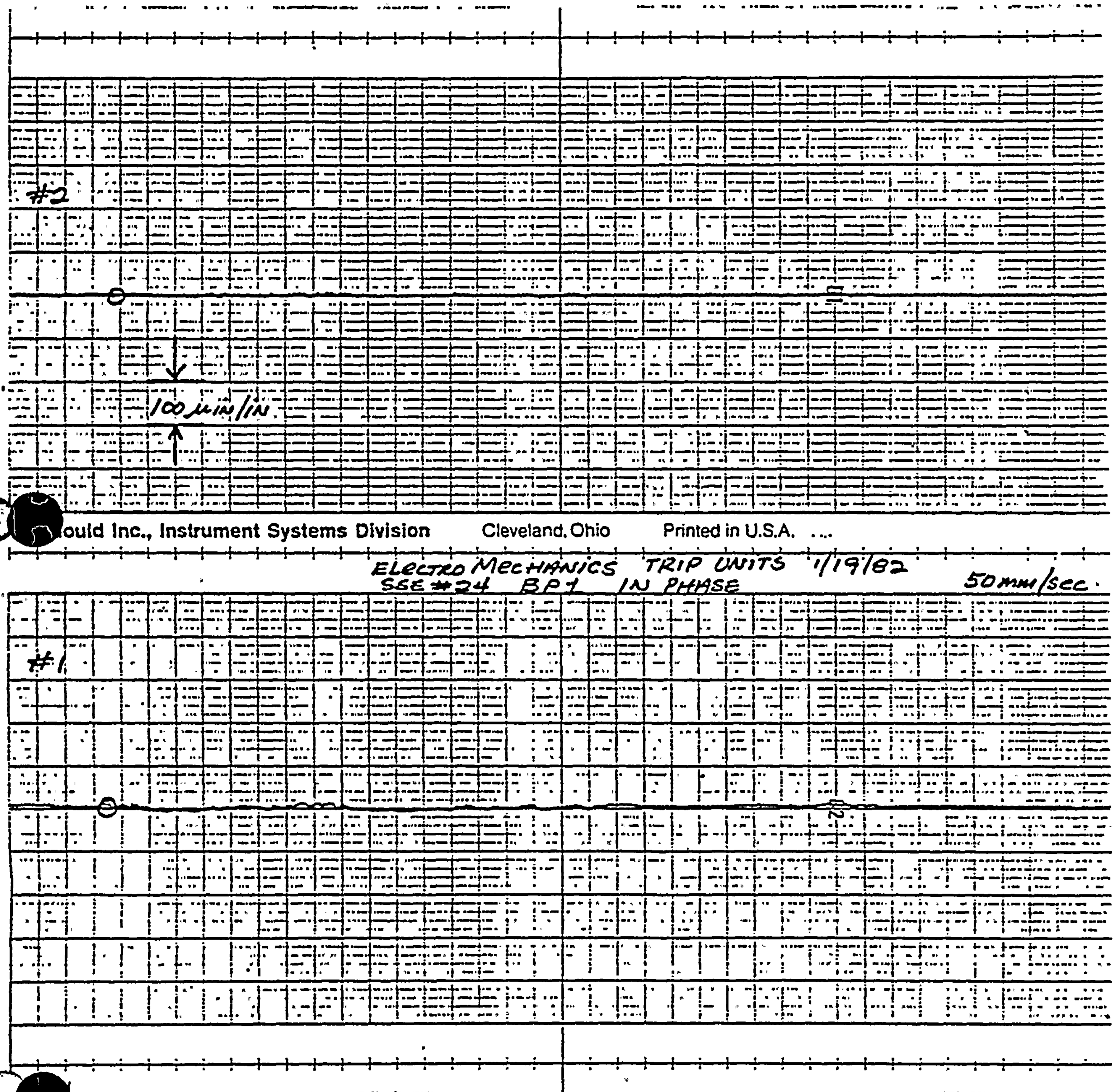
Accelerometer Number	Value (g)
1	7.54 - Horizontal Control
2	7.50 - Vertical Control
3	7.47
4	7.60
5	7.59
6	7.44
7	7.47
8	7.61

RECORDED ZPA VALUES
BIAXIAL PAIR NO. 1 OUT-OF-PHASE
RUN - SSE NUMBER 18

Accelerometer Number	Value (g)
1	7.38 - Horizontal Control
2	7.41 - Vertical Control
3	7.54
4	7.53
5	7.47
6	7.61
7	7.34
8	7.52

RECORDED ZPA VALUES
BIAXIAL PAIR NO. 1 IN-PHASE
RUN - SSE NUMBER 24

Accelerometer Number	Value (g)
1	7.42 - Horizontal Control
2	7.42 - Vertical Control
3	7.37
4	7.39
5	7.41
6	7.38
7	7.44
8	7.53



STRAIN GAUGE RECORDINGS
SSE #24
BIAXIAL PAIR NO. 1 IN-PHASE

CALCULATION II

The maximum deflection of the specimen exterior relative to the mounting base was calculated as follows:

d = g/0.1022 * f^2

Where:

- d = Single amplitude deflection
- f = lowest resonance frequency of specimen structure
- g = highest measured acceleration (ZPA value of response spectra) from accelerometers selected to represent maximum deflection of test specimen.

For SSE Number 6:

Biaxial Pair No. 2 Out-Of-Phase

No resonances observed Use f = 33 Hz
d = 7.57/0.1022 * (33)^2 = 0.068 inches

For SSE Number 12:

Biaxial Pair No. 2 In-Phase

No resonances observed Use f = 33 Hz
d = 7.60/0.1022 * (33)^2 = 0.0684 inches

For SSE Number 18:

Biaxial Pair No. 1 Out-Of-Phase

No resonances observed Use f = 33 Hz
d = 7.61/0.1022 * (33)^2 = 0.0684 inches

For SSE Number 24:

Biaxial Pair No. 1 In-Phase

No resonances observed Use f = 33 Hz
d = 7.53/0.1022 * (33)^2 = 0.0677 inches

Note: As no resonances were observed, 33 Hz, the maximum required frequency for the resonance search, was used in order to yield the greatest (most conservative) deflection possible for the test specimen within an earthquake frequency domain.

APPENDIX D

TRANSMISSIBILITY DATA PLOTS

FOR

ELECTRO-MECHANICS INC.

BISTABLE-AUXILIARY TRIP UNITS

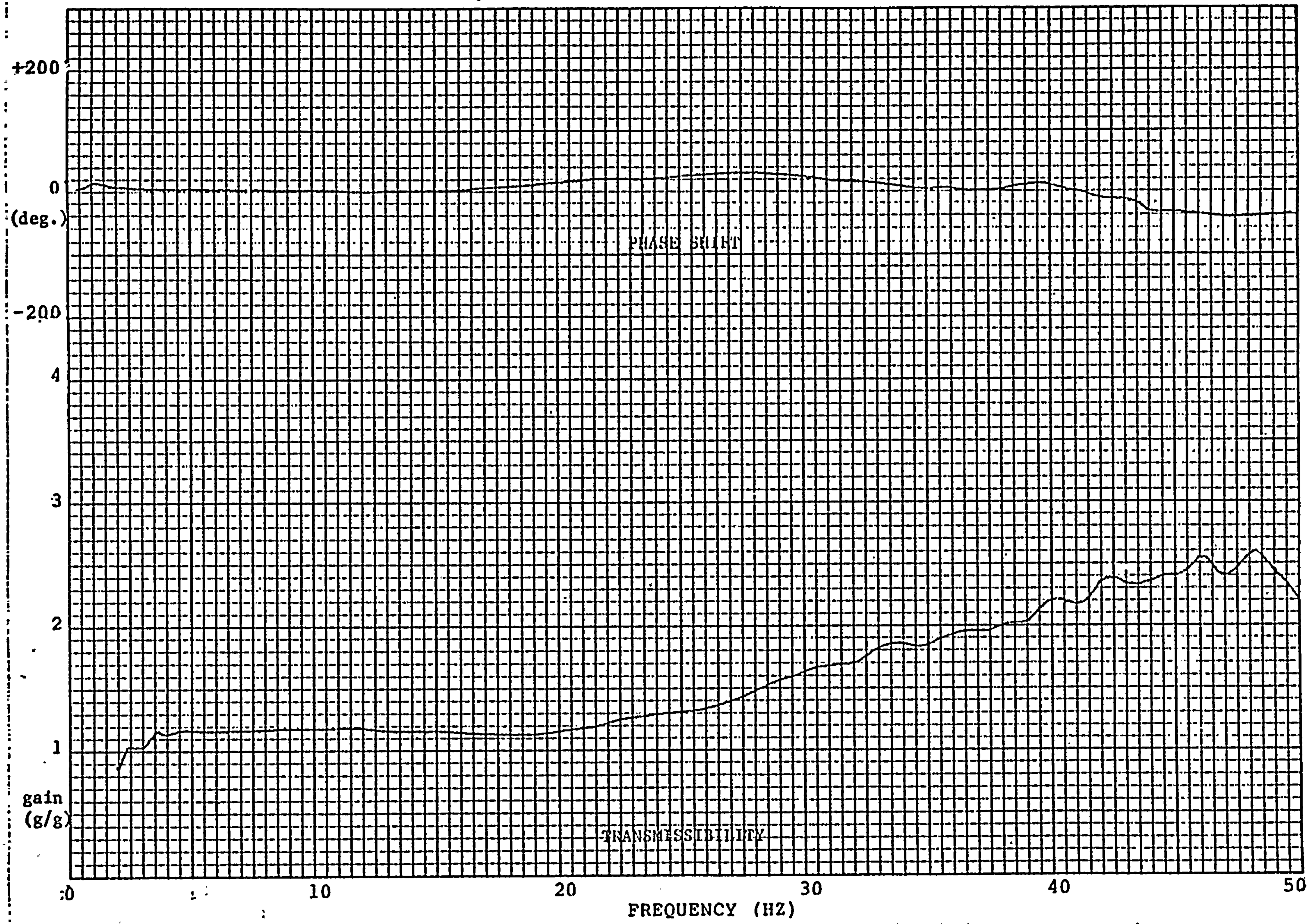
STR-145380-1

TABLE I

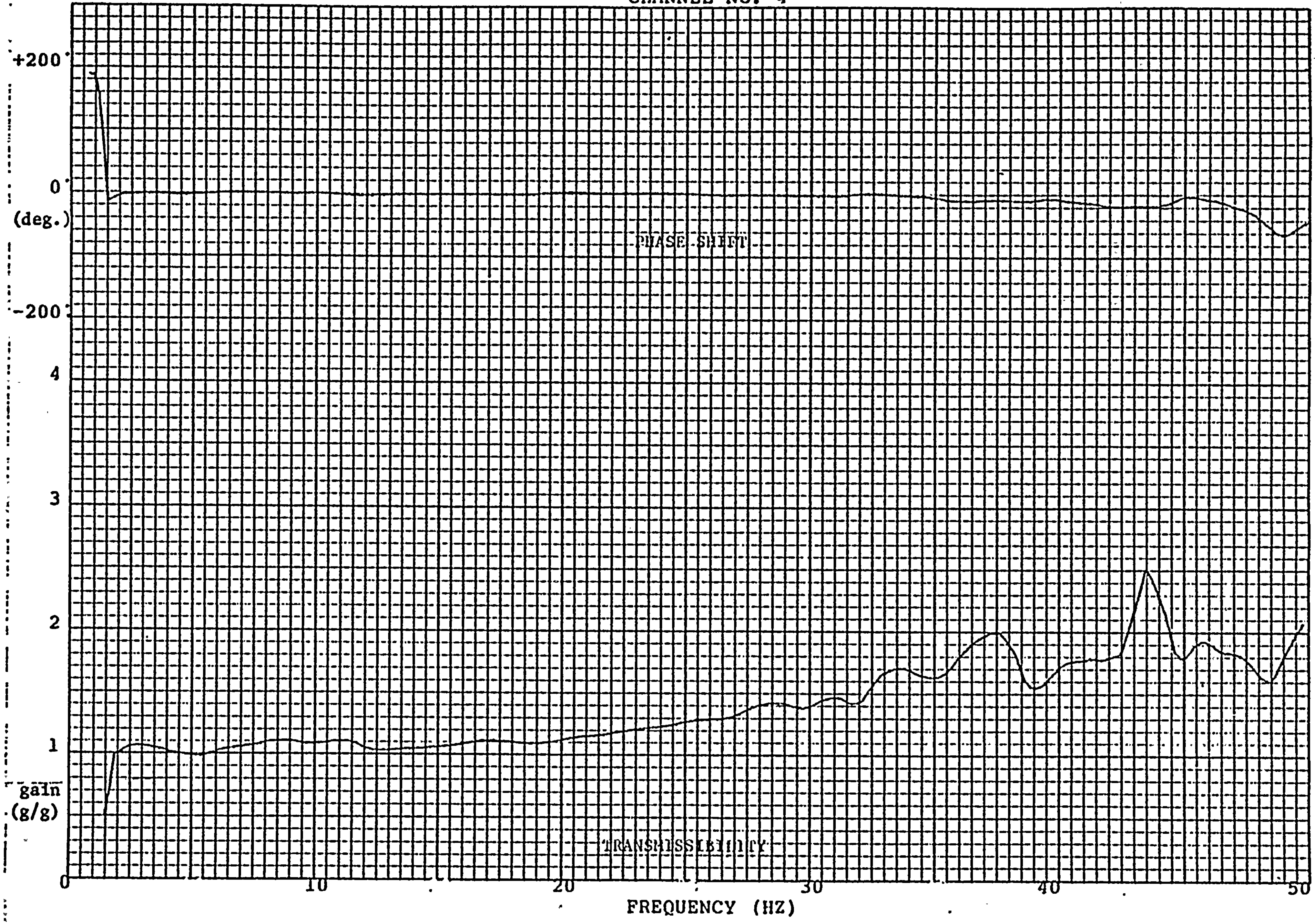
ACCELEROMETER MOUNTING LOCATIONS

Accelerometer Number	Motion Axis Monitored	Location
1	Horizontal	Control - on Seismic Table
2	Vertical	Control - on Seismic Table
3	Horizontal	Top of the BTU Assembly
4	Vertical	
5	Horizontal	Top of the ATU Assembly
6	Vertical	
7	Horizontal	Top Left Corner of E-M Test fixture near mounting screw
8	Vertical	

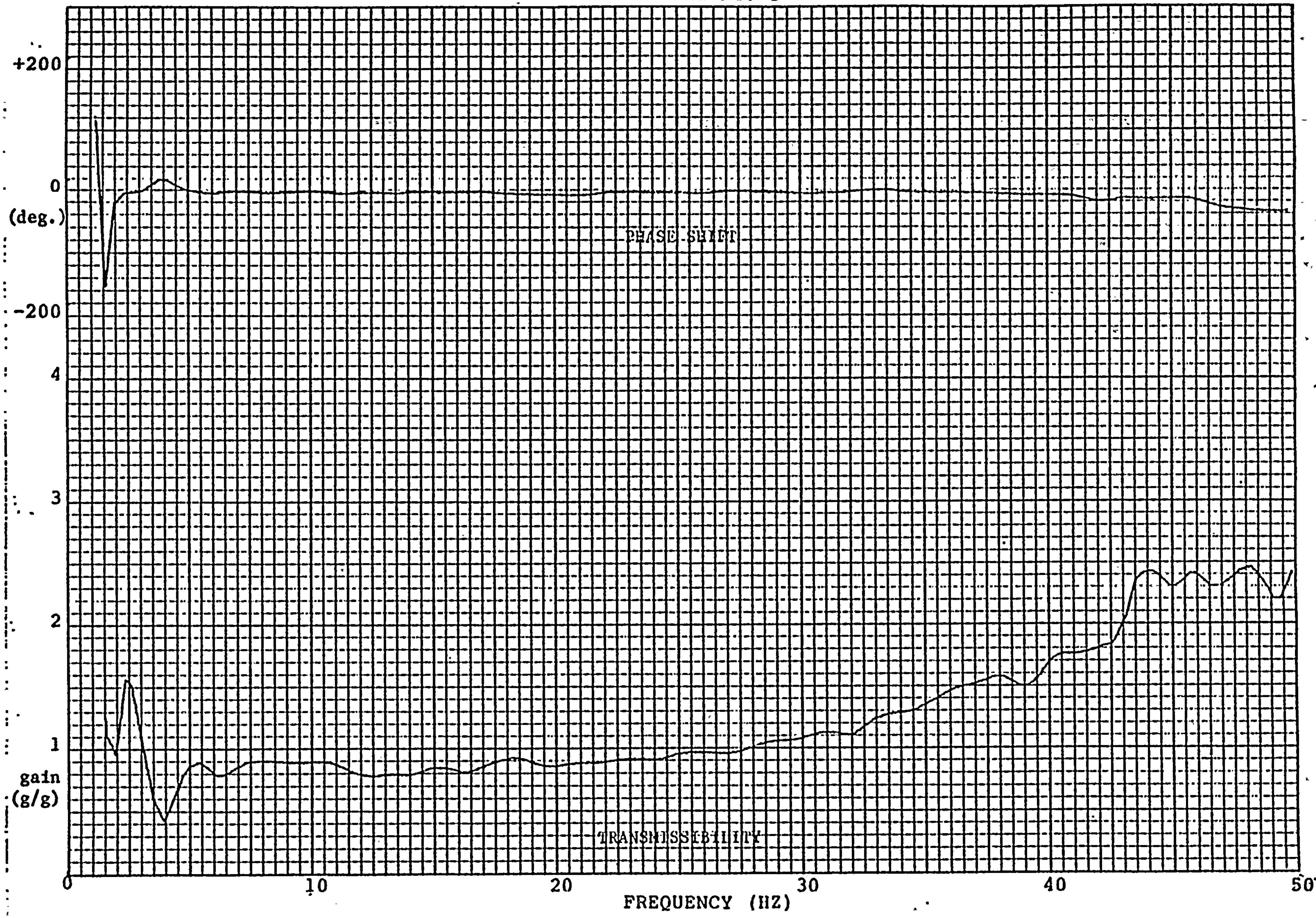
TRANSFER FUNCTIONS
BIAXIAL R NO. 1 IN-PHASE
CHANNEL NO. 3



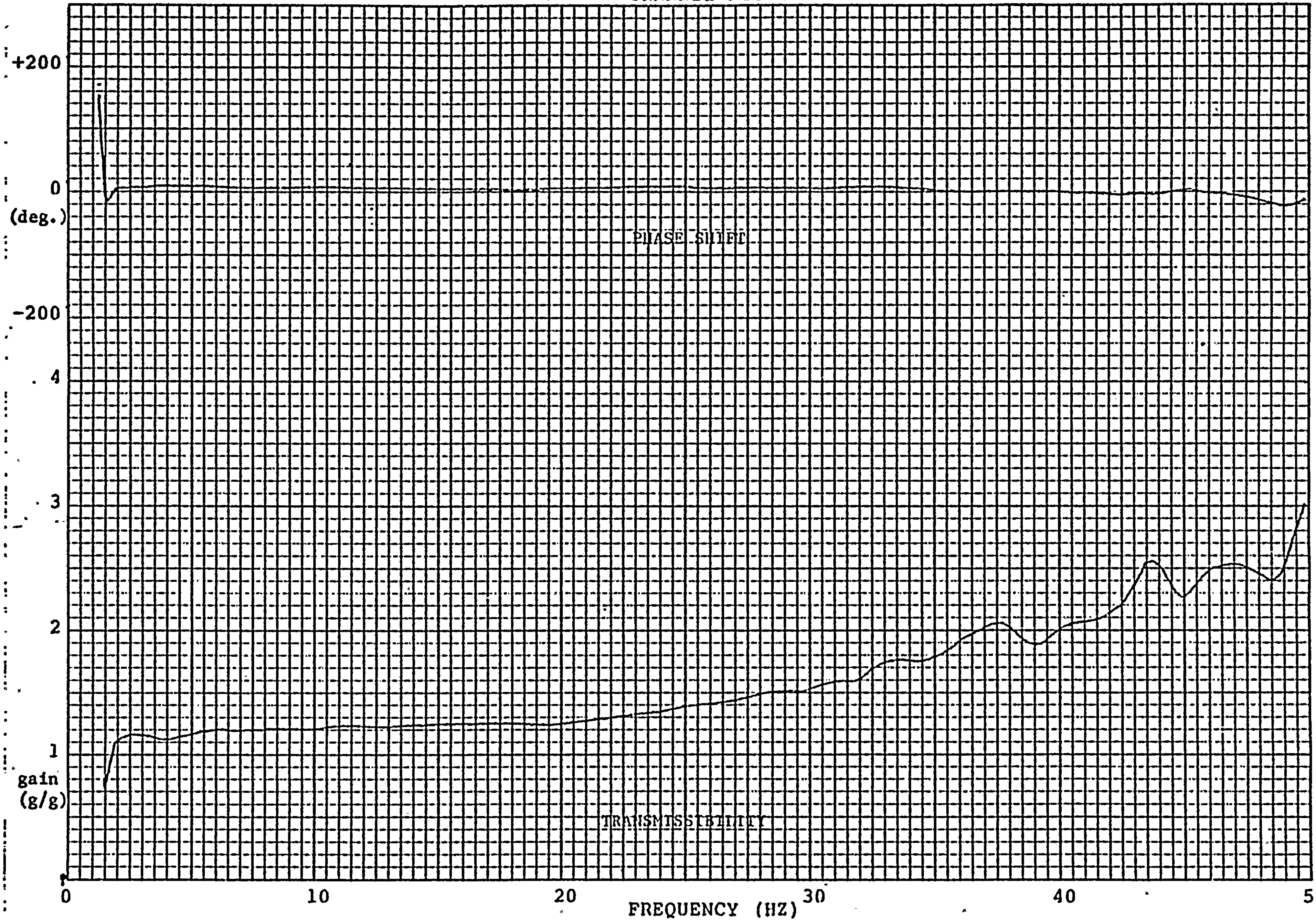
TRANSFER FUNCTIONS
BIAXIAL PAIR NO. 1 IN-PHASE
CHANNEL NO. 4



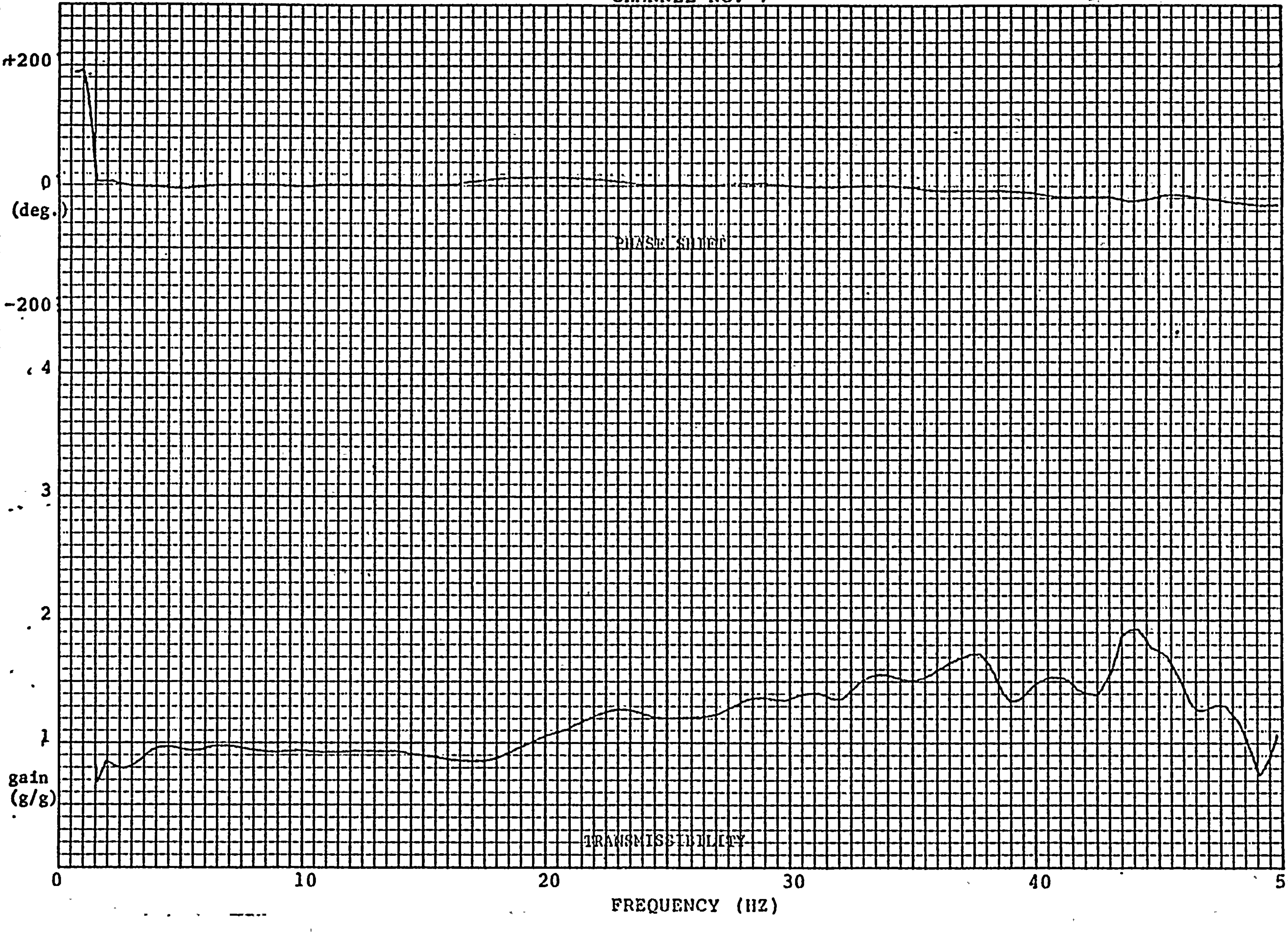
TRANSFER FUNCTIONS
BIAXIAL PAIR NO. 1 IN-PHASE
CHANNEL NO. 5



TRANSFER FUNCTIONS
BIAXIAL P[illegible] NO. 1 · IN-PHASE
CHANNEL NO. 6



TRAN… FUNCTIONS
BIAXIAL PAIR NO. 1 IN-PHASE
CHANNEL NO. 7



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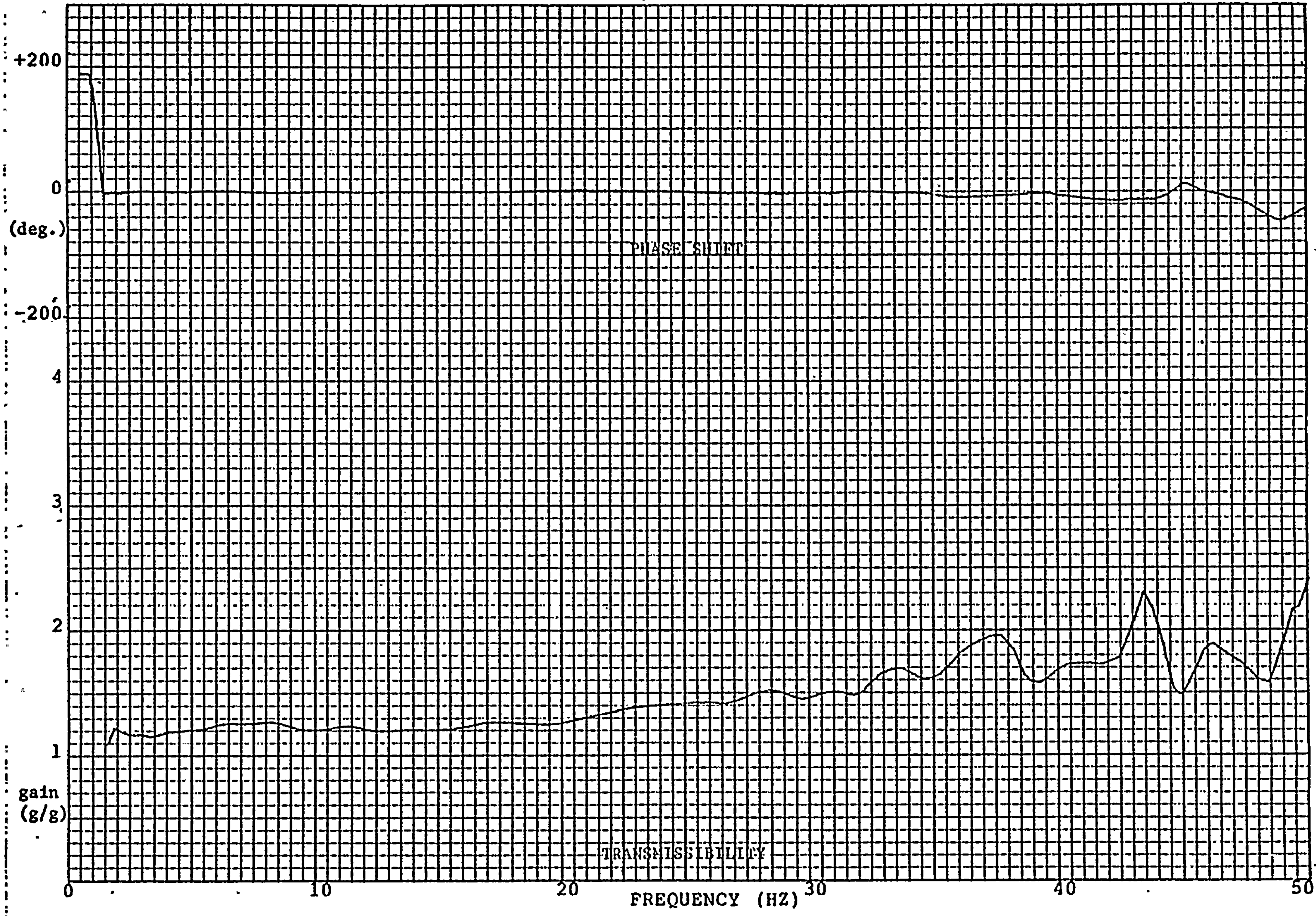
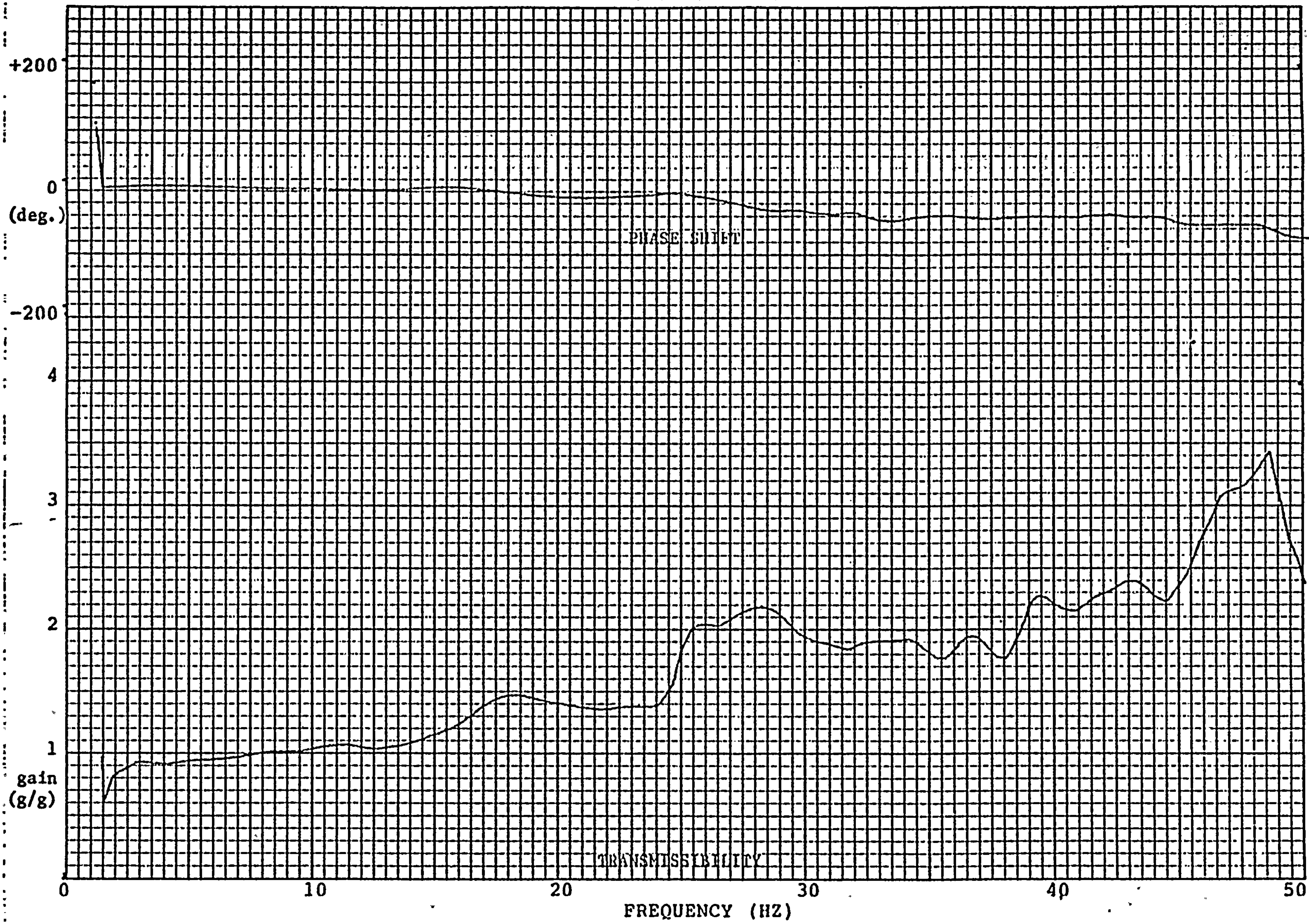
TRANSFER FUNCTIONS
BIAXIAL PAIR NO. 1 IN-PHASE
CHANNEL NO. 8



TRANSFER FUNCTIONS
BIAXIAL PAIR NO. 1 OUT-OF-PHASE
CHANNEL NO. 3



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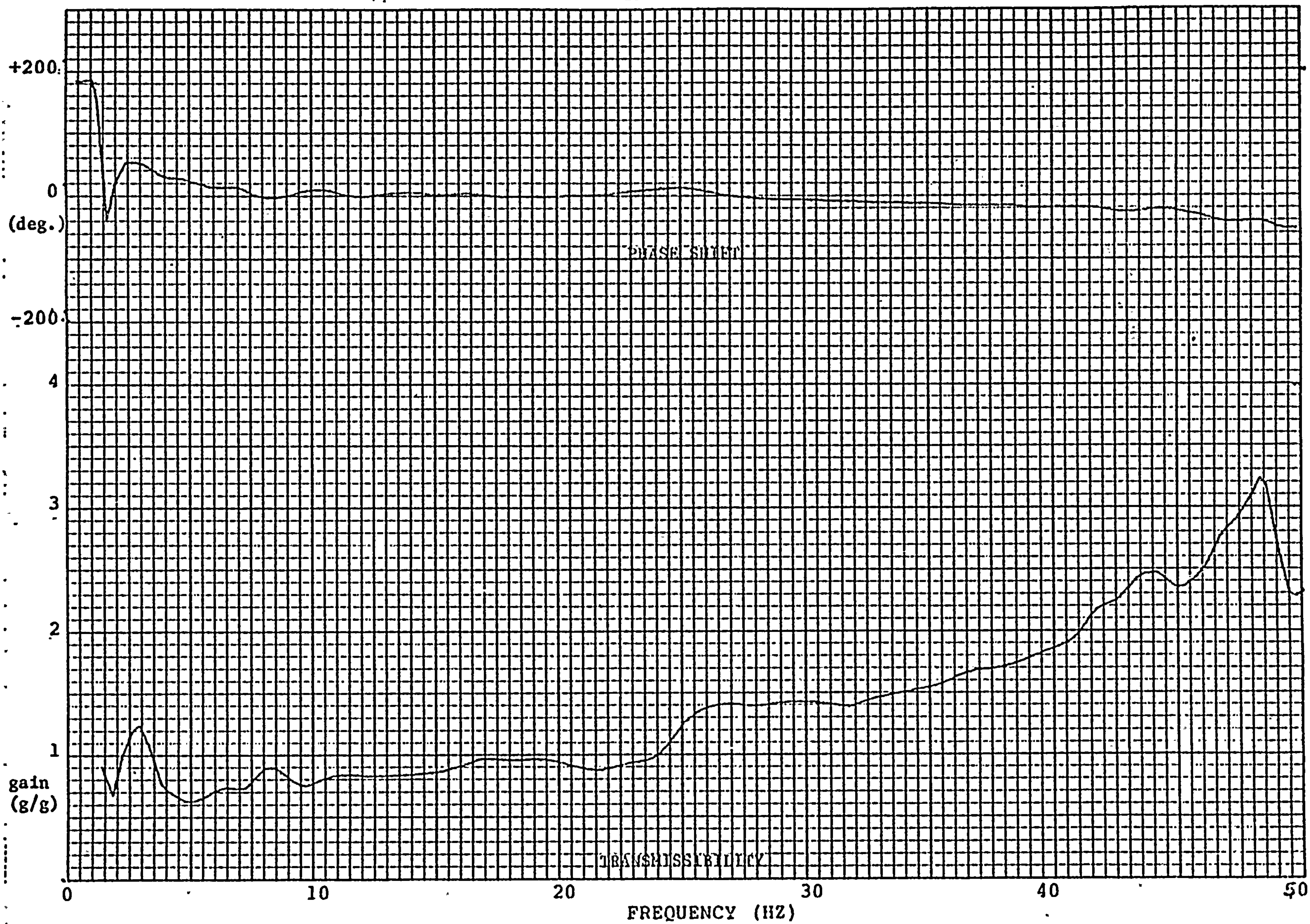
BIAXIAL PAIR NO. 1 OUT-OF-PHASE
CHANNEL NO. 5



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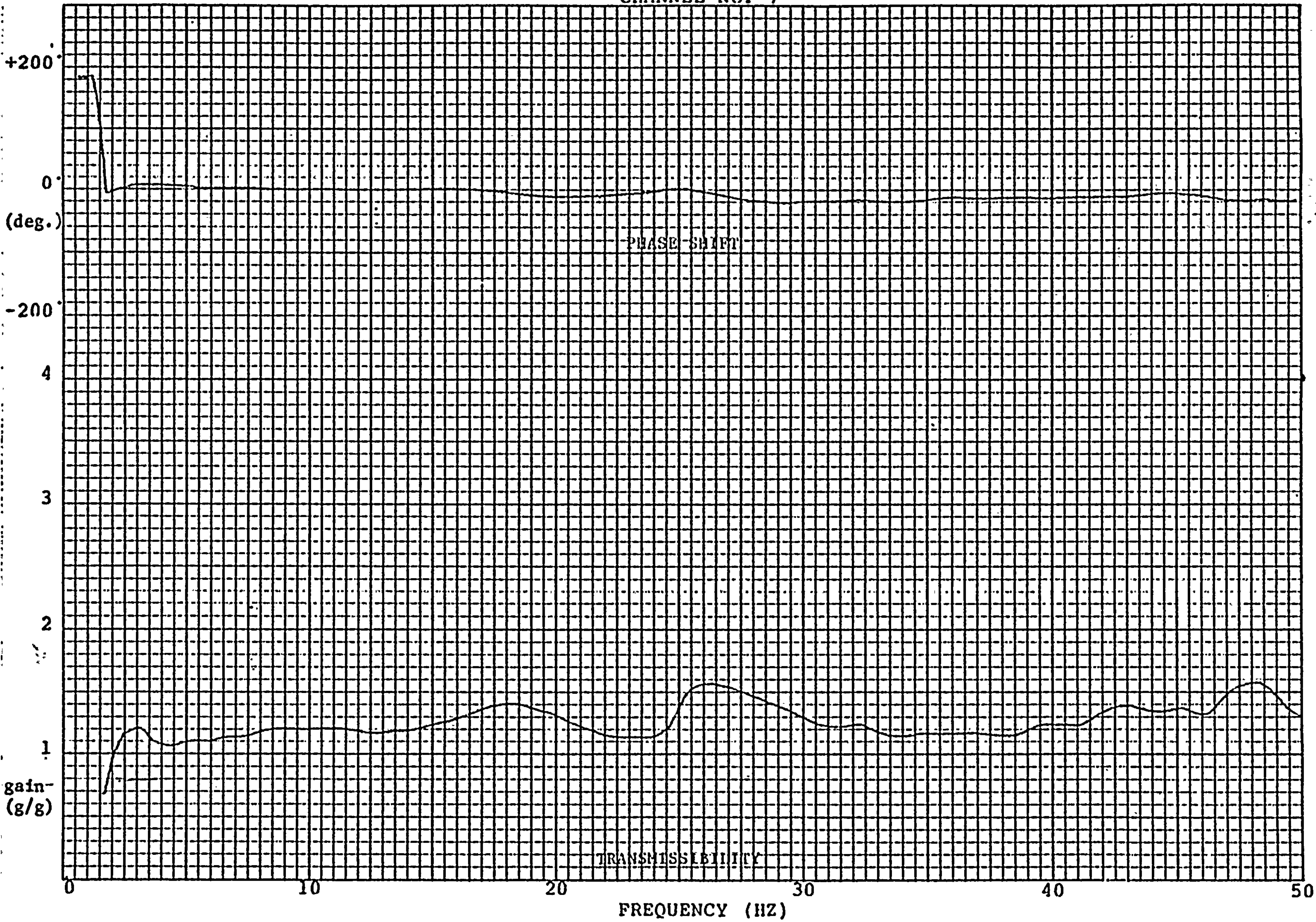
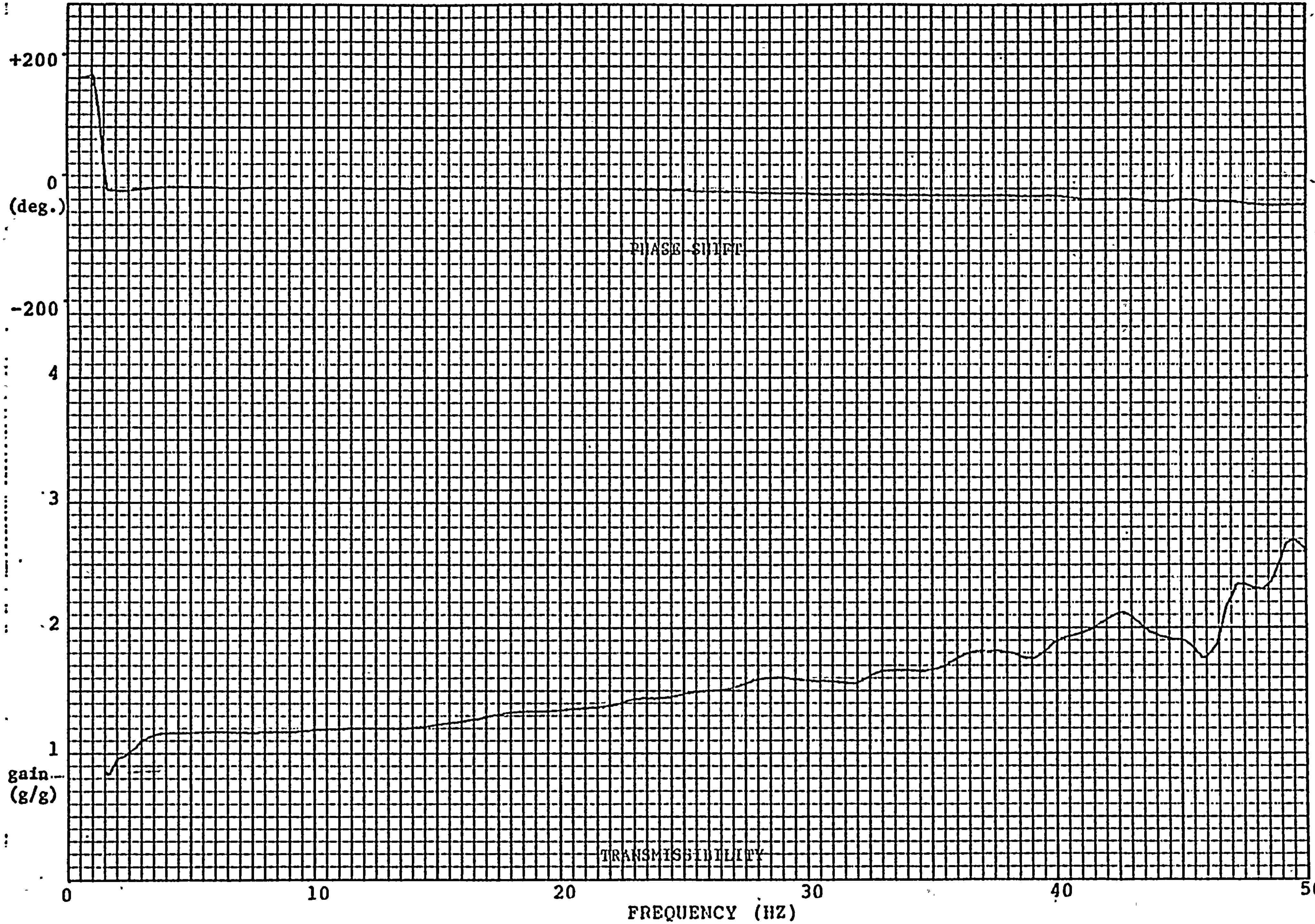
BIAXIAL PAIR [illegible]. 1 OUT-OF-PHASE
CHANNEL NO. 7

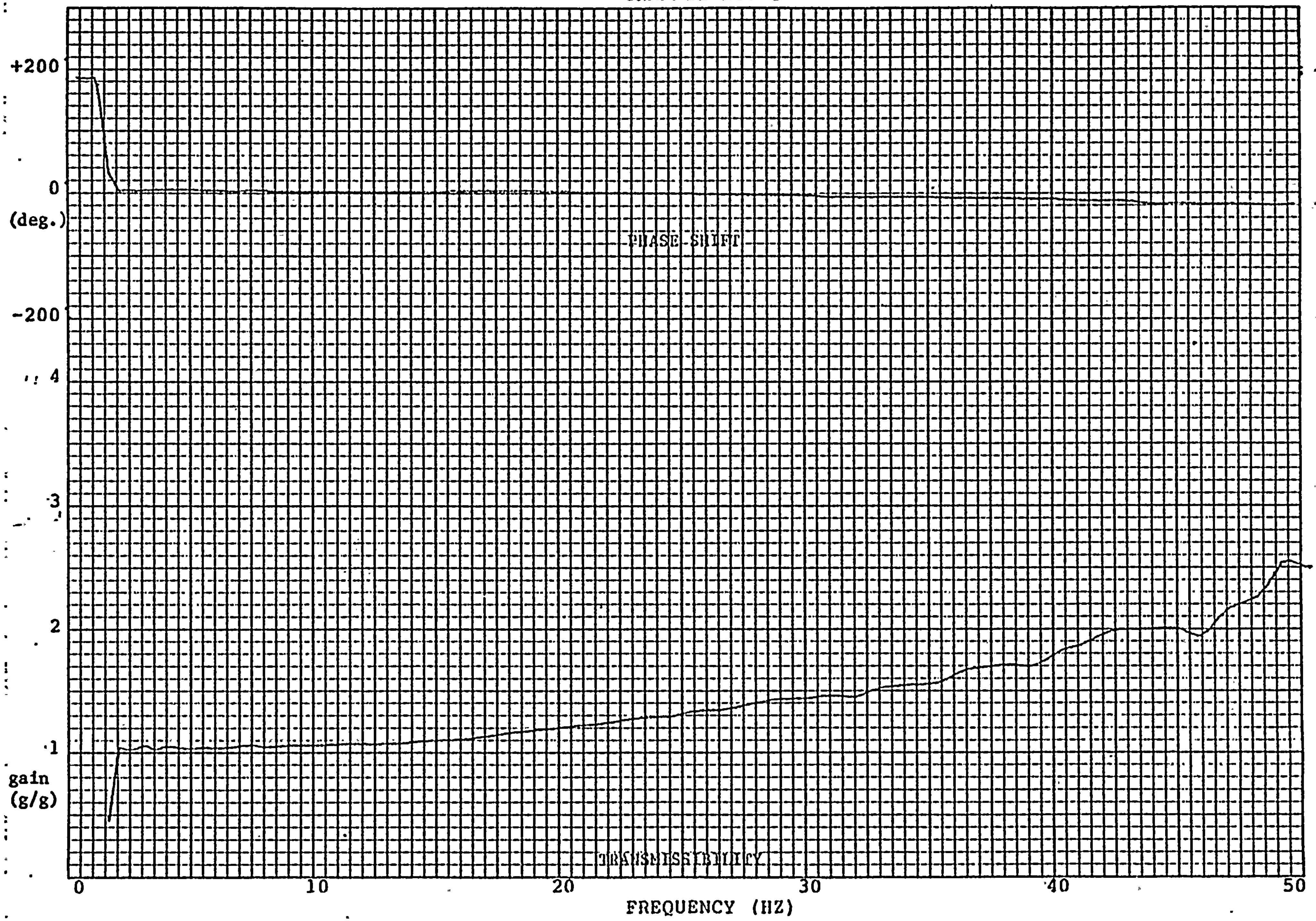


TRAN[illegible] FUNCTIONS
BIAXIAL PA[illegible] NO. 2 IN-PHASE
CHANNEL NO. 5



GRAPH PAPER GRAPHIC CONTROLS CORPORATION Buffalo, New York Printed in U.S.A.

TRANS[illegible] FUNCTIONS
BIAXIAL PA[illegible] NO. 2 IN-PHASE
CHANNEL NO. 3



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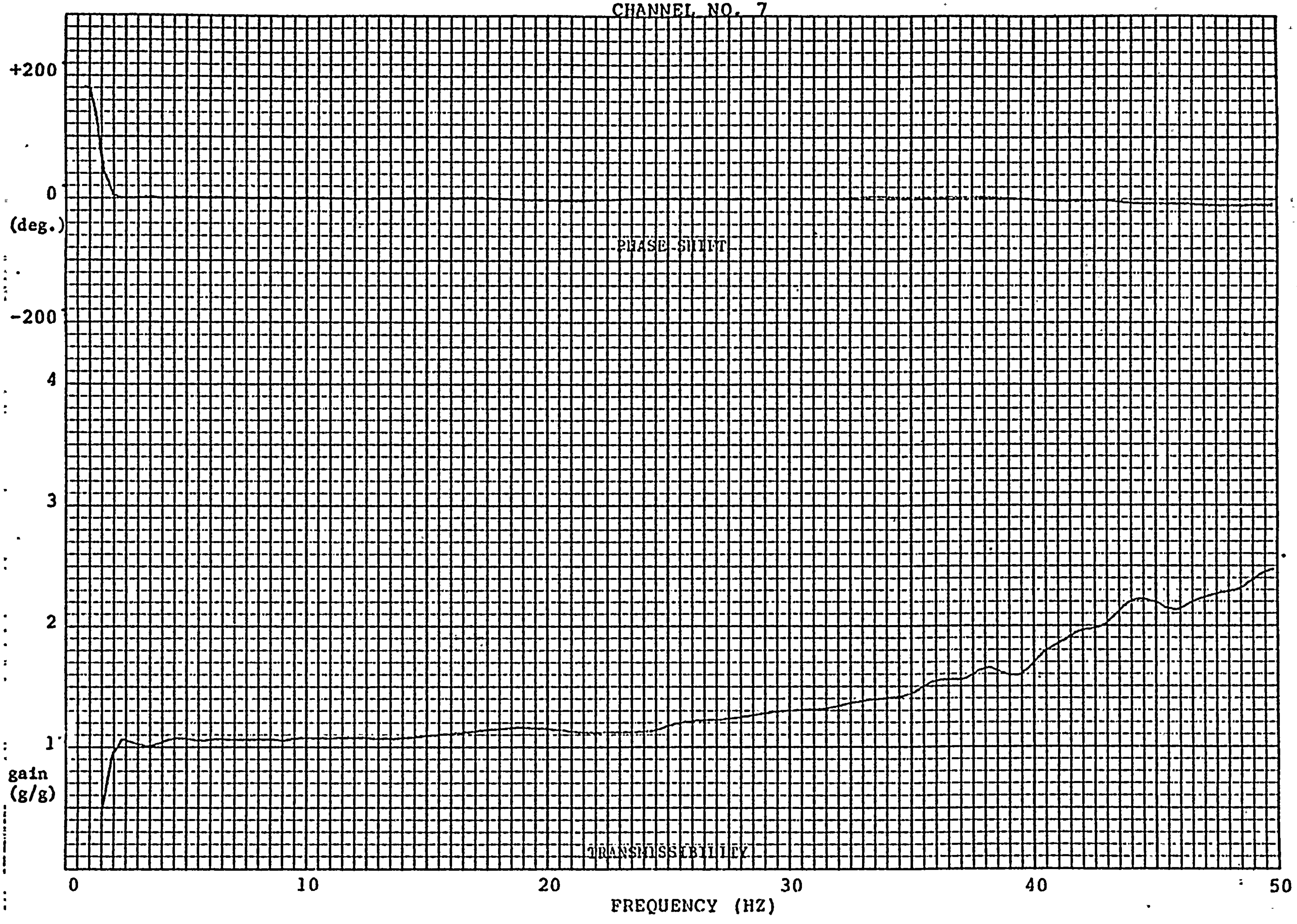
TRA[illegible]R FUNCTIONS
BIAXIAL PAIR NO. 2 IN-PHASE
CHANNEL NO. 7



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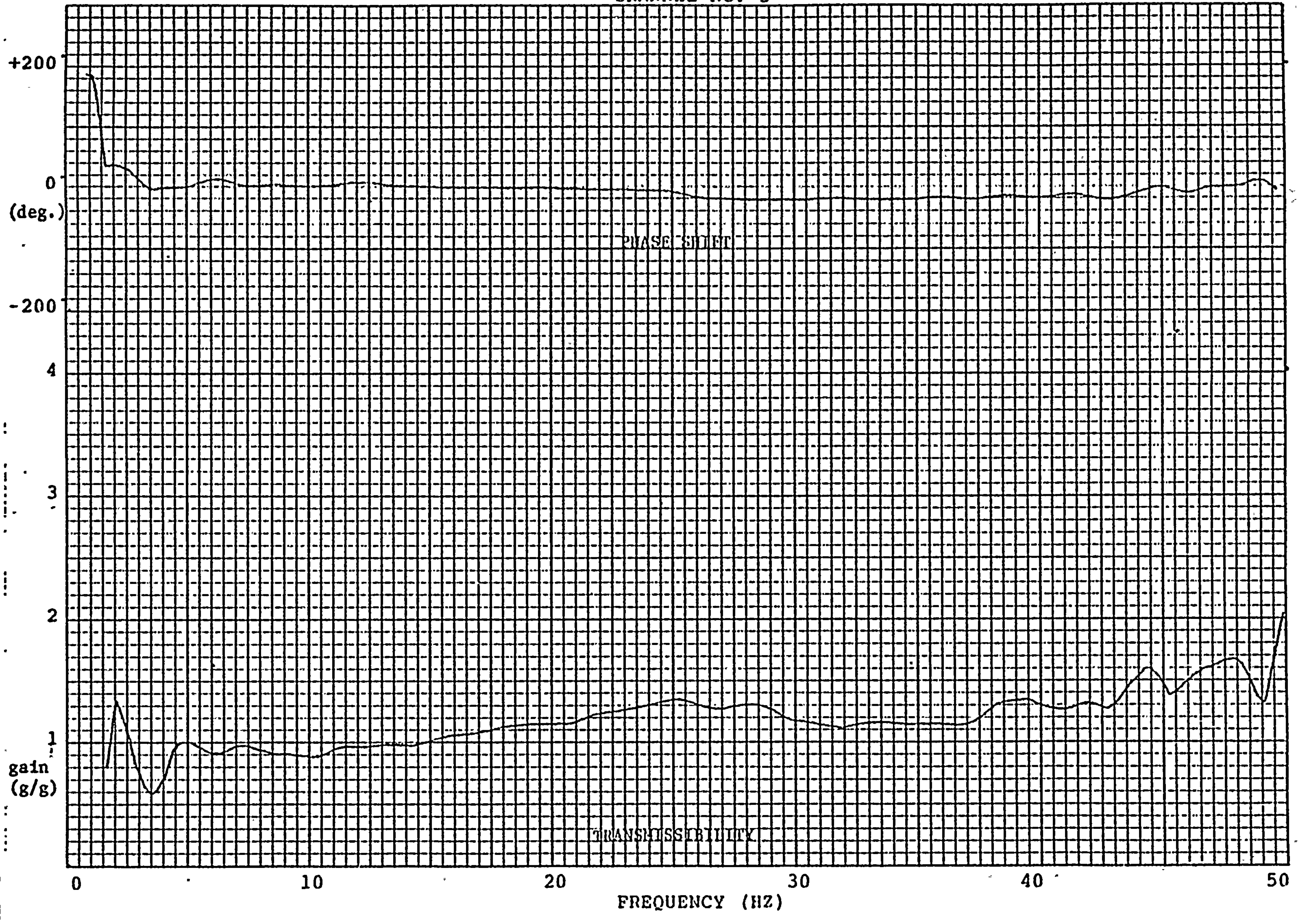
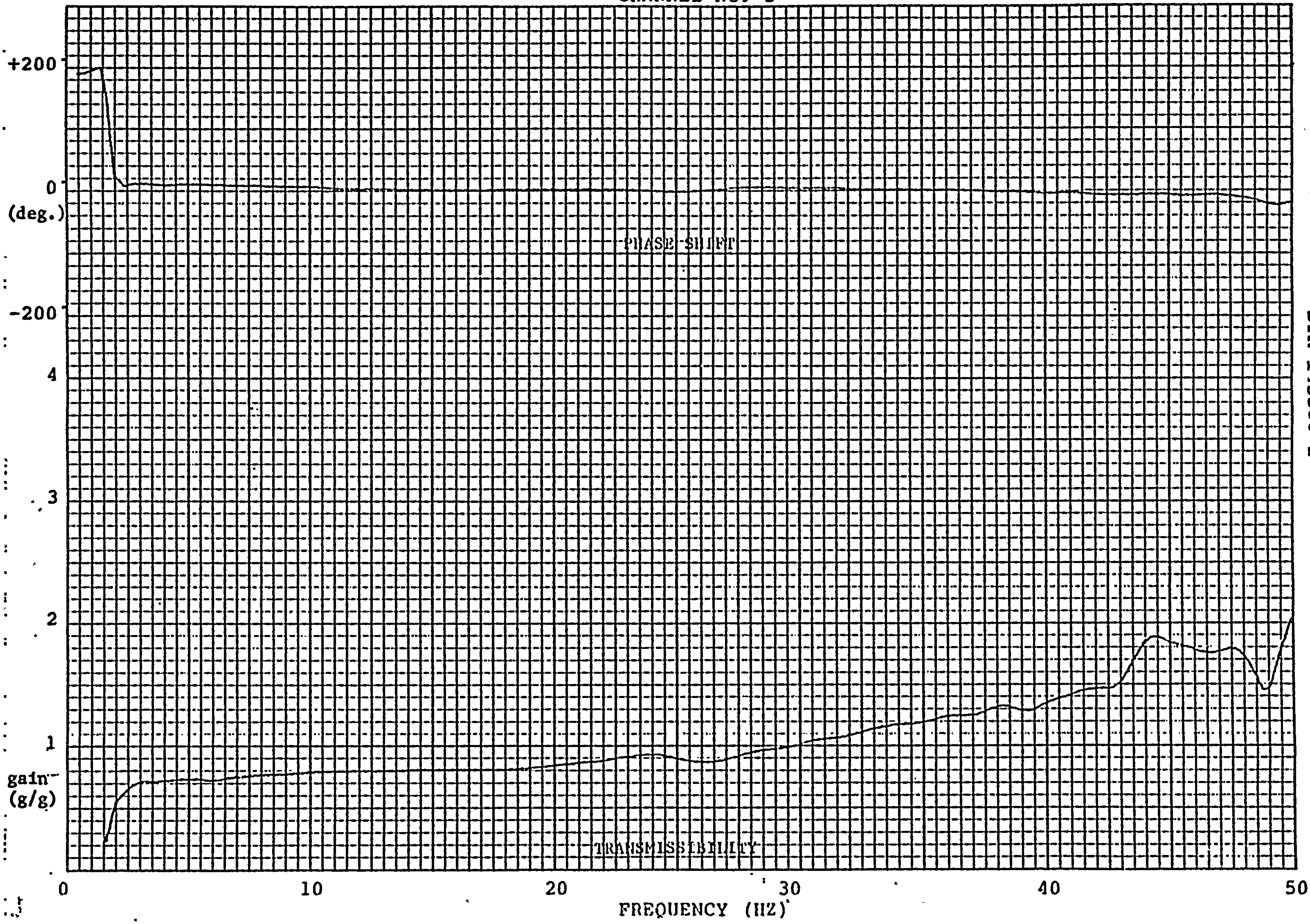
BIAXIAL PAIR NO. 2 OUT-OF-PHASE
CHANNEL NO. 3



TRANSFER FUNCTIONS

BIAXIAL PAIR NO. 2 OUT-OF-PHASE

CHANNEL NO. 5



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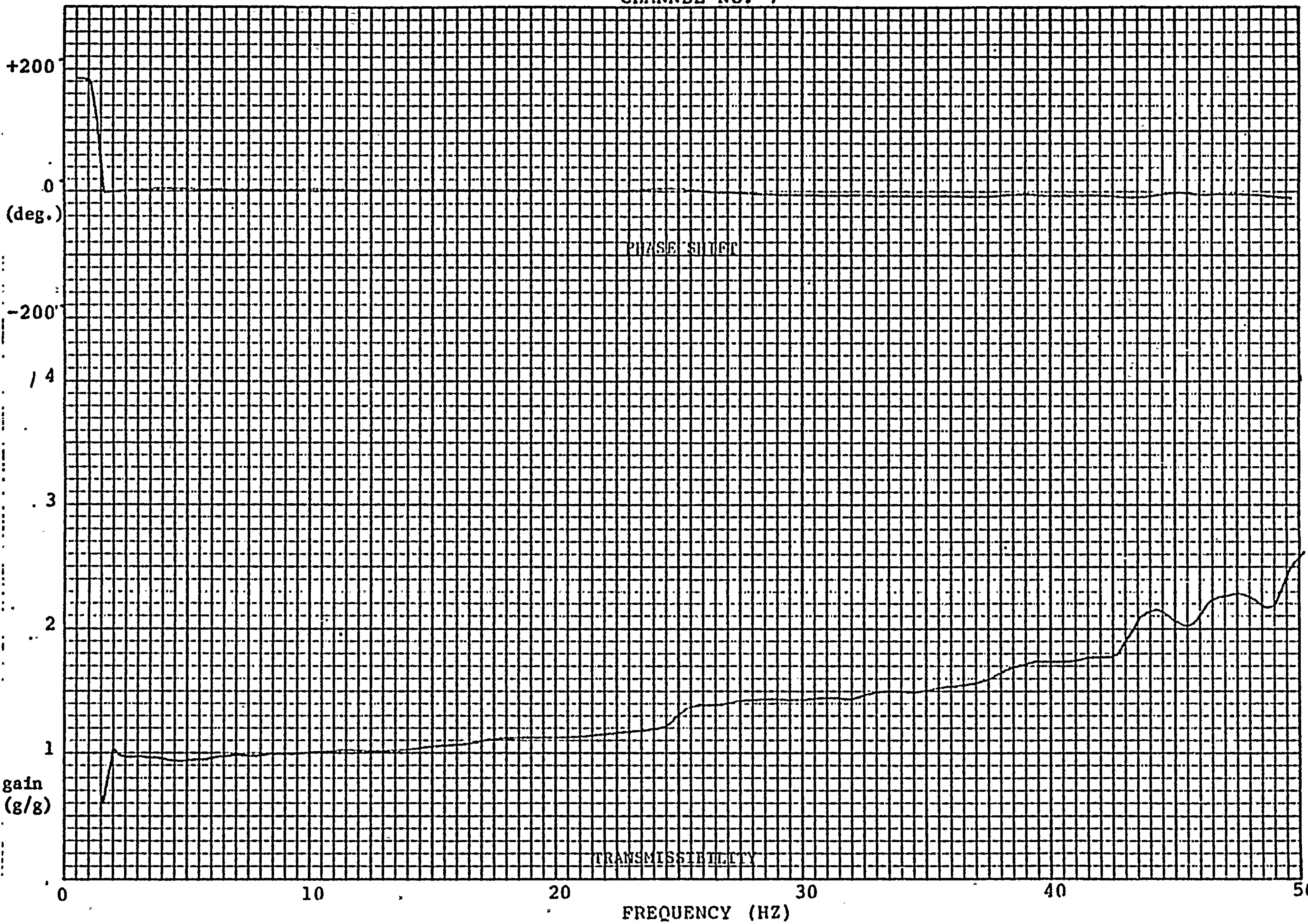
TRANSFER FUNCTIONS
BIAXIAL PAIR NO. 2 OUT-OF-PHASE
CHANNEL NO. 7



APPENDIX E

TEST RESPONSE SPECTRA

FOR

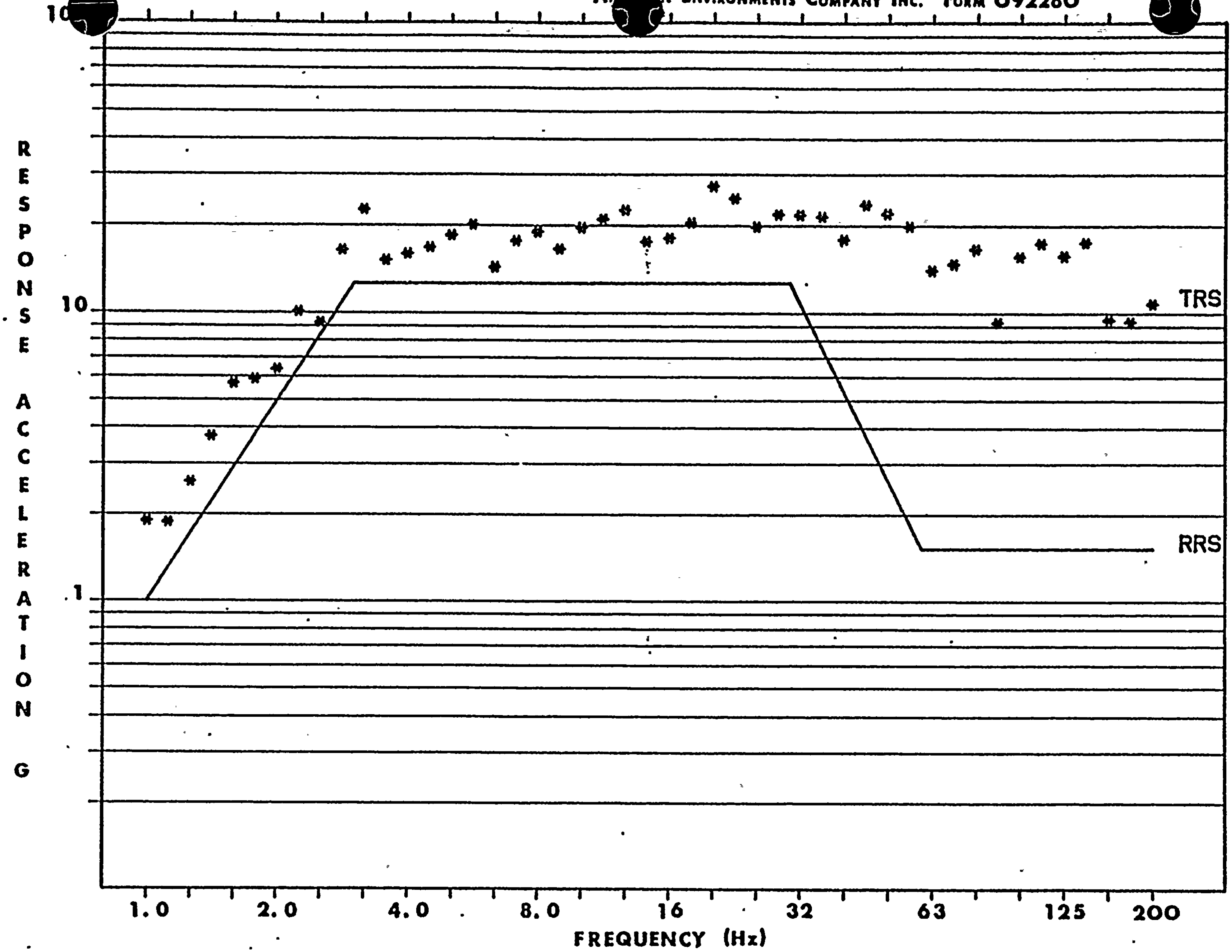
ELECTRO-MECHANICS INC.

BISTABLE-AUXILIARY TRIP UNITS

TABLE I

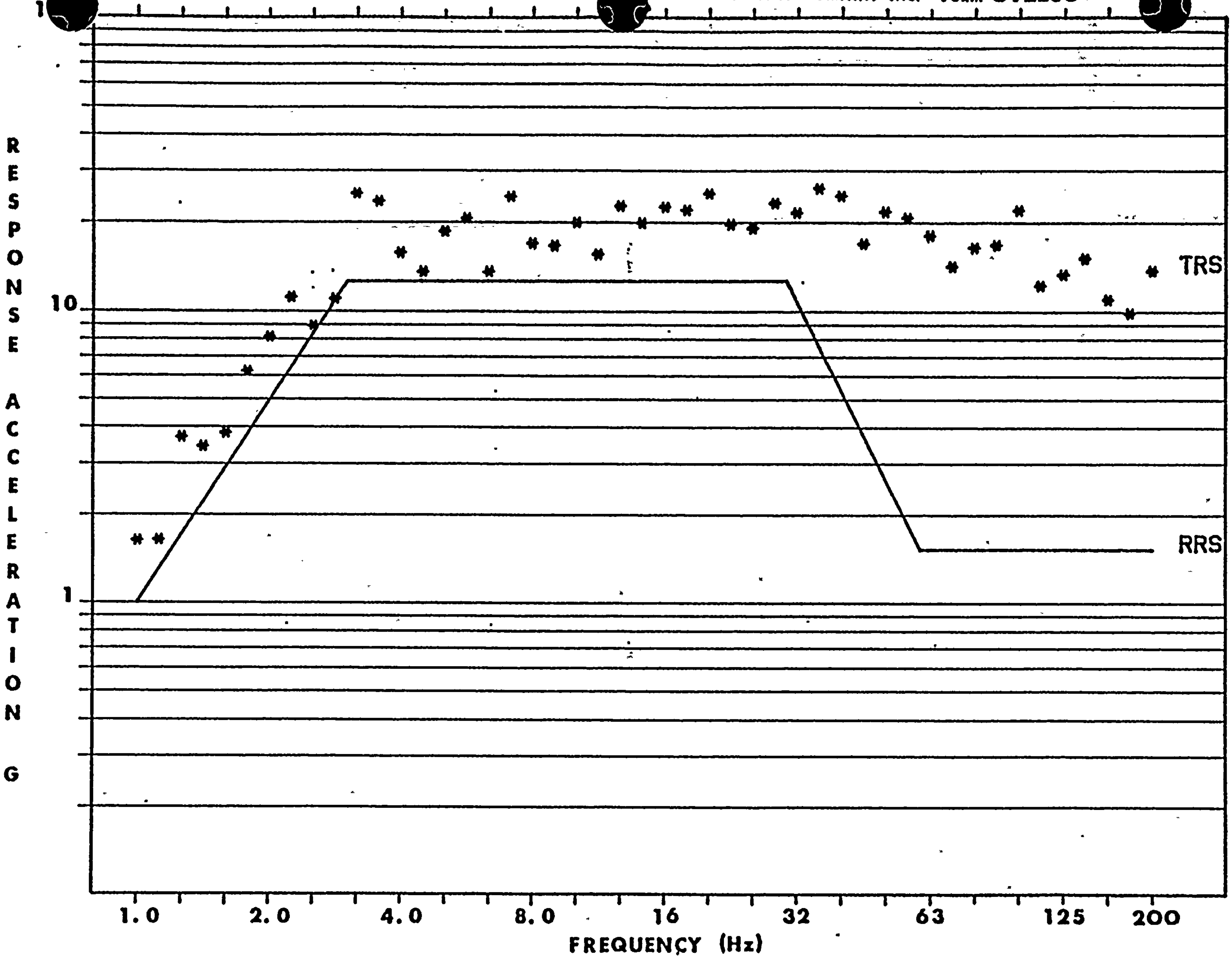
ACCELEROMETER MOUNTING LOCATIONS

Accelerometer Number	Motion Axis Monitored	Location
1	Horizontal	Control - on Seismic Table
2	Vertical	Control - on Seismic Table
3	Horizontal	Top of the BTU Assembly
4	Vertical	
5	Horizontal	Top of the ATU Assembly
6	Vertical	
7	Horizontal	Top Left Corner of Specimen Near Mounting Screw.
8	Vertical	

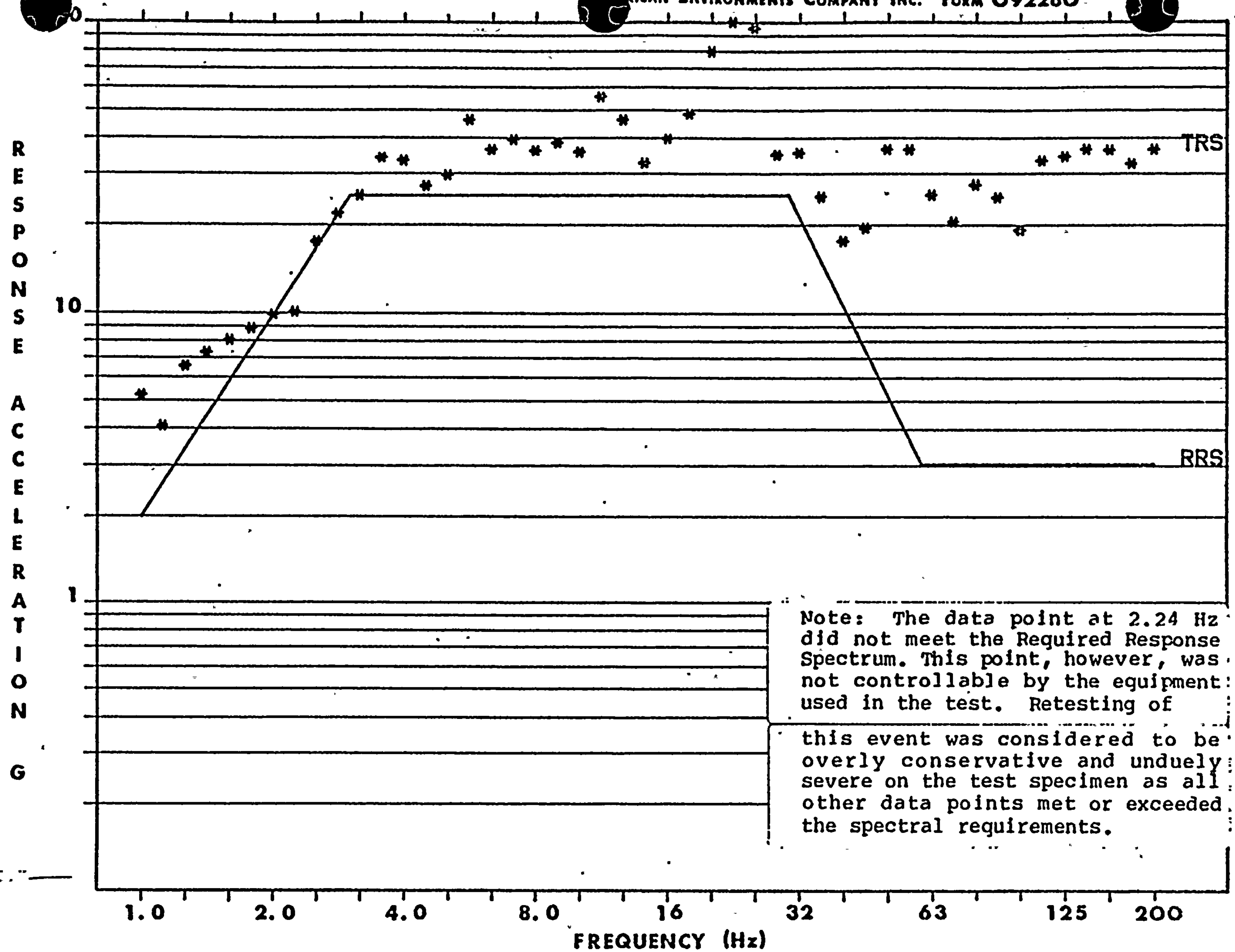


RUN NUMBER.. 5 TRS - HORIZONTAL (BIAXIAL PAIR NO. 2 OUT-OF-PHASE) - OBE
CHANNEL NUMBER.. 1 1.0 % OF CRITICAL DAMPING

STR-145380-1

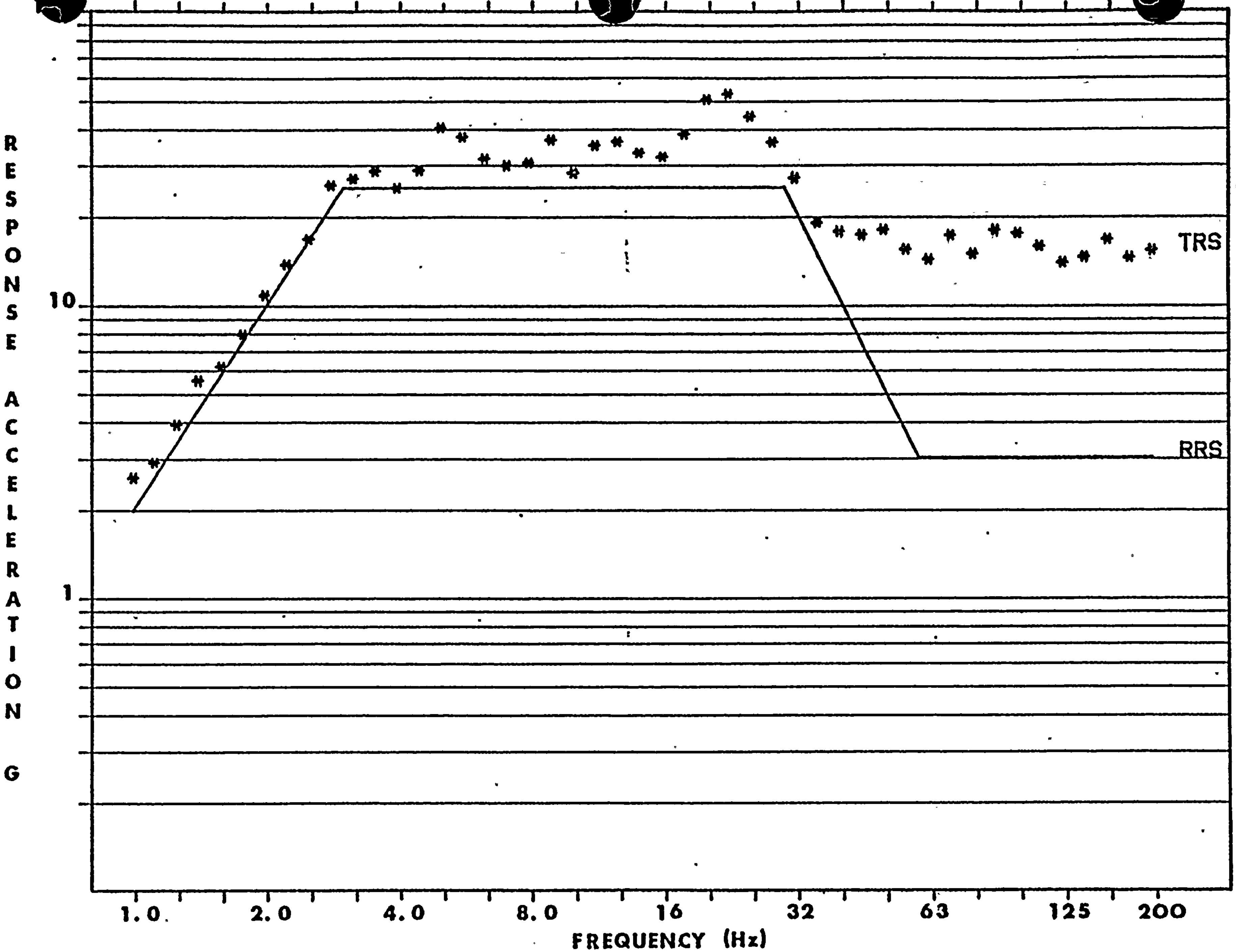


RUN NUMBER.. 5 TRS - VERTICAL (BIAXIAL PAIR NO. 2 OUT-OF-PHASE) - OBE
CHANNEL NUMBER.. 2 1.0 % OF CRITICAL DAMPING



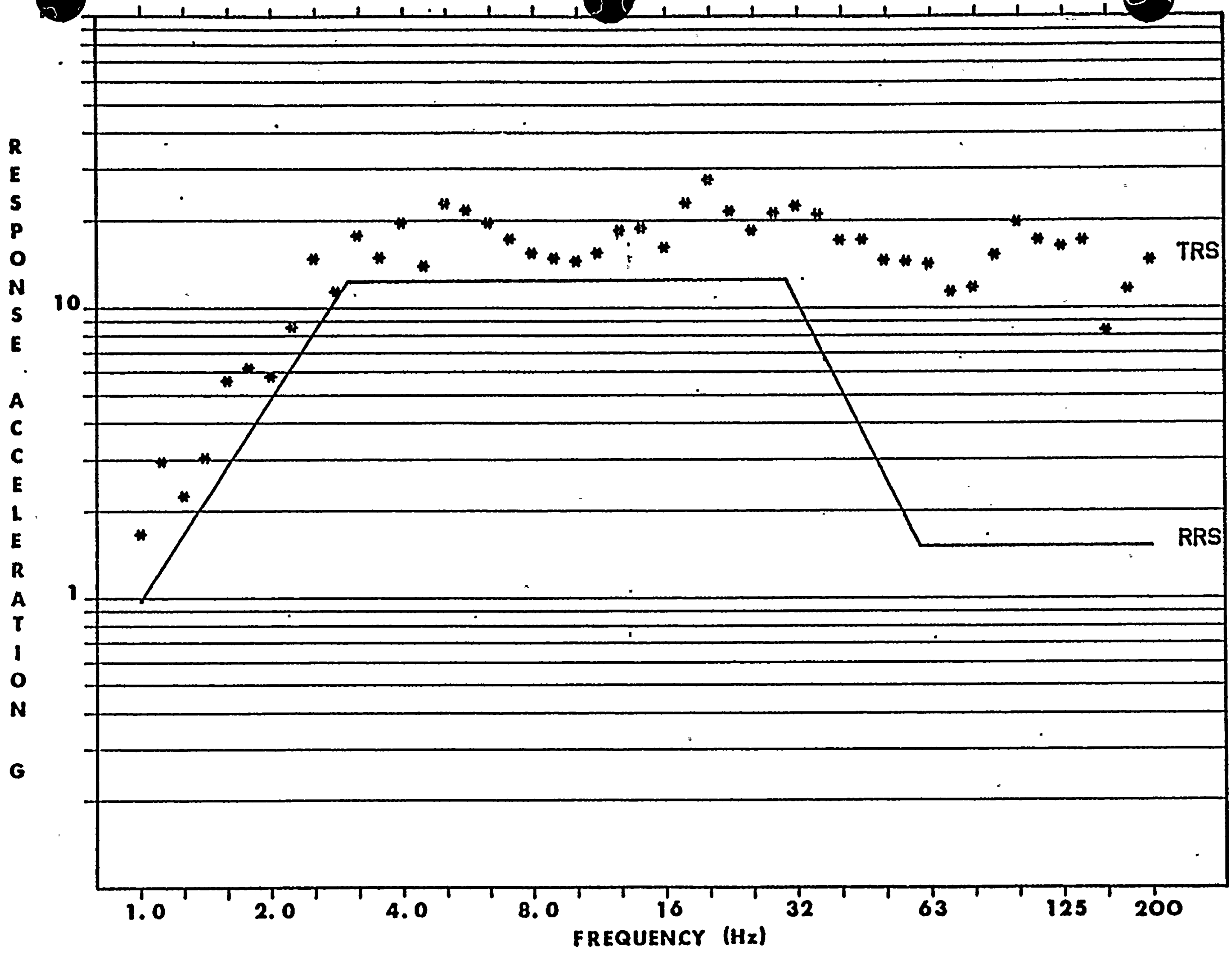
Note: The data point at 2.24 Hz did not meet the Required Response Spectrum. This point, however, was not controllable by the equipment used in the test. Retesting of this event was considered to be overly conservative and unduely severe on the test specimen as all other data points met or exceeded the spectral requirements.

RUN NUMBER.. 8 TRS - HORIZONTAL (BIAXIAL PAIR NO. 2 OUT-OF-PHASE) - SSE
CHANNEL NUMBER.. 1 1.0 % OF CRITICAL DAMPING

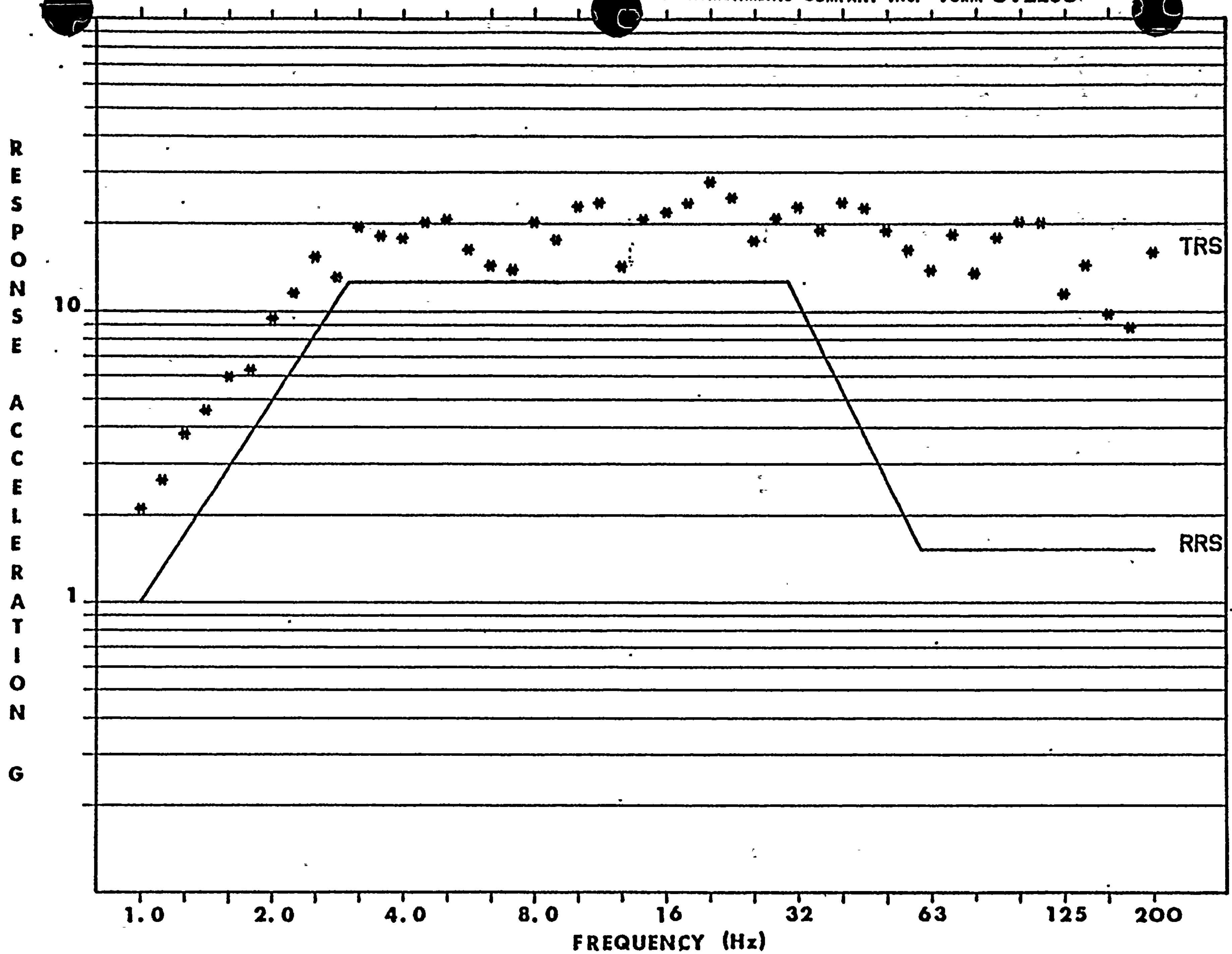


RUN NUMBER.. 6 TRS - VERTICAL (BIAXIAL PAIR NO. 2 OUT-OF-PHASE) - SSE
CHANNEL NUMBER.. 2 1.Ø % OF CRITICAL DAMPING

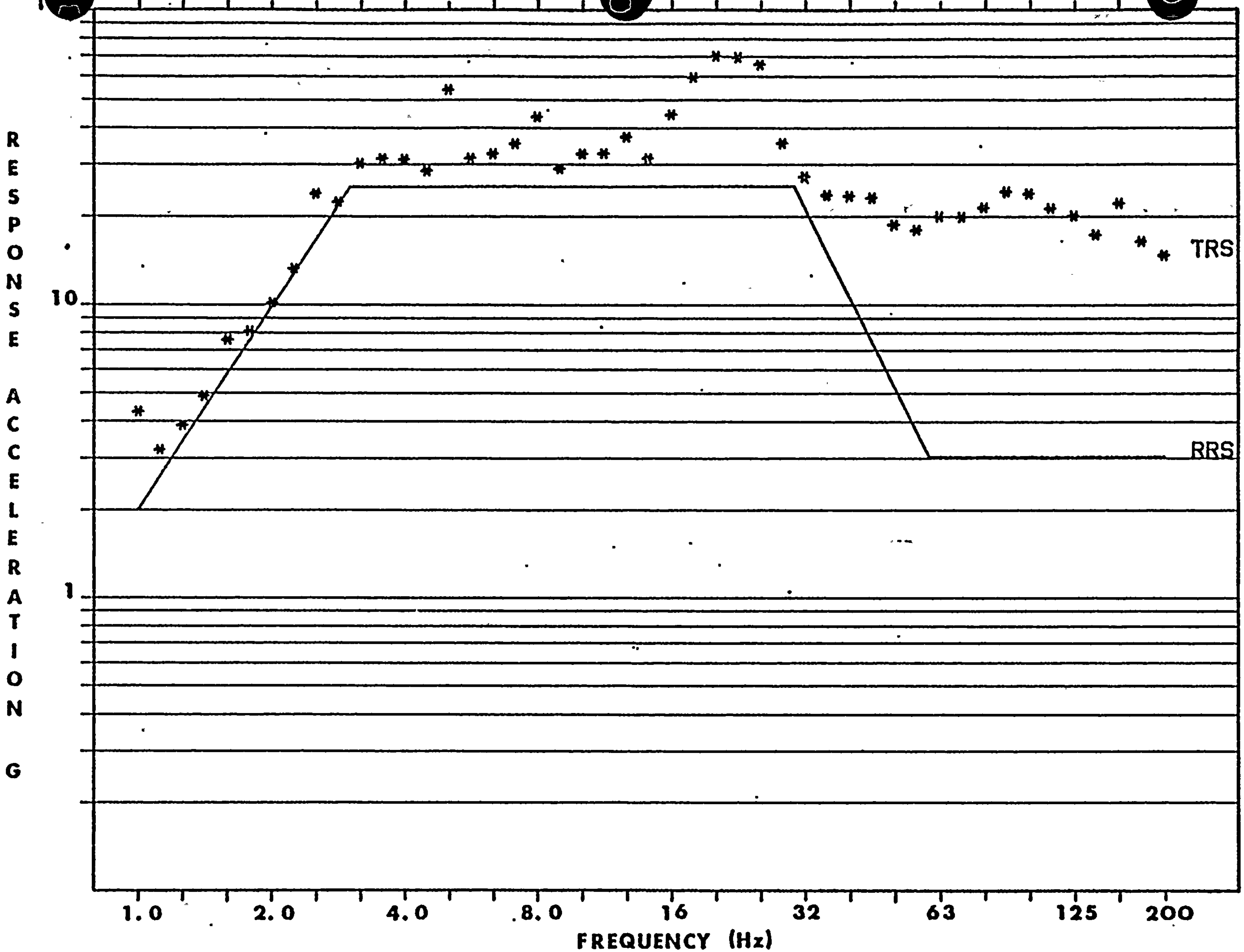
STR-145380-1



RUN NUMBER.. 11 TRS - HORIZONTAL (BIAXIAL PAIR NO. 2 IN-PHASE) - OBE
CHANNEL NUMBER.. 1 1.0 % OF CRITICAL DAMPING

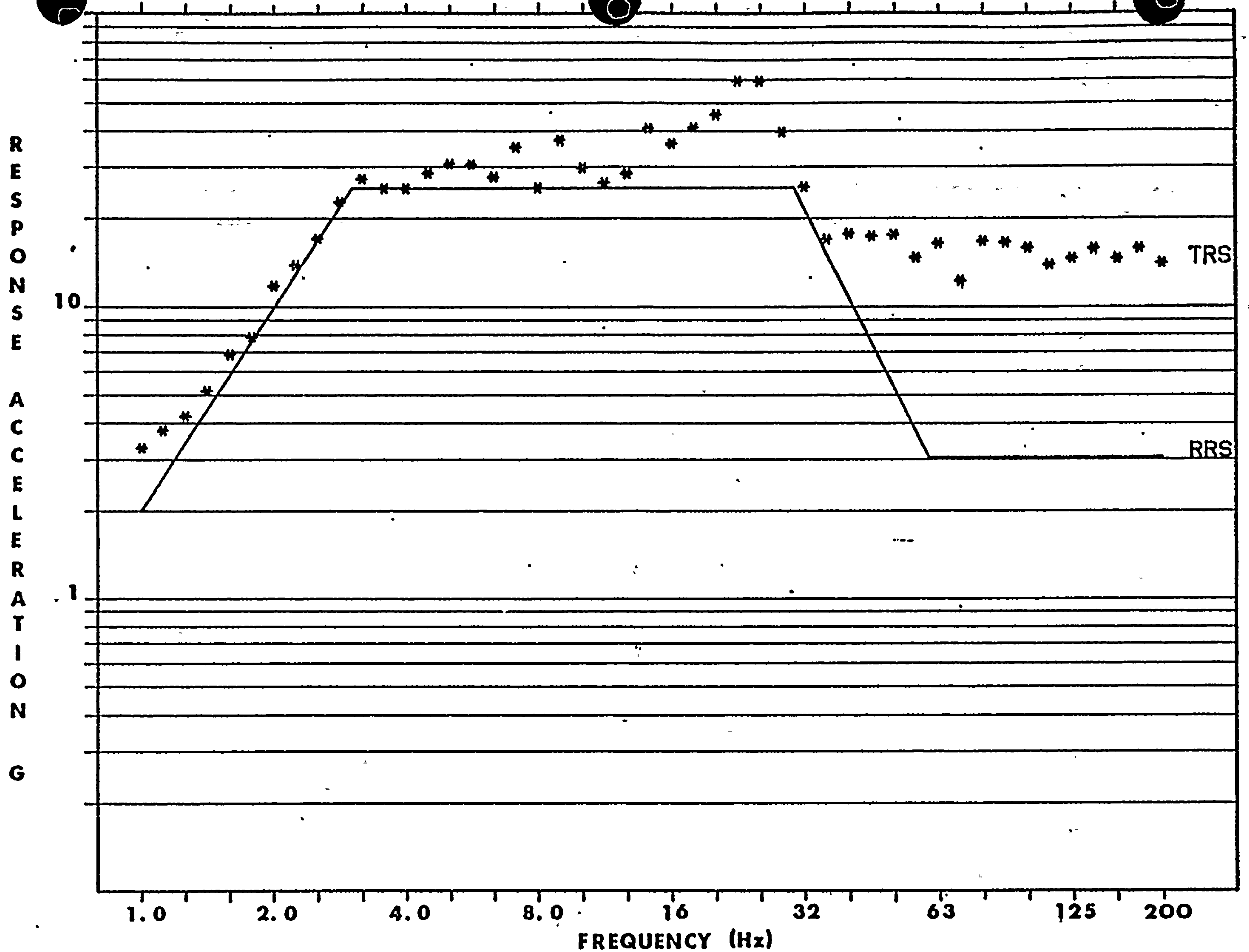


RUN NUMBER.. 11   TRS - VERTICAL (BIAXIAL PAIR NO. 2 IN-PHASE) - OBE
CHANNEL NUMBER.. 2   1.Ø % OF CRITICAL DAMPING



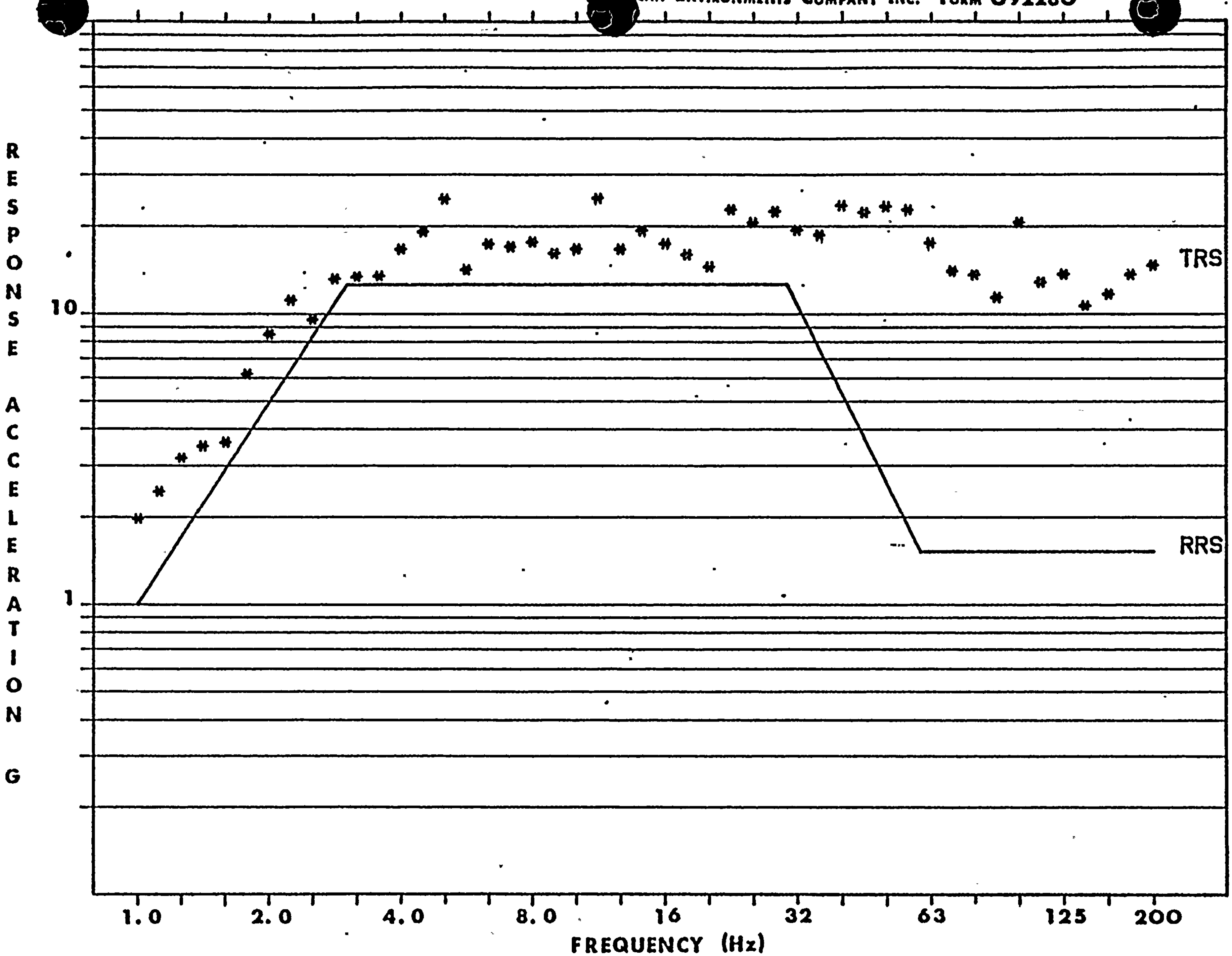
RUN NUMBER.. 12 TRS - HORIZONTAL (BIAXIAL PAIR NO. 2 IN-PHASE) - SSE
CHANNEL NUMBER.. 1 1.0 % OF CRITICAL DAMPING

STR-145380-1



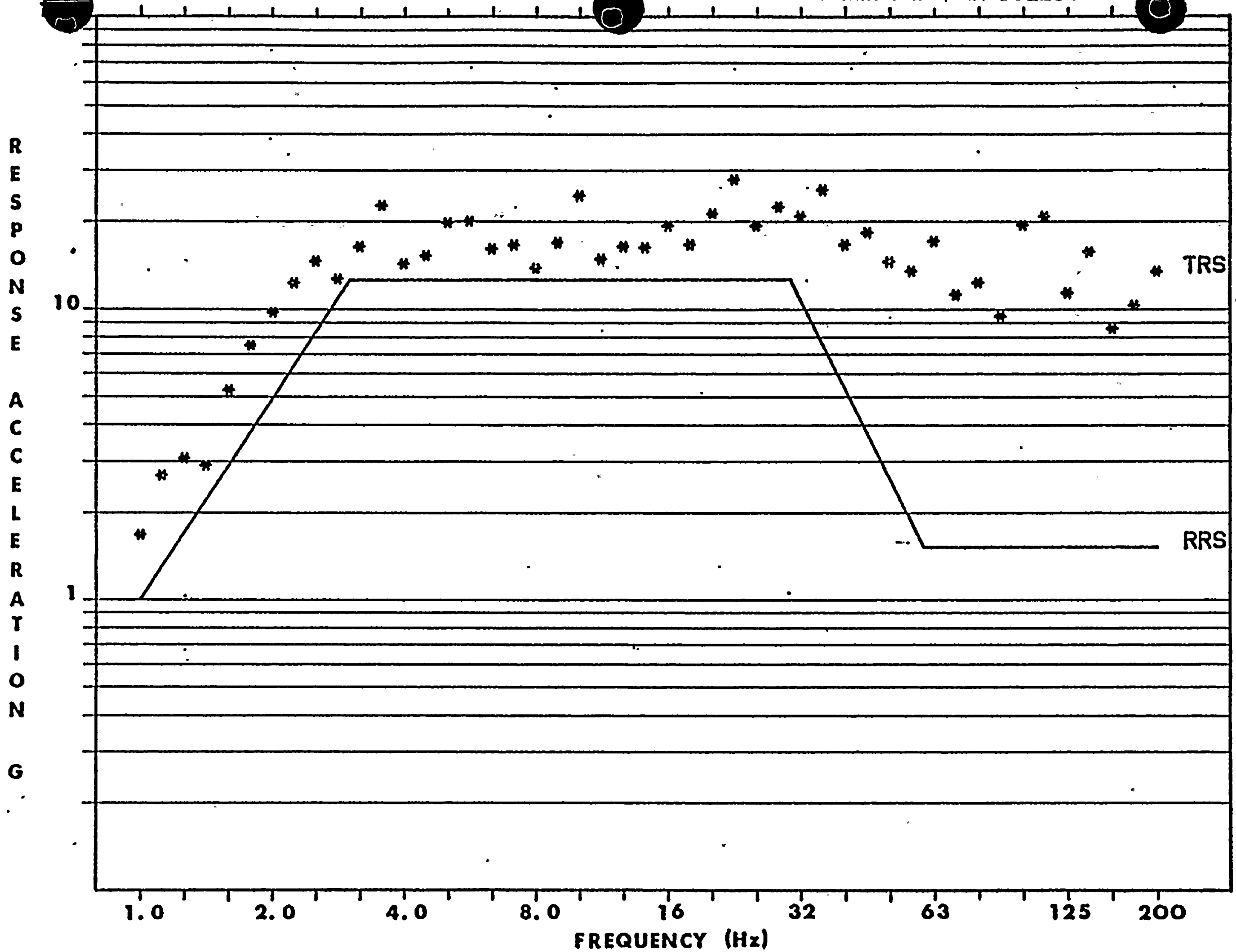
RUN NUMBER.. 12 TRS - VERTICAL (BIAXIAL PAIR NO. 2 IN-PHASE) - SSE
CHANNEL NUMBER.. 2 1.Ø % OF CRITICAL DAMPING

STR-145380-1

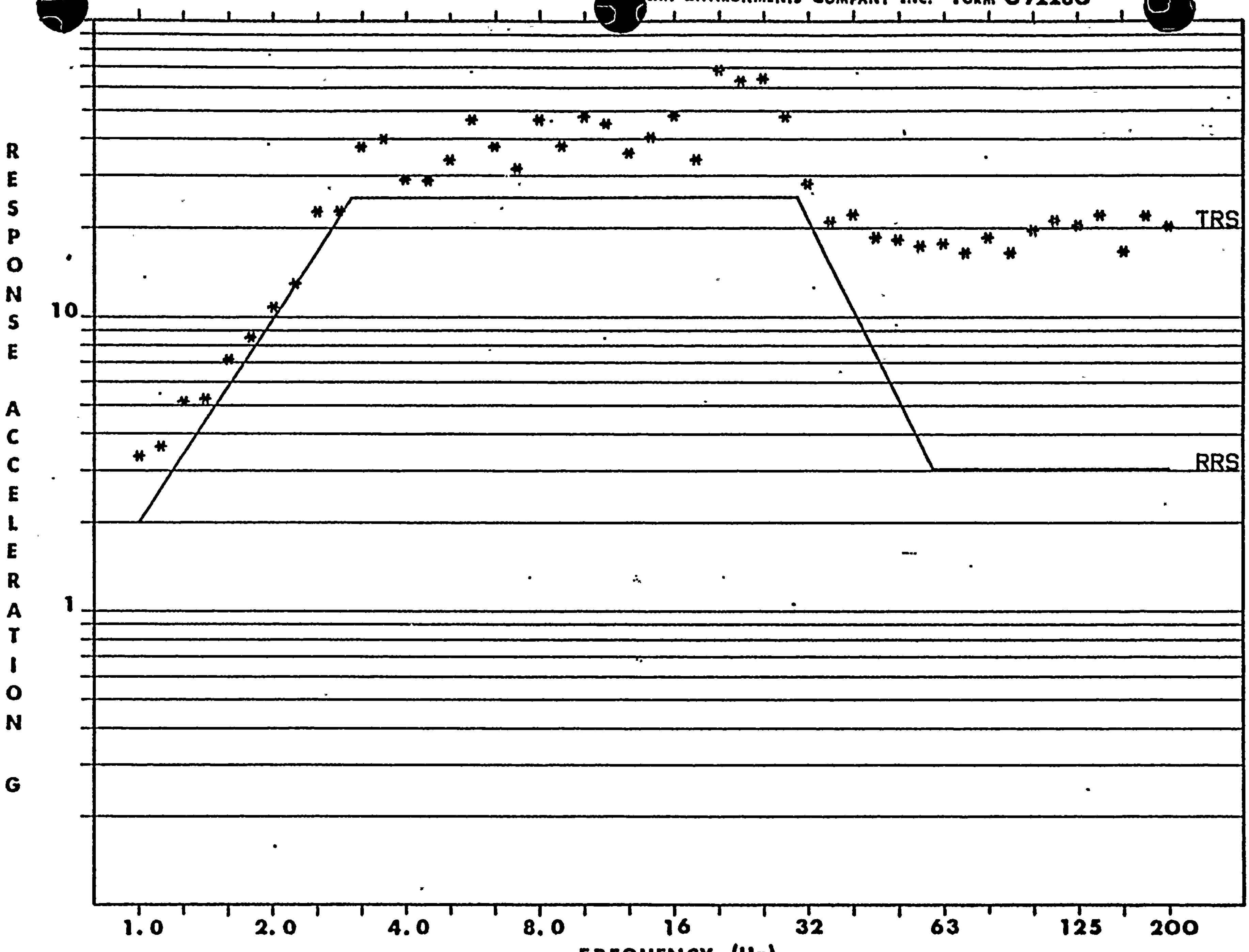


RUN NUMBER.. 17 TRS - HORIZONTAL (BIAXIAL PAIR NO. 1 OUT-OF-PHASE) - OBE
CHANNEL NUMBER.. 1 1.0 % OF CRITICAL DAMPING

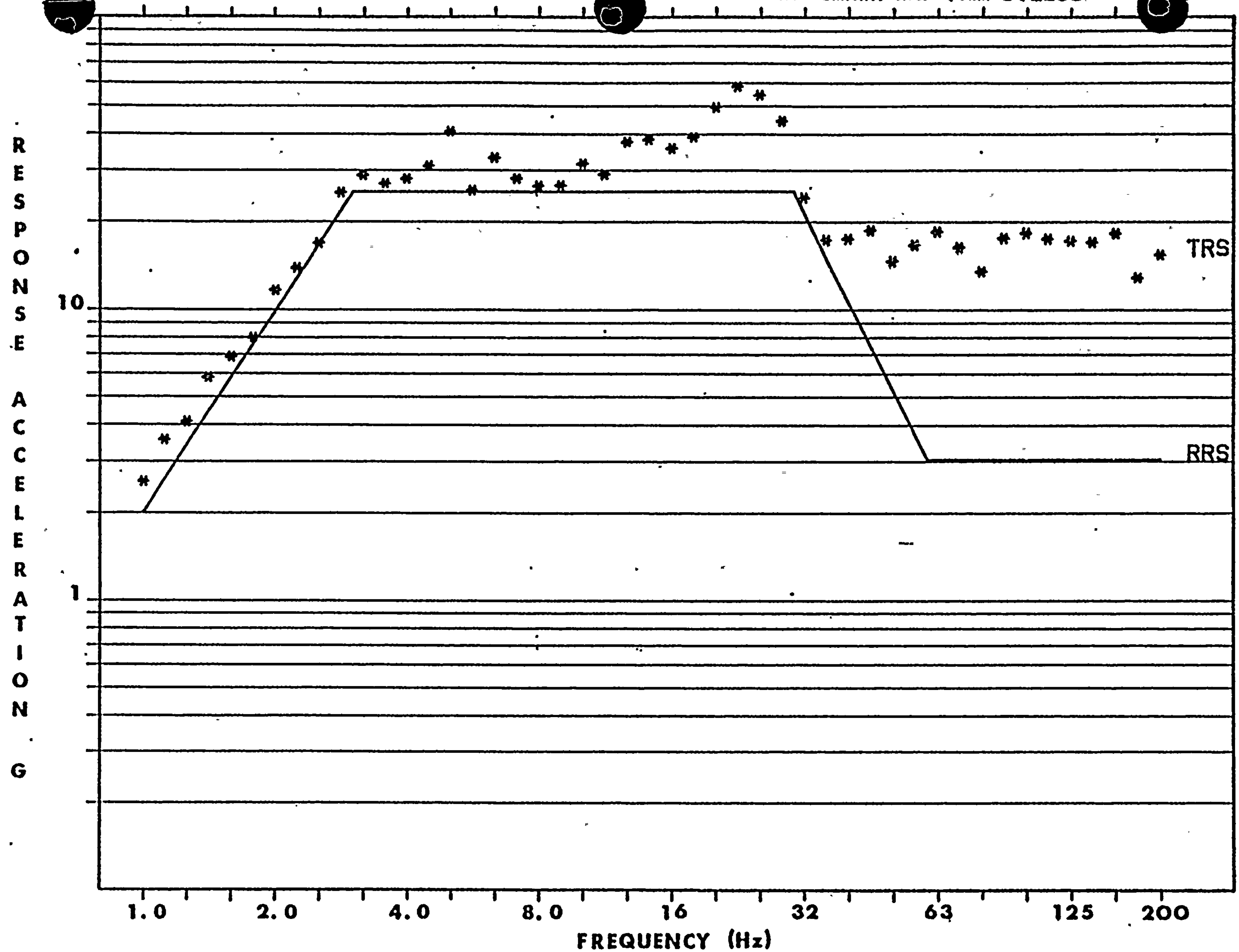
STR-145380-1



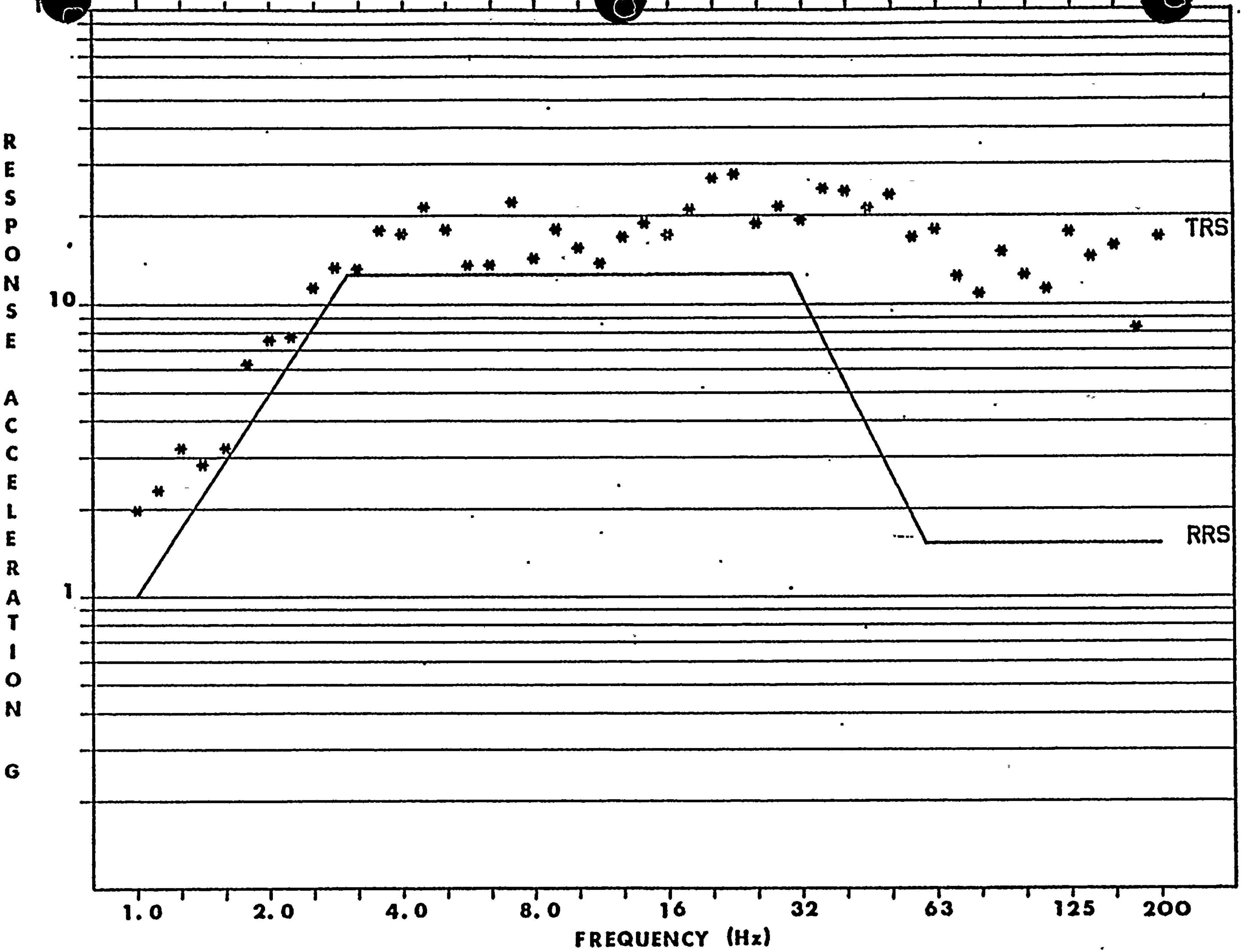
RUN NUMBER.. 17 TRS - VERTICAL (BIAXIAL PAIR NO. 1 OUT-OF-PHASE) - OBE
CHANNEL NUMBER.. 2 1.Ø % OF CRITICAL DAMPING



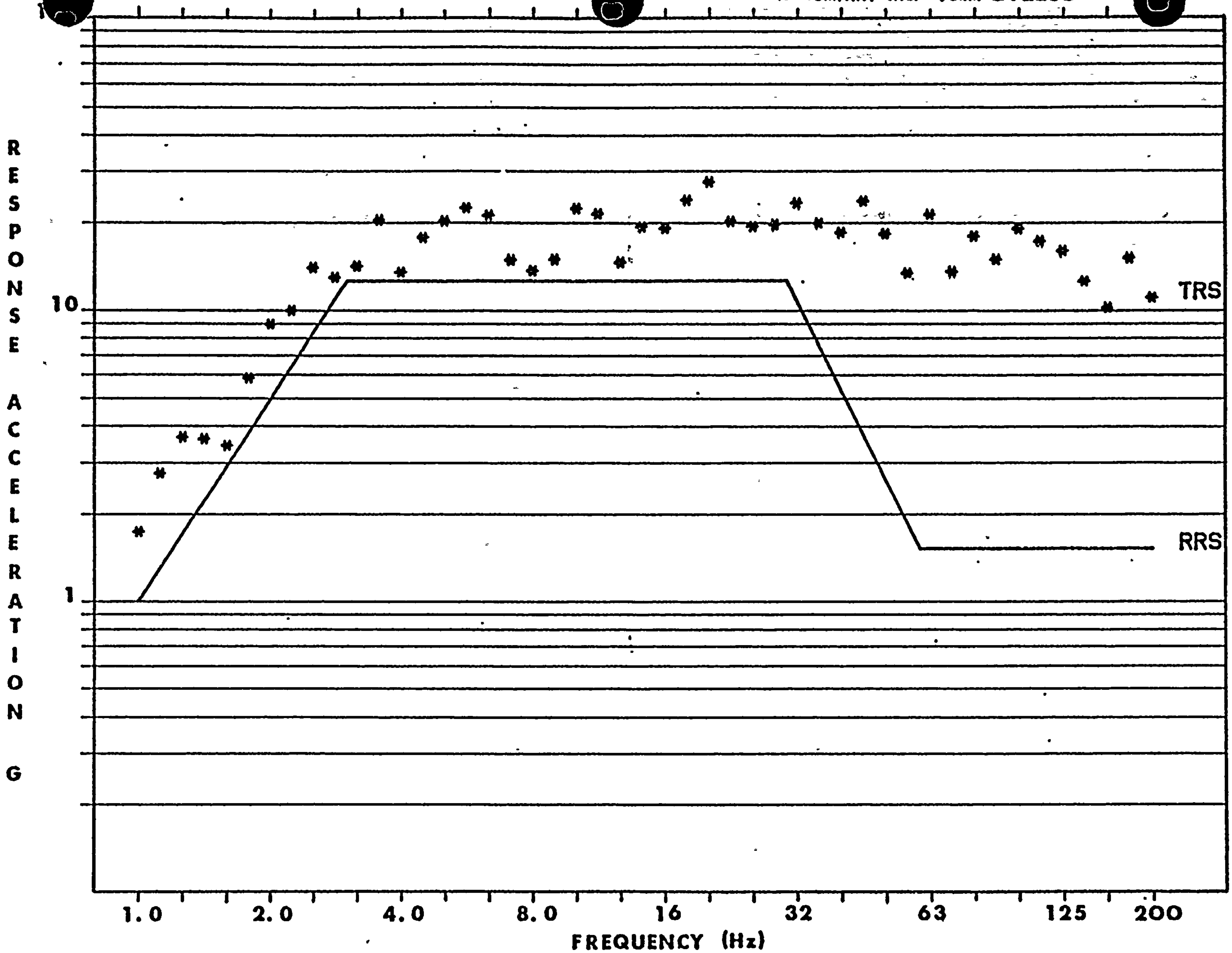
RUN NUMBER.. 18 TRS - HORIZONTAL (BIAXIAL PAIR NO. 1 OUT-OF-PHASE) - SSE
CHANNEL NUMBER.. 1 1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 18 TRS - VERTICAL (BIAXIAL PAIR NO. 1 OUT-OF-PHASE) - SSE
CHANNEL NUMBER.. 2 1.Ø % OF CRITICAL DAMPING

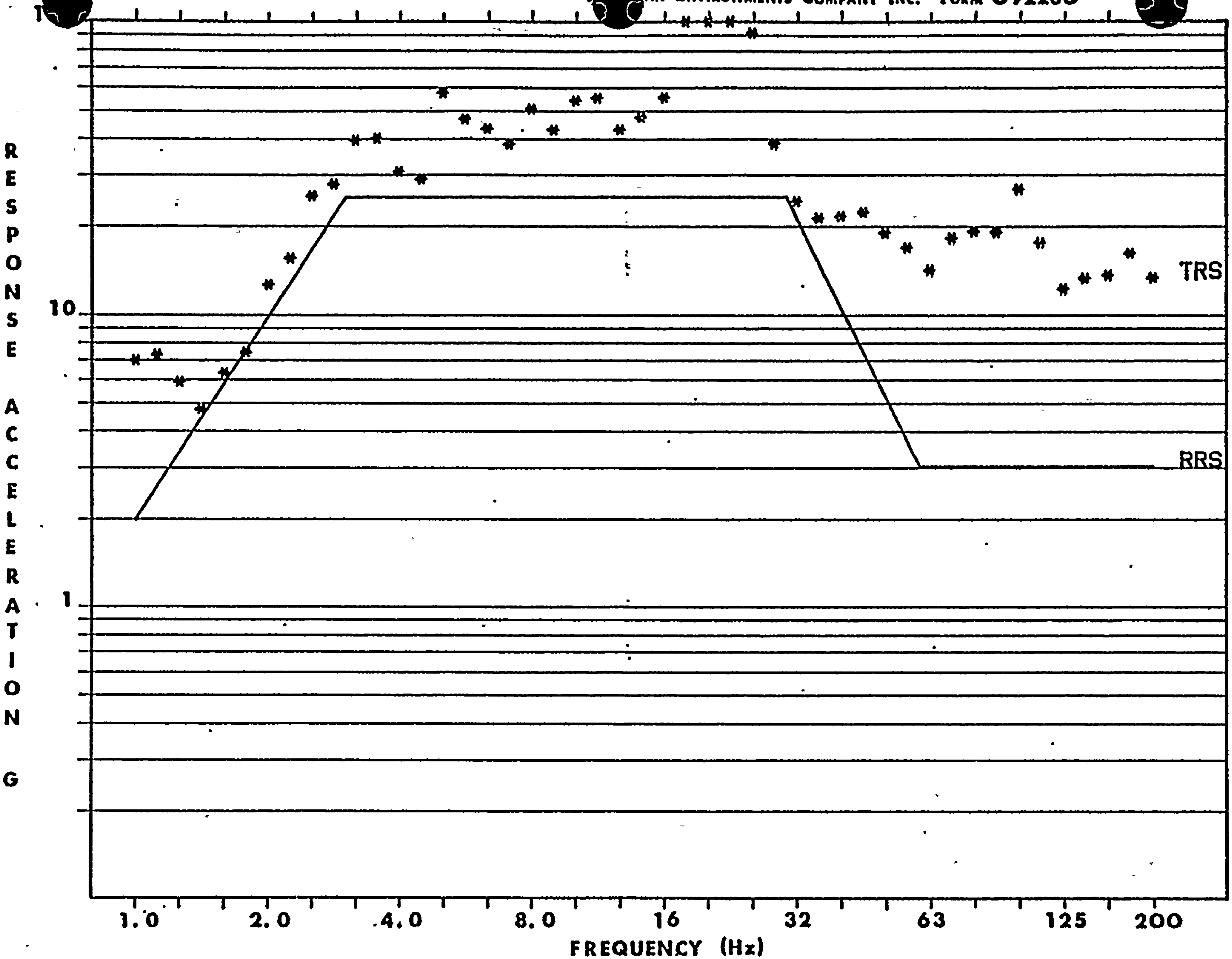


RUN NUMBER.. 23 TRS - HORIZONTAL (BIAXIAL PAIR NO. 1 IN-PHASE) - OBE
CHANNEL NUMBER.. 1 1.0 % OF CRITICAL DAMPING

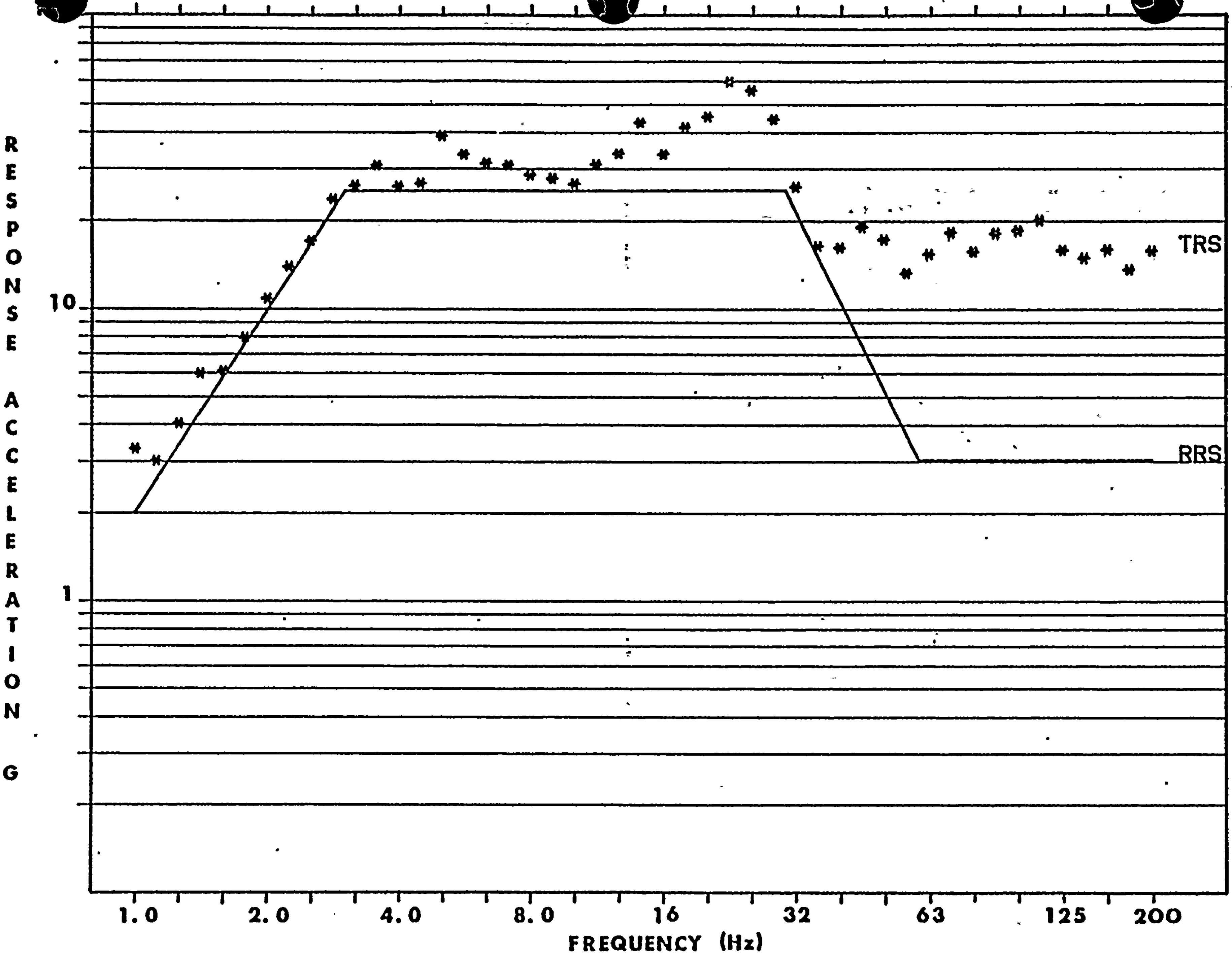


RUN NUMBER.. 23 TRS - VERTICAL (BIAXIAL PAIR NO. 1 IN-PHASE) - OBE
CHANNEL NUMBER.. 2 1.0 % OF CRITICAL DAMPING

STR-145380-1



RUN NUMBER.. 24 TRS - HORIZONTAL (BIAXIAL PAIR NO. 1 IN-PHASE) - SSE
CHANNEL NUMBER.. 1 1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 24 TRS - VERTICAL (BIAXIAL PAIR NO. 1 IN-PHASE) - SSE
CHANNEL NUMBER.. 2 1.0 % OF CRITICAL DAMPING

APPENDIX F

EQUIPMENT RESPONSE SPECTRA

FOR

ELECTRO-MECHANICS INC.

BISTABLE-AUXILIARY TRIP UNITS

NOTE: Typical OBE response data is presented in this appendix. The OBE response data not shown was verified to be consistent with the response data presented.

TABLE I

ACCELEROMETER MOUNTING LOCATIONS

Accelerometer Number	Motion Axis Monitored	Location
1	Horizontal	Control - on Seismic Table
2	Vertical	Control - on Seismic Table
3	Horizontal	Top of the BTU Assembly
4	Vertical	
5	Horizontal	Top of the ATU Assembly
6	Vertical	
7	Horizontal	Top Left Corner of Specimen Near Mounting Screw.
8	Vertical	

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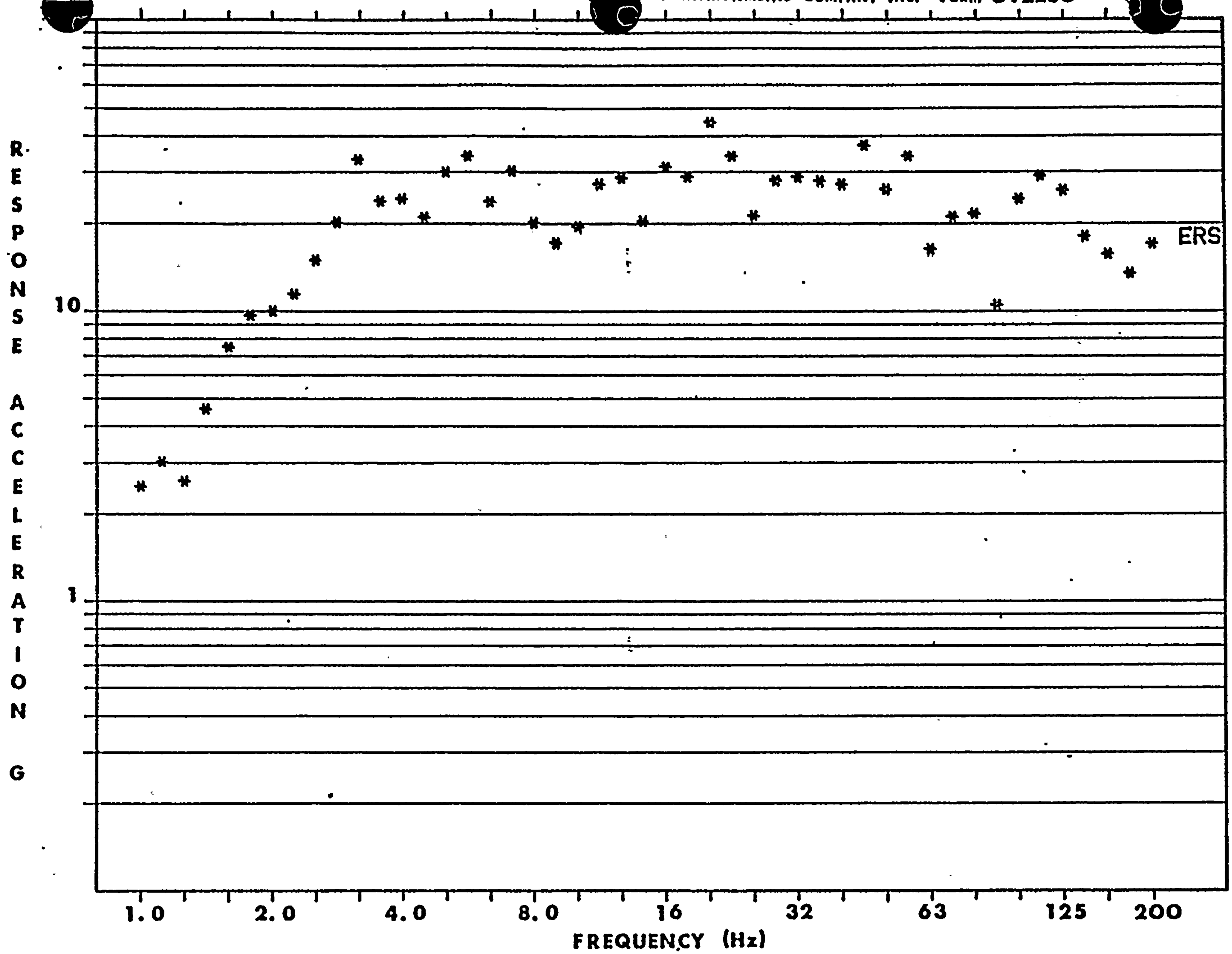
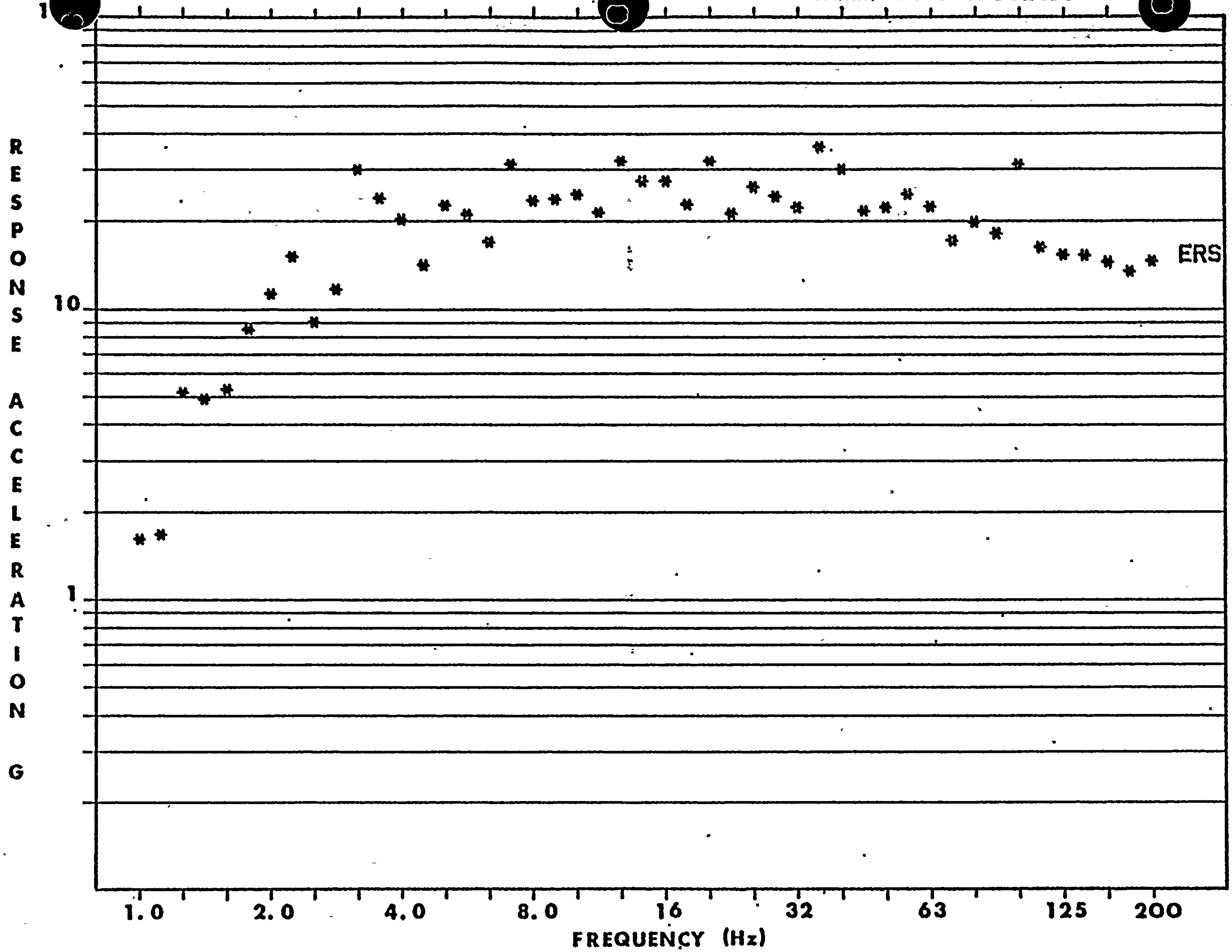


RUN NUMBER.. 5
CHANNEL NUMBER.. 3

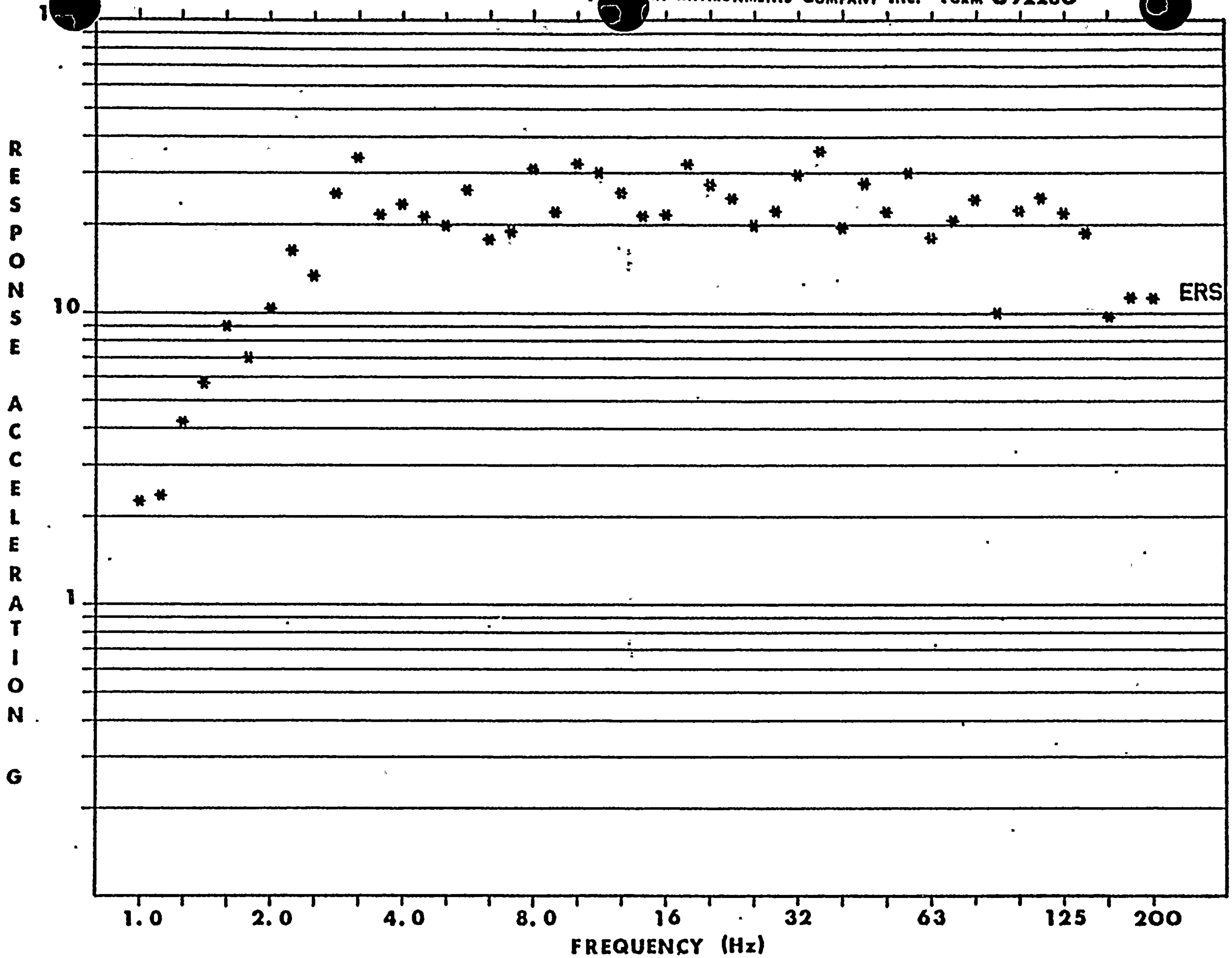
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING

STR-145380-1



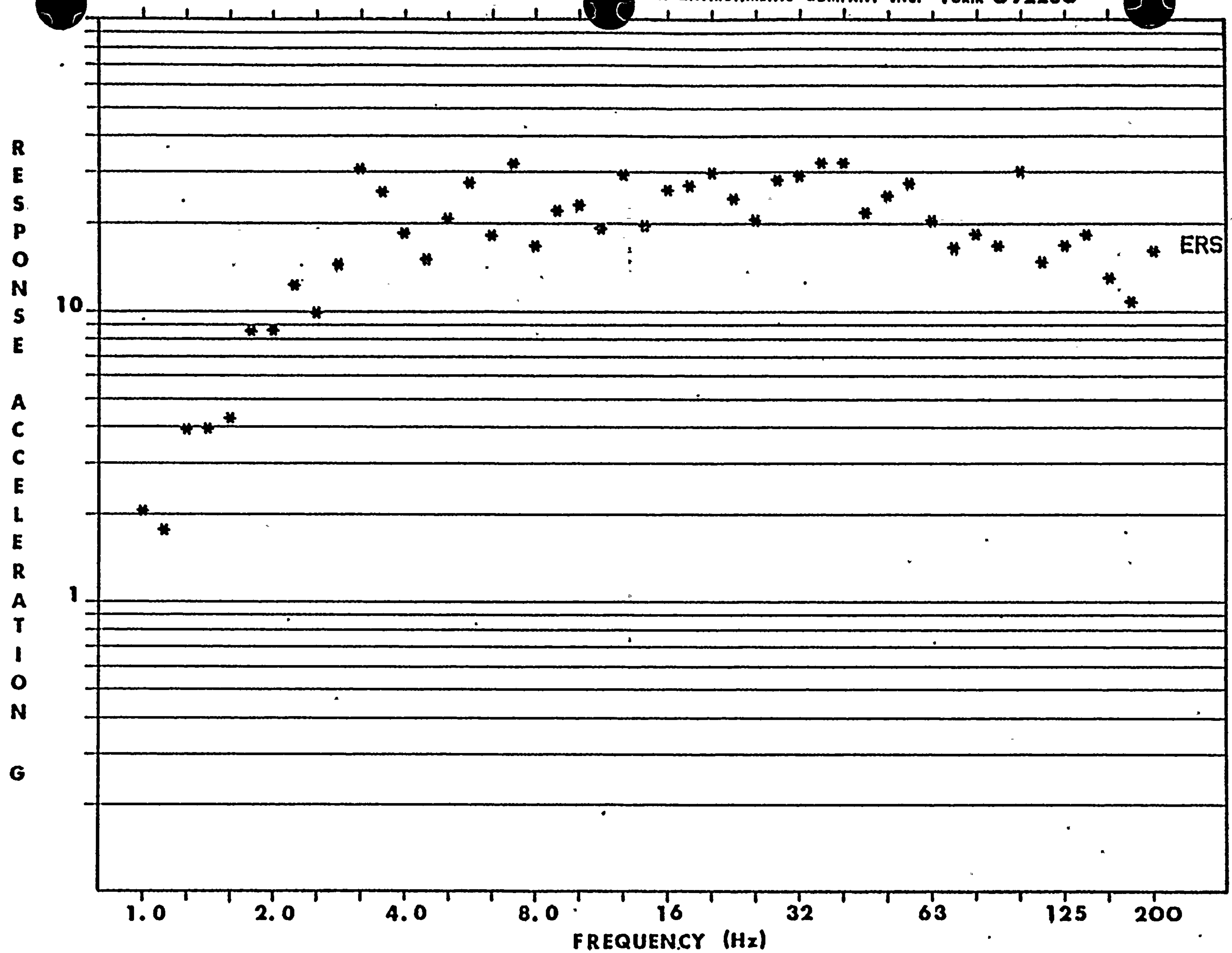
RUN NUMBER.. 5
CHANNEL NUMBER.. 4

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 5
CHANNEL NUMBER.. 5

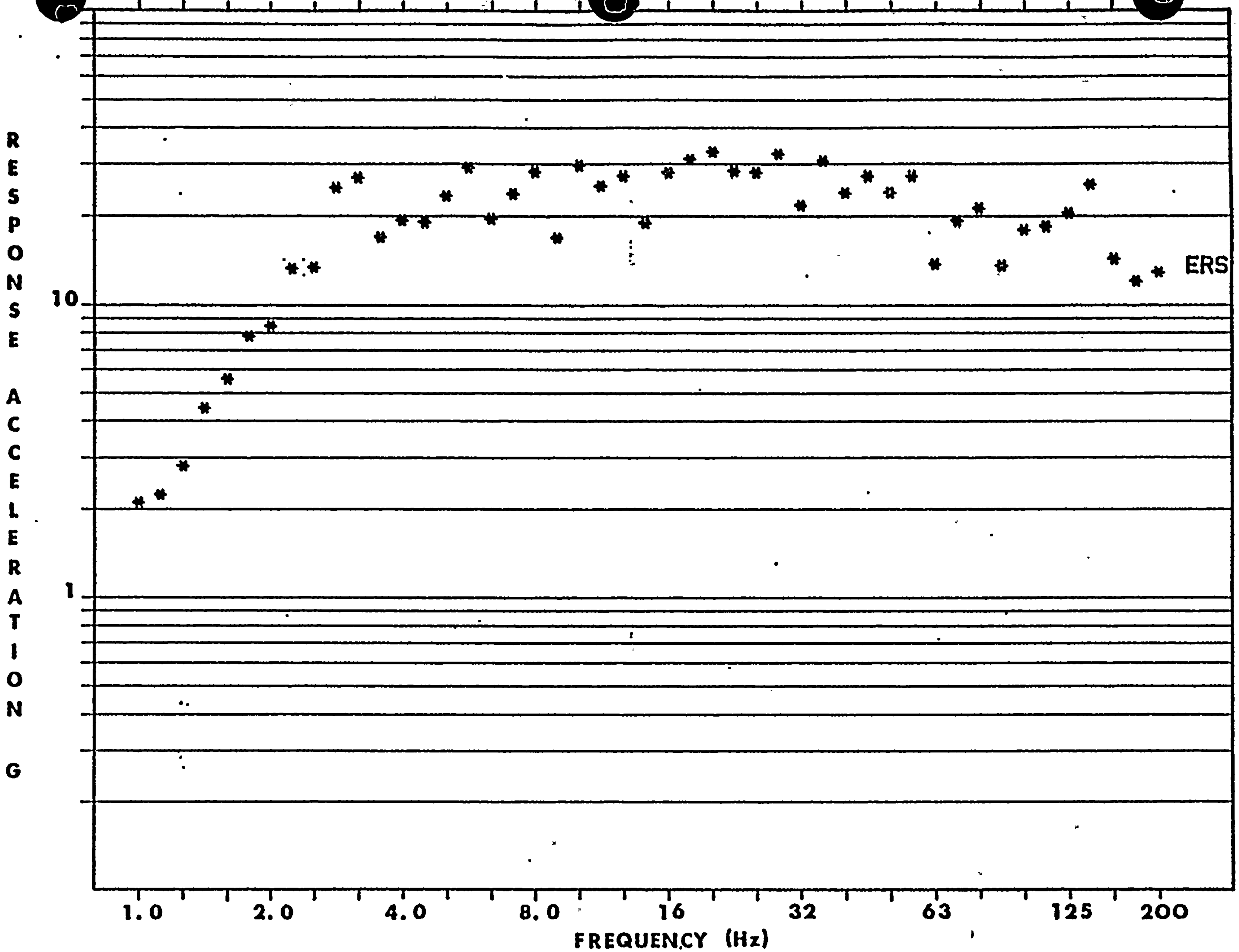
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 5
CHANNEL NUMBER.. 6

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING

STR-145380-1

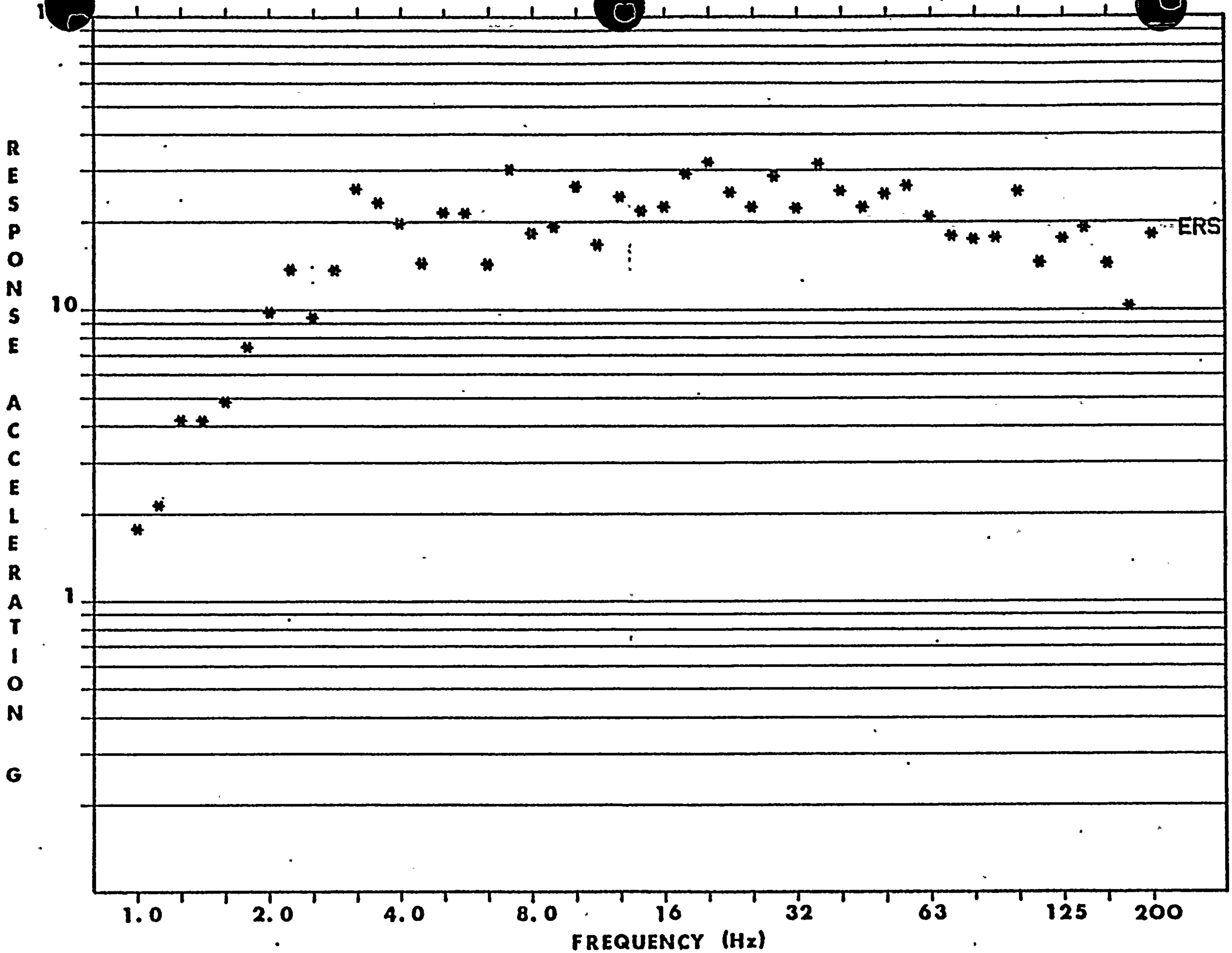


STR-145380-1

RUN NUMBER.. 5
CHANNEL NUMBER.. 7

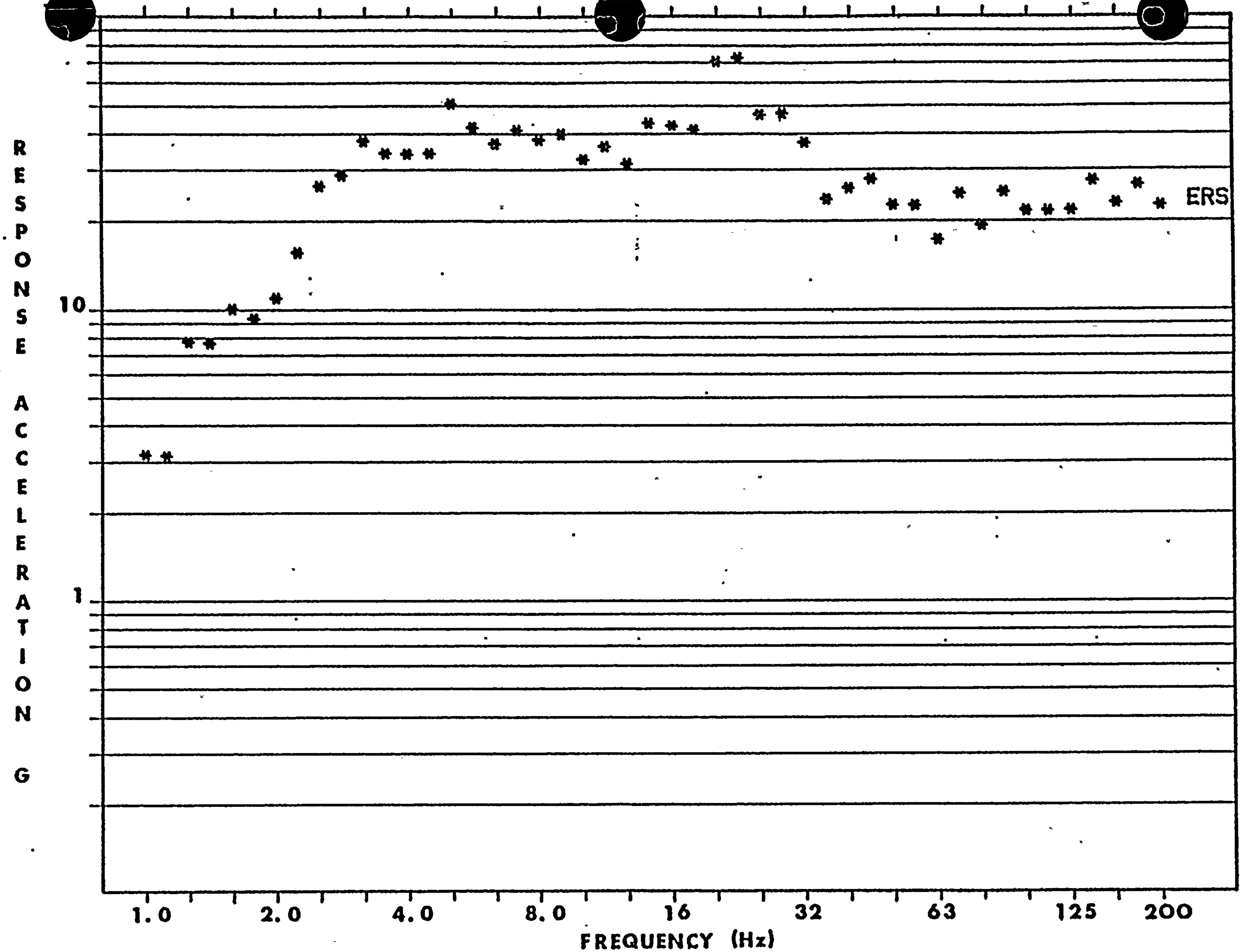
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING

STR-145380-1



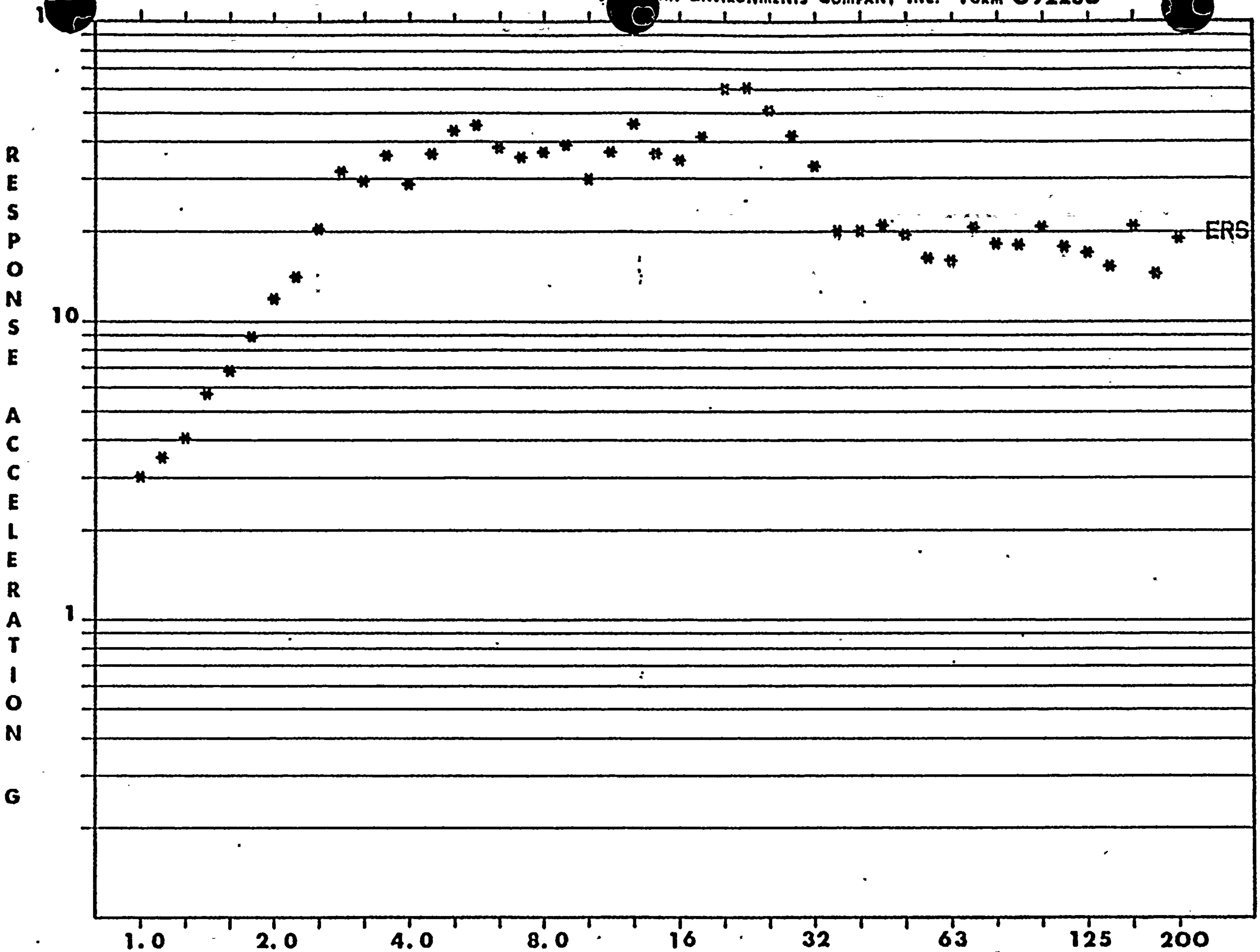
RUN NUMBER.. 5
CHANNEL NUMBER.. 8

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



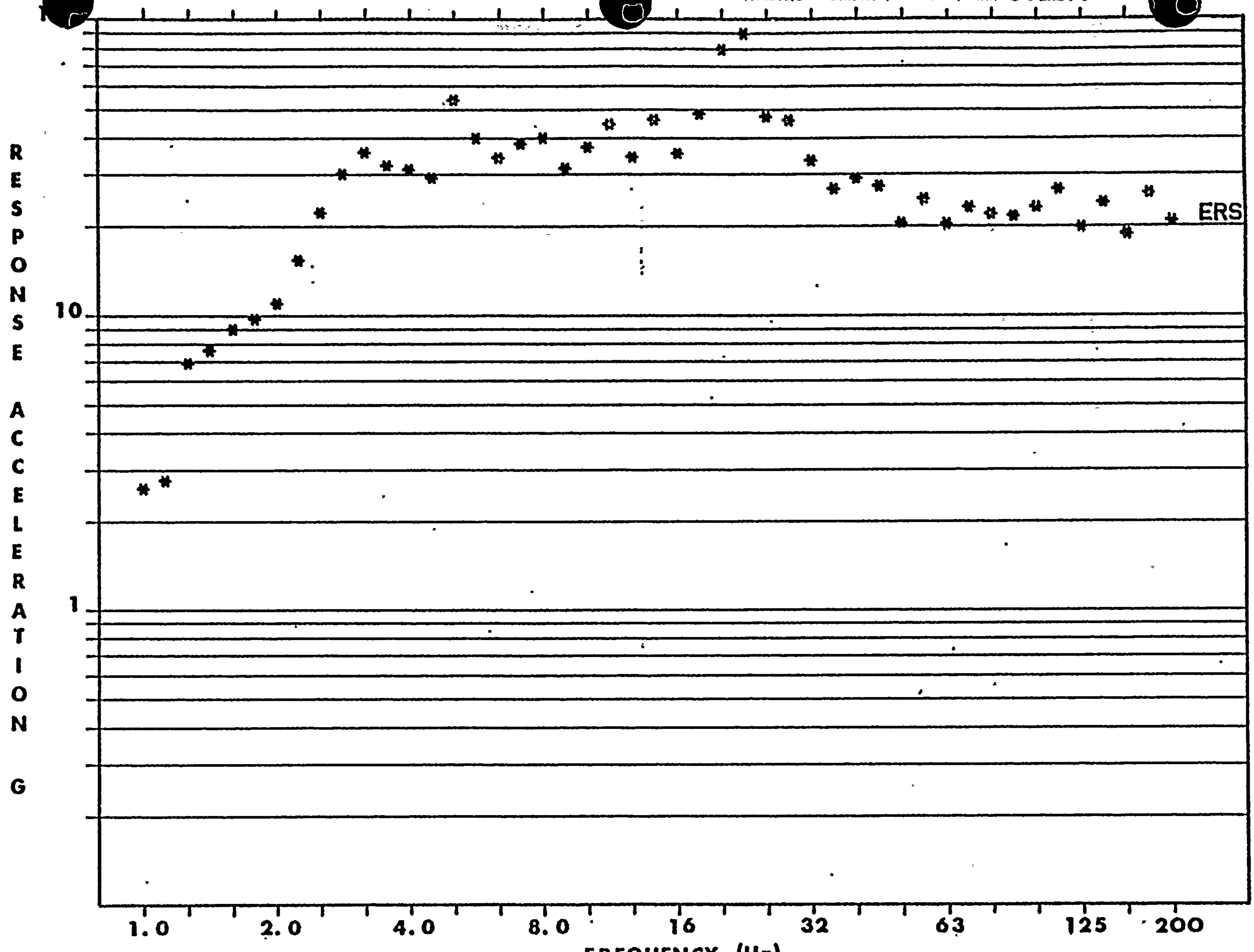
RUN NUMBER.. 6
CHANNEL NUMBER.. 3

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



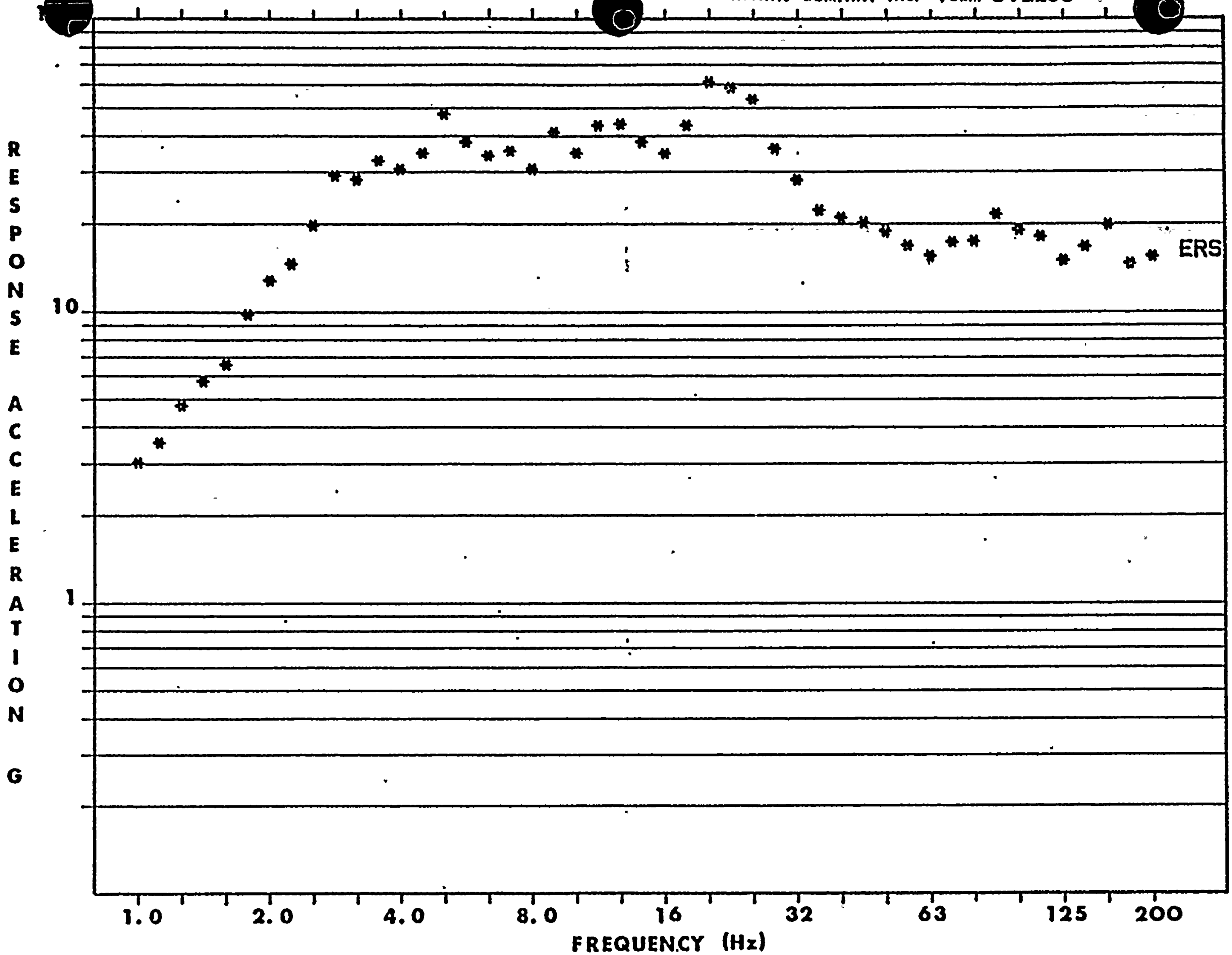
RUN NUMBER.. 6
CHANNEL NUMBER.. 4

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



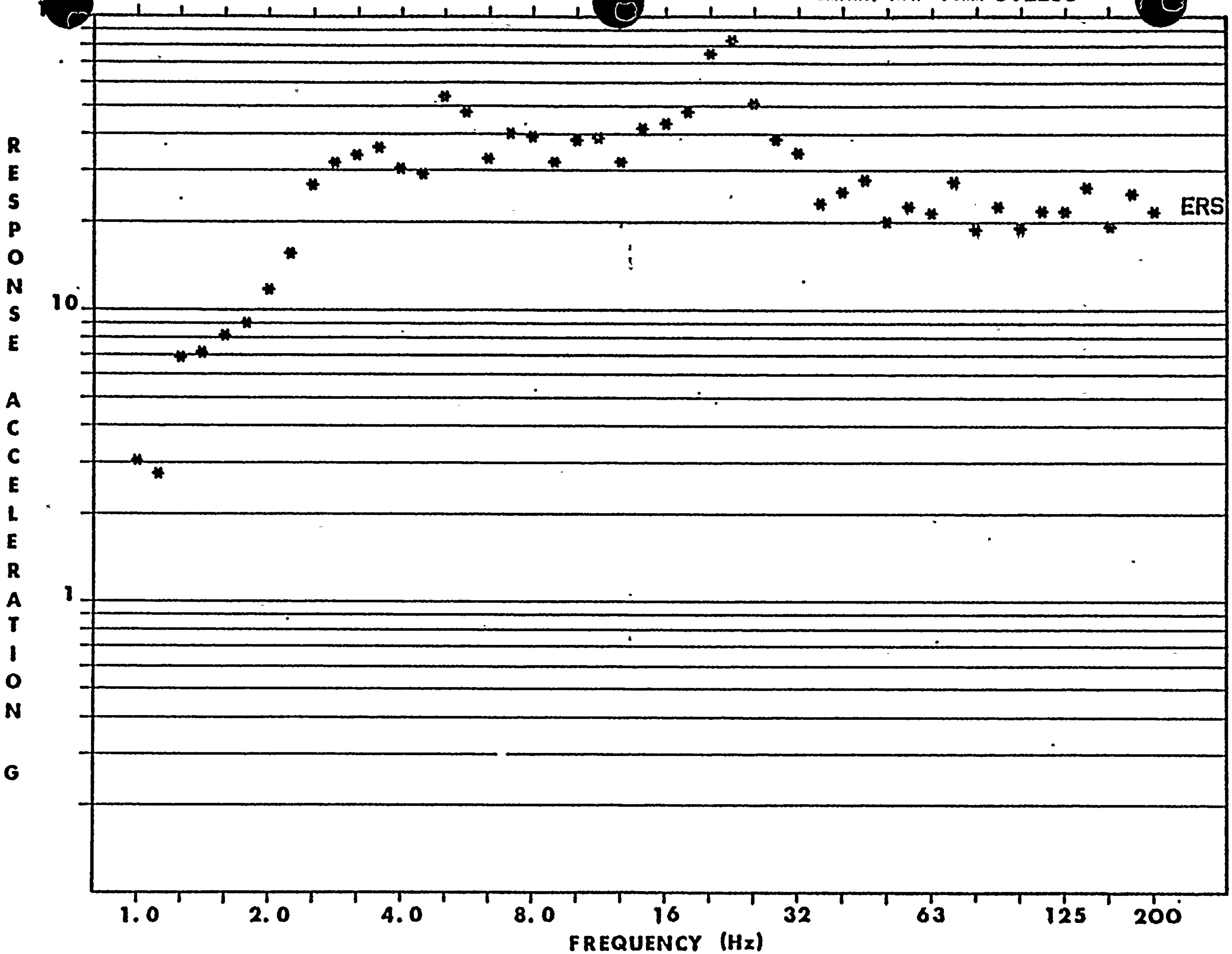
RUN NUMBER.. 6
CHANNEL NUMBER.. 5

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 6
CHANNEL NUMBER.. 6

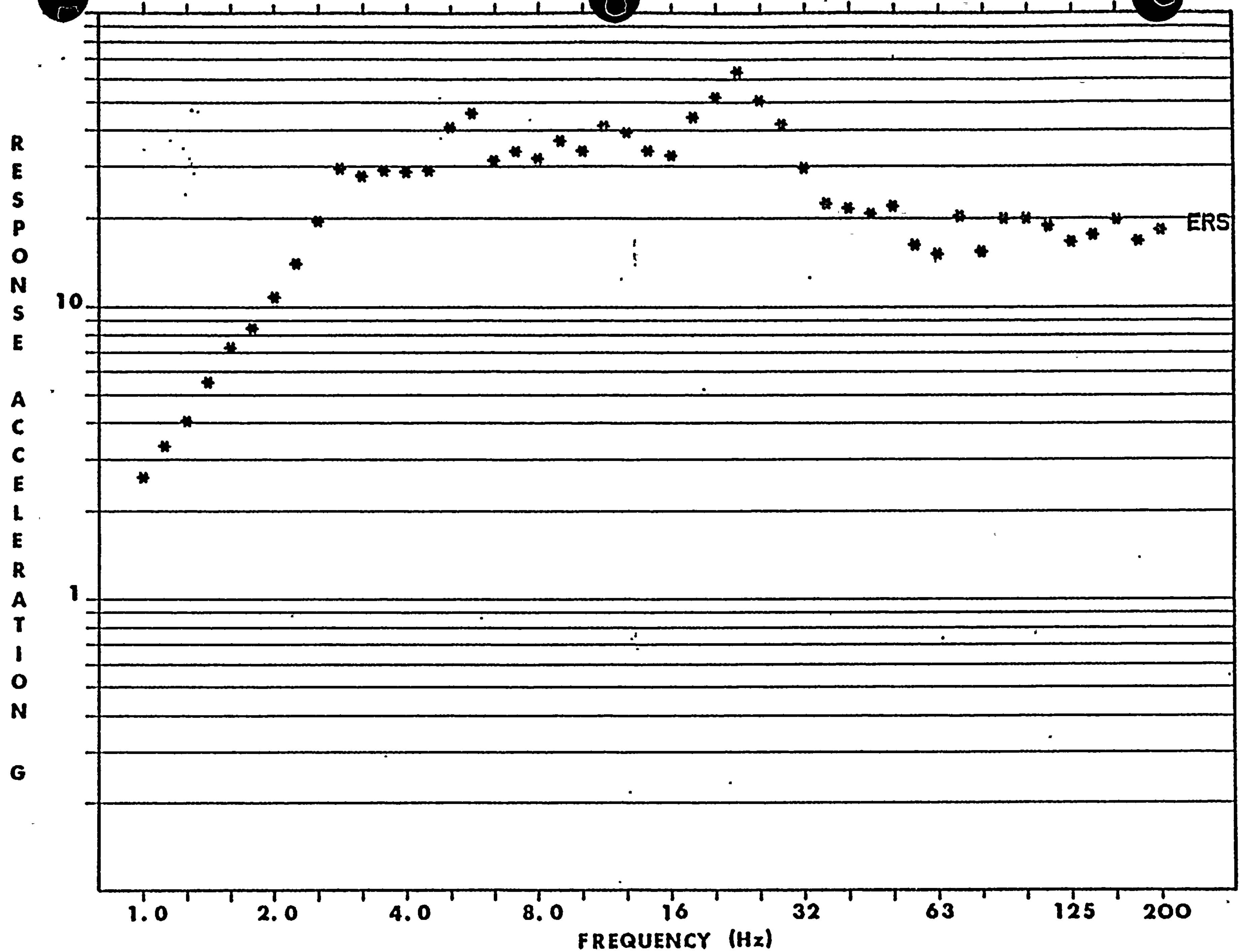
EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 8
CHANNEL NUMBER.. 7

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING

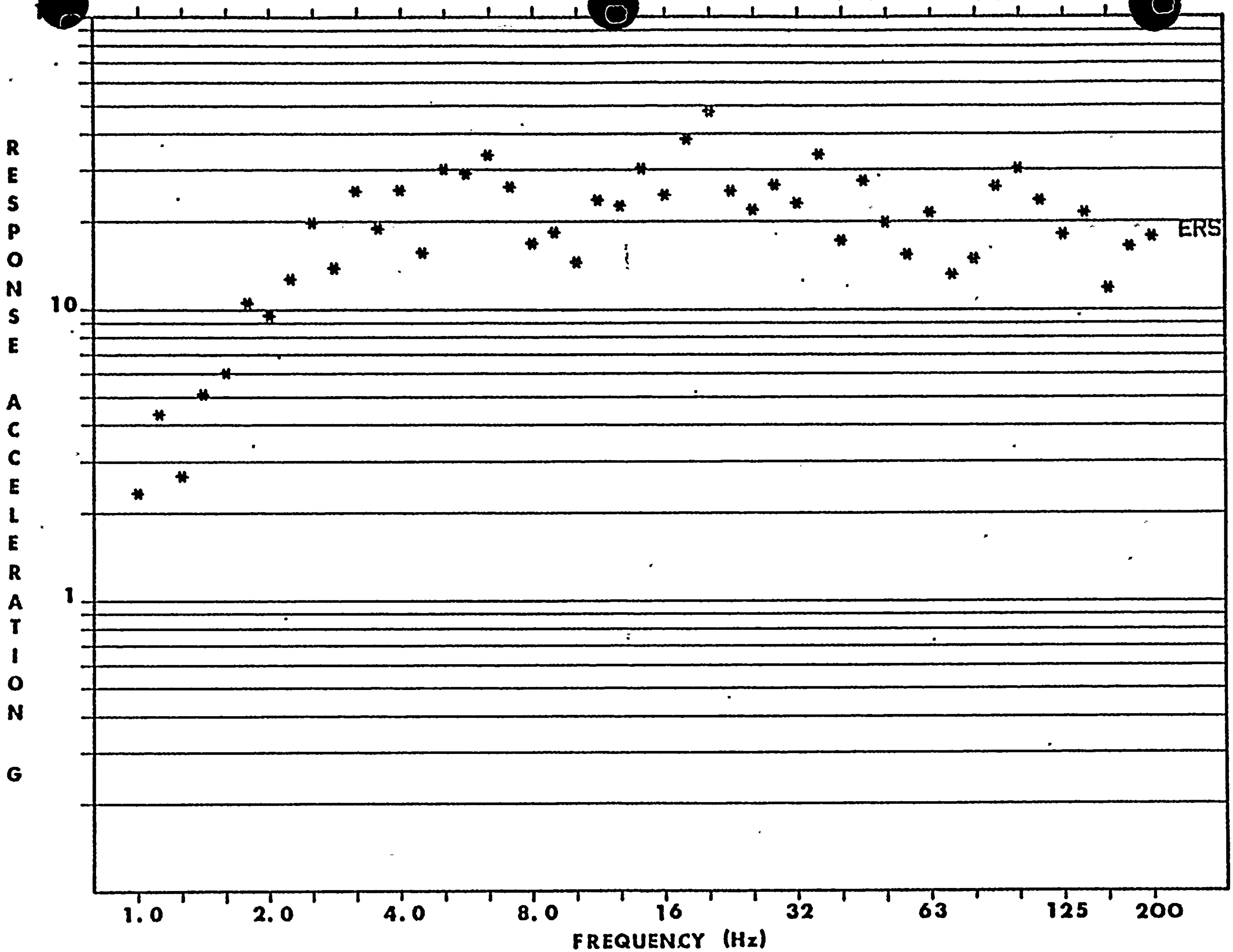
STR-145380-1



STR-145380-1

RUN NUMBER.. 8
CHANNEL NUMBER.. 8

EQUIPMENT RESPONSE SPECTRUM -- SSE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 11
CHANNEL NUMBER.. 3

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING

STR-145380-1

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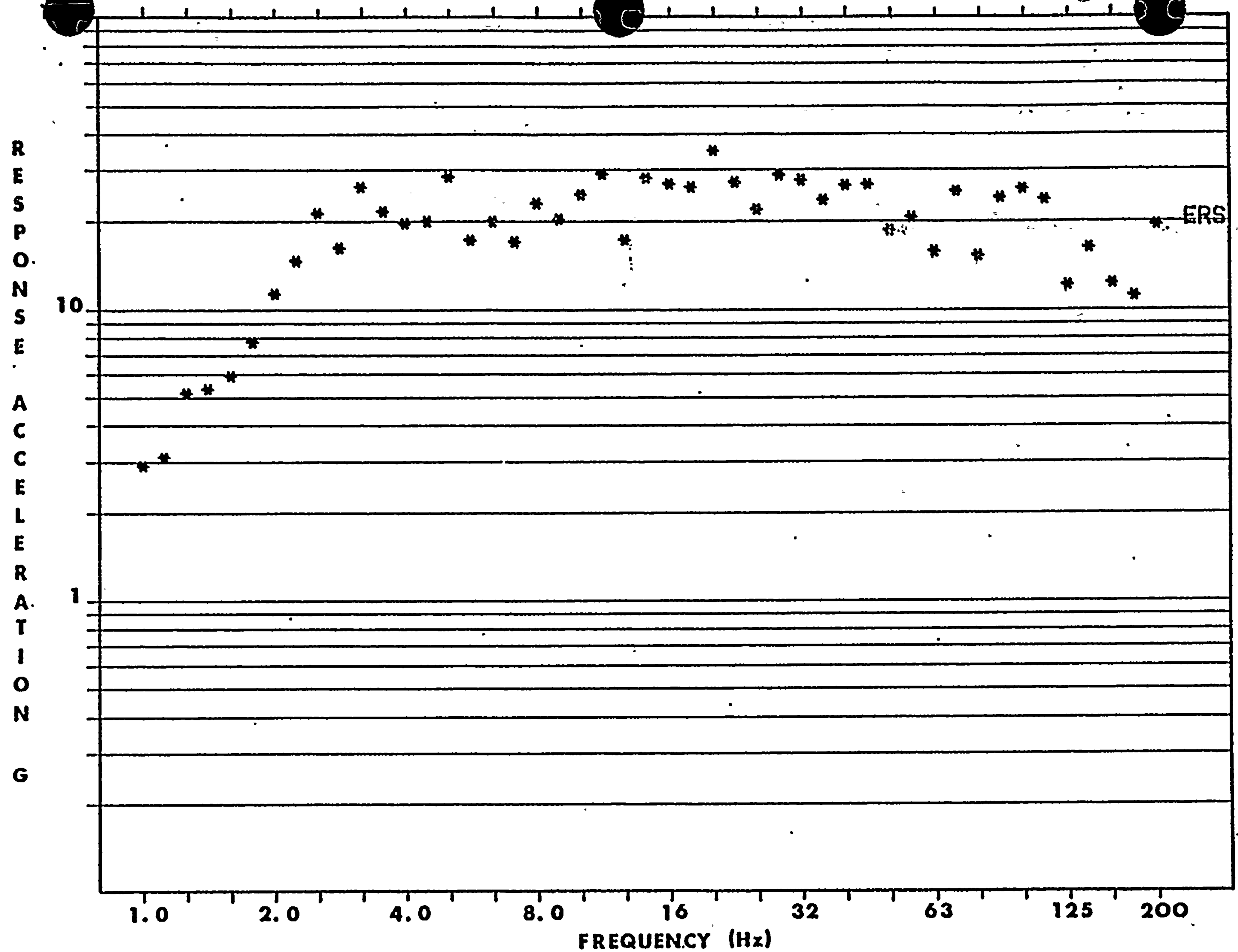
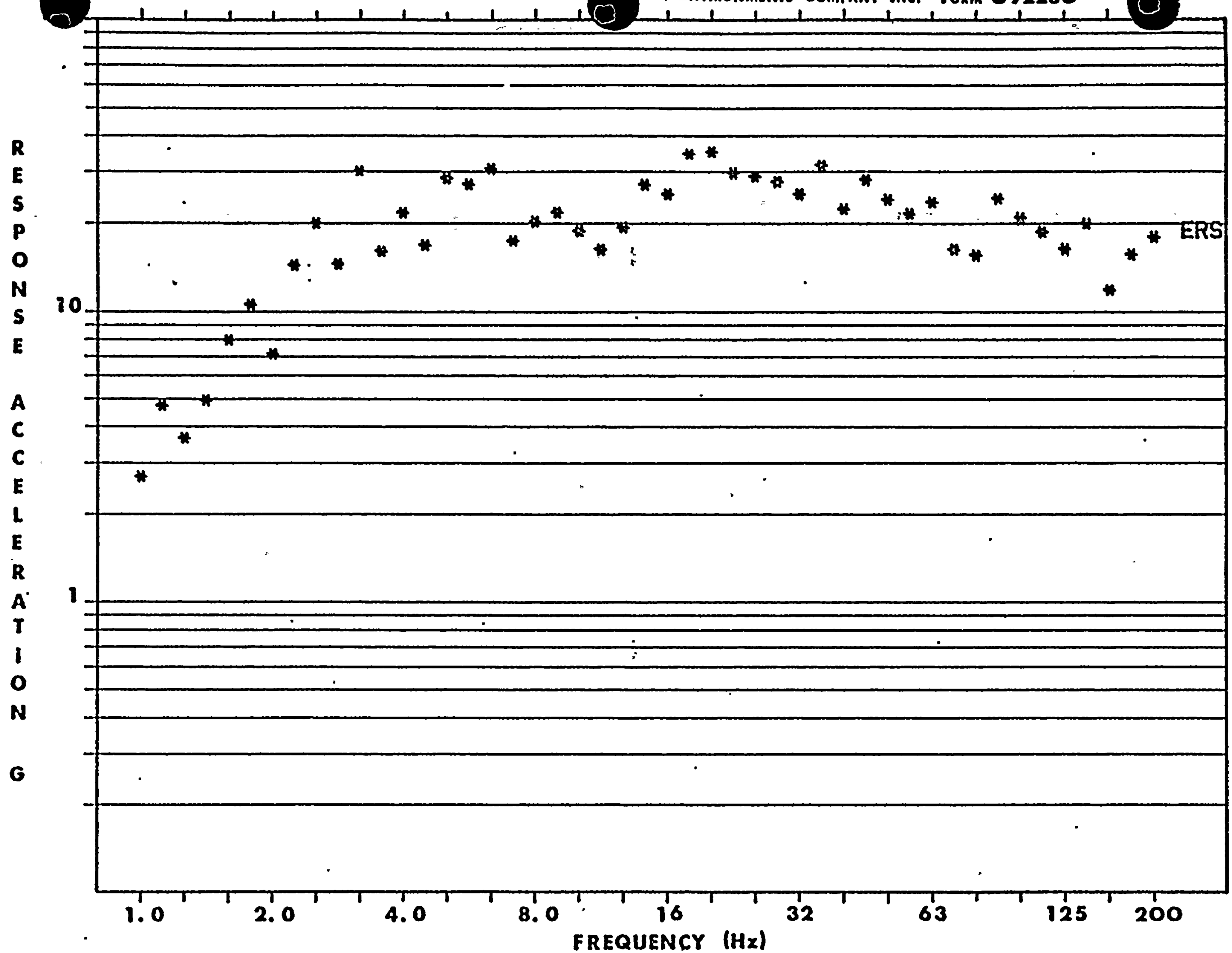


STR-145380-1

RUN NUMBER.. 11
CHANNEL NUMBER.. 4

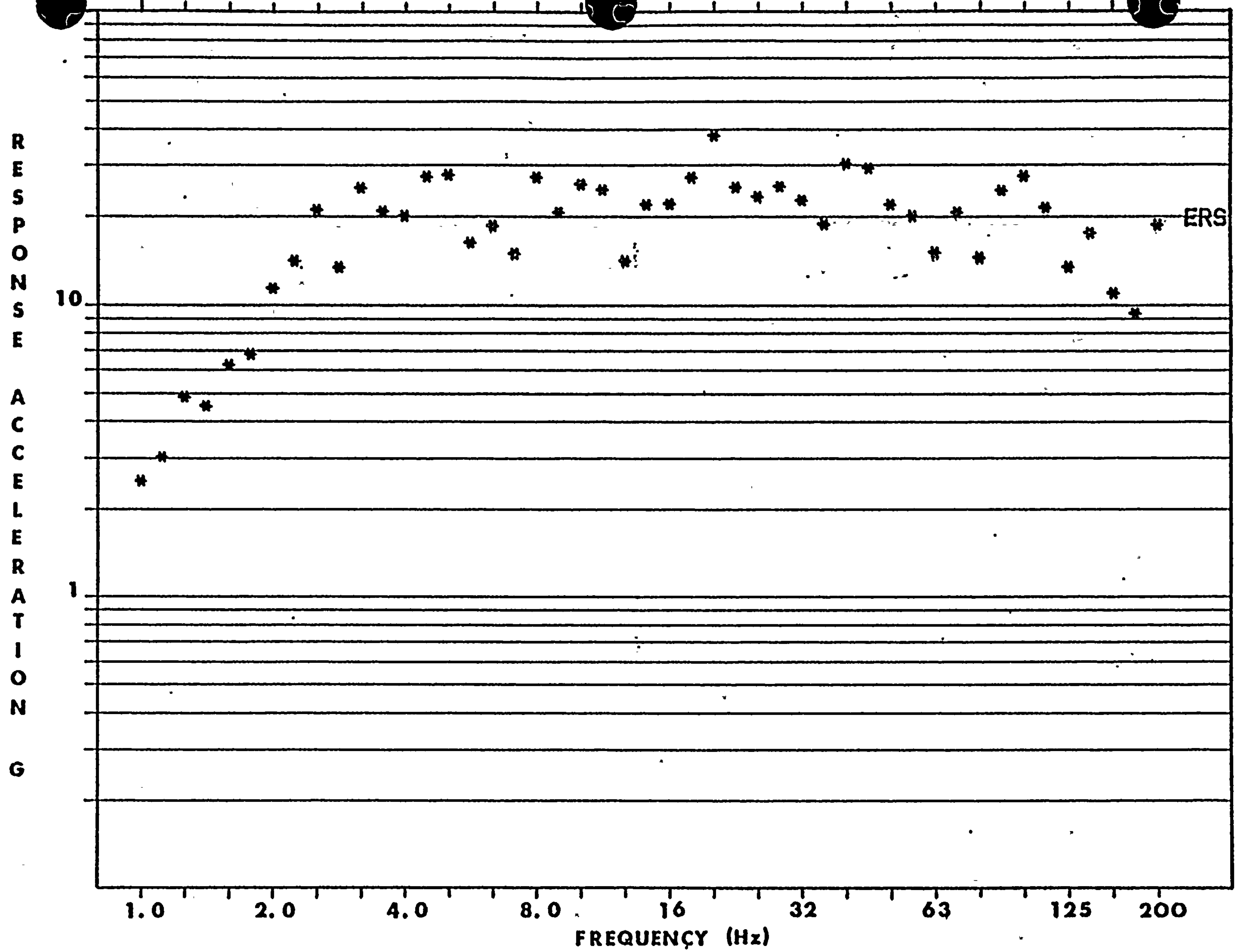
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



STR-145380-1

RUN NUMBER.. 11
CHANNEL NUMBER.. 5

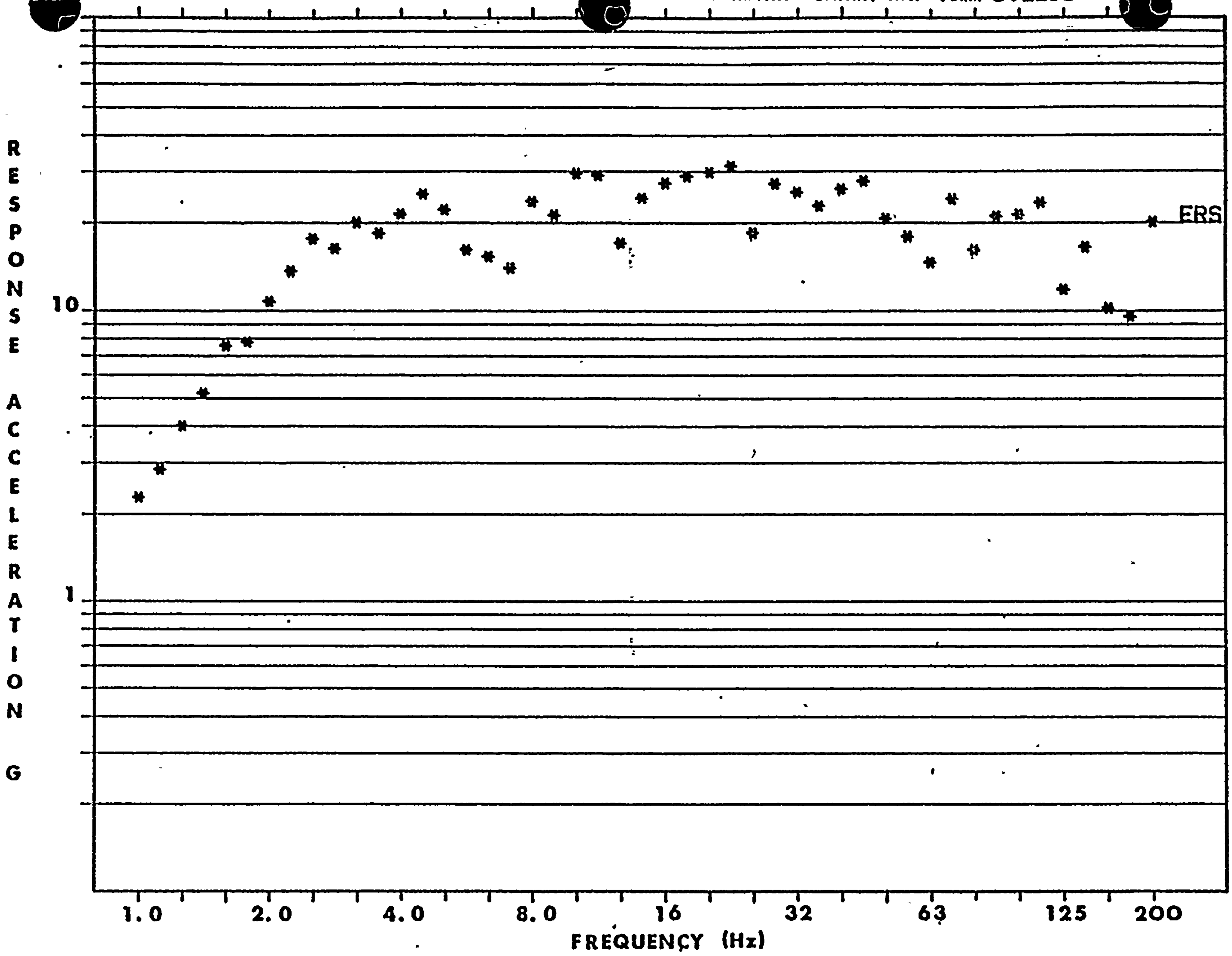
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 11
CHANNEL NUMBER.. 6

EQUIPMENT RESPONSE SPECTRUM - OBE
1.Ø % OF CRITICAL DAMPING

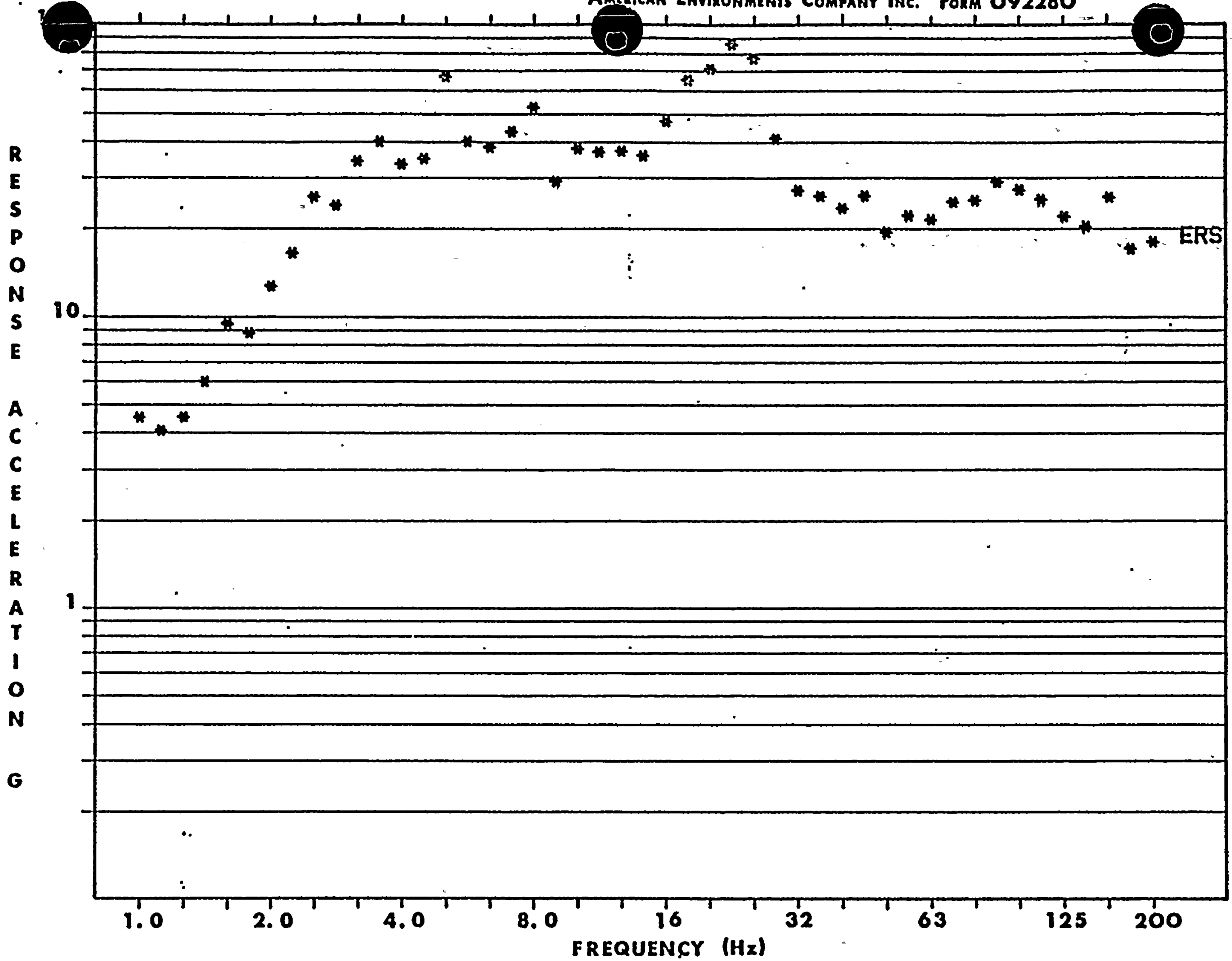
STR-145380-1



RUN NUMBER.. 11
CHANNEL NUMBER.. 8

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING

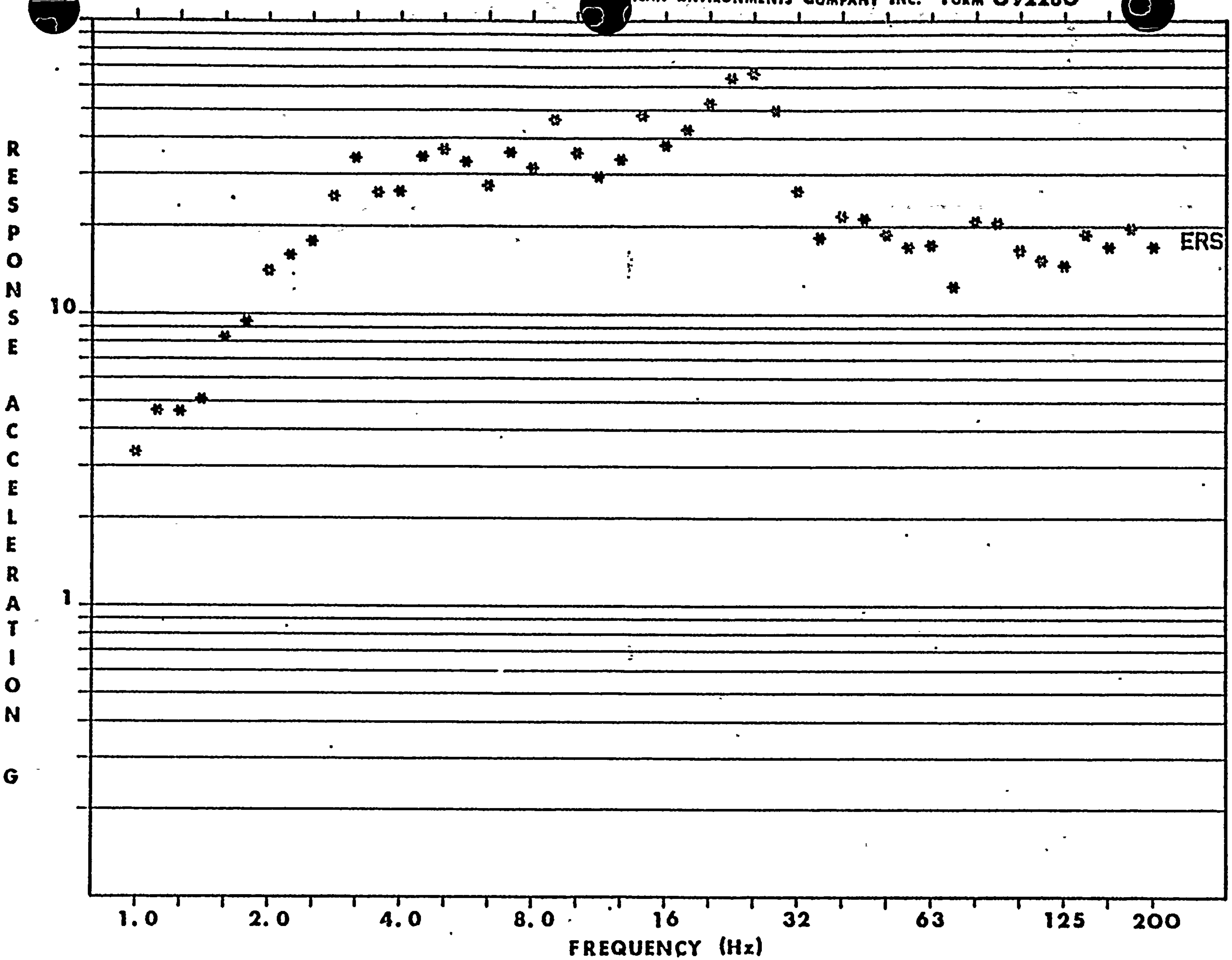
STR-145380-1



RUN NUMBER.. 12
CHANNEL NUMBER.. 3

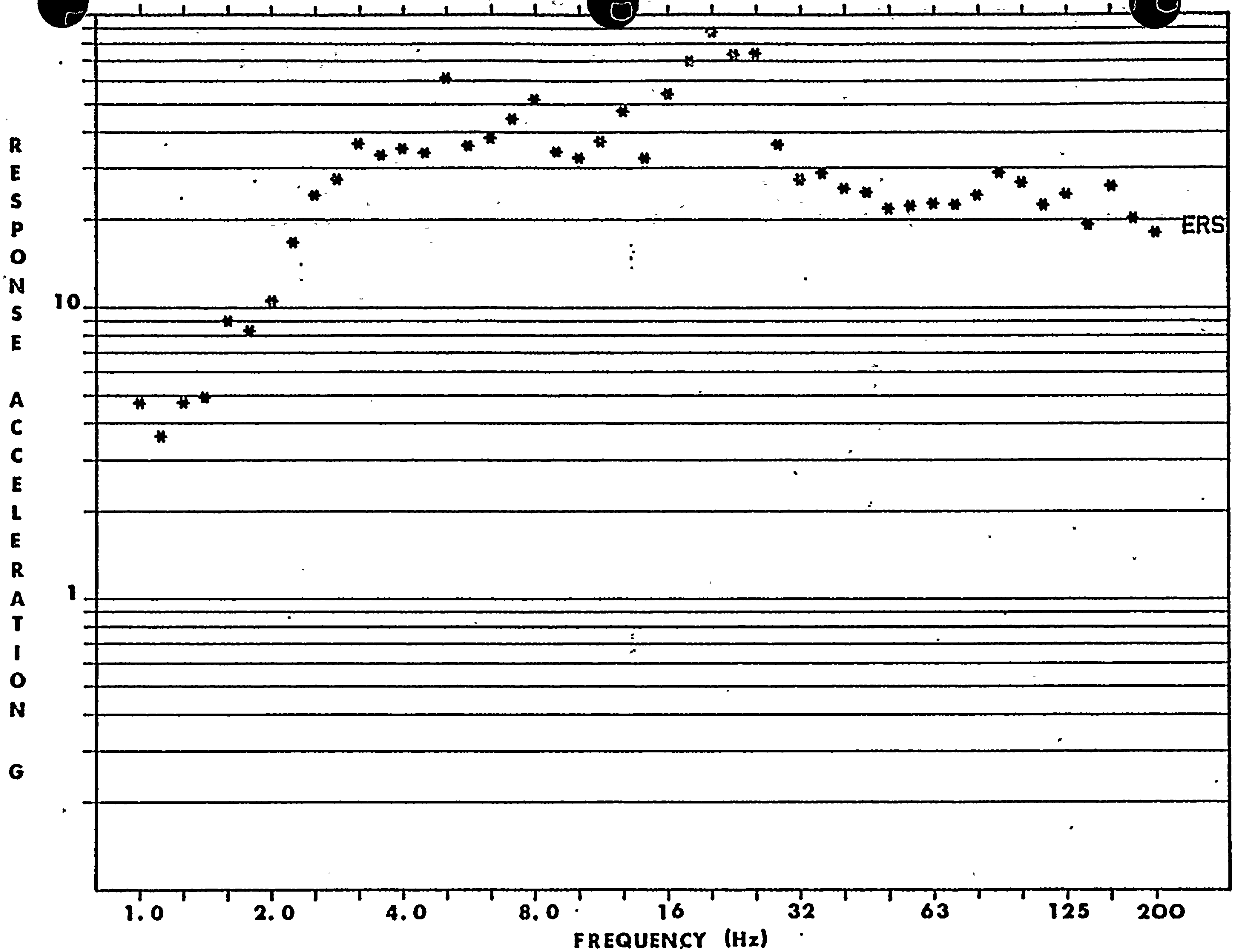
EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING

STR-145380-1



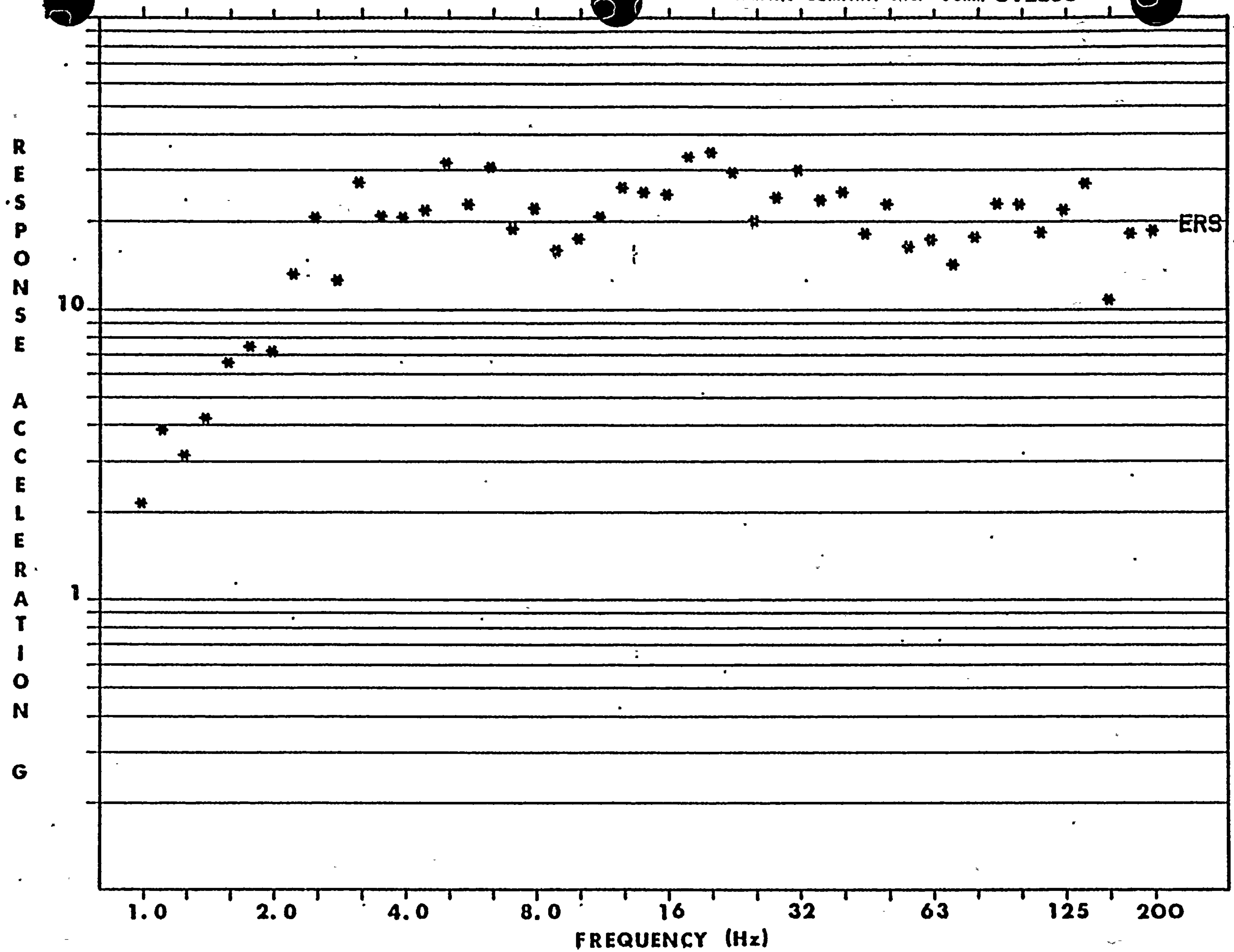
RUN NUMBER.. 12
CHANNEL NUMBER.. 4

EQUIPMENT RESPONSE SPECTRUM - SSE
1.Ø % OF CRITICAL DAMPING



RUN NUMBER.. 12
CHANNEL NUMBER.. 5

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 11
CHANNEL NUMBER.. 7

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING

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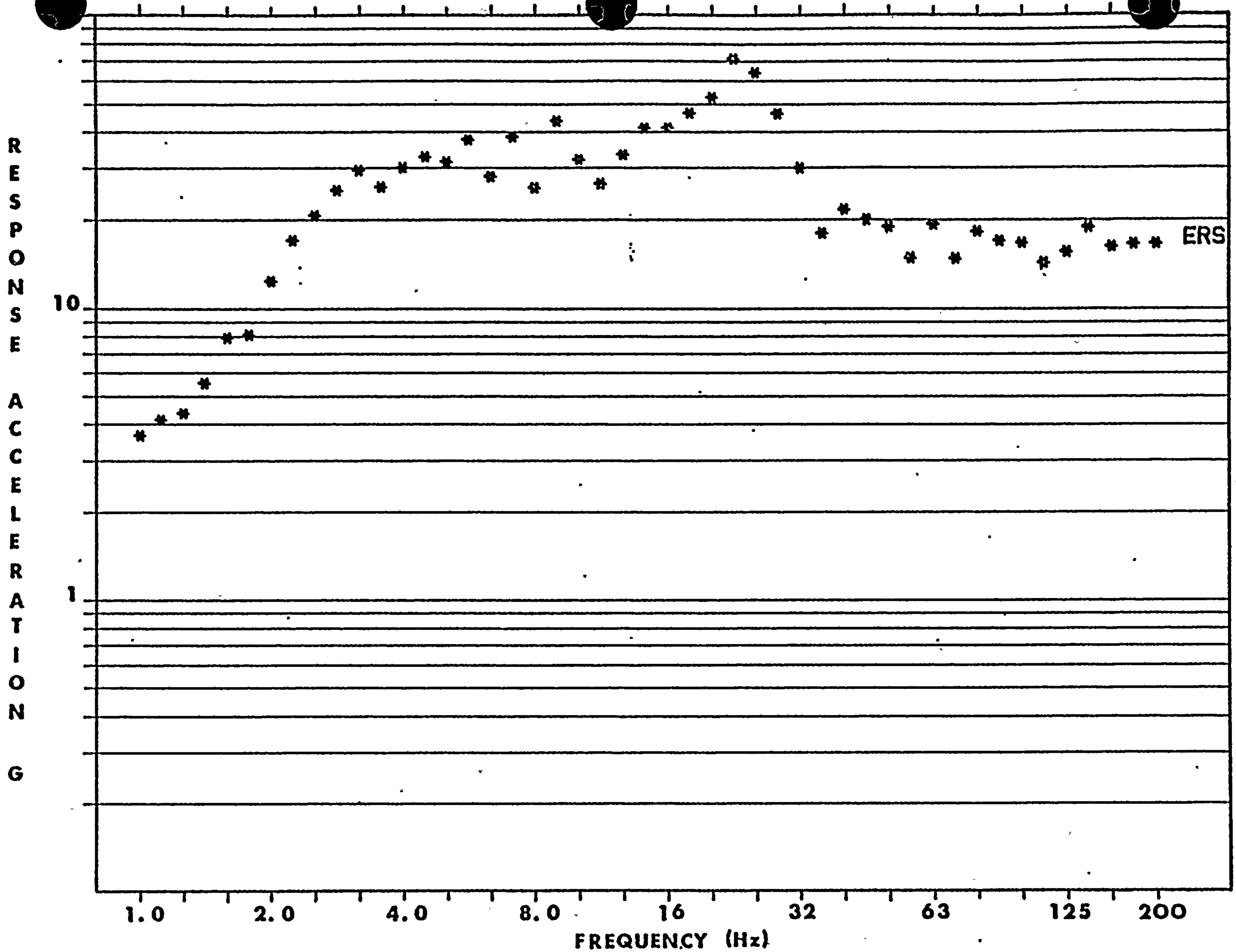
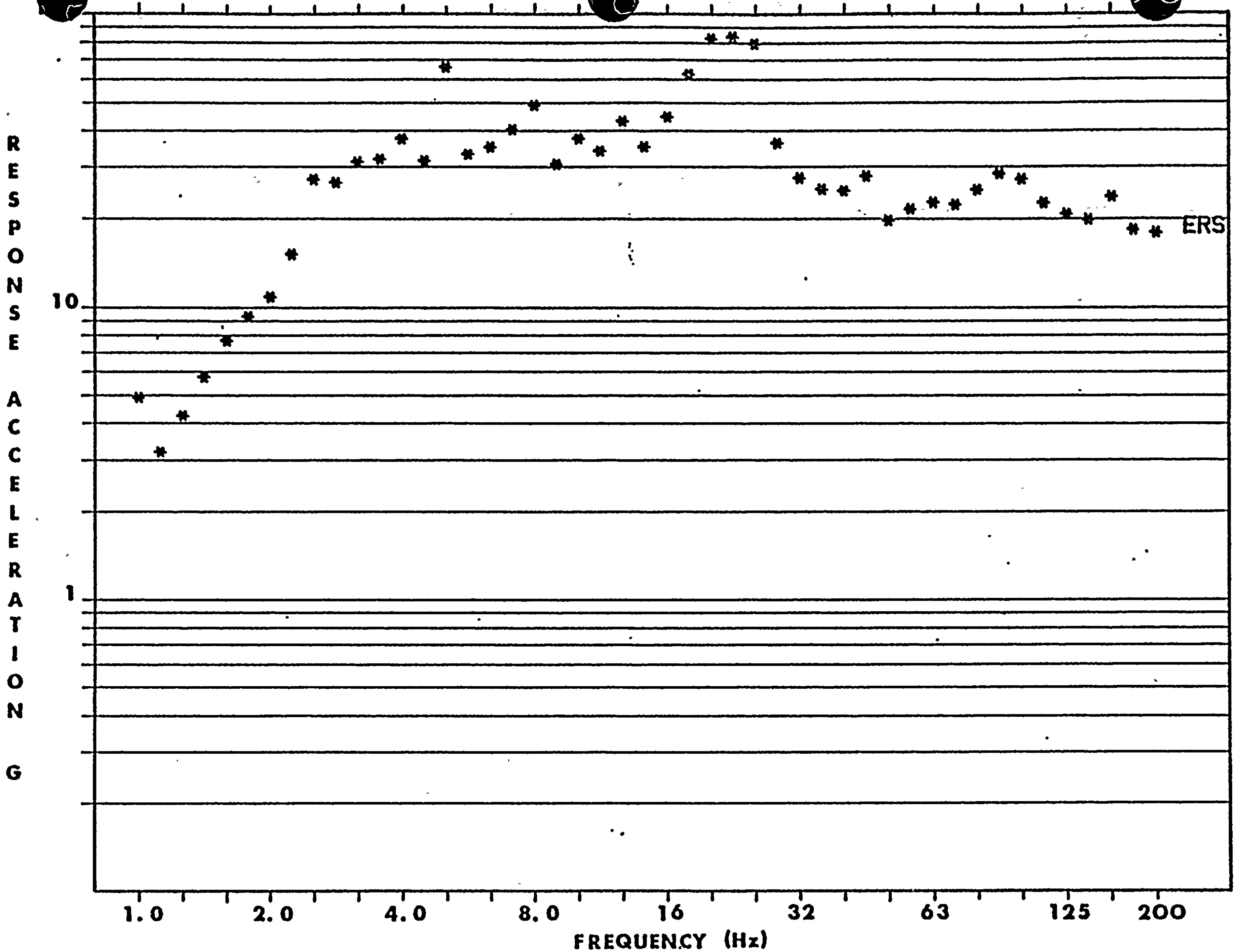


RUN NUMBER.. 12
CHANNEL NUMBER.. 6

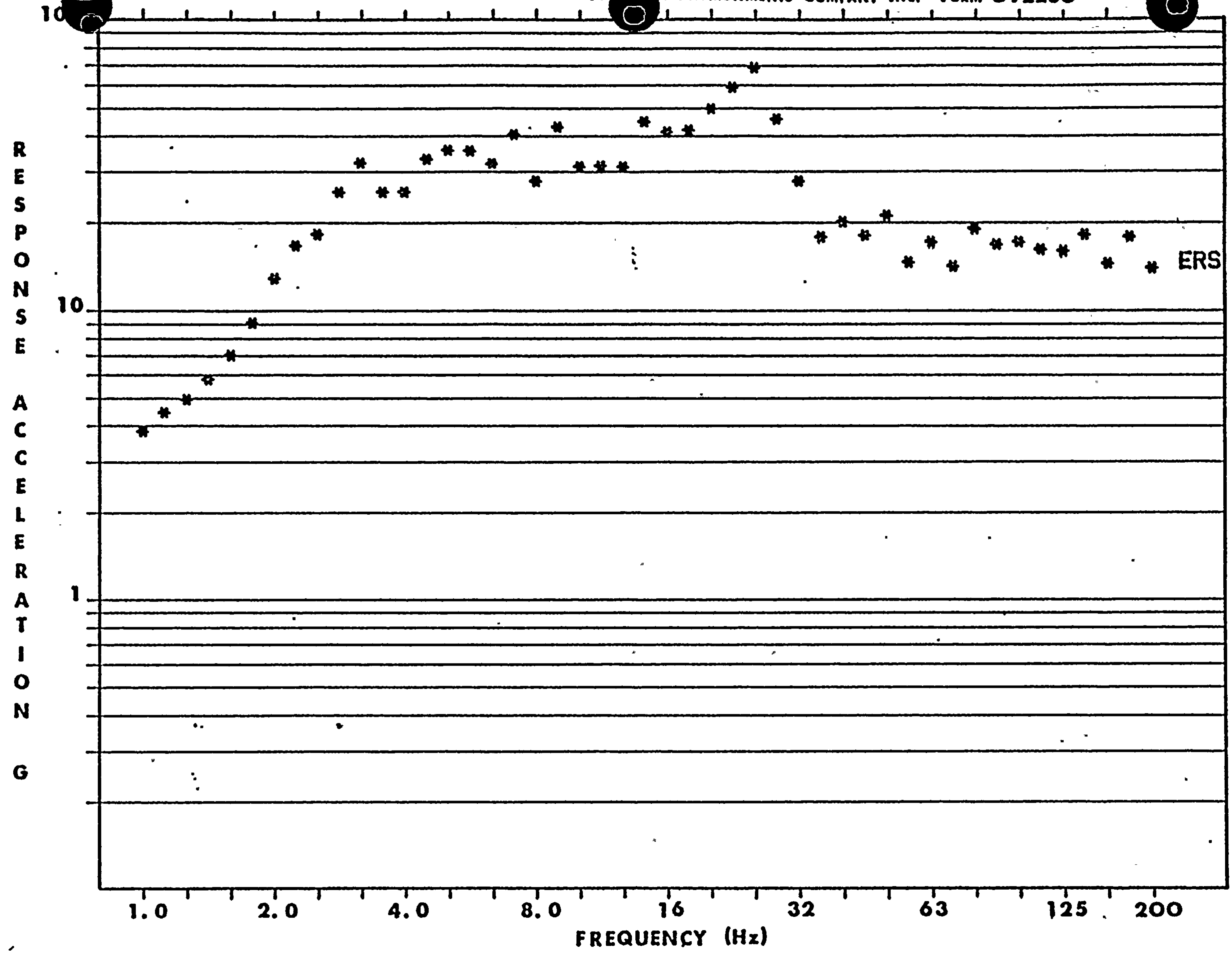
EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING

STR-145380-1



RUN NUMBER.. 12
CHANNEL NUMBER.. 7

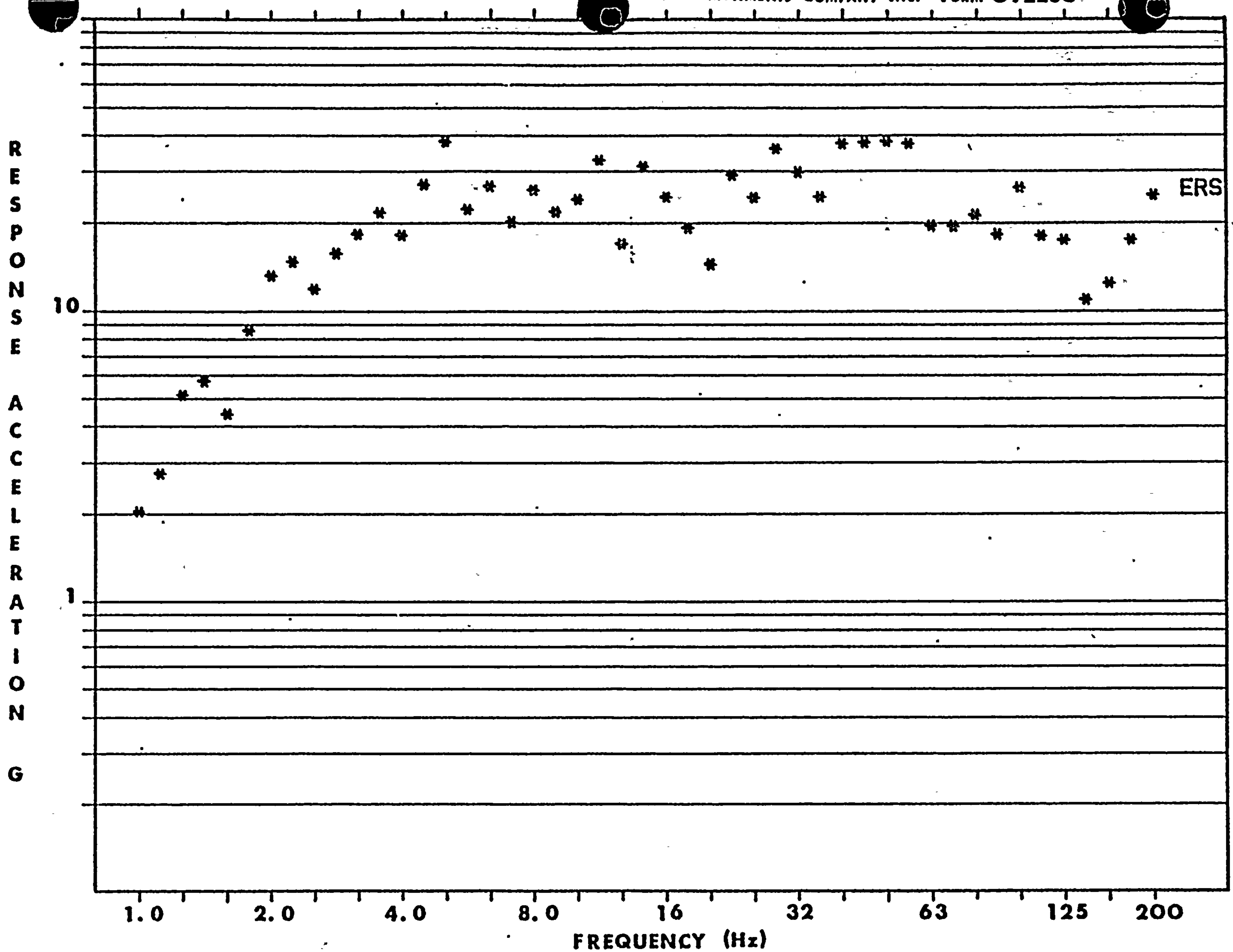
EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 12
CHANNEL NUMBER.. 8

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING

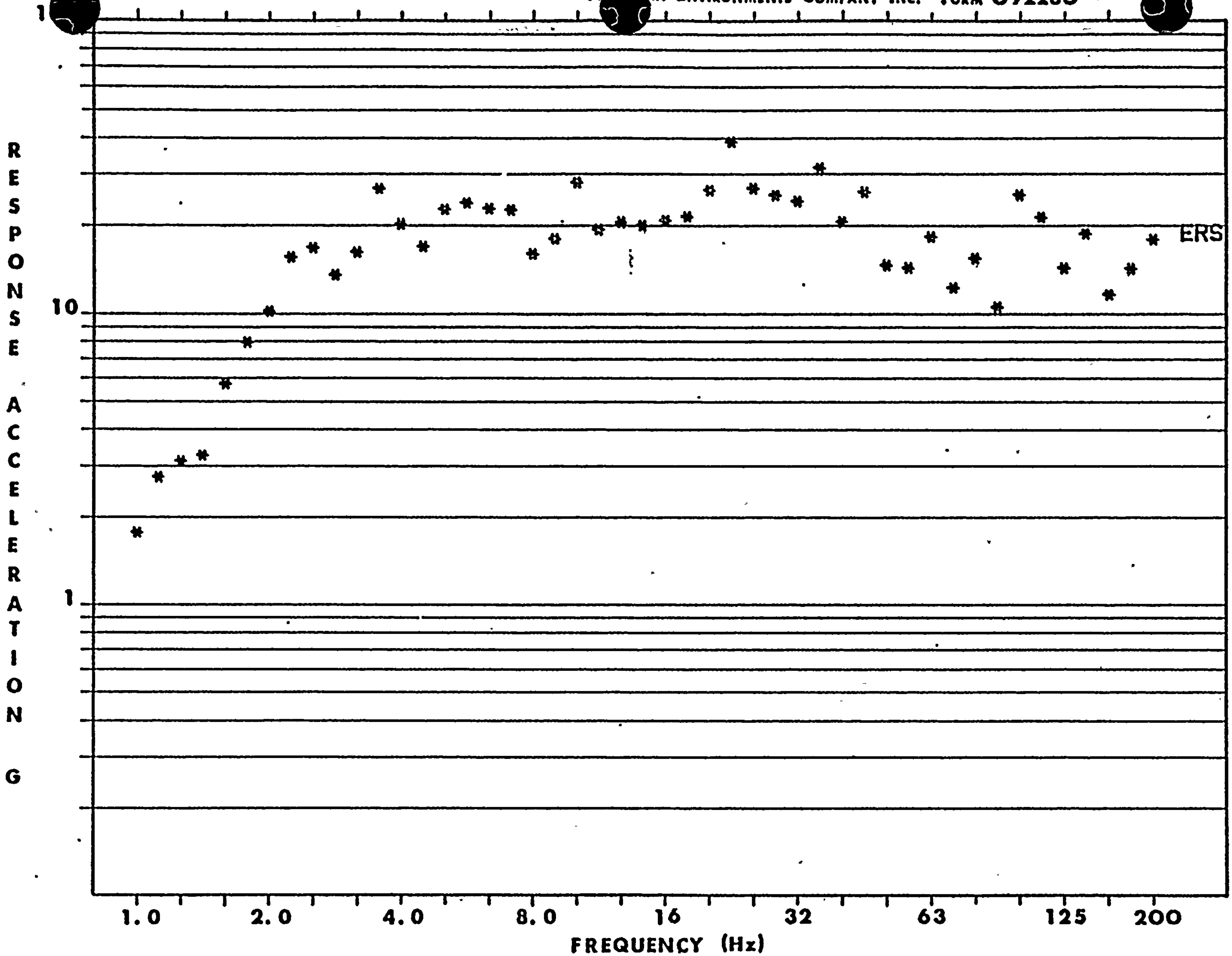
STR-145380-1



STR-145380-1

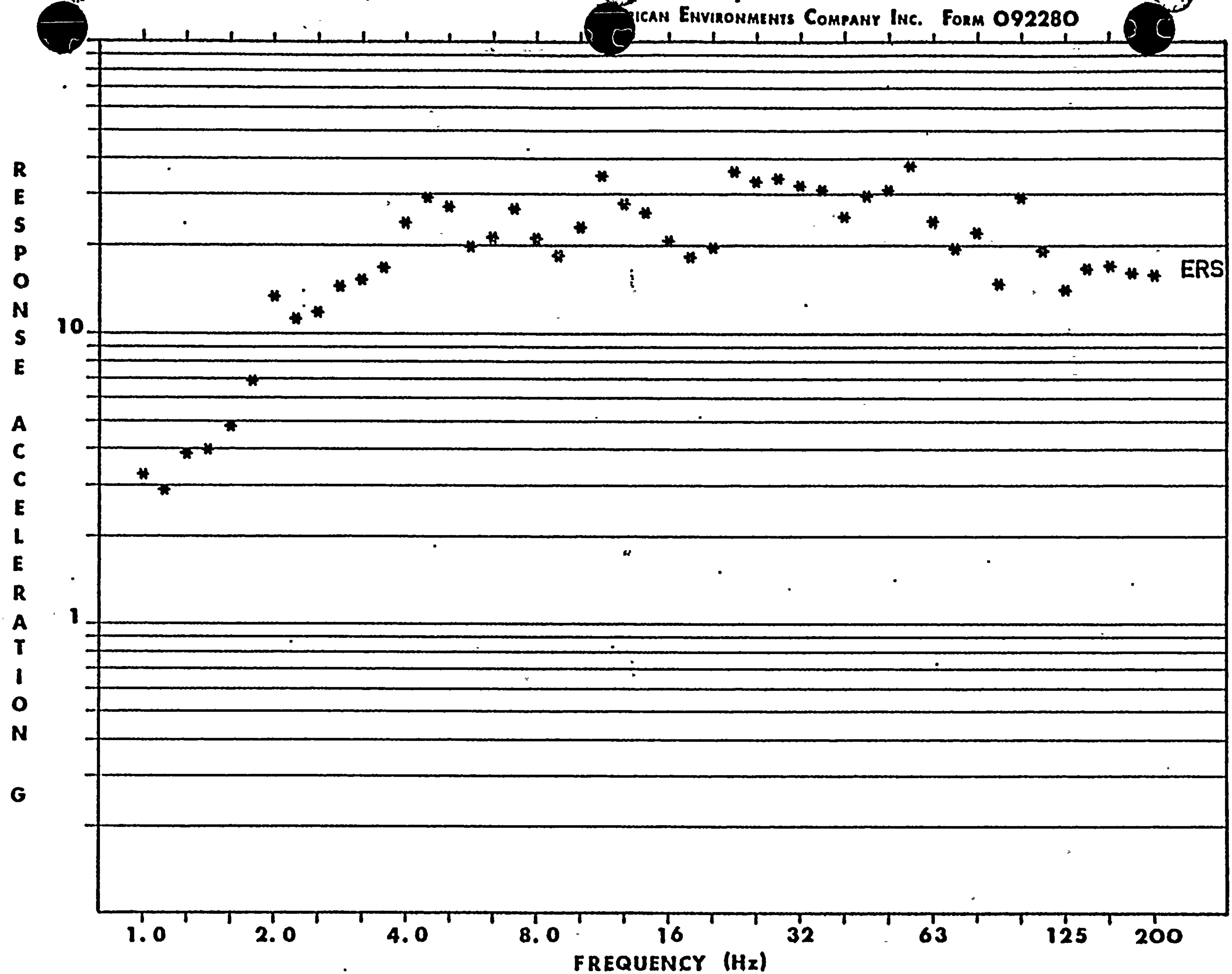
RUN NUMBER.. 17
CHANNEL NUMBER.. 3

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 17
CHANNEL NUMBER.. 4

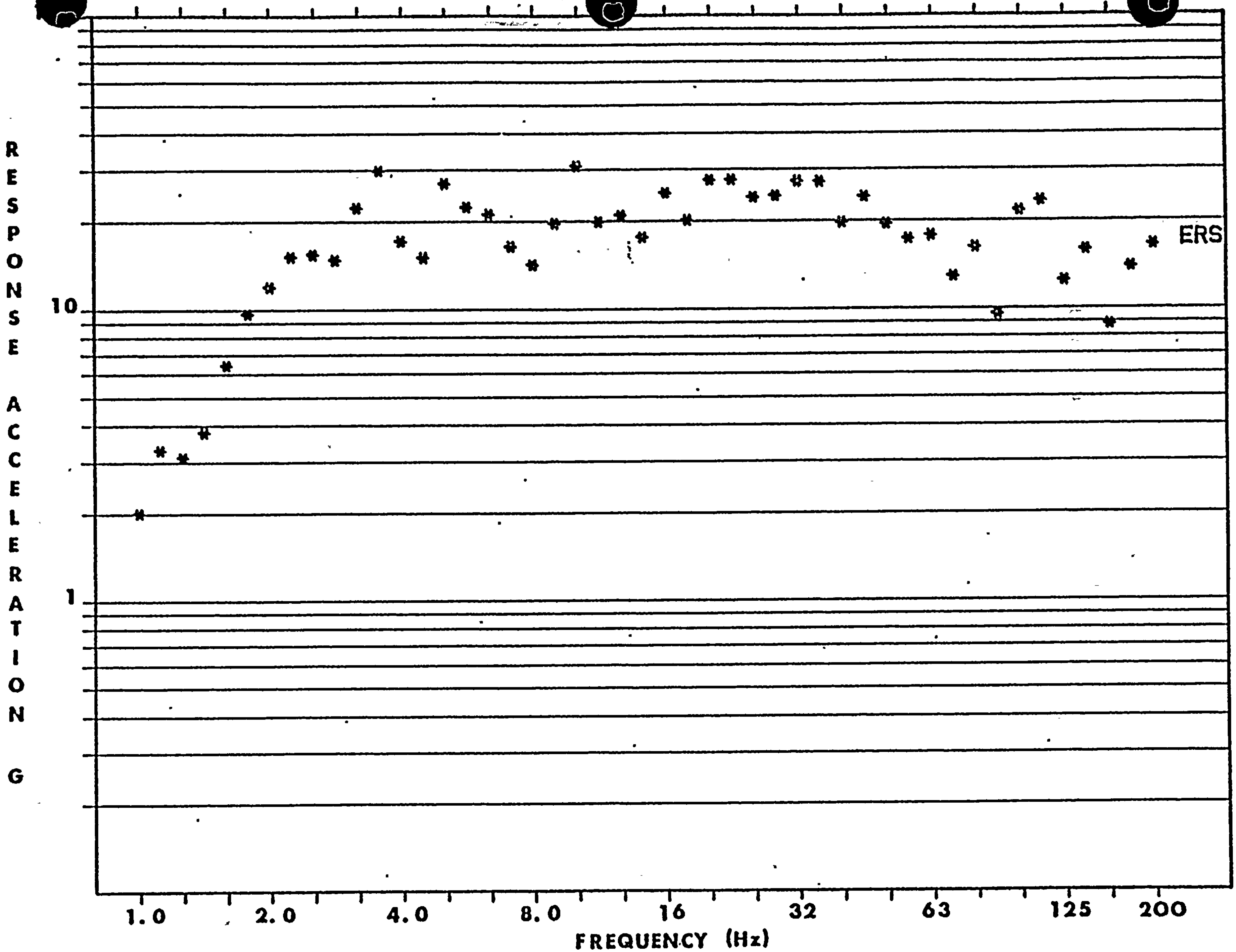
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



STR-145380-1

RUN NUMBER.. 17
CHANNEL NUMBER.. 5

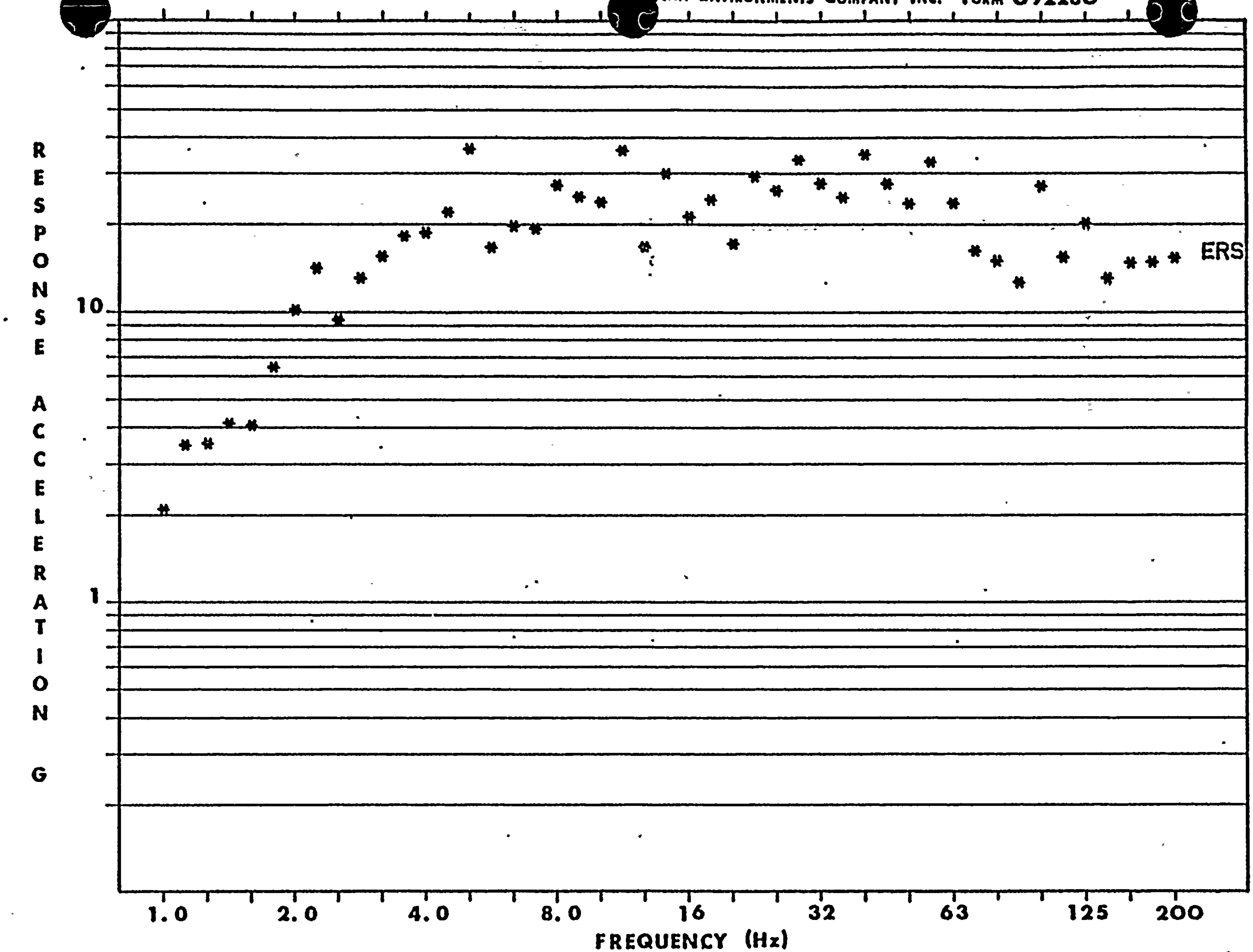
EQUIPMENT RESPONSE SPECTRUM - OBE
1.Ø % OF CRITICAL DAMPING



STR-145380-1

RUN NUMBER.. 17
CHANNEL NUMBER.. 6

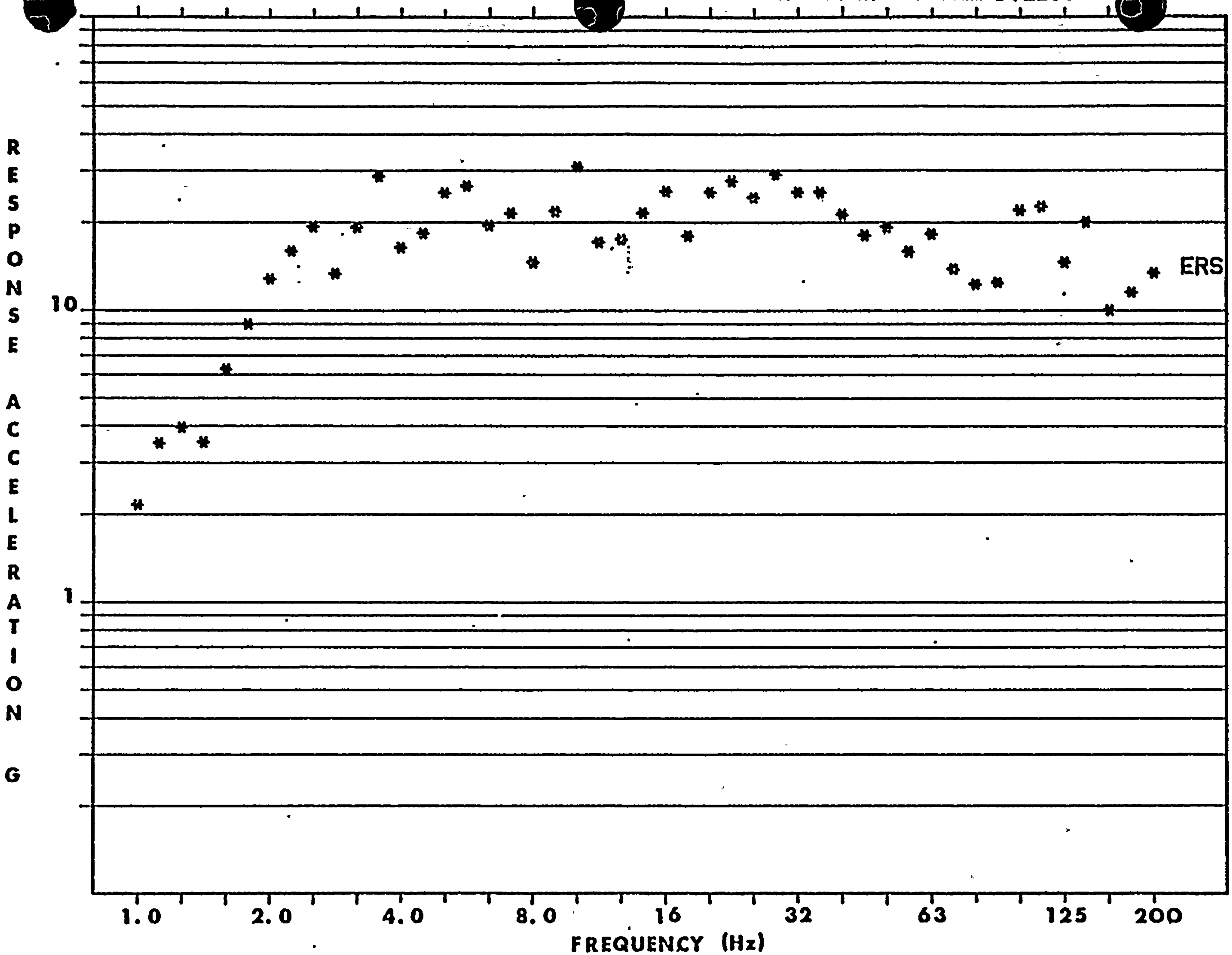
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 17
CHANNEL NUMBER.. 7

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING

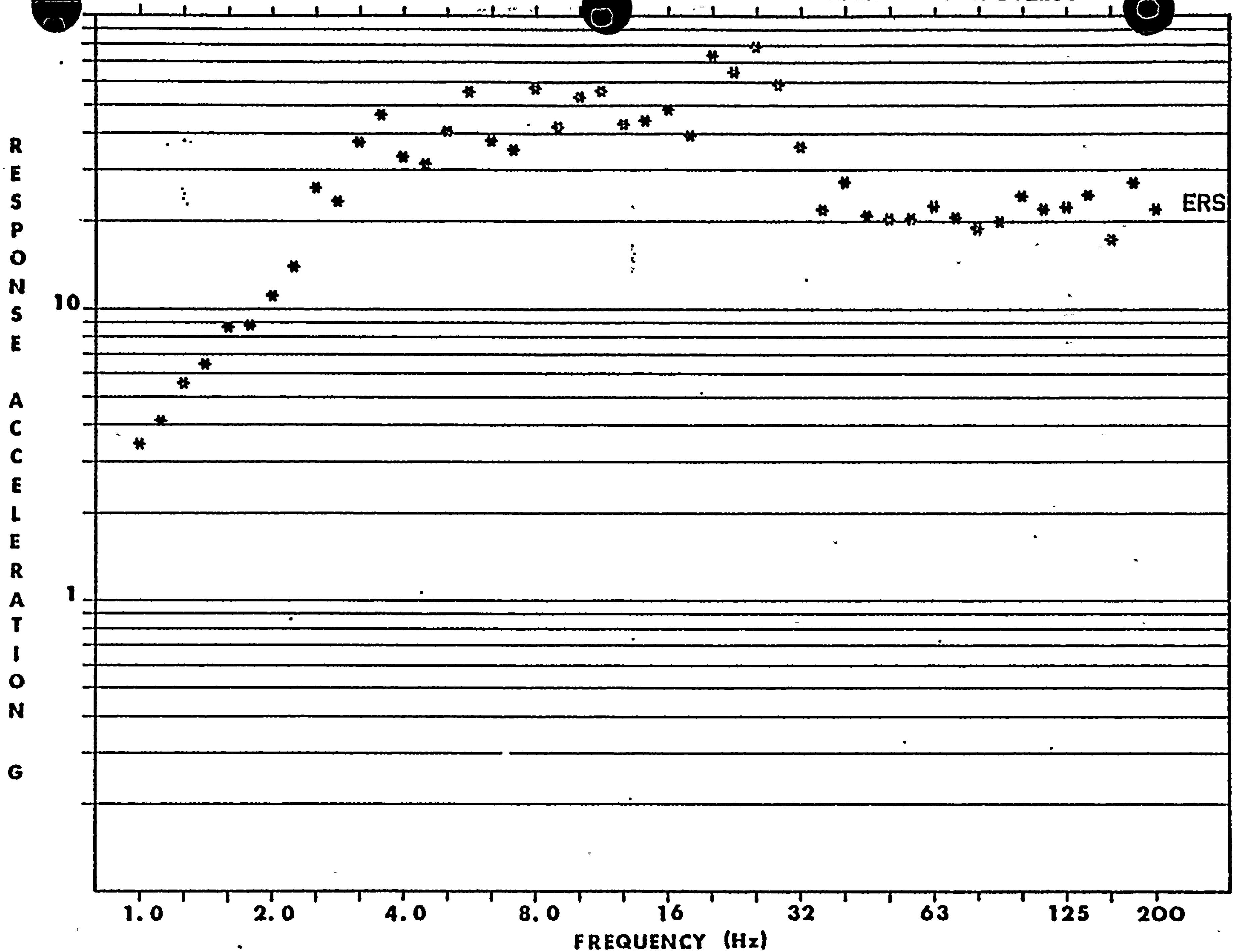
AMERICAN ENVIRONMENTS COMPANY INC. FORM 092280



STR-145380-1

RUN NUMBER.. 17
CHANNEL NUMBER.. 8

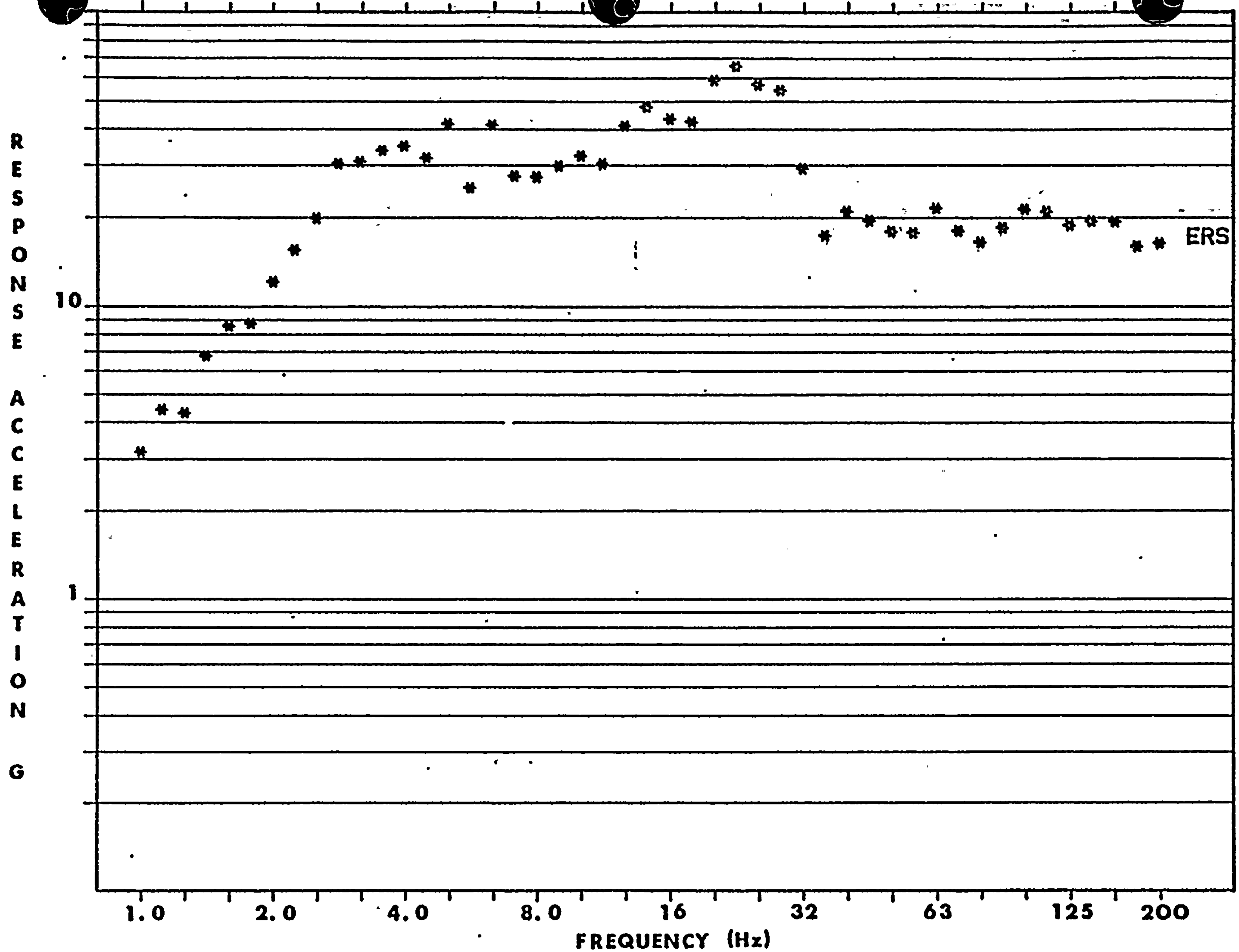
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



STR-145380-1

RUN NUMBER.. 18
CHANNEL NUMBER.. 3

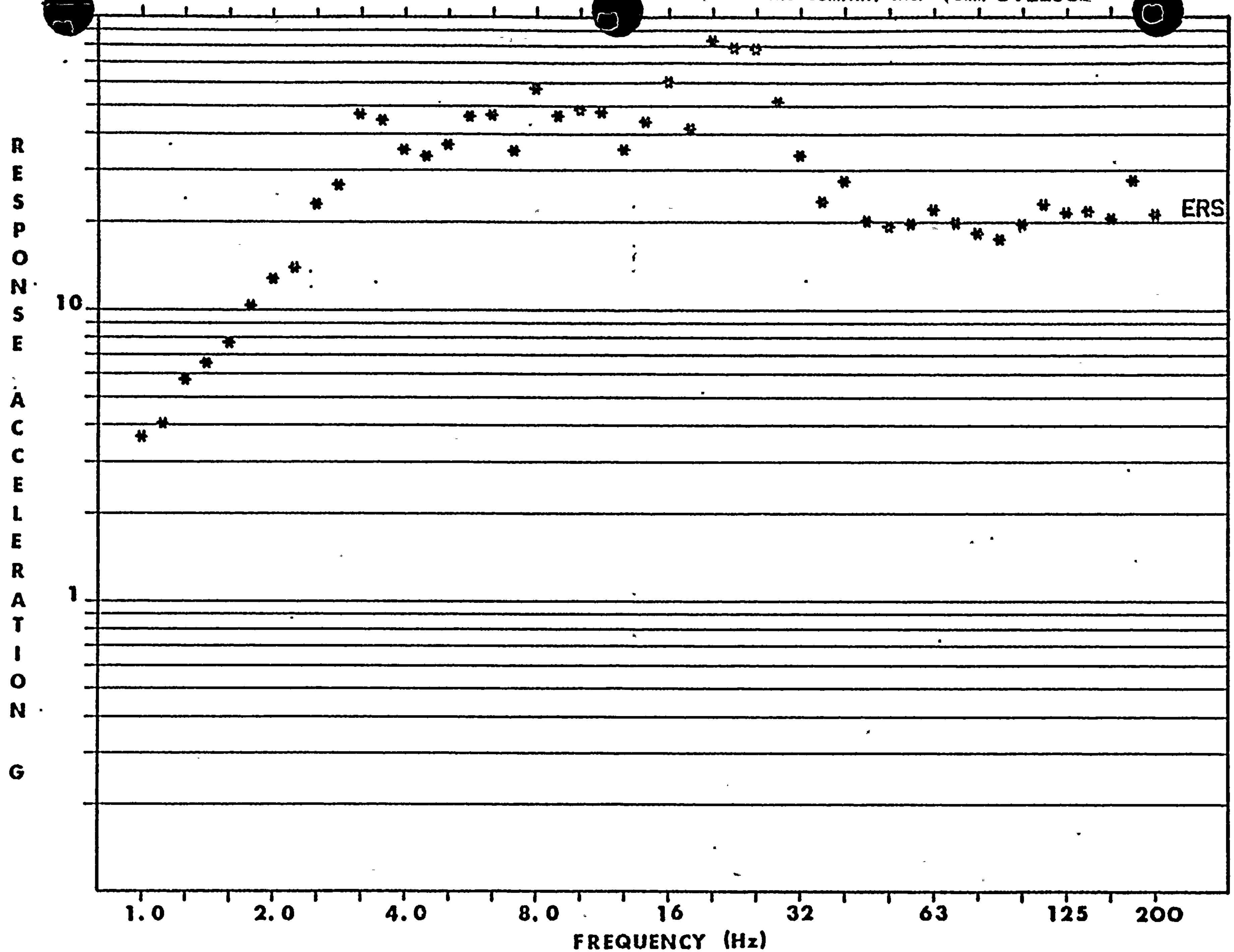
EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 18
CHANNEL NUMBER.. 4

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING

STR-145380-1



RUN NUMBER.. 18
CHANNEL NUMBER.. 5

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING

STR-145380-1

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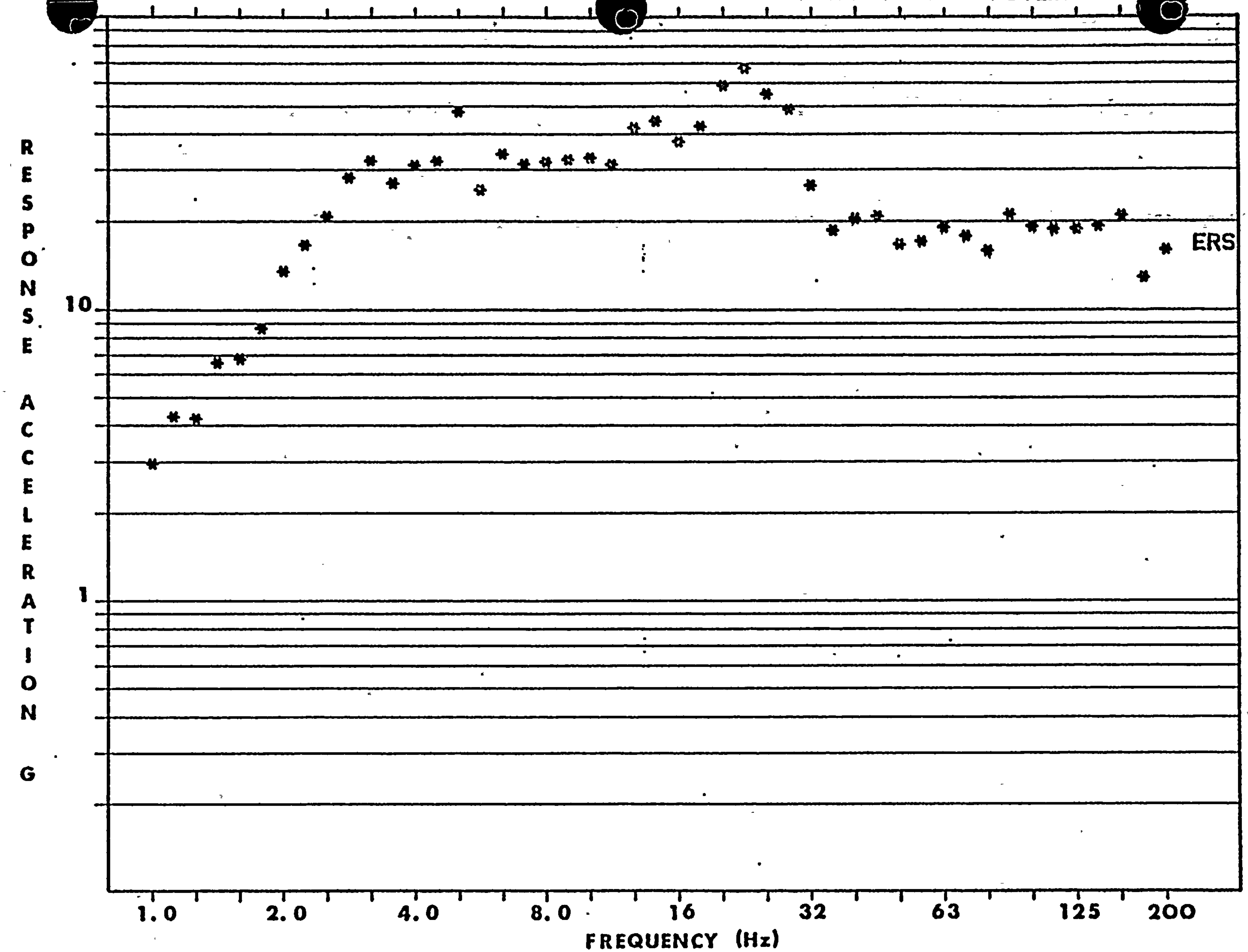
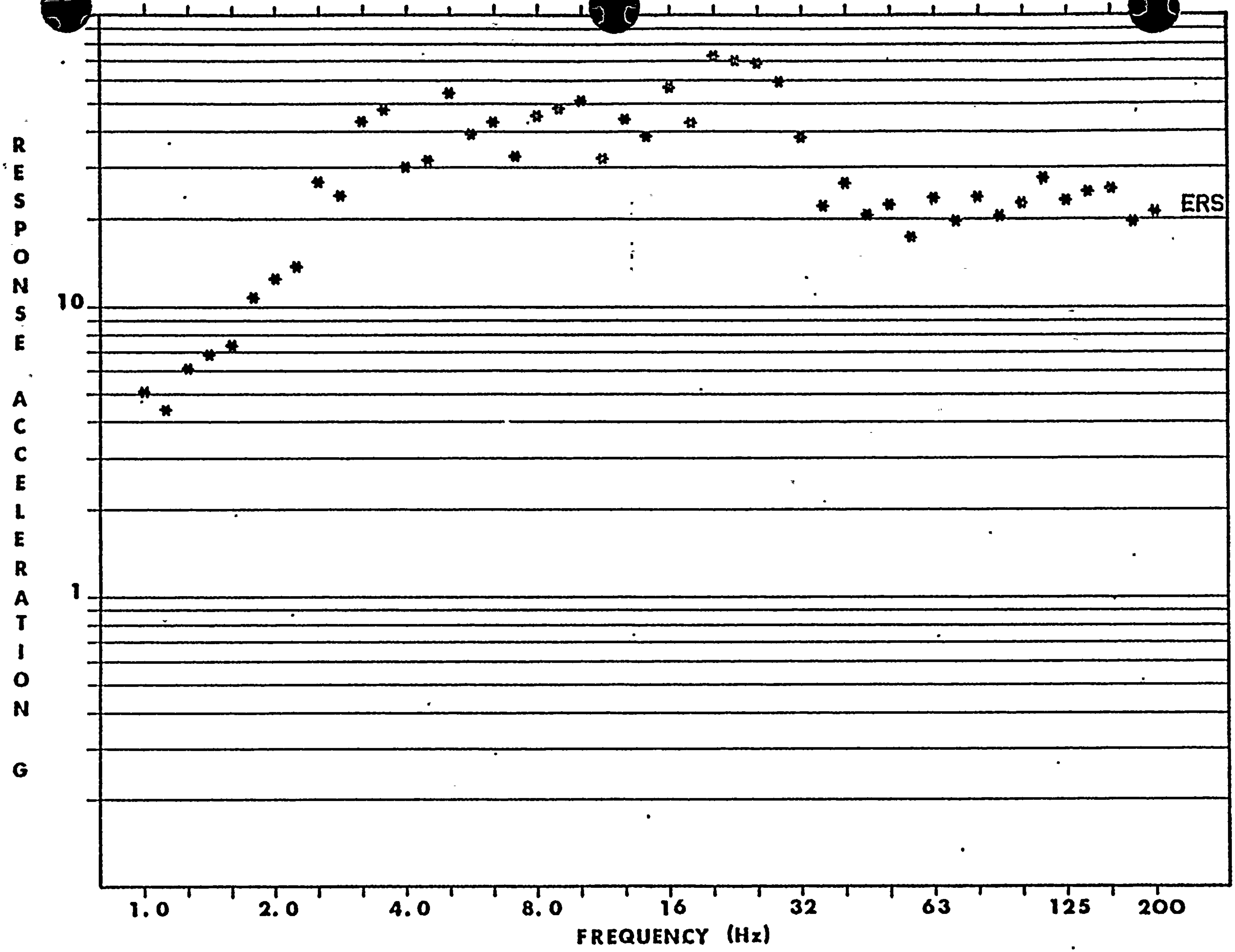


STR-145380-1

RUN NUMBER.. 18
CHANNEL NUMBER.. 6

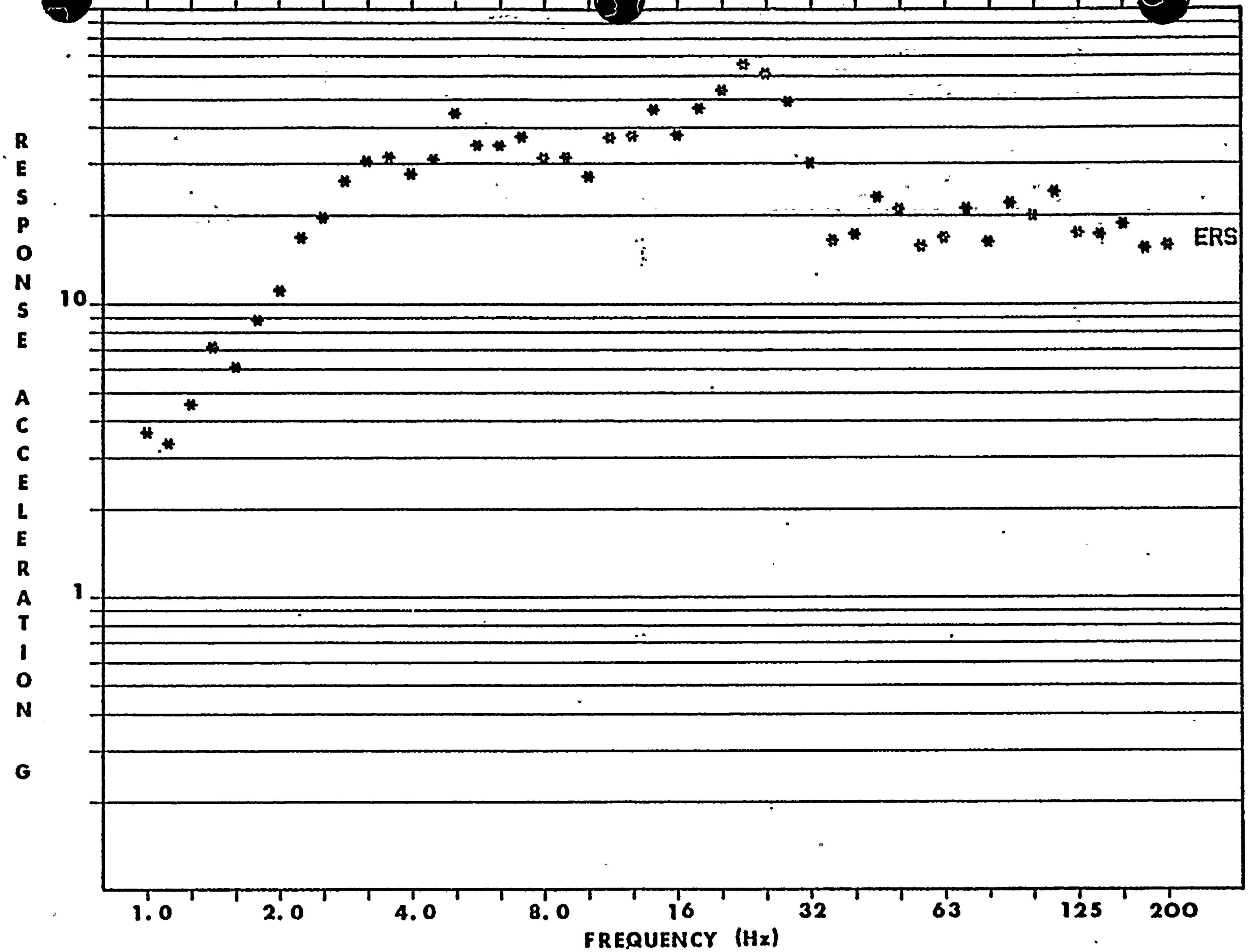
EQUIPMENT RESPONSE SPECTRUM - SSE
1.Ø % OF CRITICAL DAMPING



RUN NUMBER.. 24
CHANNEL NUMBER.. 7

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING

STR-145380-1

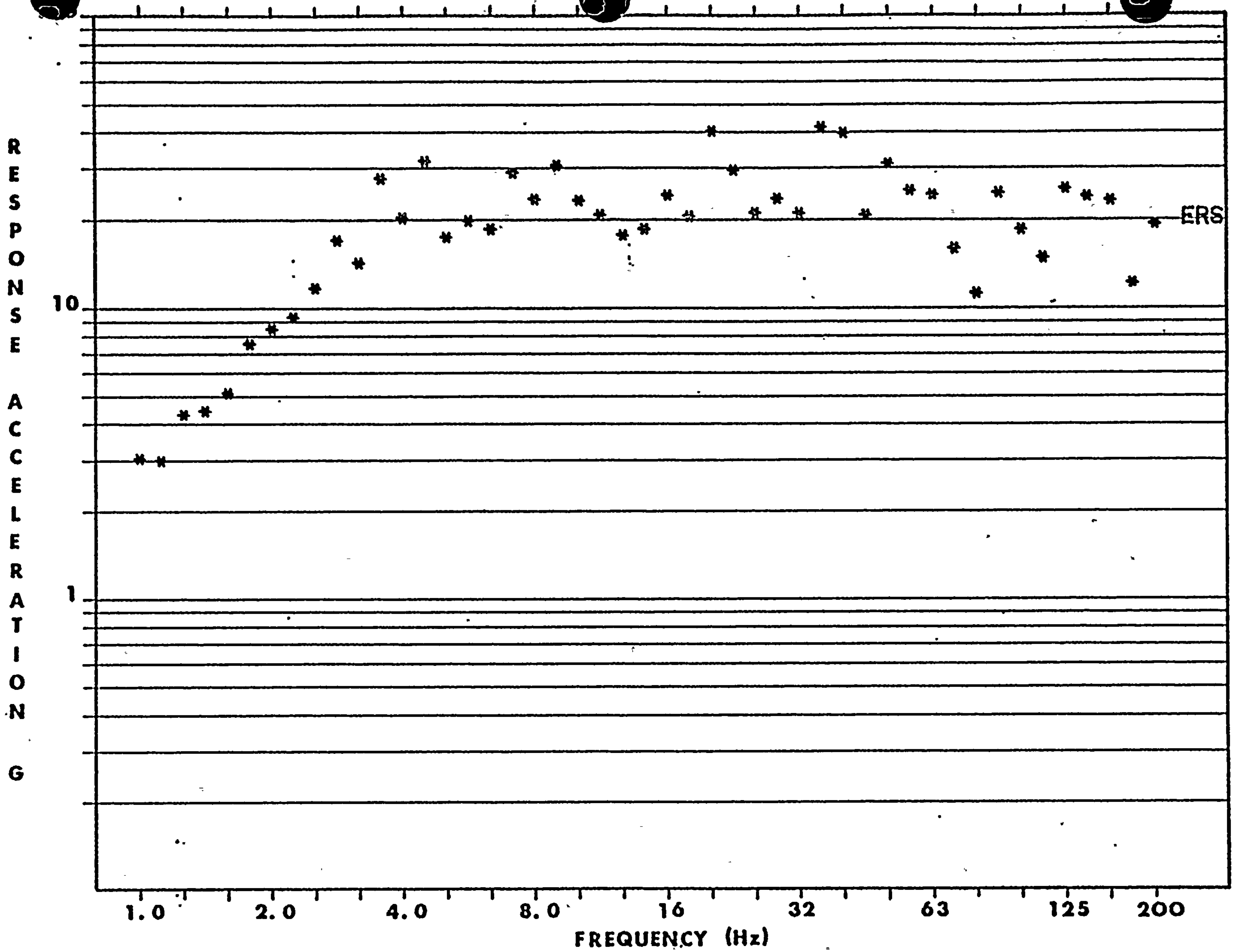


STR-145380-1

RUN NUMBER.. 24
CHANNEL NUMBER.. 8

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING

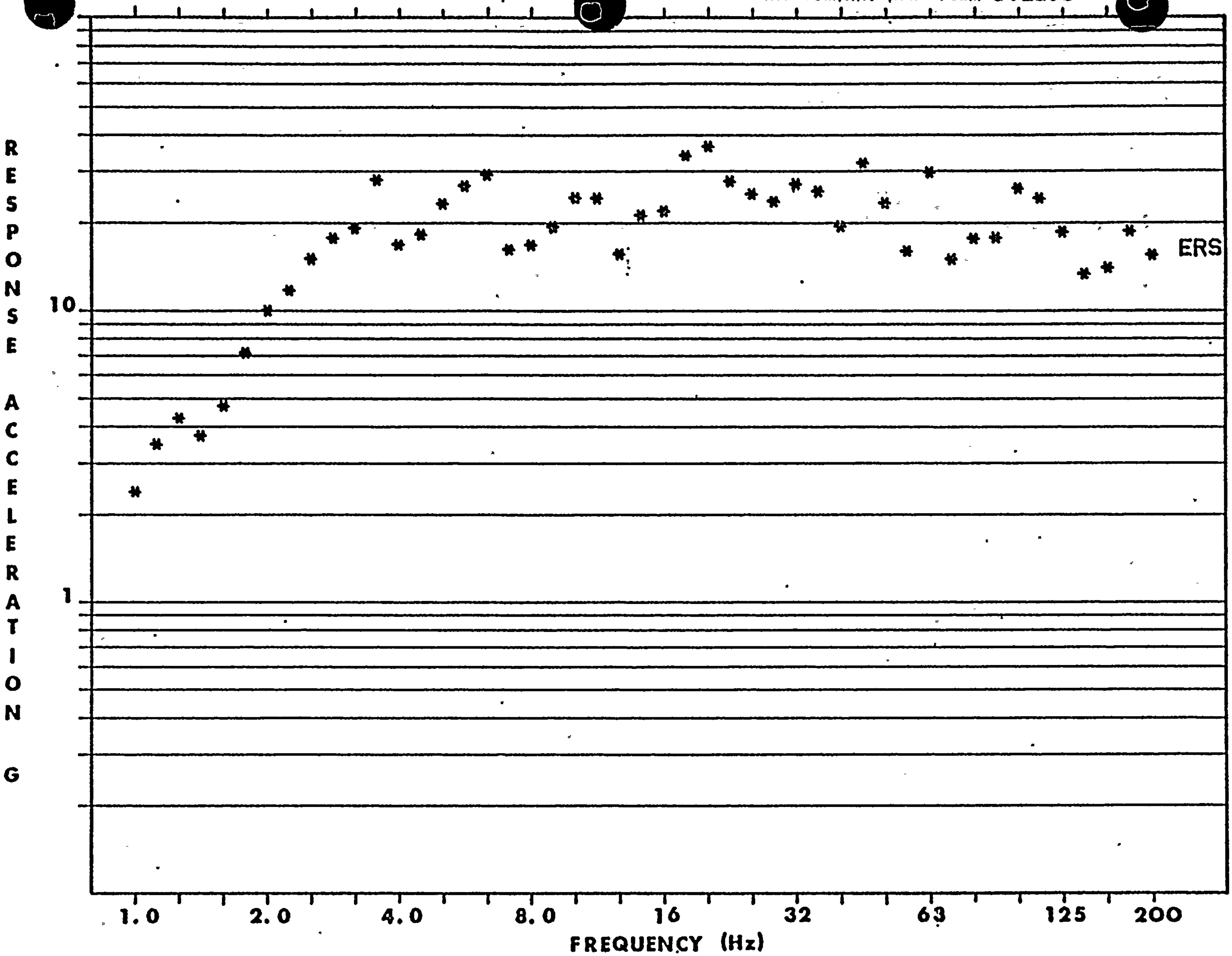
...ICAN ENVIRONMENTS COMPANY INC. FORM O92280



STR-145380-1

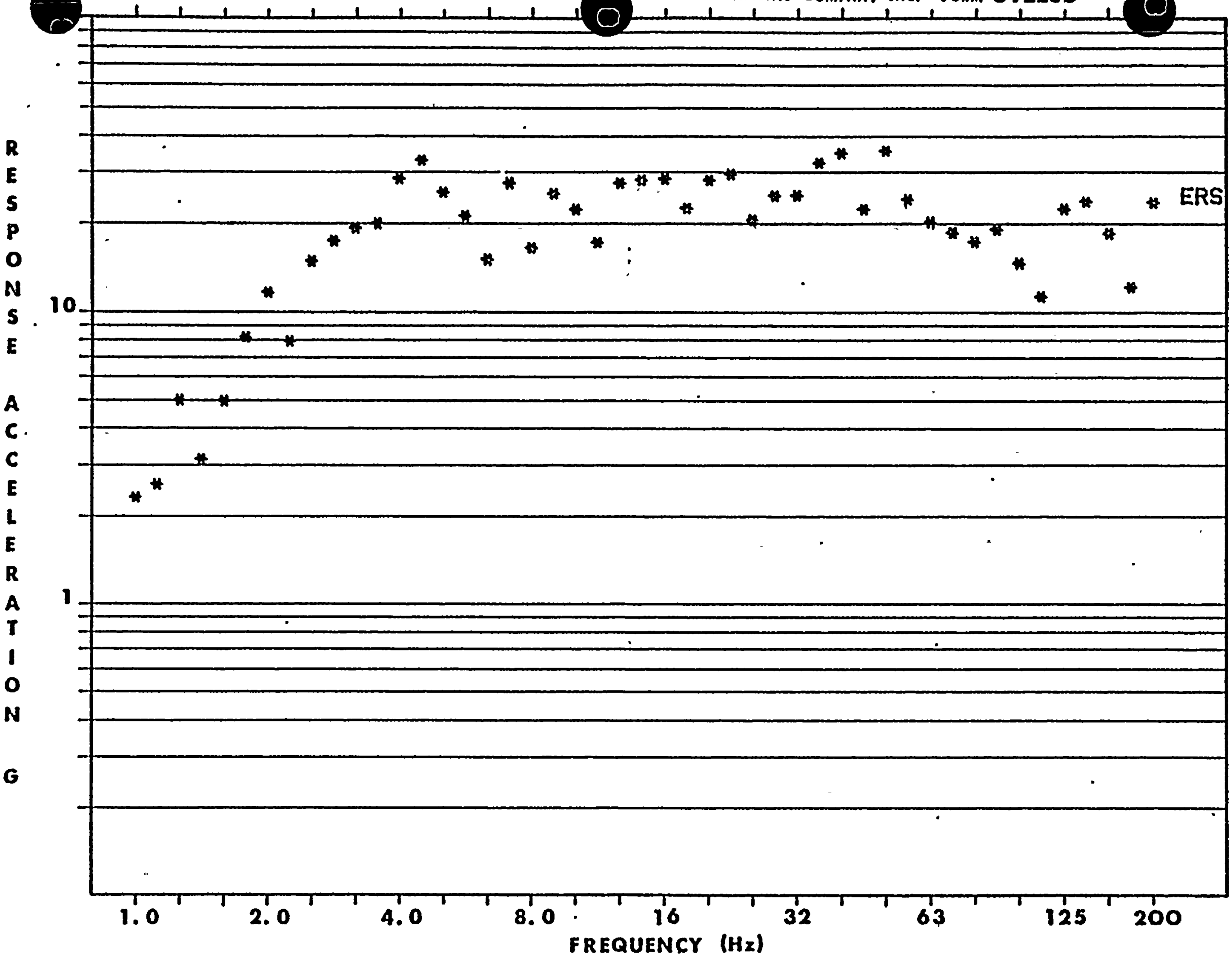
RUN NUMBER.. 23
CHANNEL NUMBER.. 3

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



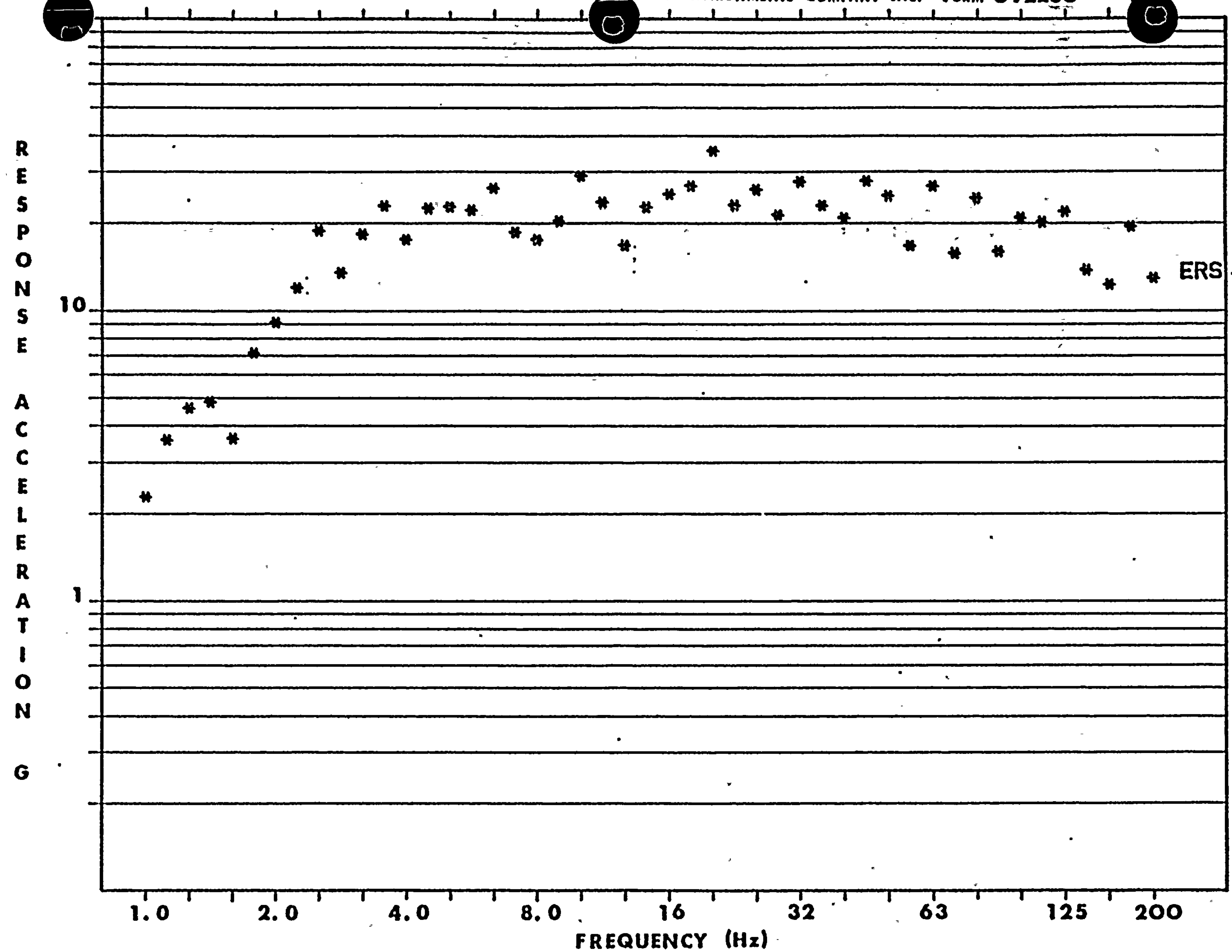
+ RUN NUMBER.. 23
CHANNEL NUMBER.. 4

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 23
CHANNEL NUMBER.. 5

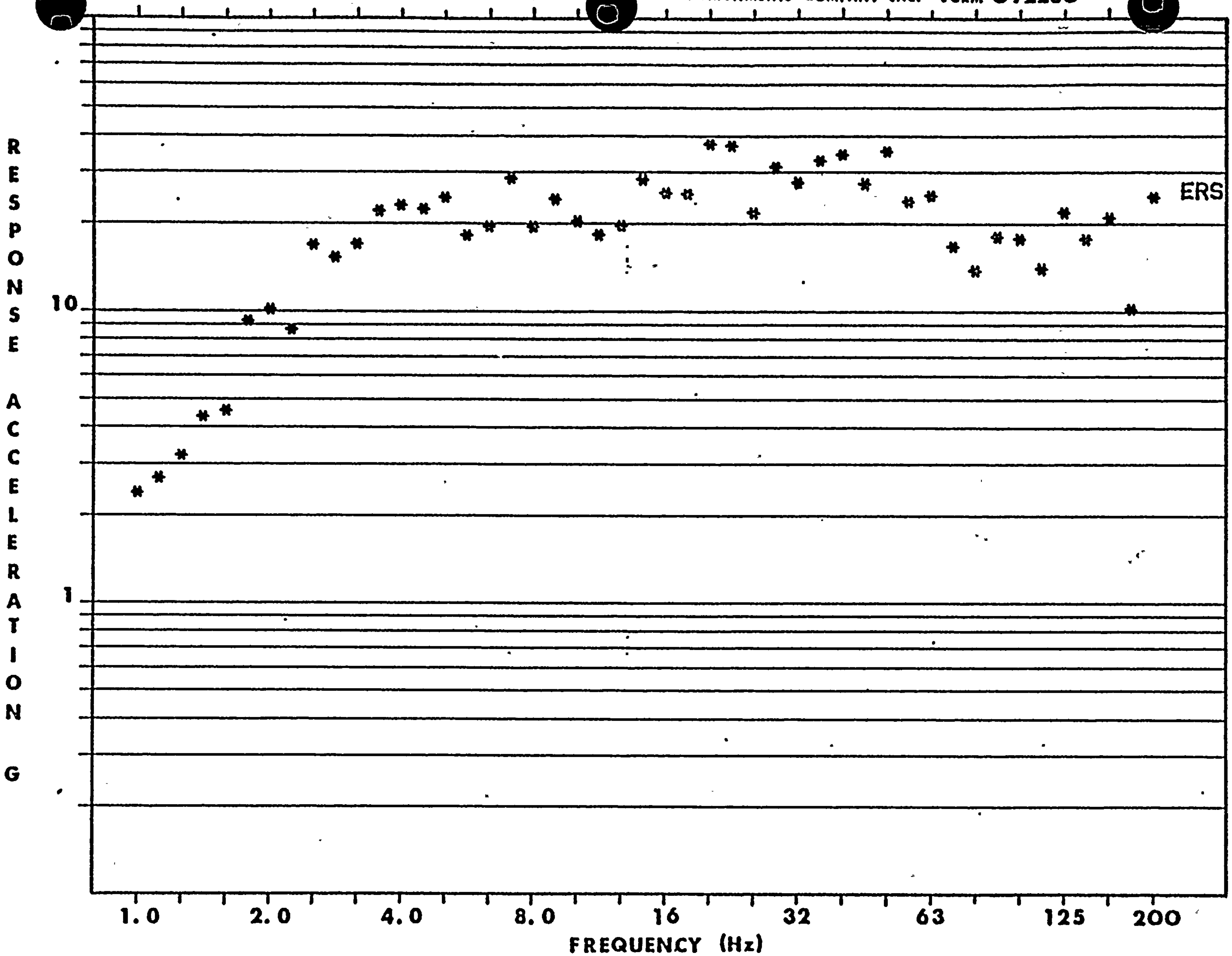
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 23
CHANNEL NUMBER.. 6

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING

...ICAN ENVIRONMENTS COMPANY INC. FORM 092280

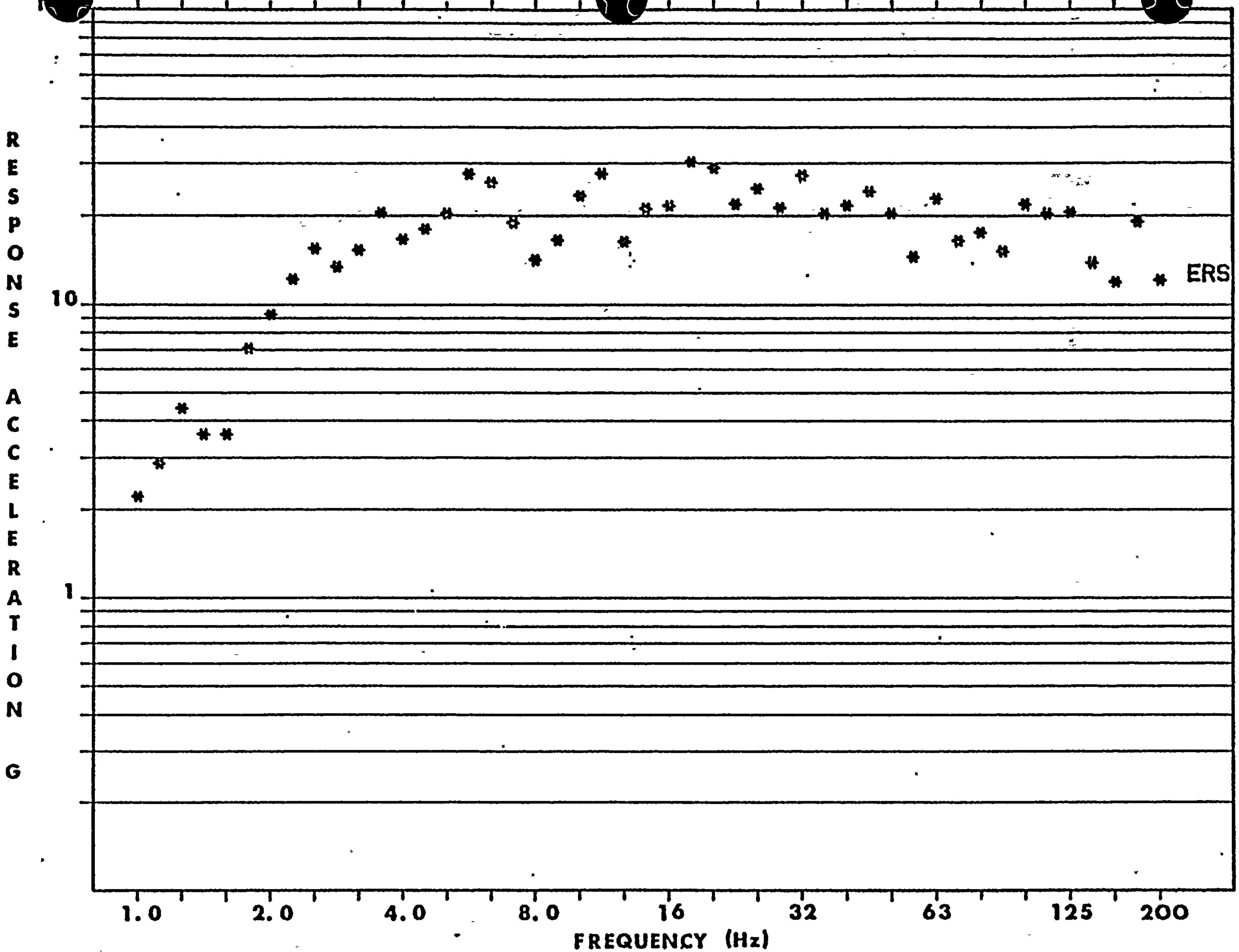


STR-145380-1

PAGE 106

RUN NUMBER.. 23
CHANNEL NUMBER.. 7

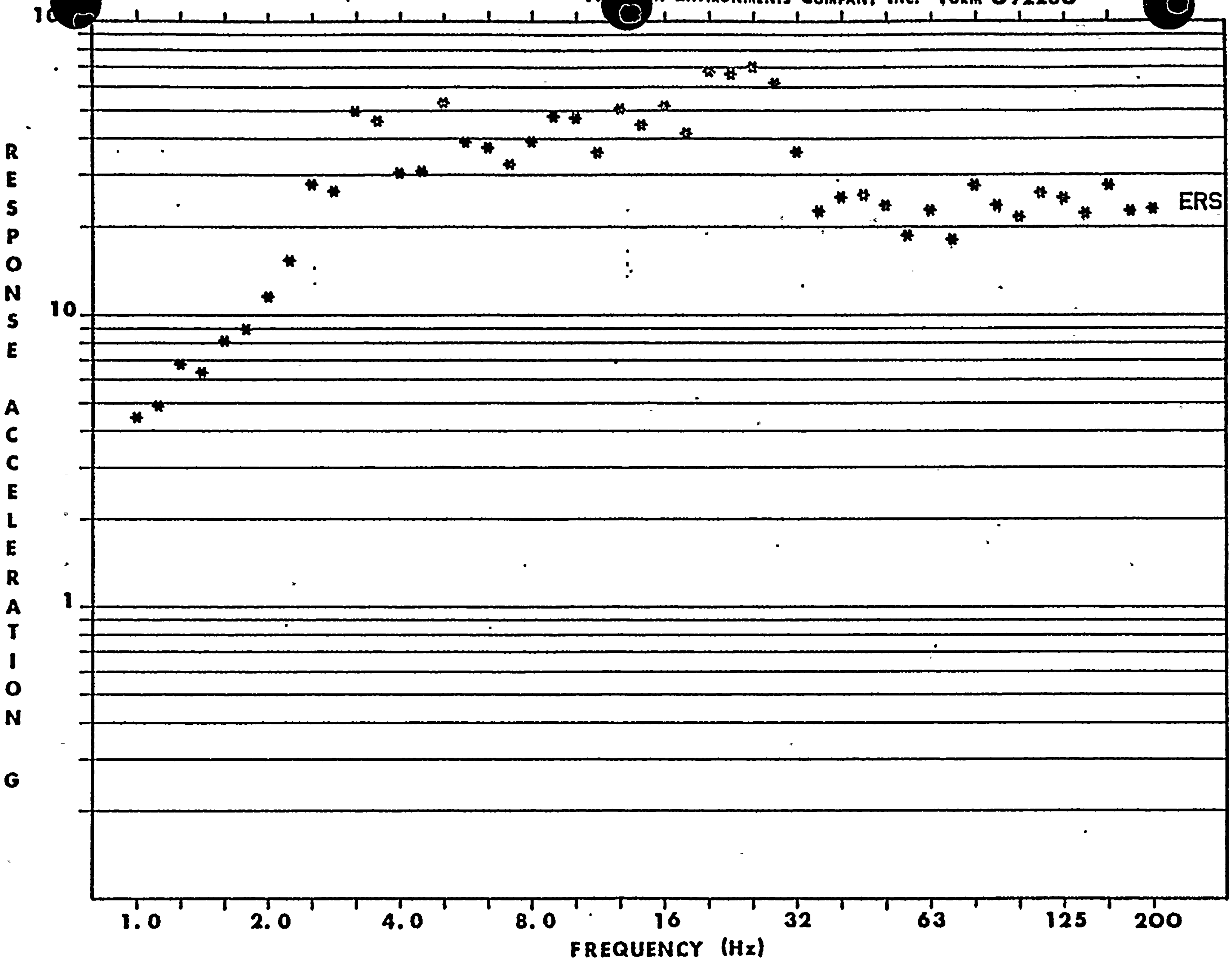
EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



STR-145380-1

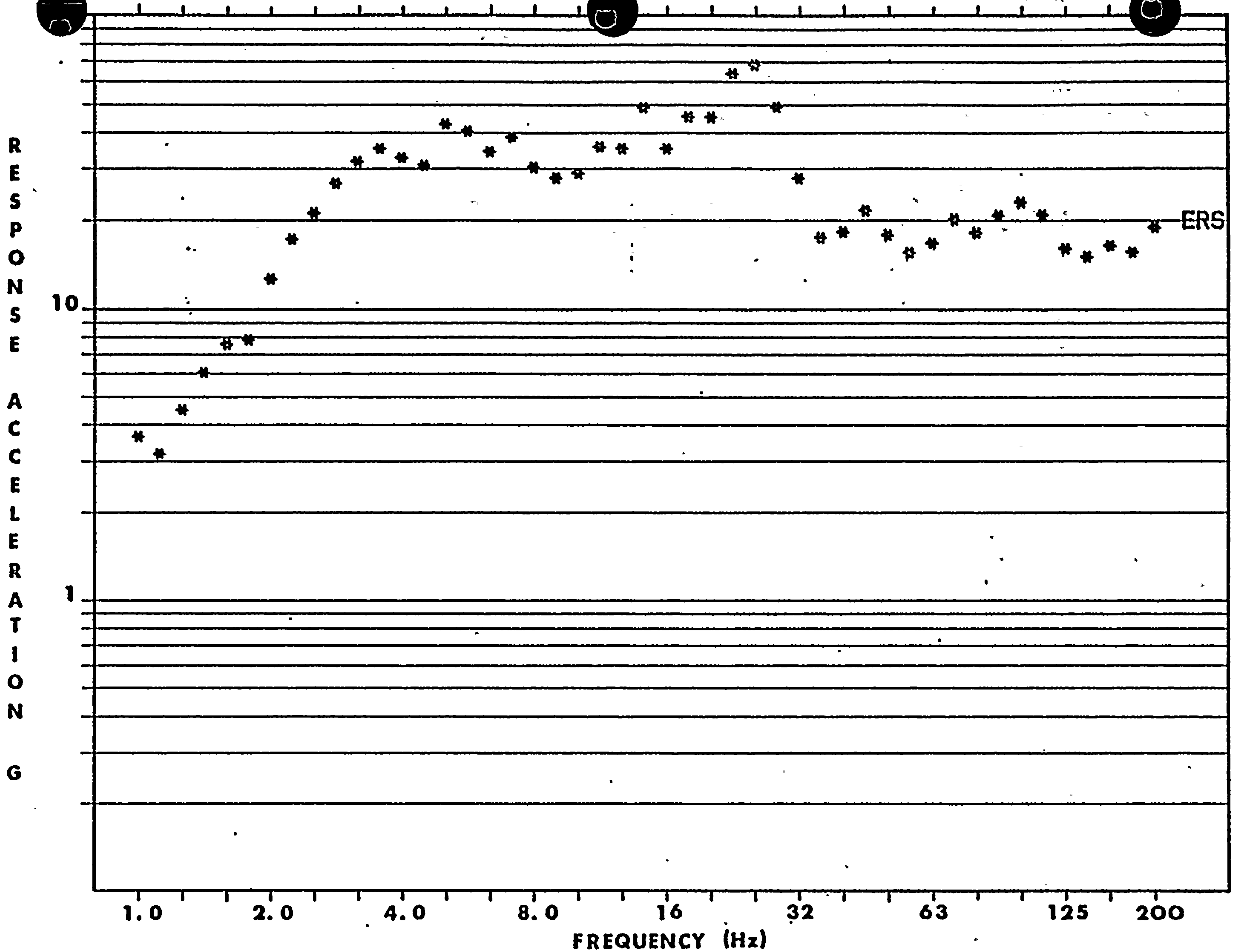
RUN NUMBER.. 23
CHANNEL NUMBER.. 8

EQUIPMENT RESPONSE SPECTRUM - OBE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 24
CHANNEL NUMBER.. 3

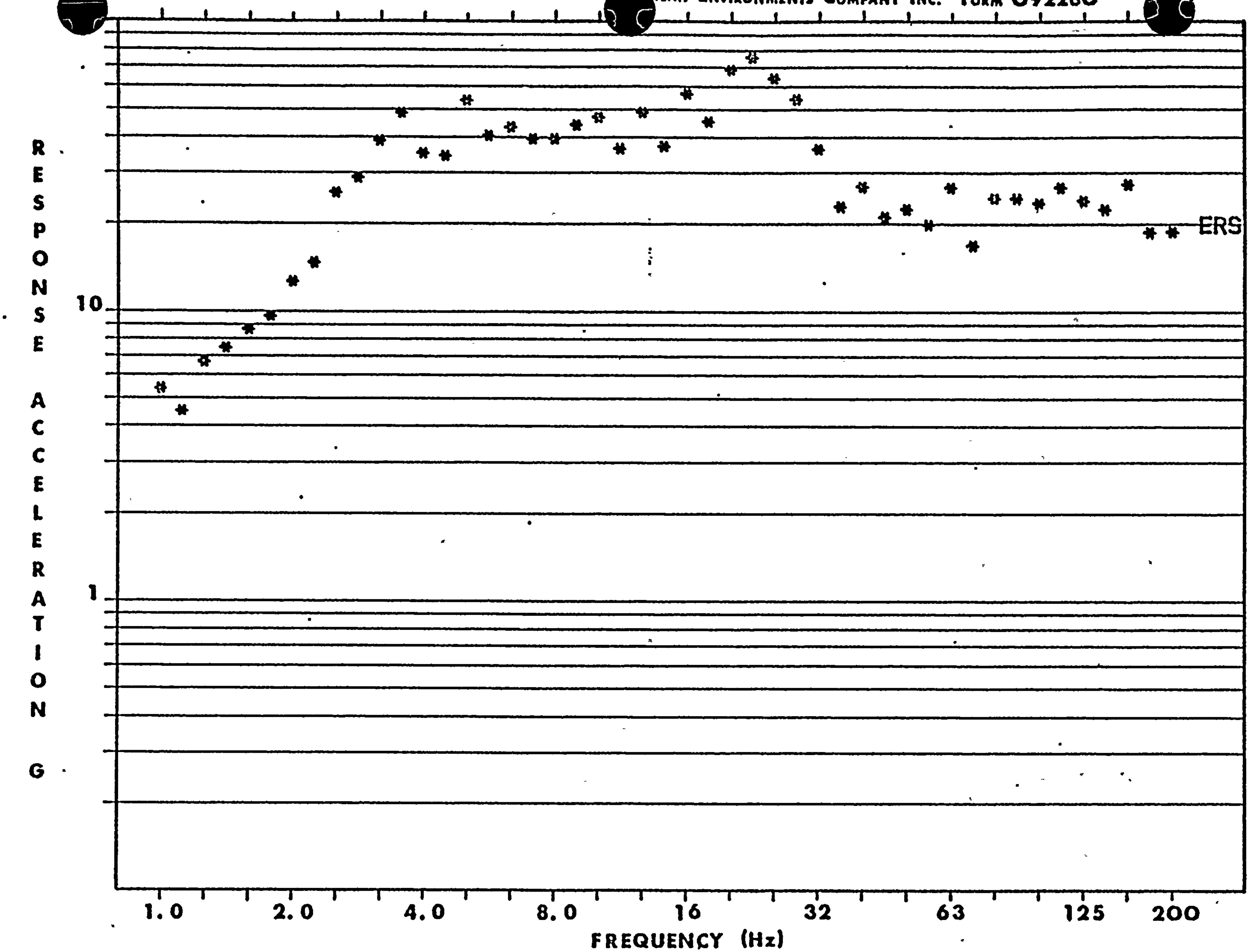
EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



STR-145380-1

RUN NUMBER.. 24
CHANNEL NUMBER.. 4

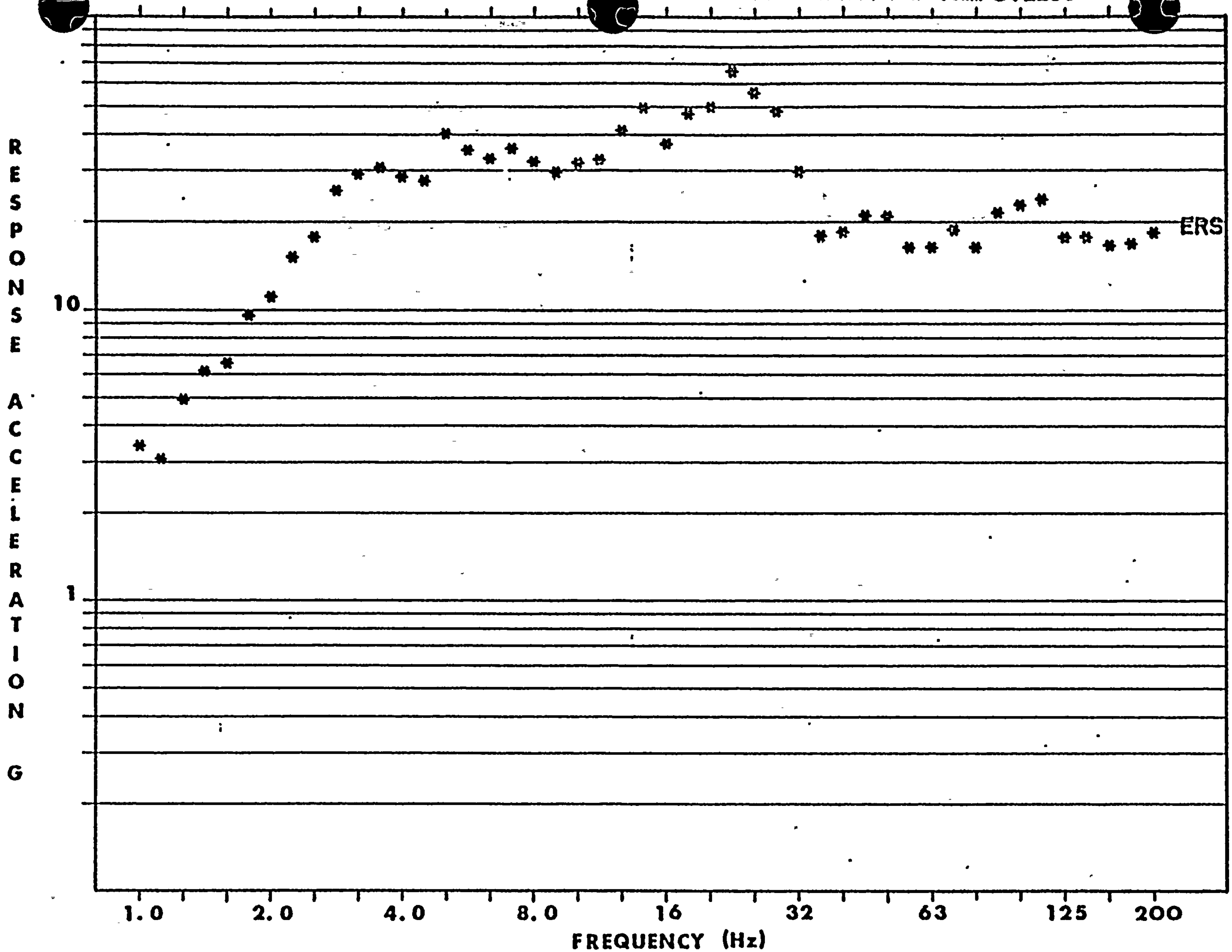
EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



STR-145380-1

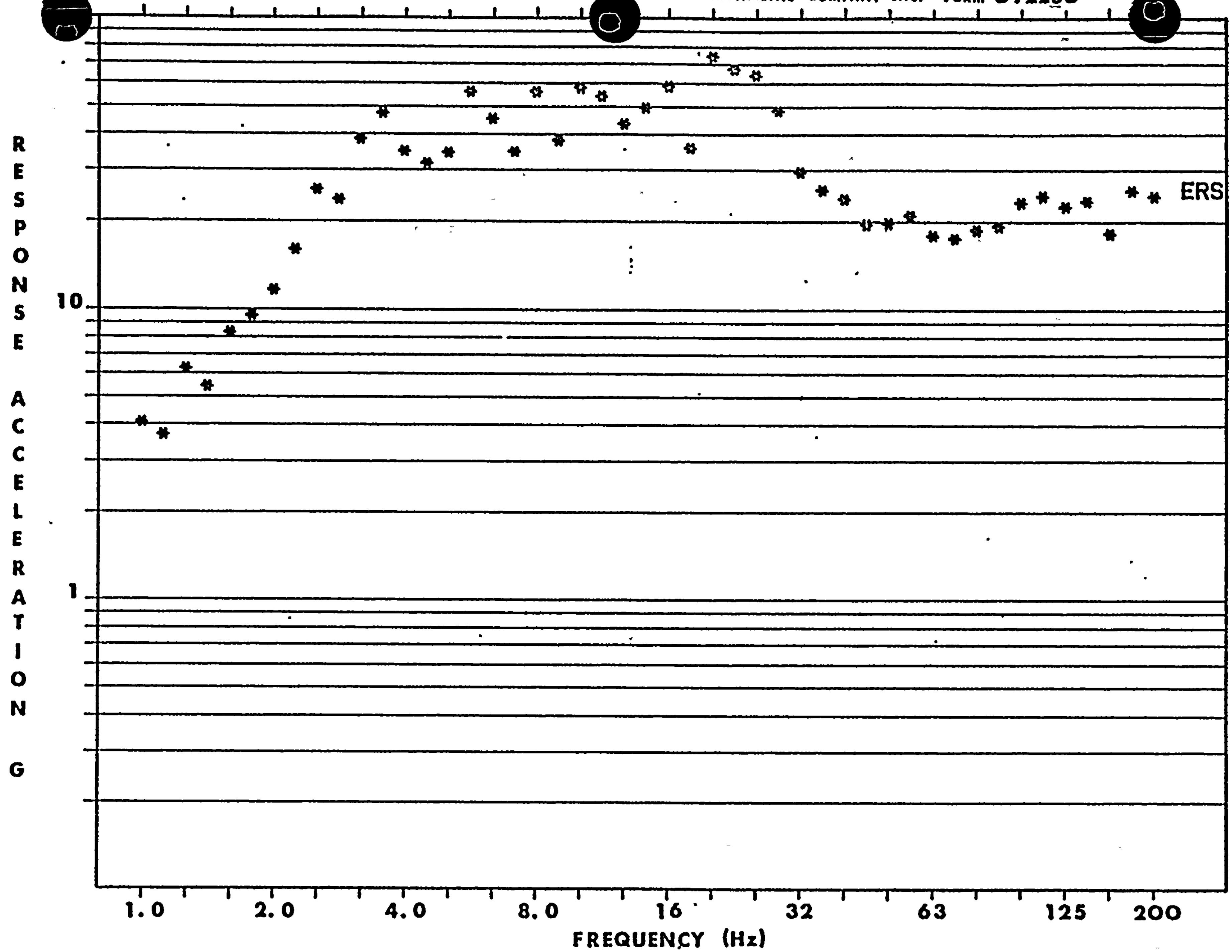
RUN NUMBER.. 24
CHANNEL NUMBER.. 5

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



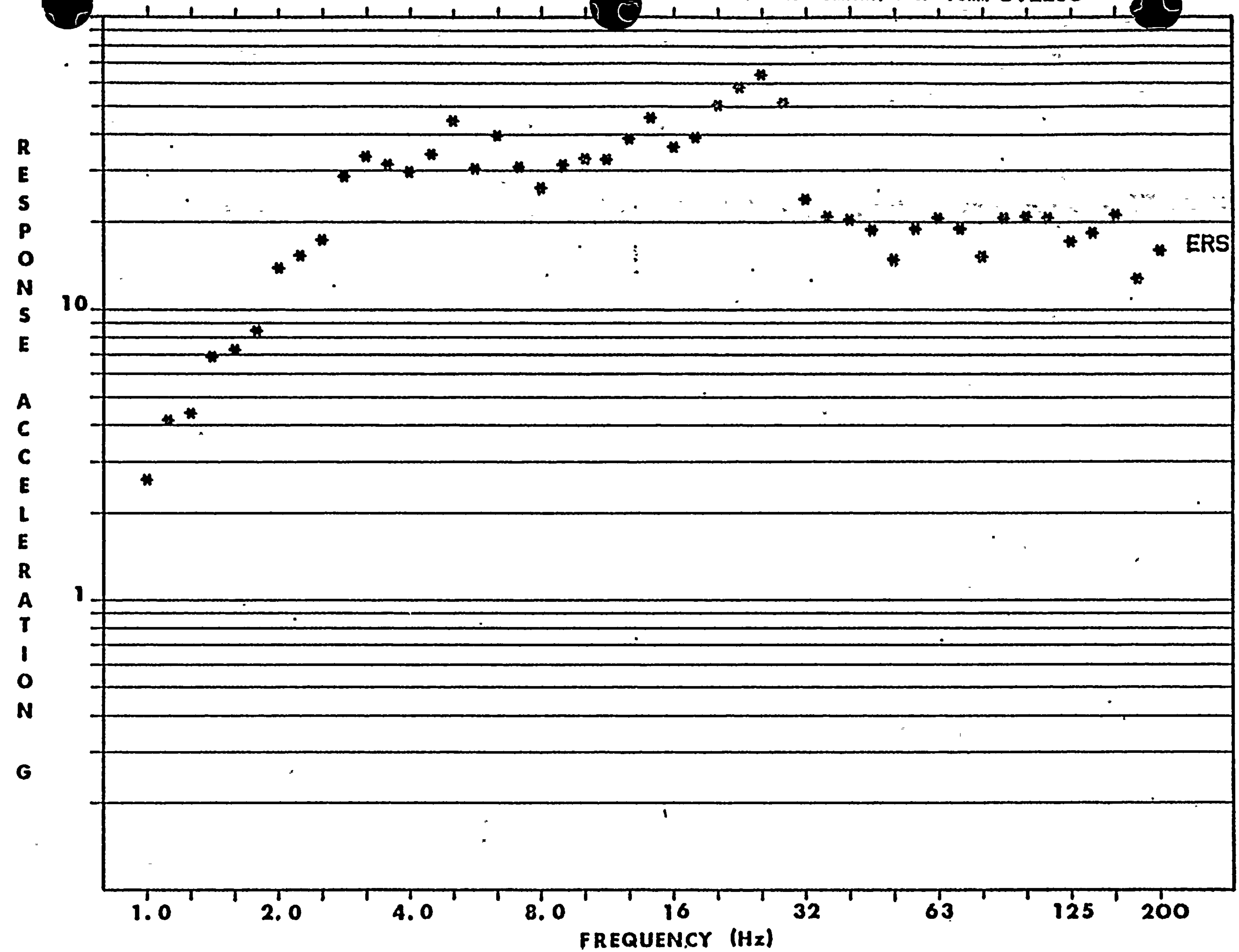
RUN NUMBER.. 24
CHANNEL NUMBER.. 6

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 18
CHANNEL NUMBER.. 7

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING



RUN NUMBER.. 18
CHANNEL NUMBER.. 8

EQUIPMENT RESPONSE SPECTRUM - SSE
1.0 % OF CRITICAL DAMPING

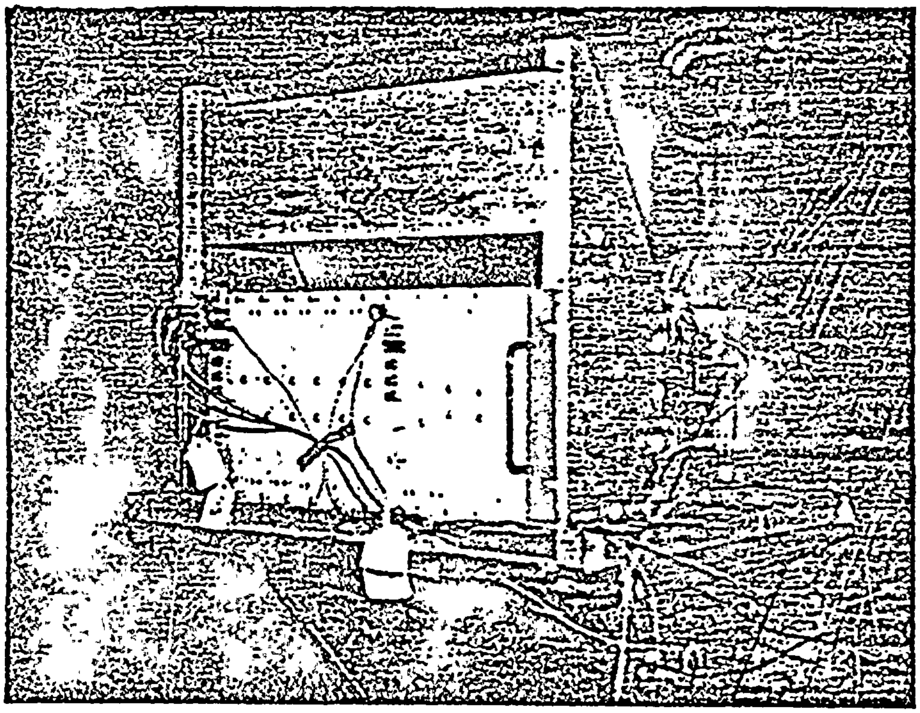
APPENDIX G

PHOTOGRAPHS

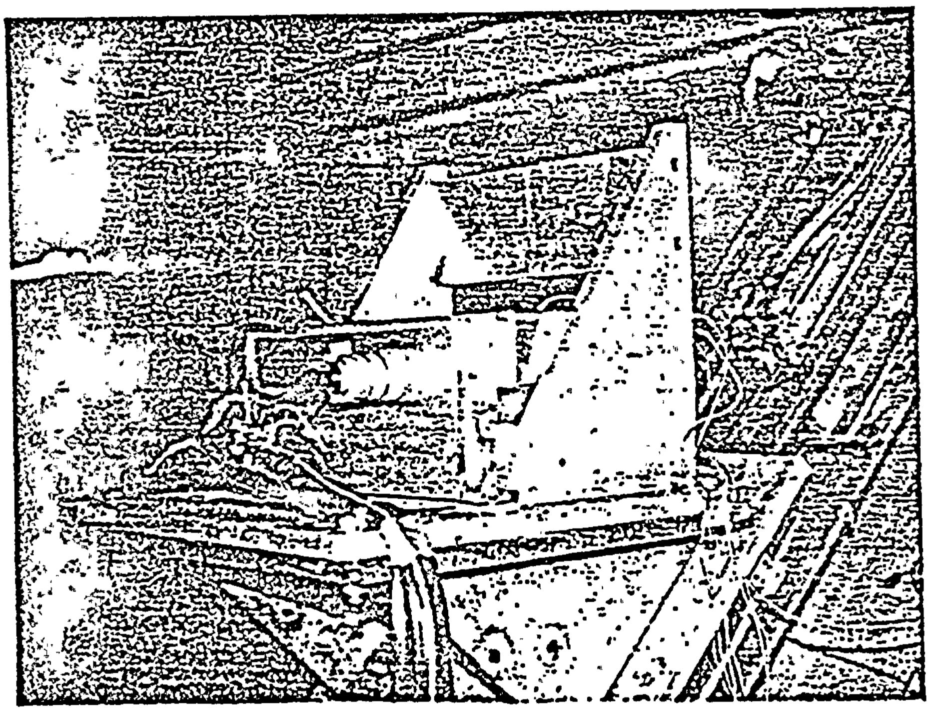
FOR

ELECTRO-MECHANICS INC.

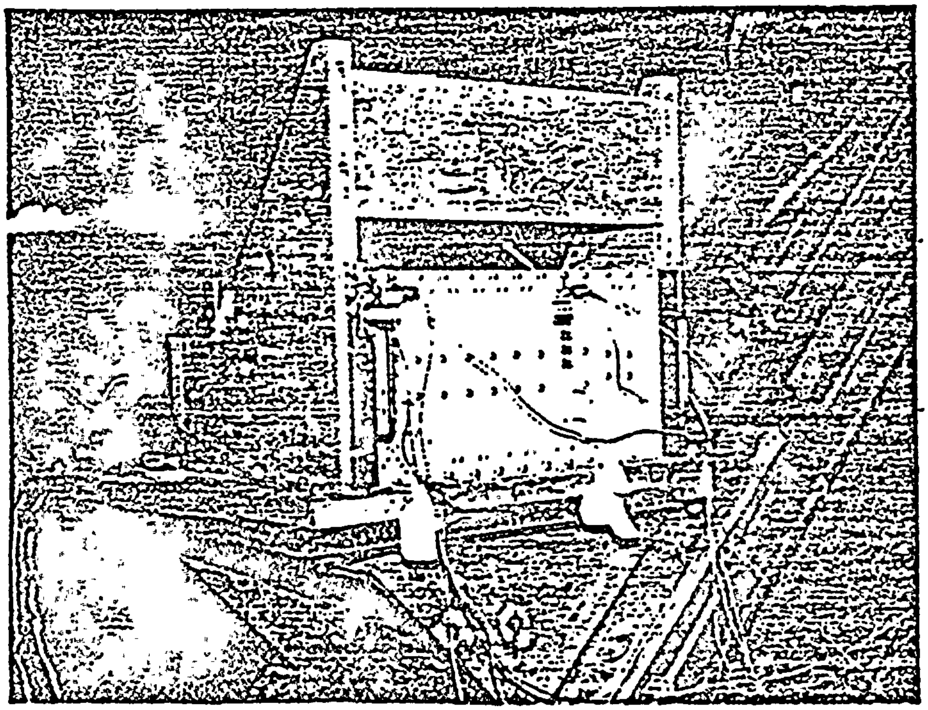
BISTABLE-AUXILIARY TRIP UNITS



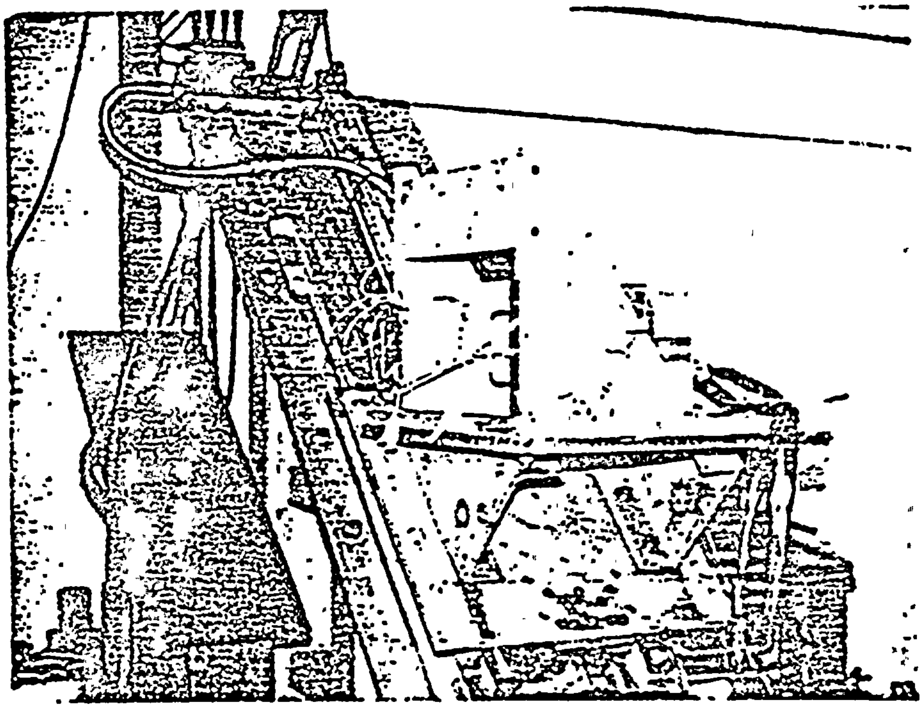
TEST SET UP
BIAXIAL PAIR NO. 1
IN-PHASE



TEST SET UP
BIAXIAL PAIR NO. 1
OUT-OF-PHASE



TEST SET UP
BIAXIAL PAIR NO. 2
IN-PHASE



TEST SET UP
BIAXIAL PAIR NO. 2
OUT-OF-PHASE

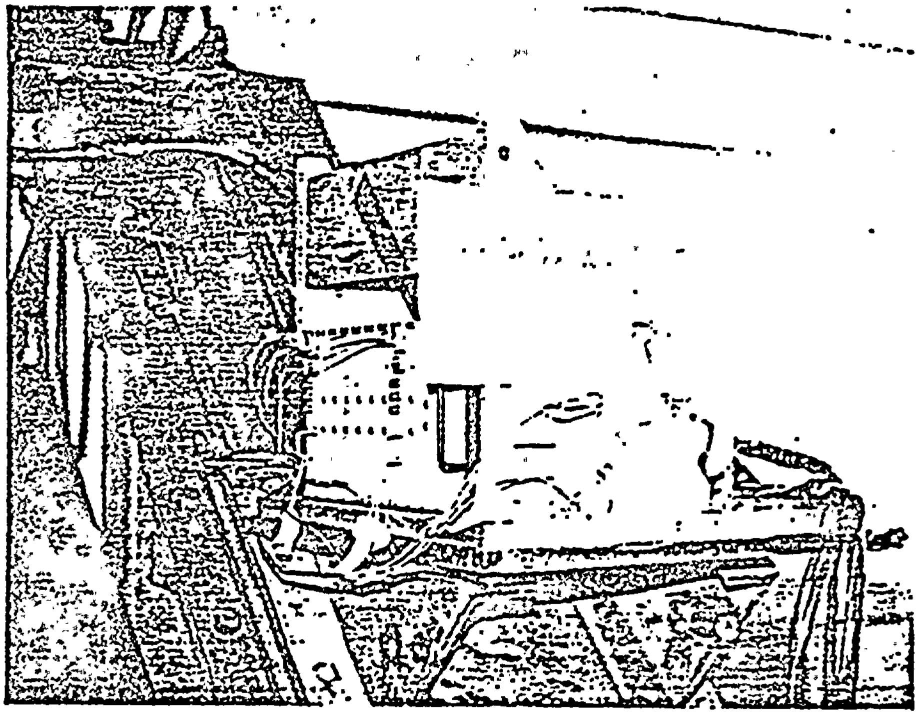
TABLE I

ACCELEROMETER MOUNTING LOCATIONS

Accelerometer Number	Motion Axis Monitored	Location
1	Horizontal	Control - on Seismic Table
2	Vertical	Control - on Seismic Table
3	Horizontal	Top of the BTU Assembly
4	Vertical	
5	Horizontal	Top of the ATU Assembly
6	Vertical	
7	Horizontal	Top Left Corner of Specimen Near Mounting Screw.
8	Vertical	

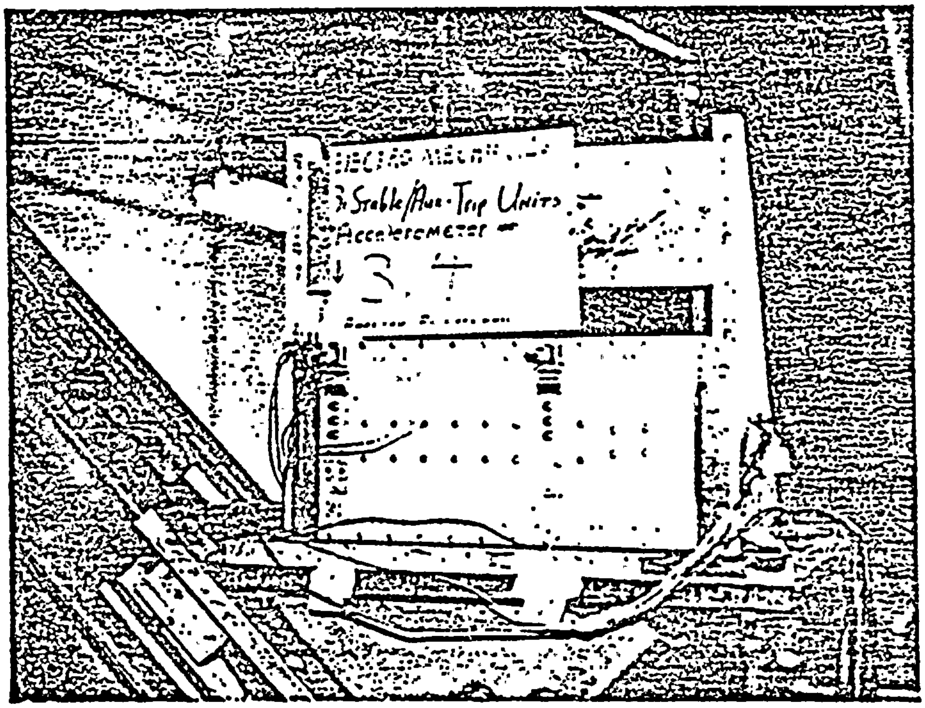
STRAIN GAUGE MOUNTING LOCATIONS

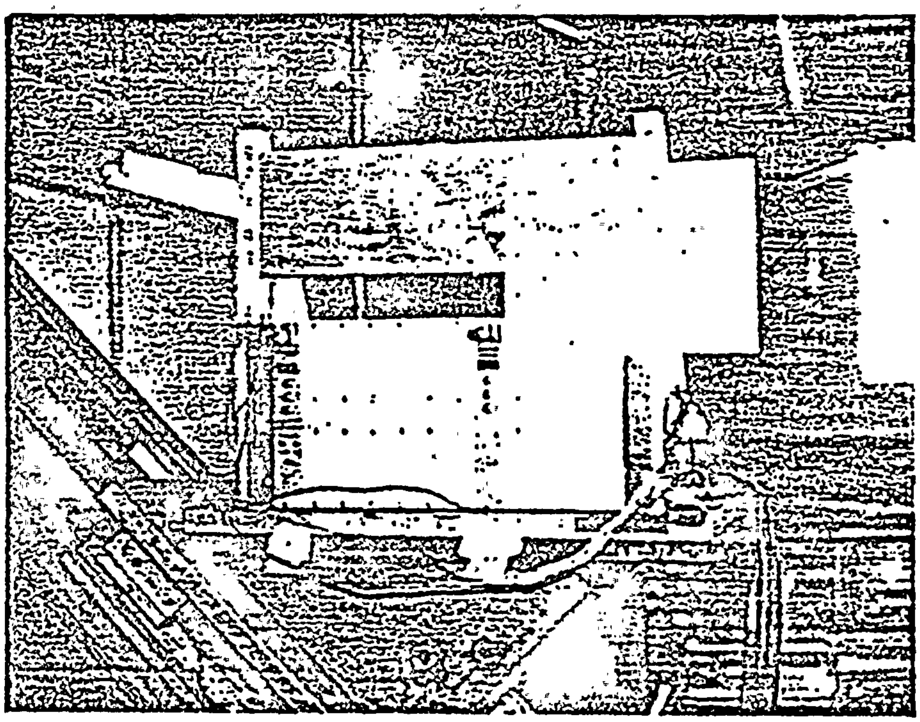
Gauge Number	Motion Axis Monitored	Location
1	Vertical	Right Rear Side of Specimen
2	Horizontal (F/B)	



CONTROL
ACCELEROMETERS
CHANNELS 1 & 2

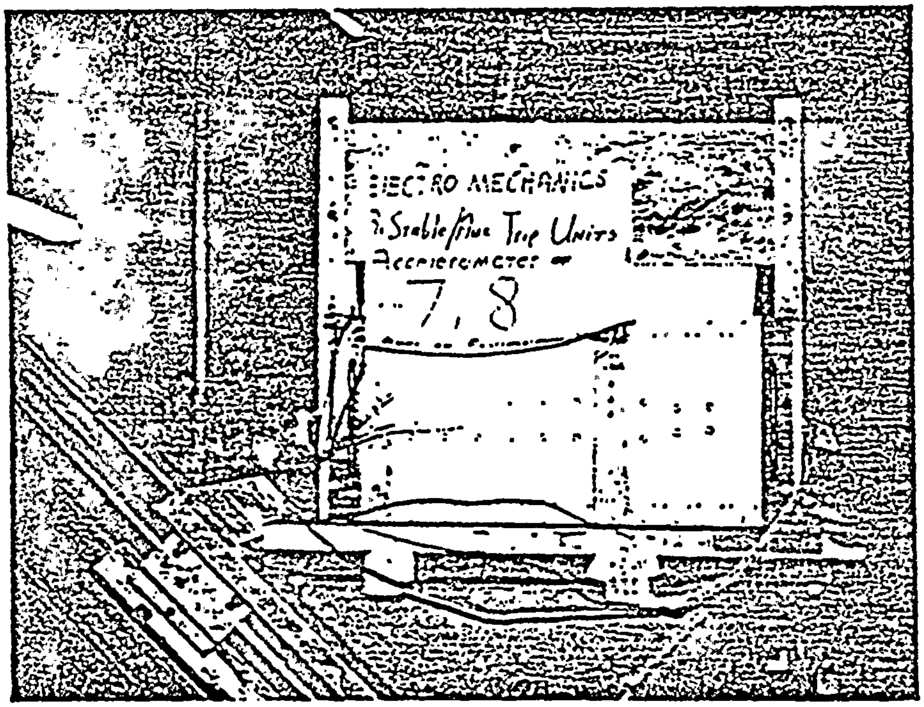
RESPONSE
ACCELEROMETERS
CHANNELS 3 & 4

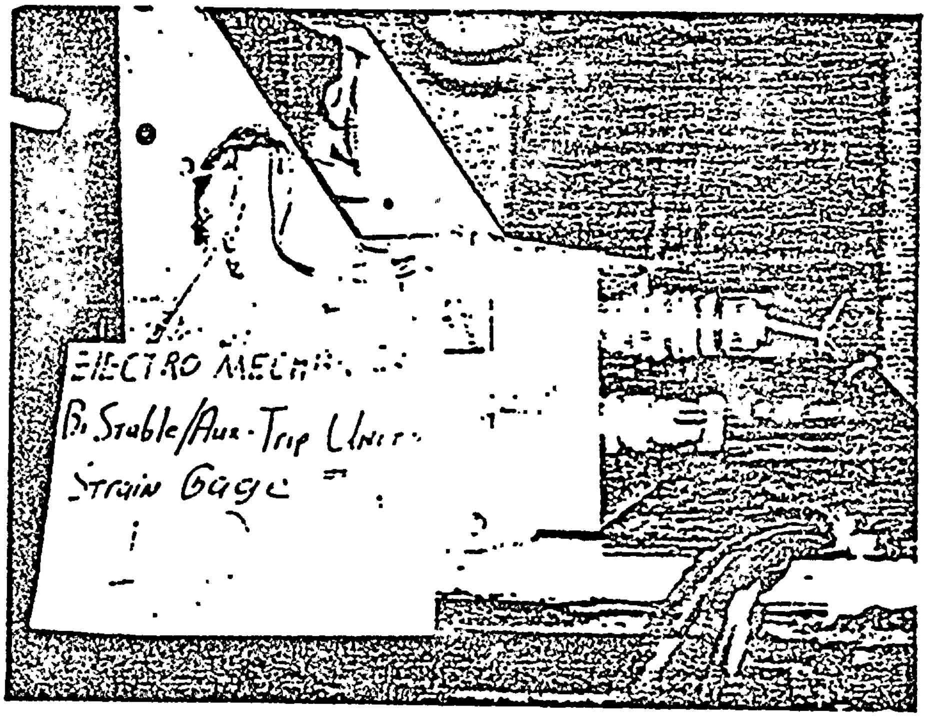




RESPONSE
ACCELEROMETERS
CHANNELS 5 & 6

RESPONSE
ACCELEROMETERS
CHANNELS 7 & 8





STRAIN GAUGE
LOCATIONS
CHANNELS 1 & 2

APPENDIX V

to

TS 6575-2

Bistable/Auxiliary Trip Units

Seismic Qualification Report

TE-291N
BISTABLE/AUX. TRIP UNIT TEST SET

TE-271N
TEST BIN ASSEMBLY