Bendix

Aerospace Systems Division

Mercer

Array E Subpack I Dynamic Analysis

NO.	REV. NO.
ATM 989	
PAGE ____ OF ____	
DATE 5/24/71	

This ATM presents the results of the dynamic analyses performed on Array E, Subpack-1 for both the LSG and the PSE versions.

Prepared by: G. B. Min

G. B. Min

K H Wadleigh

K. H. Wadleigh

Approved by: J Maszatics

J. Maszatics

CONTENTS

LIST OF ABBREVIATIONS

LMS	Lunar Mass Spectrometer
LSG	Lunar Surface Gravimeter
LSP	Lunar Surface Profilometer
PSE	Passive Seismic Experiment
L&B	Launch and Boost
L. D.	Lunar Descent
EASE	Elastic Analysis for Structural Engineering (Digital Computer Program)
RMS	Root mean square
C/S	Central Station
CSE	Central Station Electronics
GEO	Geophone
ANT	Antenna
SP	Subpackage
PDM	Power Dissipation Module
CMD	Command
DATA/PRO. D/P, DA/PR	Data Processor
C/D, COM/DEC	Command Decoder
DIPL	Diplexer
SW	Switch
ELEC	Electronics
XMTR	Transmitter

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (CONT.)

LIST OF FIGURES (CONT.)

LIST OF FIGURES (CONT.)

1.0 INTRODUCTION AND SUMMARY

This ATM presents the results of the dynamic analyses performed on two different versions of ALSEP Array E - Subpack I. One version contained the Lunar Surface Gravimeter (LSG) experiment, among others, while the other version contained the Passive Seismic Experiment (PSE) in place of the LSG.

The analysis was undertaken to obtain an early estimate of the experiment dynamic environments and dynamic loads in order to compare these with previous Subpack I arrays. While the previous SP-1 array basic structures were similar to Array E, the experiments involved were quite different. Thus it would be expected that the Array E SP-1 vibration levels would be similar to previous arrays but would differ in detail for the same ALSEP vibration environment from the LM. However, the random vibration from the LM was also increased somewhat, and these effects are accounted for in the analysis.

Dynamic analysis of the LSG revealed internal resonances which could best be avoided by mounting the experiment on shock/vibration isolators. Such isolators are included in the mathematical model of the subpackage used in this analysis. Details of the models associated with the LMS given in this report are for the arrangement without the rubber grommets.

The LSP geophone package is considered hard mounted to the brackets for this analysis, although this is only an approximation. Part of the package is suspended in foam in the direction perpendicular to the plate. Thus the calculated LSP results are somewhat severe.

The analysis models and modeling techniques are given with a brief description of the computer program inputs. This is followed by the computed results such as the natural mode frequencies and the plotted output responses. Finally, the subject of dynamic loads is discussed and some comparisons are made with the 20g "quasi-steady-state" load factor assumed for design purposes.

All tables have been grouped together and all figures have likewise been grouped together to facilitate the location of the data.

In general the computed responses agree reasonably well with comparable previous Subpack-I measured results.

2.0 ANALYSIS MODELS

The system mass properties used for the analysis were taken from Reference 1 and are repeated in Tables 1 and 2. The experiment packages were regarded as rectangular or cylindrical masses of the proper dimensions and weight but with assumed uniform mass density. The masses of the sunshield and thermal plates were distributed throughout the system. The thermal plate electronics masses were concentrated near their c. g. locations and assumed to have negligible height.

The complete assembly is shown in Figure 1, and the arrangement of the packages on the plates is shown in Figure 1a for the sunshield components and in Figure 1b for the thermal plate components.

In the alternate arrangement subsystem packages are the same except that the PSE is substituted for the LSG and one more package is included on the thermal plate for the PSE electronics. These arrangements are shown in Figures 2a and 2b for the sunshield and thermal respectively.

The mass and dimensional characteristics of the major sunshield components are shown in Figures 3-6 for the LSG, LMS, LSP and PSE packages.

Allowing all degrees of freedom to the experiment packages but X-direction only degrees of freedom to the thermal plate packages results in a 32 D.O.F. system for the LSG version and a 30 D.O.F. system for the PSE version. These degrees of freedom are listed in Table 3 and are the generalized coordinates of the two versions.

Figure 7 gives a listing of the computer programs used in the present analyses and a listing of some of the assumptions involved.

2.1 Stiffness Matrix

The stiffness matrix for the generalized coordinate system was evolved from the element stiffness matrices by the transformation

$$[k]_q = [B]^T [K] [B] \tag{1}$$

where the matrix [B] is the matrix relating the subsystem coordinates to the generalized coordinates, i.e.,

$$\{S\} = [B] \{q\} \tag{2}$$

the matrix {S} elements are listed in Table 4a for the LSG version and in Table 4b for the PSE version.

The matrix [K] is made up of subsystem stiffness matrices which are connected together by Eq. (1). The sub matrices of [K] are shown in Figures 8 & 9 for the two versions. The [B] and [K] numerical values are given in Appendix A Figures A-1 through A-4.

The subsystem stiffness matrices were computed by means of the EASE structural analysis program. The thermal plate and sunshield plates were divided into about 75 and 100 triangular finite elements respectively. Subsystem attachment nodes were given unit loads to develop the flexibility influence coefficient matrices.

The brackets were also modeled as plate elements making up the flanges, bases, and tops. Also, since the lateral forces due to the subsystems are being considered at the at the top of the brackets, but the base motion is at the bottom of the brackets, the rigid body forces will tend to deform the plate and give the bracket top more lateral flexibility than just the bracket flexibility as determined by the EASE program. This type of analysis gives the additional "u" deflections associated with the three main subsystems in the [B] matrix, and it gives the lateral stiffness matrices for these subsystems in the large [K] matrices.

2.2 Mass Matrix

The mass matrix in generalized coordinates was developed from the c.g. mass data of the components involved. This transformation is as follows:

$$[M]_q = [C]^T [M]_q [C] \qquad (3)$$

where the mass matrix $[M]_q$ is the diagonal matrix of c.g. mass characteristics and the matrix [C] is the relationship of the c.g. coordinates {p} in terms of the generalized coordinates {q}

$$\{p\} = [C] \{q\} \qquad (4)$$

These matrices are given in the Appendix as Figures A-5 through A-8.

2.3 Forcing Matrices and Input Levels

The forcing matrices are functions of the base acceleration and the transformed mass matrix as follows

$$\begin{Bmatrix}\text{Forcing}\\ \text{Matrix}\end{Bmatrix} = [C]^T [M]_p \{\ddot{p}_o\}$$

where the matrix $\{\ddot{p}_o\}$ is the column matrix of applicable base motion coordinates, i.e., $\ddot{X}_o$, $\ddot{Y}_o$ etc. depending on the excitation direction.

The input levels (design limit) at the LM interface are shown in Figures 10 and 11 for sinusoidal and random vibration respectively.

3.0 COMPUTED ACCELERATION RESPONSES

The computed responses at various points throughout the structure were obtained for each version of the Array E and are presented in the form of curves of transmissibility, sine response and random vibration response as well as Tables of RMS values of accelerations at various locations.

Initially the normal mode shapes and natural frequencies were calculated resulting in 32 mode shapes and natural frequencies for the LSG version and 30 mode shapes and frequencies for the PSE version. The many numbers involved here are reduced to those of Table 5 wherein the frequencies are listed along with the largest responding coordinate.

These natural frequencies are in the general range of previous Subpackage-1 natural frequencies as would be expected. The lowest plate mode frequency of about 50 Hz appears in many previous test results.

The other resonant frequencies are all associated with a particular motion as indicated in Table 5. The highest frequencies in this dynamic model are around 1300 to 1400 Hz; thus no computed response occurs much past these frequencies.

Computed frequency responses for sine and random inputs were obtained for most of the generalized coordinates, and in an effort to reduce the quantity of data presented many of the response curves are presented in one figure. Tables of overall G-RMS responses are also presented for easier comparison. These values have been selected from the response curve value or were obtained by averaging two or three sets of values for one package. Tables of G-RMS values are presented in Table 6 for the LSG version and Table 7 for the PSE version.

A damping factor of 10% of critical viscous damping was used in all modes except the ones involving the LSG resonances where 15% was used. This will tend to be on the conservative side since previous Sub-pack-1 tests have indicated somewhat higher damping. Another factor not in the analysis is the pin clearances at the LM interface. This reduces the actual transmissibility from the shaker to experiment subsystems in the measured results, particularly in the lateral directions Y & Z and at high frequencies, giving slightly more conservatism.

Response curves that are included in this report are presented in the coordinate number order so they can be located using Table 3 and/or Figures 1 & 2. A typical set of curves for a given coordinate response might consist of the in-axis transmissibility and sine response, and the combined random responses due to the in-axis and the cross axis excitations. Also shown on the sine and random response figures are the design specification values from Reference 2. For the random vibration spectrums, the in-axis response curve is presented as a solid line. The numerical value on the upper corner of the grid is the in-axis G-RMS value.

Details of the computer program used in the analysis are given in Reference 3.

Most of the curves presented were calculated for the LSG version, and, unless the computed responses for that location in the PSE version were appreciably different, the PSE version curves are not presented in this report. Unless noted, then, the curves of response for the LMS, LSP and other locations can be considered to apply to Array E, SP-1 versions.

3.1 Computed Responses at Specific Locations

The response curves are presented in successive numerical order for the generalized coordinate number designated as "location" on the curve. For the LSG version these are Figures 12 through 30 and for the PSE version Figures 31 through 33. The LMS was hard-mounted to its brackets in all the calculations except the ones so designated in the LMS response curves. These are the cases where the rubber grommets were included in the analysis. There was little difference in effect on other subsystem responses.

LMS responses are given in Figures 12, 27, and 28 & 29 for the X, Y, and Z axis responses. Some peak values for the random launch and boost responses exceed the specified value curves in amplitude but the overall rms response value is still fairly low. The effect of the rubber grommets is to lower the natural frequencies and the peaks somewhat with the largest effects occurring in the Z axis. Here the largest in-axis peak response (Figure 28c) is decreased appreciably (Figure 28c*). This is at the top of the bracket at the single attachment point end, w_2. A decrease in levels also occurs at the large bracket end, w_1, as shown in Figures 29c and 29c*. Use of the rubber grommets will apparently decrease the vibration environment of the LMS appreciably.

Responses of a point near a center boyd bolt and some of the C/S/E equipment attachments are shown in Figure 13. A predominant effect here is the lowest frequency "drum-head" or plate mode around 54 Hz where the launch and boost random level has a high peak. Again, the rms value is low (2.37 g-rms).

The computed x axis responses of a point on the sun shield beneath the LSG are shown in Figure 14. This is a point with relatively small mass.

LSP responses are shown in Figures 12, 26, and 30 for the X, Z, and Y axis respectively. The x-axis responses are within specification limits, even with the rigid body assumption for the LMS package. However, the Y and Z random responses indicate that high frequency modes cause transmissibilies of one or more, generally, across the spectrum (See Figure 11).

It would be expected that the test response spectrums at the geophones will be less than indicated here since the geophones are mounted in a soft foam in the X direction and supported by a "rigid" foam in Y and Z directions.

Random responses only are shown in Figures 16 and 17 for the other two center boyd bolt locations which are the connection points between sun-shield and thermal plate. These responses also form part of the response for the electronics packages below. There is considerable higher frequency response at 500 Hz and up, and the cross axis responses are sizeable.

Figure 18 shows the random response spectrum for the LSP electronics package on the thermal plate. This and the four part Figure 19 (for one of the transmitters) are typical of the thermal plate package responses.

The LSG responses are presented in the six Figures 20-25. In this case isolators in all three axes are used between the bottom of the package and the sun shield. Thus the lowest mode frequencies in the system occur for this subsystem, i.e., 31.0 and 43.4 Hz. The largest dynamic deflections will likely occur for this package also. The motion responses were calculated for both the LSG, c.g. Figures (20-22) and the bottom corner responses Figures (23-25) just above the isolator attachment. In general the high frequency responses are attenuated as planned and the sine responses in the Y and Z directions for the c.g. (Figures 21b and 23b) respond at the lowest frequencies. The overall rms responses to ramdom inputs are all quite low even though an occasional peak value (Figure 25c) exceeds the specified curve level.

The LSG isolators were selected on the basis of the work discussed in Reference 4 wherein the responses of the c.g. when excited by the specified levels of Reference 2 are presented. The corresponding curves in the present report are those of Figures 20-22 as mentioned previously, and comparisons reveal that the presently computed levels are all appreciably lower than those of Reference 4 which were considered to be a satisfactory environment for the LSG.

The final set of response curves presented is for the PSE version of Subpack-1. These are Figures 31, 32, and 33 for the X, Y, and Z PSE package responses as calculated at the bracket/experiment interface. The overall responses indicate that the input levels from Figure 11 are attenuated, but there the usual peak values of power spectral density occurring at the system resonances. As stated earlier, only the PSE response curves are presented here for the PSE version of Array E since the other computed locations did not differ largely from the same location in the LSG version.

The computed PSE response curves have been compared with some of the Subpack 1 Qual test data and found to be of the same order of magnitude in RMS value and to have a similar shape at the low frequency end. The previous test result curves are presented in Reference 6. Of the three sets of test data, Qual C data is the closest to the presently calculated responses. Overall the PSE should not see a more severe environment in Array E than it has been subjected to in previous arrays.

In general there are no unusual or severe vibration response problems indicated by this analysis. The results are in general agreement with previous Subpack 1 test results although in two instances, the LSP Y and Z responses (Figures 26 and 30), the fairly large deviations of the PSD peaks from the specified curve indicate that these points should be monitored during the Engineering Model testing in order to determine if this level of high frequency response actually exists.

4.0 DYNAMIC LOADS

The internal loading in the structural assemblies were calculated by a process of inserting the product of mass and acceleration into the original stiffness matrix and computing the internal loads and deflections for the coordinates of Tables 4a and 4b. Details of the method of calculation are given in Reference 3. The objective here is to be able to compare the loads with the "quasi-steady-state" design load factor assumption of 20 g throughout the structure.

Calculations were made for both versions of the Array E SP-1 but only the LSG version loads and deflections are included here. The PSE version loads do not differ appreciably in those cases where direct comparisons can be made.

A listing of the worst case loads due to x-axis sine excitation is shown in Table 8. This occurs at 54.5 Hz. The highest loads here are indicated to occur at the LSP attachment points, u_{10}, u_{11}, u_{12}, u_{13}, but this is due to the rigid body assumption for this package. The loads shown here would be relieved somewhat by the package tab bending and the racking deflection of the package.

A listing of the worst case Launch and Boost random loads and deflections is shown in Table 9 for the LSG version. These are root mean square values (one sigma) and should be multiplied by 3 to compare with a 30 g load (20 g load factor x 1.5 factor of safety) at a particular location.

Lunar descent environment loads are all less than those shown in Table 9. The coordinate location numbers correspond to Table 4a.

An interpretation of the load figures of Table 9 is given in Table 10 where direct comparisons are made between the various subsystem dynamic loads and the design load assumed initially.

For the first 3 subsystems, the LMS, LSP and LSG, the loads are those occurring at the top of the bracket at the experiment/tab interface. The third column of figures is the root-mean-square (one sigma) load value obtained at the coordinate location indicated in the first column. The numbers are multiplied by 3 to obtain a 3-sigma load for comparison with a 30 g ultimate design load factor at that location. For the LSP and LSG, two brackets carry the computed load in the lateral directions at each end of the package.

In the remaining cases, i.e., the antenna cable reel, electronics packages, etc., the Table 9 load represents the load at the c.g. of the designated package. These loads are in the X-axis direction only. Calculated loads in the Y and Z lateral directions for these components would be about half the magnitude of the 30 g design load column figures.

An assumed design load factor of 30 g on ultimate in the present case was a safe assumption throughout the structure as can be seen by comparing the last two columns in Table 10. The last column figures are 25% or more greater than the 3-sigma loads.

5.0 REFERENCES

1. ATM 268 ALSEP System Mass Properties, 6 Nov 70.
2. Letter No. 9712-56, Array E Subpack #1 Subsystem Dynamic Environment, 15 Oct 70.
3. BSR 3095 "Dynload" An Integrated Dynamics and Loads Analysis Program, March, 1971.
4. Letter No. 984-ME-007, Isolation of the LSG from its Vibration Environment.
5. ATM 832, ALSEP Qualification Design Limit Vibration Test Data Summary, 27 June 69.

ALSEP ARRAY E WEIGHT ESTIMATE

SUBPACKAGE #1

	Configuration Prime	Configuration Alternate
C/S and LSP/CSE	44.2	N/A
C/S and LSP & PSE CSE	N/A	48.4
Primary Structure	9.0	9.0
Sunshield Assy/Sub/Fast	12.0	12.0
T/C Curtains	2.0	2.0
Boom	.9	.9
PDM	1.0	1.0
Sunshield Extenders	1.0	1.0
Antenna & Cable	1.3	1.3
Antenna Mast	.8	.8
Fasteners	1.0	1.0
LSG/Cable	26.2	N/A
LSP/Geo/Ant/Cable	11.2	11.2
LMS/Cable	22.7	22.7
PSE	N/A	22.3
Miscellaneous	1.0	1.0
Total	134.3 lb.	134.6 lb.

TABLE 1

ALSEP ARRAY E
CENTRAL STATION ASSEMBLY
DETAILED WEIGHT BREAKDOWN (ESTIMATE)

Data Processor/Multiplexer	4.20
CMD Receiver	2.50
Diplexer Filter	1.00
Filter Switch	1.30
Transmitters (2)	4.20
CMD Decoder	3.20
PCU/PDU	8.00
Thermal Plate & Hdwe	9.00
Harness Assy	2.50
Thermal Bag	1.50
PSE Elect.	4.20
LSP Elect.	4.30
Miscellaneous (includes Ant. Cable)	2.0
	48.40 LB.

(44.20 LB. less PSE elect.)

NOTE: All weights are estimates based on previous ALSEP Models.

TABLE 2

TABLE 3

GENERALIZED COORDINATES
(REFER TO FIGURES 1 & 2)

LSG Version

1	u_1	LMS	
2	u_2		
3	u_3	Boyd Bolt Near LMS	
4	u_4	Cable Reel	
5	u_5	Antenna	
6	u_1	Below LSG on Sun Sh.	
7	u_2		
8	u_3		
	u_4		
10	u_1	LSP	
11	u_3		
12	u_3		
13	u_{13}	Boyd Bolt	RCVR, DIPL
14	u_{14}	Boyd Bolt	RCVR, DIPL
15	u_{15}	Thermal Plate Components	PCU/PDU
16	u_{16}		COM/DEC
17	u_{17}		DATA/PRO.
18	u_{18}		DIPL/SW
19	u_{19}		LSP/ELEC
20	u_{20}		XMTR
21	u_{21}		XMTR

PSE Version

1	u_1	LMS	
2	u_2		
3	u_3	Boyd Bolt Near LMS	
4	u_4	Cable Reel	
5	u_5	Antenna	
6	u_1	PSE	
7	u_2		
8	u_4		
9	u_1	LSP-Geophones	
10	u_3		
11	u_4		
12	u_{12}	Boyd Bolt	RCVR, DIPL
13	u_{13}	Boyd Bolt	RCVR, DIPL
14	u_{14}	Thermal Plate Components	PCU/PDU
15	u_{15}		COM/DEC
16	u_{16}		DATA/PRO.
17	u_{17}		DIPL/SW
18	u_{18}		LSP/ELEC.
19	u_{19}		XMTR
20	u_{20}		XMTR
21	u_{21}		PSE/ELEC.

TABLE 3 (CONT)

LSG Version

22	u_1	LSG	u	LSG
23	u_2	at	v	at
24	u_3	Isolators	w	C.G.
25	v_1		θ	
26	w_1		ψ	
27	v_1	LSP		
28	w_1			
29	v_2			
30	w_2	LMS		
31	w_3			
32	v_2	LSP		

PSE Version

22	v_1	
23	v_2	PSE
24	w_1	
25	v_1	
26	v_2	LSP-Geophones
27	w_1	
28	v_2	
29	w_2	LMS
30	w_1, w_3	

TABLE 4a

SUBSYSTEM COORDINATES ARRAY E
SP-1 (LSG VERSION)

1	u_1	LMS
2	u_2	
3	u_3	Boyd Bolt Near LMS
4	u_4	Cable
5	u_5	Antenna
6	u_1	Below LSG on Sun Shield
7	u_2	
8	u_3	
9	u_4	
10	u_1	LSP
11	u_2	
12	u_3	
13	u_4	
14	u_{14}	Boyd Bolt
15	u_{15}	Boyd Bolt
16	u_{16}	
17	u_{17}	Thermal Plate
18	u_{18}	
19	u_{19}	
20	u_{20}	
21	u_{21}	
22	u_{22}	
23	u_{23}	
24	u_{24}	
25	u_{25}	
26	u_1	LSG
27	u_2	
28	u_3	
29	u_4	
30	v_1	
31	v_2	
32	w_1	
33	w_3	
34	u_1^l	Isolators: Sunshield Connection end
35	u_2^l	
36	u_3^l	
37	u_4^l	
38	v_1	LSP
39	w_1	
40	v_1	LMS
41	v_2	
42	v_3	
43	w_2	
44	w_3	
45	v_2	LSP
46	w_4	

TABLE 4b

SUBSYSTEM COORDINATES ARRAY E
SP-1 (PSE VERSION)

No.	Coordinate	Description
1	u_1	LMS
2	u_2	LMS
3	u_3	Boyd Bolt Near LMS
4	u_4	Cable
5	u_5	Antenna
6	u_1	PSE
7	u_2	PSE
8	u_3	PSE
9	u_4	PSE
10	u_1	LSP
11	u_2	LSP
12	u_3	LSP
13	u_4	LSP
14	u_{14}	Boyd Bolt
15	u15	Boyd Bolt
16	u_{16}	Thermal Plate
17	u_{17}	Thermal Plate
18	u_{18}	Thermal Plate
19	u_{19}	Thermal Plate
20	u_{20}	Thermal Plate
21	u_{21}	Thermal Plate
22	u_{22}	Thermal Plate
23	u_{23}	Thermal Plate
24	u_{24}	Thermal Plate
25	u_{25}	Thermal Plate
26	u_{26}	Thermal Plate
27	v_1	PSE Above
28	v_2	PSE Above
29	w_1	PSE Above
30	w_3	PSE Above
31	v_1	LSP Above
32	v_2	LSP Above
33	w_1	LSP Above
34	w_4	LSP Above
35	v_1	LMS Above
36	v_2	LMS Above
37	v_3	LMS Above
38	w_2	LMS Above
39	w_3	LMS Above

TABLE 5

NATURAL FREQUENCIES AND RESPONDING MOTIONS

LSG Version

	Freq. (Hz)	Motion
1.	31	LSG Rot* about Z axis
2.	43.4	LSG Rot, about Y axis
3.	54.8	Lowest Plate mode X
4.	75.4	LMS Z
5.	82.0	Th. Plate 16, LSG X
6.	95.0	LSG X
7.	103	Th. Plate 16
8.	118	Th. Plate 19
9.	125	LSP X
10.	132	Th. Plate XMTRS
11.	145	LSG Y
12.	147	LSG Z
13.	152	Th. Plate 17
14.	162	Th. Plate 17, LMS Y
15.	183	LMS X, LMS Z
16.	212	LSP X
17.	230	Th. Plate 18
18.	256	Th. Plate 18
19.	259	LMS Rot. about X
20.	323	Ant. Cable
21.	385	Th. Plate XMTRS
22.	399	Th. Plate XMTRS
23.	434	LSP X
24.	460	LSP Y
25.	496	Center Boyd Bolt
26.	529	Antenna
27.	640	LSP Rot, about X axis
28.	769	Under LSG X (28–32)
29.	953	
30.	1153	
31.	1277	
32.	1411	

PSE Version

	Freq. (Hz)	Motion
1.	53.3	Lowest Plate Mode X
2.	69.8	Th. Plate 21
3.	81.6	Th. Plate 14
4.	88.6	Th. Plate 21
5.	103	Th. Plate 15
6.	113	Th. Plate 19
7.	123	PSE Z (24)
8.	126	LSP X
9.	129	PSE Y
10.	138	Th. Plate 20
11.	145	Th. Plate 16, LSP X
12.	161	Th. Plate 16, LMS Y
13.	171	LMS X, LMS Z
14.	201	Th. Plate 17, 20
15.	223	Th. Plate 17, 10
16.	241	Th. Plate 17, 9
17.	254	Th. Plate 17, 4
18.	283	PSE X
19.	302	Ant. Cable X
20.	347	PSE X
21.	373	Ant Cable & 13
22.	398	Th. Plate XMTR
23.	421	Boyd Bolt 12
24.	448	LSP Y
25.	475	LSP X
26.	535	PSE Y
27.	576	Ant
28.	610	Boyd Bolt 13
29.	640	LSP Rot. about X
30.	1280	Boyd Bolt 12

* Rot. = Rotation

TABLE 6

ARRAY E SP-1 VIBRATION ANALYSIS RESULTS
(LSG VERSION)

ROOT MEAN SQUARE RESPONSE (G-RMS)

Input Axis		X		Y		Z	
Subsys	Resp. Axis	L & B	L. D.	L & B	L. D.	L & B	L. D.
LSG @ BASE	X	1.94	1.34	.92	.70	1.38	1.04
	Y	.54	.31	2.32	1.73	.19	.14
	Z	.78	.48	.38	.27	2.08	1.48
LSG @ C.G.	X	1.52		.32		.63	
	Y	.61		.81		.16	
	Z	.94		.15		.96	
LMS	X	3.42	1.6	1.4	1.0	2.25	.9
	Y	.98	.47	3.1	2.26	.62	.37
	Z	2.4	1.25	1.56	1.1	3.24	2.0
LSP Geoph.	X	3.7	1.08	2.4	1.7	2.9	1.6
	Y	1.2	.52	5.1	3.6	5.6	2.8
	Z	1.02	.49	3.9	2.65	7.3	3.8
Recvr	X	3.4	1.7	2.1	1.4	3.9	1.9
C/D	X	2.4	1.7	.9	.7	1.1	.7
Xmtr	X	3.0	1.6	.7	.5	.8	.6
D/P & LSP CSE	X	2.4	1.4	.7	.5	1.6	1.2

TABLE 7

ARRAY E SP-1 VIBRATION ANALYSIS RESULTS
(PSE VERSION)

Root Mean Square Response (G-RMS)

Input Axis		X		Y		Z	
Subsystem	Response Axis	L & B	L. D.	L & B	L. D.	L & B	L. D.
PSE @ Bracket	X	4.0	1.85	1.72	1.25	1.87	1.07
	Y	3.6	1.60	2.7	2.00	0.88	0.46
	Z	2.7	1.18	0.56	0.40	2.39	1.73
LMS	X	3.7	1.71	2.0	1.39	1.66	0.92
	Y	0.96	0.44	2.78	2.05	0.8	0.49
	Z	2.5	1.21	2.16	1.53	3.66	2.11
LSP Geoph.	X	3.3	1.70	2.36	1.67	2.82	1.40
	Y	1.1	0.47	4.86	3.44	5.85	2.68
	Z	0.73	0.35	2.54	1.72	7.78	3.83
Recvr.	X	3.17	1.79	3.01	2.12	4.54	2.19
C/D	X	2.3	1.73	0.42	0.33	0.99	0.81
Xmtr.	X	2.94	1.58	1.25	0.90	0.91	0.62
DA/PR & LSP/CSE	X	3.22	1.55	1.86	1.32	1.77	1.14
PSE Elect.	X	2.2	1.59	0.17	0.13	0.9	0.77

TABLE 8

SINE LOADS AND DEFLECTIONS @ 54.5 Hz

Coord. No.	Defl.	Loads-lb.	Coord. No.	Defl.	Loads-lb.
1	.0104	5.9	25	.02186	12.7
2	.00762	19.7	26	.016397	-61.4
3	.02565	182.9	27	.024985	110.9
4	.01022	7.5	28	.02572	152.5
5	.00462	2.6	29	.017135	67.4
6	.02564	-52.1	30	.001213	10.8
7	.0083	112.2	31	.001213	10.8
8	.00279	153.5	32	.002764	24.5
9	.006997	68.5	33	.002764	24.5
10	.01598	178.	34	.02564	61.4
11	.002115	-172.	35	.008307	-110.9
12	.00861	197.2	36	.002794	-152.5
13	.02305	-147.3	37	.006997	-67.4
14	.02372	75.9	38	.000784	36.
15	.02186	38.3	39	-.000113	0.5
16	.027575	38.3	40	-.00396	-41.5
17	.02949	27.2	41	-.003578	-14.5
18	.0369	37.4	42	-.003197	-44.5
19	.02449	5.4	43	-.006975	16.1
20	.01541	15.4	44	-.00881	-115.7
21	.014259	5.4	45	.000782	35.8
22	.01053	4.3	46	-.000112	0.6
23	.03587	-4.2			
24	.02372	-57.6			

(LSG Version)

	DEFLECTIONS X	INTERNAL LOADS X	DEFLECTIONS Y	INTERNAL LOADS Y	DEFLECTIONS Z	INTERNAL LOADS Z
1	0.2020616E-02	0.8518082E 02	0.1153582E-02	0.4308409E 02	0.1515978E-02	0.2868005E 02
2	0.1901251E-02	0.3922827E 02	0.1292647E-02	0.1218562E 02	0.1506715E-02	0.2587494E 02
3	0.5508518E-02	0.6255188E 02	0.2684267E-02	0.2683273E 02	0.4488319E-02	0.3415413E 02
4	0.1917944E-02	0.1856151E 02	0.9092311E-03	0.7354911E 01	0.1536674E-02	0.1390333E 02
5	0.7986578E-03	0.1075672E 02	0.3825407E-03	0.1885405E 01	0.5888520E-03	0.3426674E 01
6	0.6432772E-02	0.5601875E 02	0.3130808E-02	0.2551482E 02	0.5424883E-02	0.4624474E 02
7	0.2604981E-02	0.6993263E 02	0.1026911E-02	0.2239705E 02	0.2495511E-02	0.6902733E 02
8	0.8776561E-03	0.7556430E 02	0.4719018E-03	0.3884067E 02	0.5434684E-03	0.4934154E 02
9	0.1262621E-02	0.8041168E 02	0.6376123E-03	0.3475310E 02	0.9801141E-03	0.6346570E 02
10	0.3854132E-02	0.4777254E 02	0.3372461E-02	0.5467834E 02	0.3364185E-02	0.4672301E 02
11	0.5740609E-03	0.7252792E 02	0.6495784E-03	0.2047395E 02	0.6043436E-03	0.4468866E 02
12	0.2107331E-02	0.6345221E 02	0.1419016E-02	0.3713501E 02	0.1759830E-02	0.5086446E 02
13	0.5505380E-02	0.4261519E 02	0.3412927E-02	0.2016063E 02	0.4625294E-02	0.3970790E 02
14	0.5939178E-02	0.1861517E 02	0.3238403E-02	0.1254080E 02	0.5128782E-02	0.2795062E 02
15	0.4908271E-02	0.1714490E 02	0.2871289E-02	0.8133303E 01	0.4001319E-02	0.1207920E 02
16	0.5484492E-02	0.1145525E 02	0.2514892E-02	0.2527495E 01	0.4350029E-02	0.6446746E 01
17	0.4632499E-02	0.8959330E 01	0.1605045E-02	0.1245683E 01	0.2924795E-02	0.4292113E 01
18	0.5791582E-02	0.1138213E 02	0.2644942E-02	0.5086577E 01	0.4223011E-02	0.6819304E 01
19	0.4233275E-02	0.2961148E 01	0.2192234E-02	0.1371475E 01	0.3035684E-02	0.1732658E 01
20	0.3678838E-02	0.1032734E 02	0.2064268E-02	0.3116425E 01	0.2992881E-02	0.7060584E 01
21	0.2736617E-02	0.4632637E 01	0.1419118E-02	0.1034540E 01	0.1825278E-02	0.1250408E 01
22	0.2045263E-02	0.4580610E 01	0.9652502E-03	0.9630044E 00	0.1220793E-02	0.9925961E 00
23	0.6415819E-02	0.1210711E 02	0.3233627E-02	0.7017447E 01	0.4862860E-02	0.9727118E 01
24	0.5935179E-02	0.1329801E 02	0.3238403E-02	0.5839010E 01	0.5128782E-02	0.1027551E 02
25	0.4908271E-02	0.1039721E 02	0.2871289E-02	0.3825008E 01	0.4001319E-02	0.6745353E 01
26	0.1374900E-01	0.5555186E 02	0.5944982E-02	0.2394731E 02	0.1129451E-01	0.4441995E 02
27	0.1288143E-01	0.6976808E 02	0.4191276E-02	0.2226318E 02	0.1267591E-01	0.6874982E 02
28	0.1218907E-01	0.7529198E 02	0.6306294E-02	0.3883218E 02	0.7944521E-02	0.4927722E 02
29	0.1225281E-01	0.8032796E 02	0.5377930E-02	0.3460651E 02	0.9460084E-02	0.6311862E 02
30	0.1442564E-02	0.1278112E 02	0.6223340E-02	0.5513879E 02	0.5206796E-03	0.4613225E 01
31	0.1442564E-02	0.1278112E 02	0.6223340E-02	0.5513879E 02	0.5206796E-03	0.4613225E 01
32	0.1612786E-02	0.1428929E 02	0.7829729E-03	0.6937140E 01	0.4313566E-02	0.3821819E 02
33	0.1612786E-02	0.1428929E 02	0.7829729E-03	0.6937140E 01	0.4313566E-02	0.3821819E 02
34	0.6432772E-02	0.5555186E 02	0.3130808E-02	0.2394731E 02	0.5424883E-02	0.4441995E 02
35	0.2604981E-02	0.6976808E 02	0.1026911E-02	0.2226318E 02	0.2495511E-02	0.6874982E 02
36	0.8776561E-03	0.7529198E 02	0.4719018E-03	0.3883218E 02	0.5434684E-03	0.4927722E 02
37	0.1262621E-02	0.8032796E 02	0.6376123E-03	0.3460651E 02	0.9801141E-03	0.6311862E 02
38	0.4911276E-03	0.2022678E 02	0.8389773E-03	0.3178055E 02	0.8197923E-03	0.3396385E 02
39	0.4764248E-03	0.2715257E 02	0.9104121E-03	0.4860416E 02	0.8504733E-03	0.4858812E 02
40	0.5508538E-03	0.9155738E 01	0.1448131E-02	0.2782047E 02	0.3508602E-03	0.1229201E 02
41	0.6196331E-03	0.3051718E 01	0.1478089E-02	0.9269849E 01	0.4821070E-03	0.1685755E 01
42	0.8209320E-03	0.1308979E 02	0.1531237E-02	0.2811931E 02	0.7629539E-03	0.8408727E 01
43	0.2871378E-02	0.2115347E 02	0.2136585E-02	0.1312141E 02	0.4361380E-02	0.2482549E 02
44	0.2107688E-02	0.2942404E 02	0.1407058E-02	0.1185706E 02	0.2894565E-02	0.2383987E 02
45	0.4952652E-03	0.2081390E 02	0.8770570E-03	0.3472220E 02	0.8025661E-03	0.3270691E 02
46	0.4733258E-03	0.2664931E 02	0.9445262E-03	0.5325771E 02	0.8344580E-03	0.4646214E 02

Load Units Lbs

Defl. Units Inches

Rms. Values

Random Loads and Deflections (LSG Version)

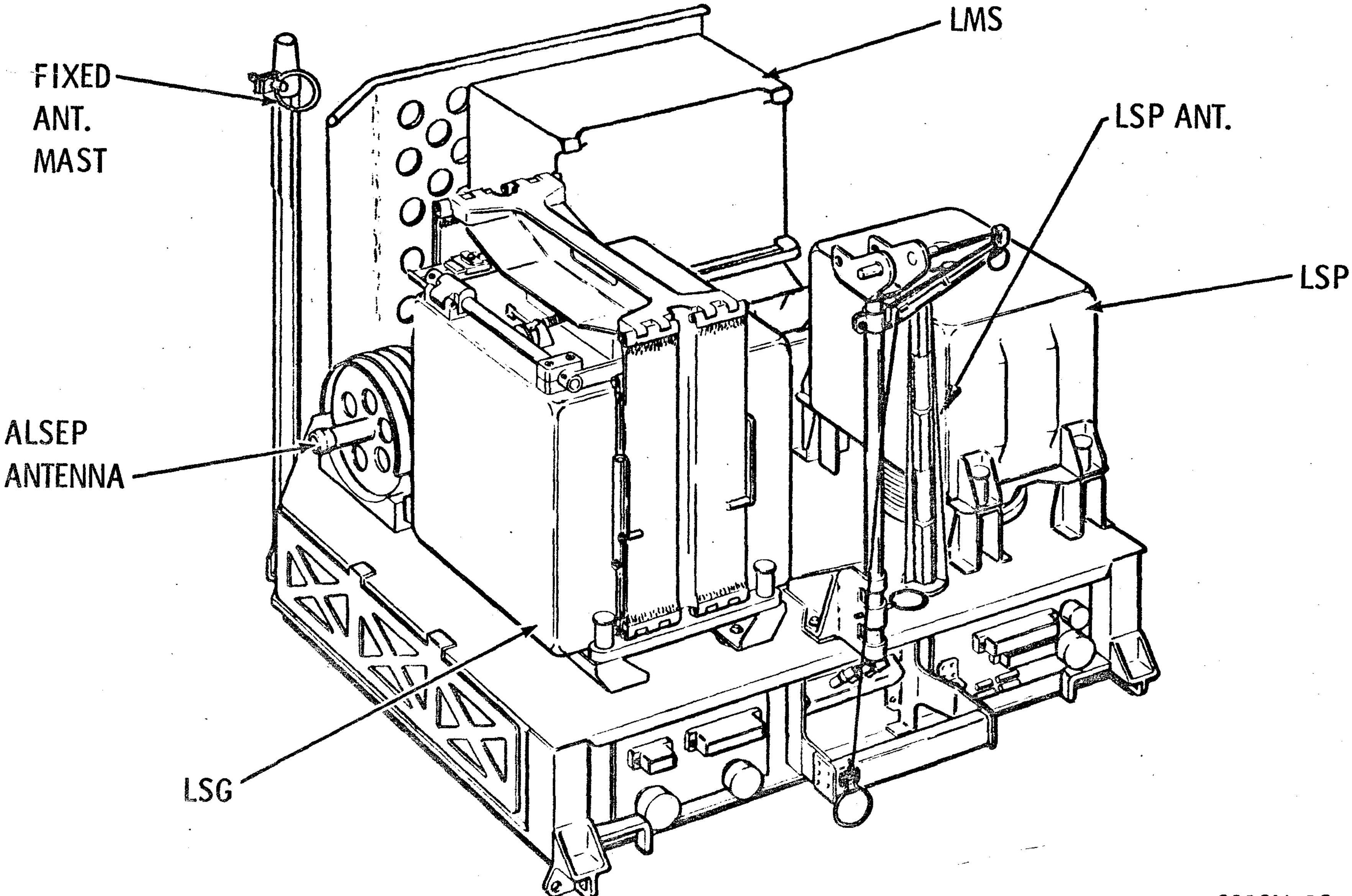
Table 9

TABLE 10

Comparison of Launch and Boost Dynamic Loads with Static Design Loads

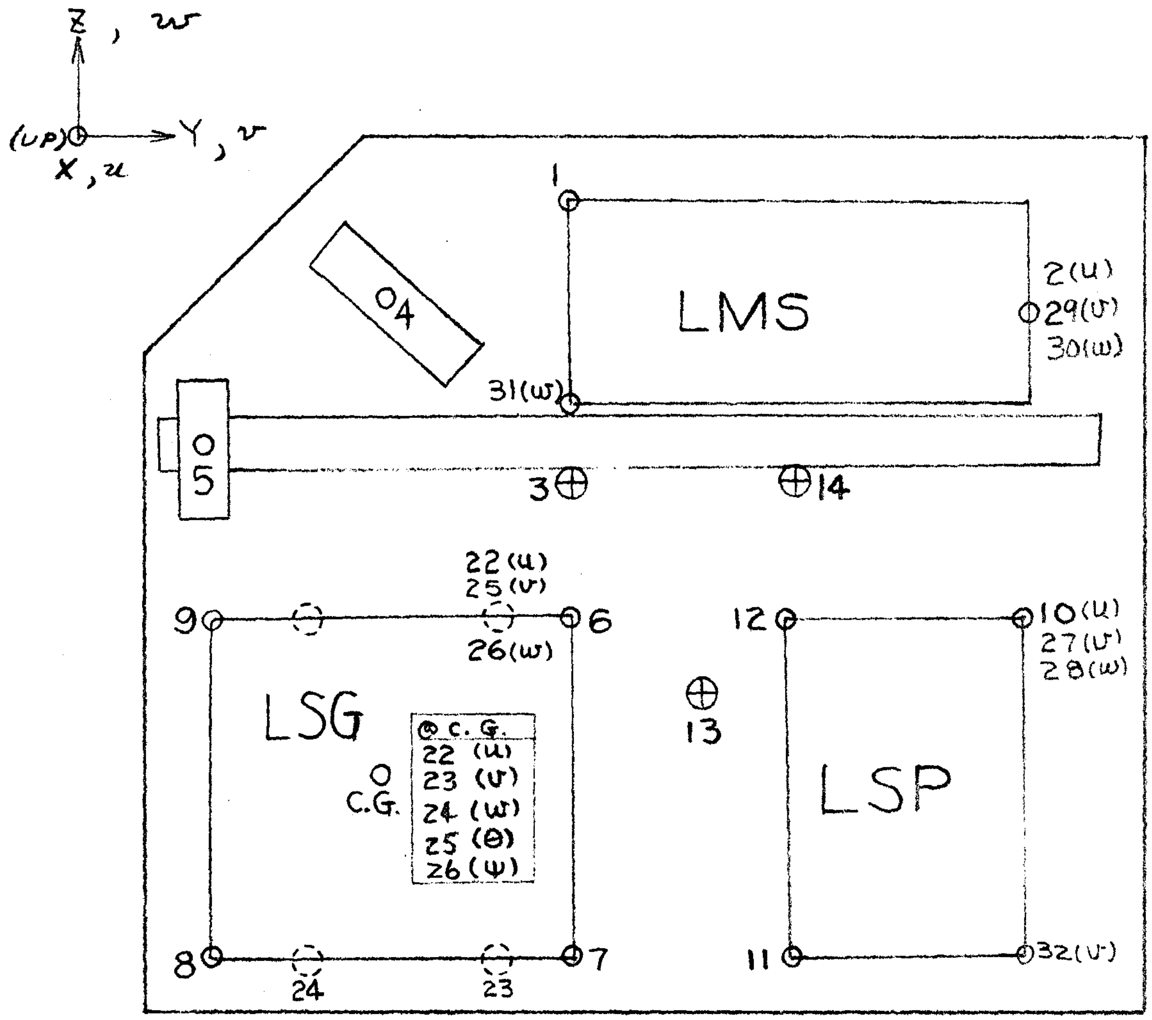
Sub-System	Table 4a and Table 9 Coord.	Local Coordinate	Table 9 L & B Load-U	Three Sigma Load-U	30g* Design Load-U
LMS	1	U_1	85.2	255.6	515
	2	U_2	39.2	117.6	420
	3	U_3	62.6	187.8	515
	40	V_1	27.8	83.4	165
	41	V_2	9.3	27.9	↓
	42	V_3	28.1	84.3	↓
	43	W_2	24.8	74.4	↓
	44	W_3	23.8	71.4	↓
LSP	10	U_1	47.8	143.4	332
	11	U_2	72.5	217.5	↓
	12	U_3	63.5	190.5	↓
	13	U_4	42.6	127.5	↓
	38	V_1	31.7	95.1	200 (Two brackets)
	45	V_2	34.7	104.1	↓
	39	W_1	48.6	145.8	↓
	46	W_4	53.3	159.9	↓
LSG	26	U_1	55.6	166.8	416 (Two brackets)
	27	U_2	69.8	189.4	↓
	28	U_3	75.3	225.9	↓
	29	U_4	80.3	240.9	↓
	30	V_1	55.1	165.3	↓
	31	V_2	55.1	165.3	↓
	32	W_1	38.2	114.6	↓
	34	W_3	38.2	114.6	↓
Ant. Cable Reed	4	U_4	18.6	55.8	102
Antenna	5	U_5	10.8	32.4	47.4
PCU/PDU	16	U_{16}	11.5	34.5	179
CDM/DEC	17	U_{17}	9.0	27.0	108
DATA/PRO.	18	U_{18}	11.4	34.2	126
DIPL/SW.	19	U_{19}	3.0	9.0	28.8
LSP/ELECT.	20	U_{20}	10.3	30.9	117
XMTR	21	U_{21}	4.6	13.8	45.6
XMTR	22	U_{22}	4.6	13.8	45.6
Load at th. plate end of Boyd bolts	23	U_{23}	12.1	36.3	116
	24	U_{24}	13.3	39.9	116
	25	U_{25}	10.4	31.2	116

* Includes a 1.5 factor of safety



8310N-10-A 10&A

Figure 1. Complete Assembly, LSG Version



O Mass Lumped

⊕ Connected Points (between sunshield thermal plate)

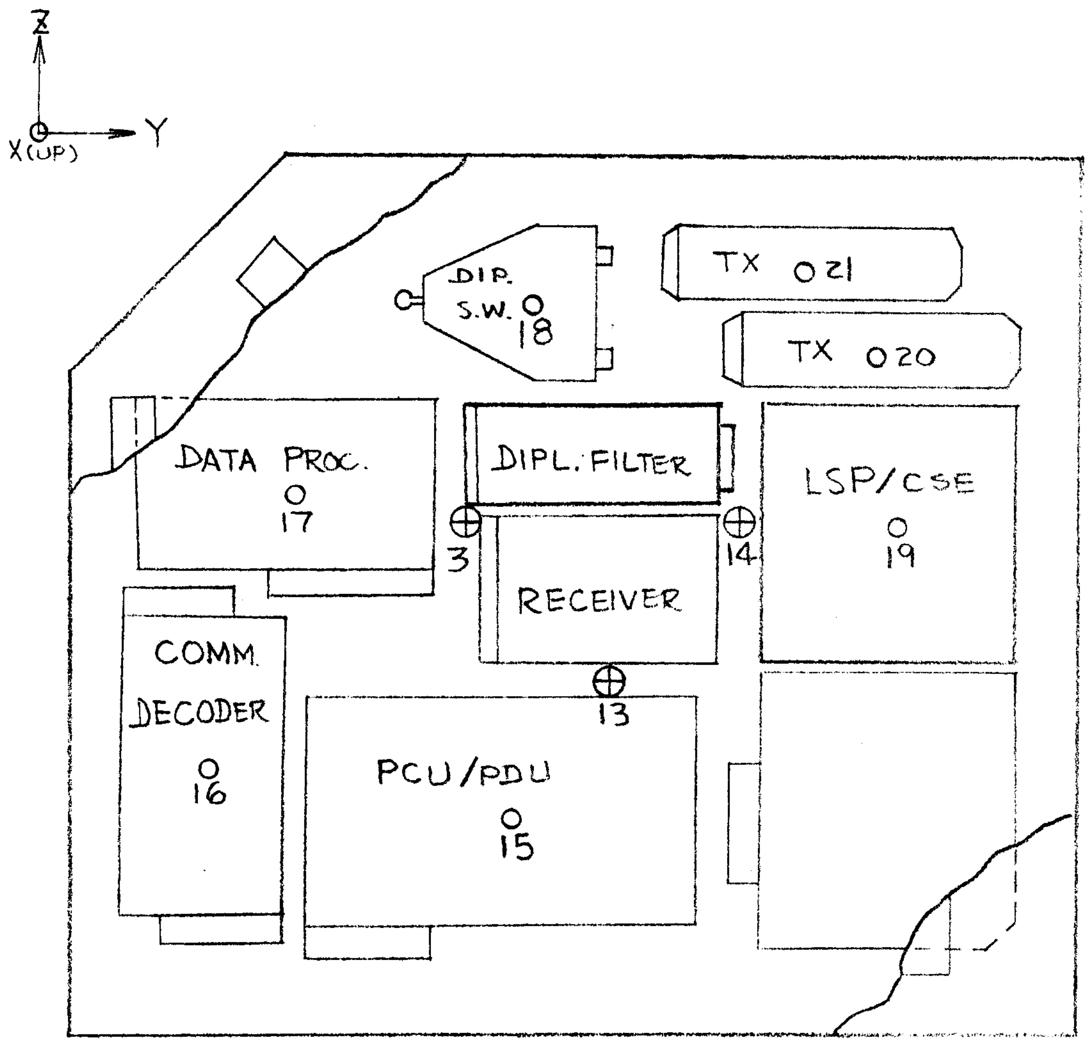
◌ Isolators

Figure 1a

Array E/Sub Pack 1, Sunshield Equipment (LSG Version)

(View From Top)

Note: Numbers Not Indicated Are in u-direction.



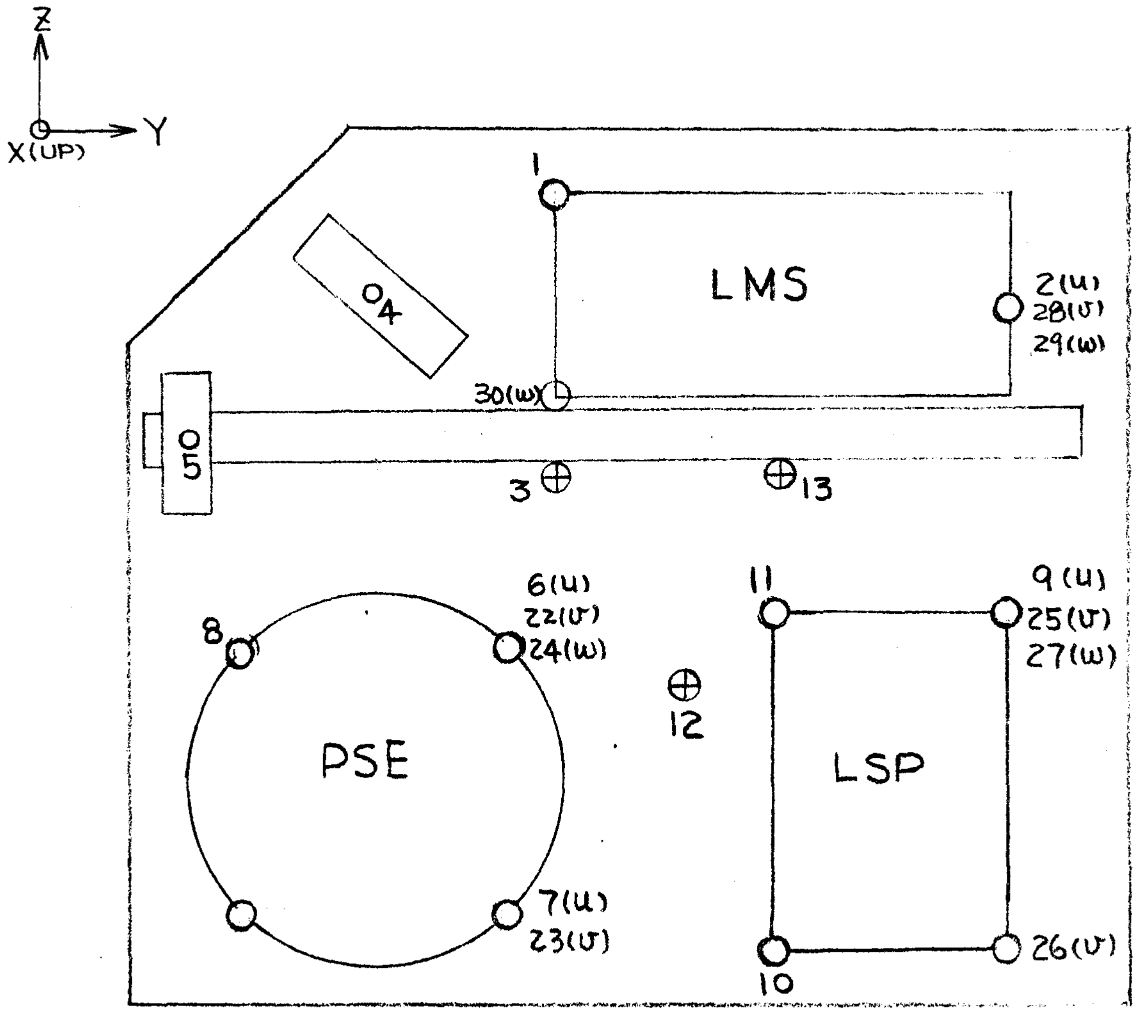
○ Mass Lumped

⊕ Connected Points (between sunshield & thermal plate)

Figure 16

Array E/Sub Pack 1, Thermal Plate (LSG Version)

(View From Top of Cut Away Sun Shield Plate)



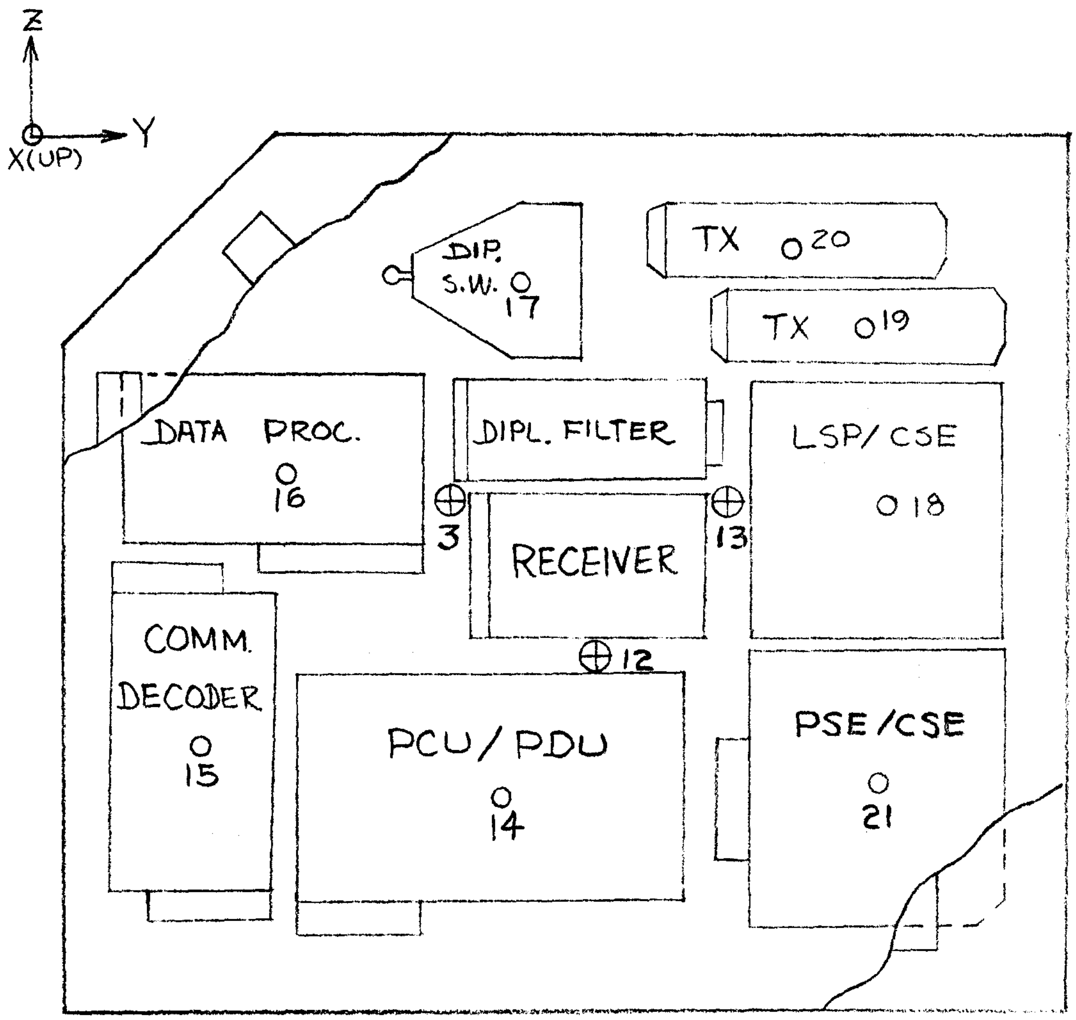
○ Mass Point

⊕ Connected Points (between sunshield & thermal plate)

Figure 2a

Array E/Sub Pack 1, Sunshield Equipment (PSE Version)

(View From Top)



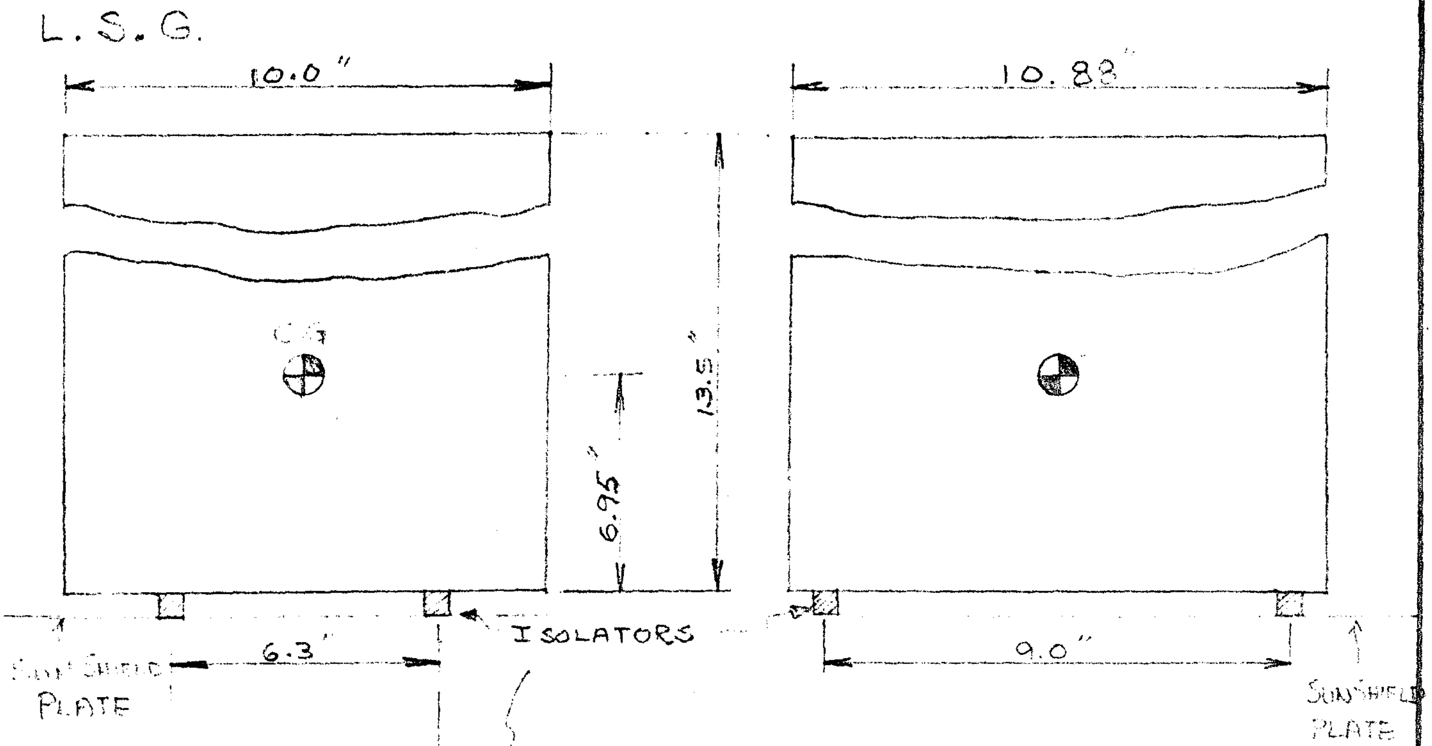
○ Mass Lumped

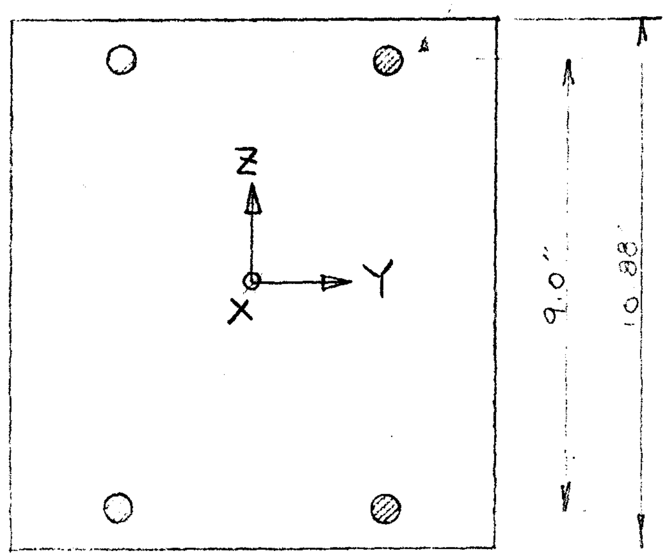
⊕ Connected Points (between sunshield & thermal plate)

Figure 2b

Array E/Sub Pack 1, Thermal Plate (PSE Version)

(View From Top of Cut Away Sunshield Plate)





W = 26.2 lb

$m_x = m_y = m_z = .0678 \ \frac{\text{lb-sec}^2}{\text{in}}$

about c.g.

$I_x = 1.3049$ in-lb-sec^2

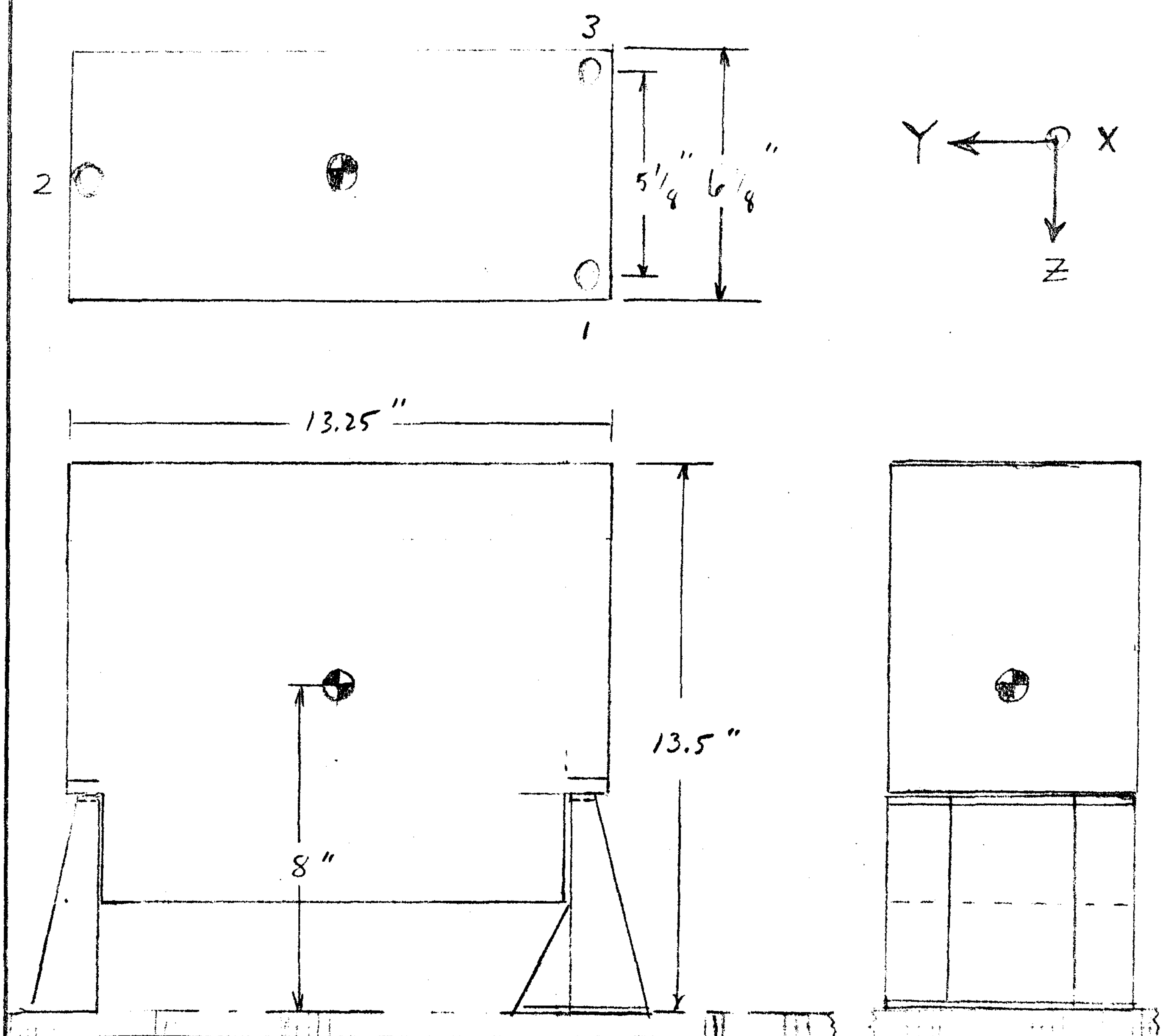
$I_y = I_z = 1.682$ in-lb-sec^2

Figure 3 LSG Equipment

PREPARED BY ____ CHECKED BY ____ REVISED BY ____

ENGINEERING REPORT
Bendix Aerospace Systems Division

DATE ____ PAGE 30
REPORT No. ____
MODEL LMS



W = 22.7 lb.

$m_x = m_y = m_z = .0588 \frac{lb\text{-}sec^2}{in}$

about c.g.

$I_x = 1.0441$ lb-in-sec^2

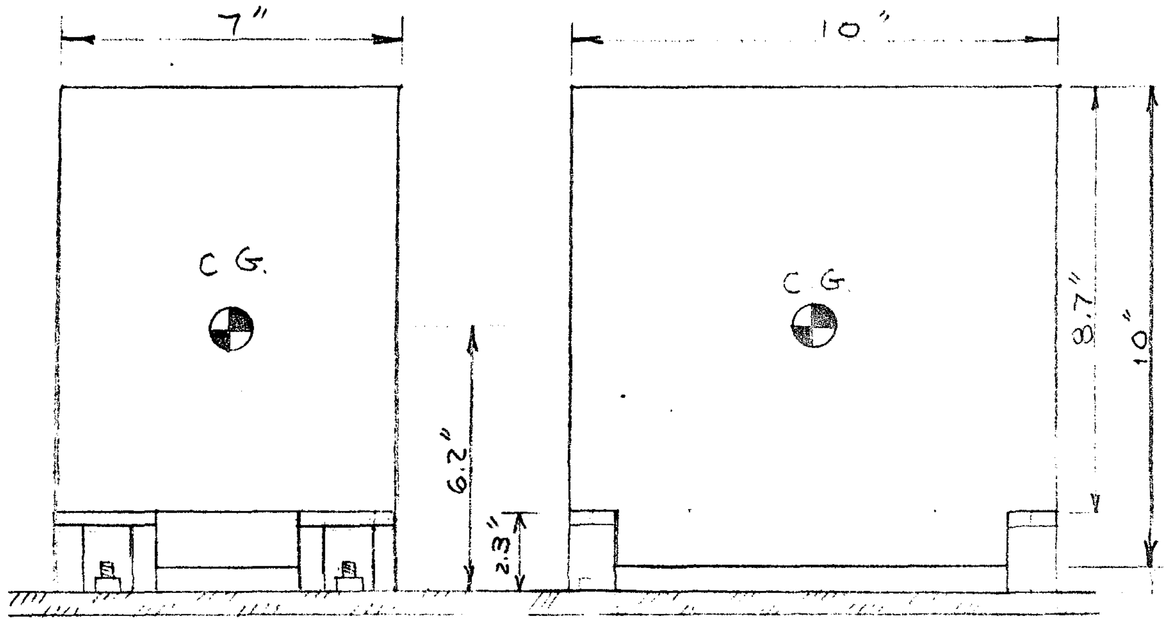
$I_y = .7633$ lb-in-sec^2

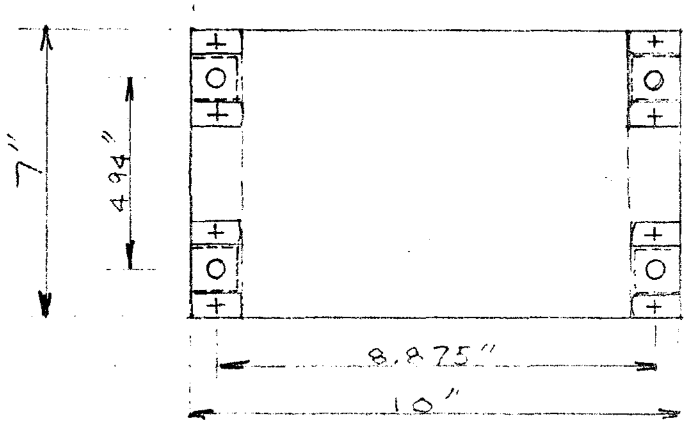
$I_z = .440$ lb-in-sec^2

Figure 4

LMS Equipment

L. S. P.





W = 11.2[illegible] lb

$m_x = m_y = m_z = .029 \frac{\text{lb-sec}^2}{\text{in}}$

about c. g.

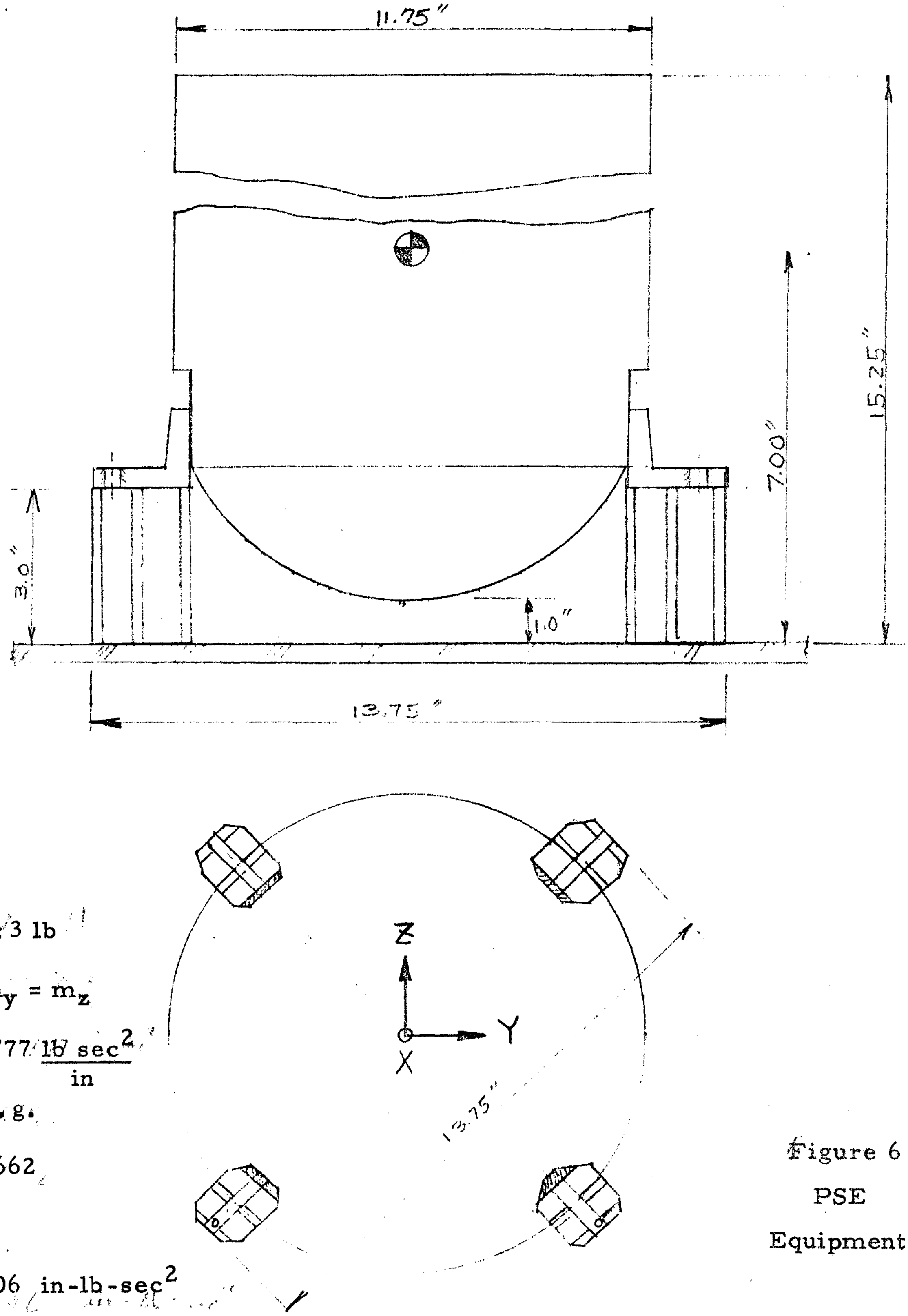
$I_x = .3602$ lb-in-sec^2

$I_y = .483$ lb-in-sec^2

$I_z = .3602$ lb-in-sec^2

Figure 5 LSP Equipment

P.S.E.



$W = 22.3$ lb

$m_x = m_y = m_z$

$= .05777 \frac{lb\ sec^2}{in}$

about c.g.

$I_x = .1662$

$I_y = I_z$

$= 1.306$ in-lb-sec^2

Figure 6
PSE
Equipment

COMPUTER PROGRAMS USED IN DYNAMICS ANALYSIS

EASE	COMPUTES FLEXIBILITY MATRICES.
MATINV 1	INVERTS FLEXIBILITY MATRICES AND COMPUTES STIFFNESS MATRICES.
REFRAM	ASSEMBLES SYSTEM STIFFNESS MATRIX FROM UNDELETED K-MATRIX SUB-MATRICES.
TRANSFORM	COORDINATE TRANSFORMATION, MASS MATRICES
FREQRSP 2	CALCULATES NATURAL FREQUENCIES AND MODE SHAPES. CALCULATES SINUSOIDAL AND RANDOM ACCELERATION RESPONSES. CALCULATES GENERALIZED DYNAMIC LOAD VECTORS.
DYNLOAD	COMBINES FUNCTIONS OF ABOVE PROGRAMS INTO ONE PROGRAM

ASSUMPTIONS IN PRESENT DYNAMICS ANALYSIS

1. LINEAR ELASTIC STRUCTURE.
2. EXPERIMENT PACKAGES ARE RIGID MASSES OF PROPER DIMENSIONS AND WEIGHT.
3. THERMAL PLATE ELECTRONICS BOXES ARE POINT MASSES.
4. LSG IS ON ISOLATORS (ALL DEGREES OF FREEDOM).
5. LMS AND LSP PACKAGES ARE ATTACHED TO SUNSHIELD PLATE BY BRACKETS (SIX DEGREES OF FREEDOM EACH.)
6. PRIMARY STRUCTURE IS RIGID.
7. DAMPING 0.1 OF CRITICAL IN ALL BUT L.S.G. MODES WHERE DAMPING IS 0.15.

Figure 7

Computer Programs and Assumptions

$$[K]_{46\times46} = \begin{bmatrix} [K_1]_{15\times15} & & & & & \\ & [K_2]_{10\times10} & & & & \\ & & [K_3]_{12\times12} & & & \\ & & & [K_4]_{2\times2} & & \\ & & & & [K_5]_{5\times5} & \\ & & & & & [K_4']_{2\times2} \end{bmatrix}$$

- $[K_1]$ ← SUN SHIELD ℞
- $[K_2]$ ← THERMAL ℞
- $[K_3]$ ← LSG ISOLATORS
- $[K_4]$ ← LSP ABOVE (v_1, ω_1)
- $[K_5]$ ← LMS ABOVE
- $[K_4']$ ← LSP ABOVE (v_2, ω_4)

$$[k] = [B]^T [K] [B]$$

$$= (32\times46)\cdot(46\times46)\cdot(46\times32)$$

$$= (32\times32)$$

Figure 8 Subsystem Stiffness Matrix (LSG Version)

$$[K]_{39\times 39} = \begin{bmatrix} [K_1]_{15\times 15} \leftarrow \text{SUN SHIELD PL} & & & & \\ & [K_2]_{11\times 11} \leftarrow \text{THERMAL PL} & & & \\ & & [K_3]_{4\times 4} \leftarrow \text{PSE ABOVE} & & \\ & & & [K_4]_{4\times 4} \leftarrow \text{LSP ABOVE} & \\ & & & & [K_5]_{5\times 5} \leftarrow \text{LMS ABOVE} \end{bmatrix}$$

$$[\mathcal{K}] = [B]^T [K] [B]$$

$$= (30\times 39)\cdot(39\times 39)\cdot(39\times 30)$$

$$= (30\times 30)$$

Figure 9 Sybsystem Stiffness Matrix (PSE Version)

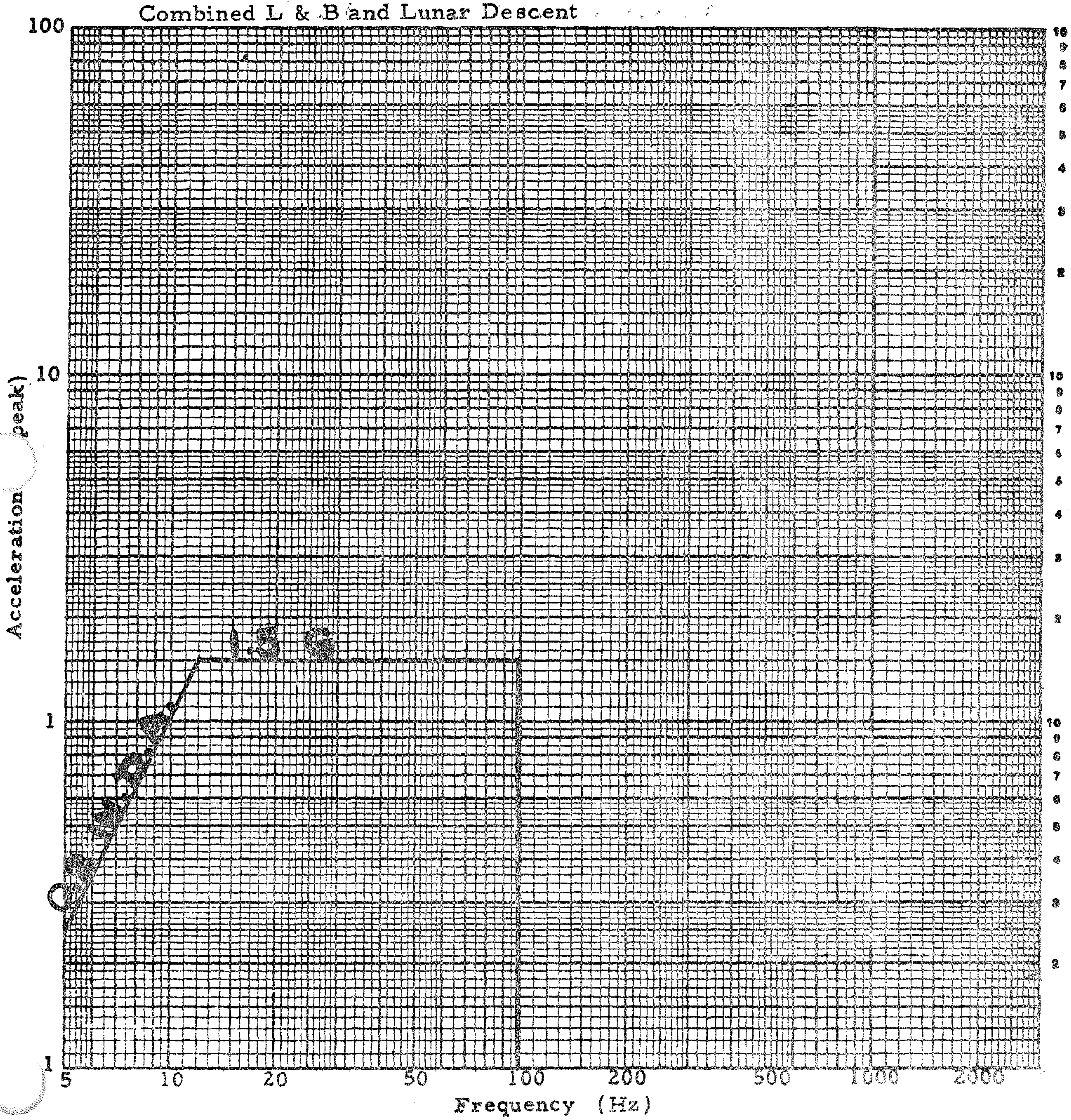
SINUSOIDAL VIBRATION

SPECIFICATION LEVELS

Input Axis:

Sweep Rate: 3 Oct. /min.

Combined L & B and Lunar Descent



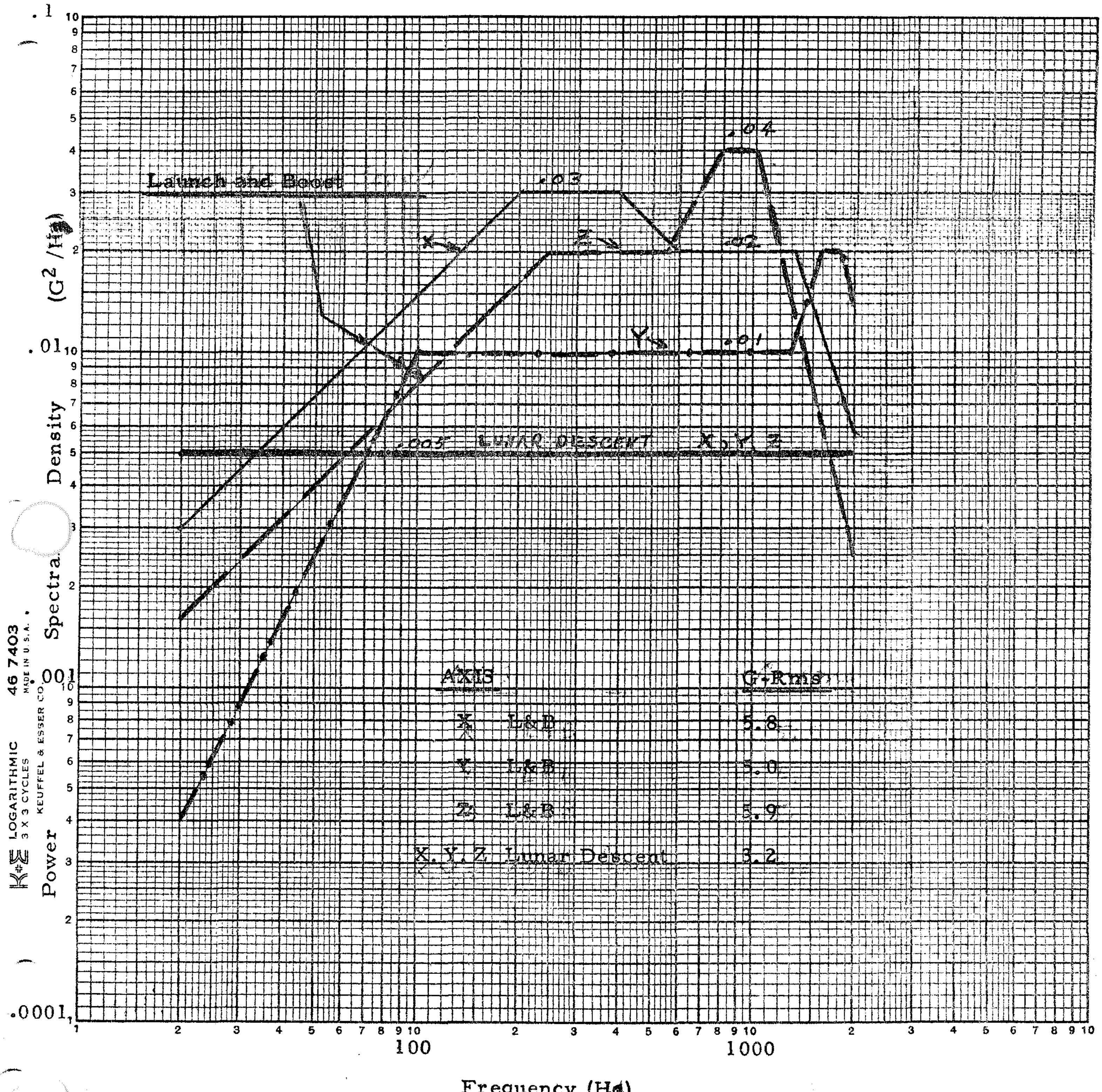


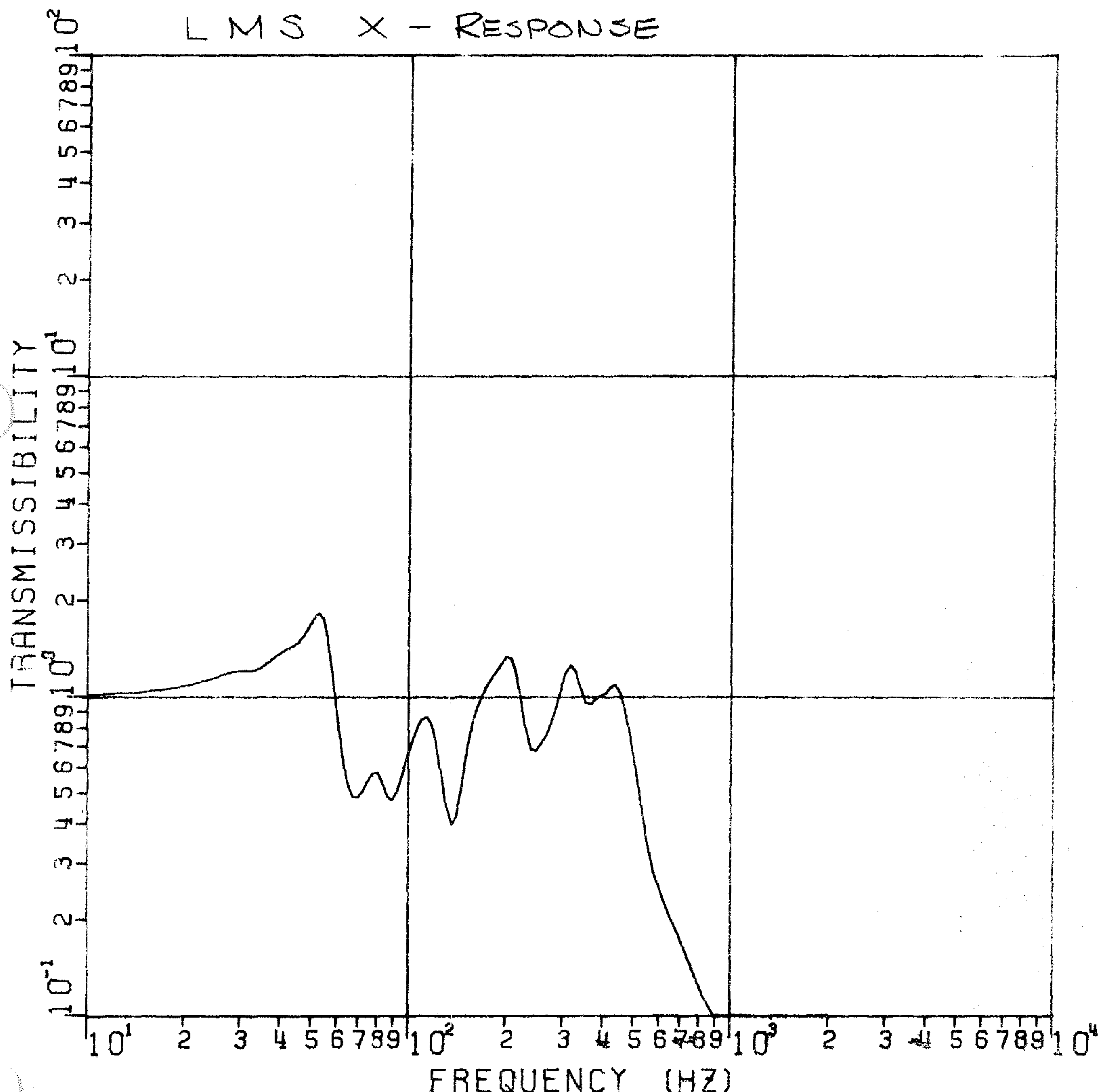
Figure 11. Random Vibration Specification Levels

** ALSEP ARRAY E/SP-1,FORCING IN X-AXIS JAN.1971 **

FIGURE 12a TRANSMISSIBILITY

LOCATION 2

LMS X - RESPONSE

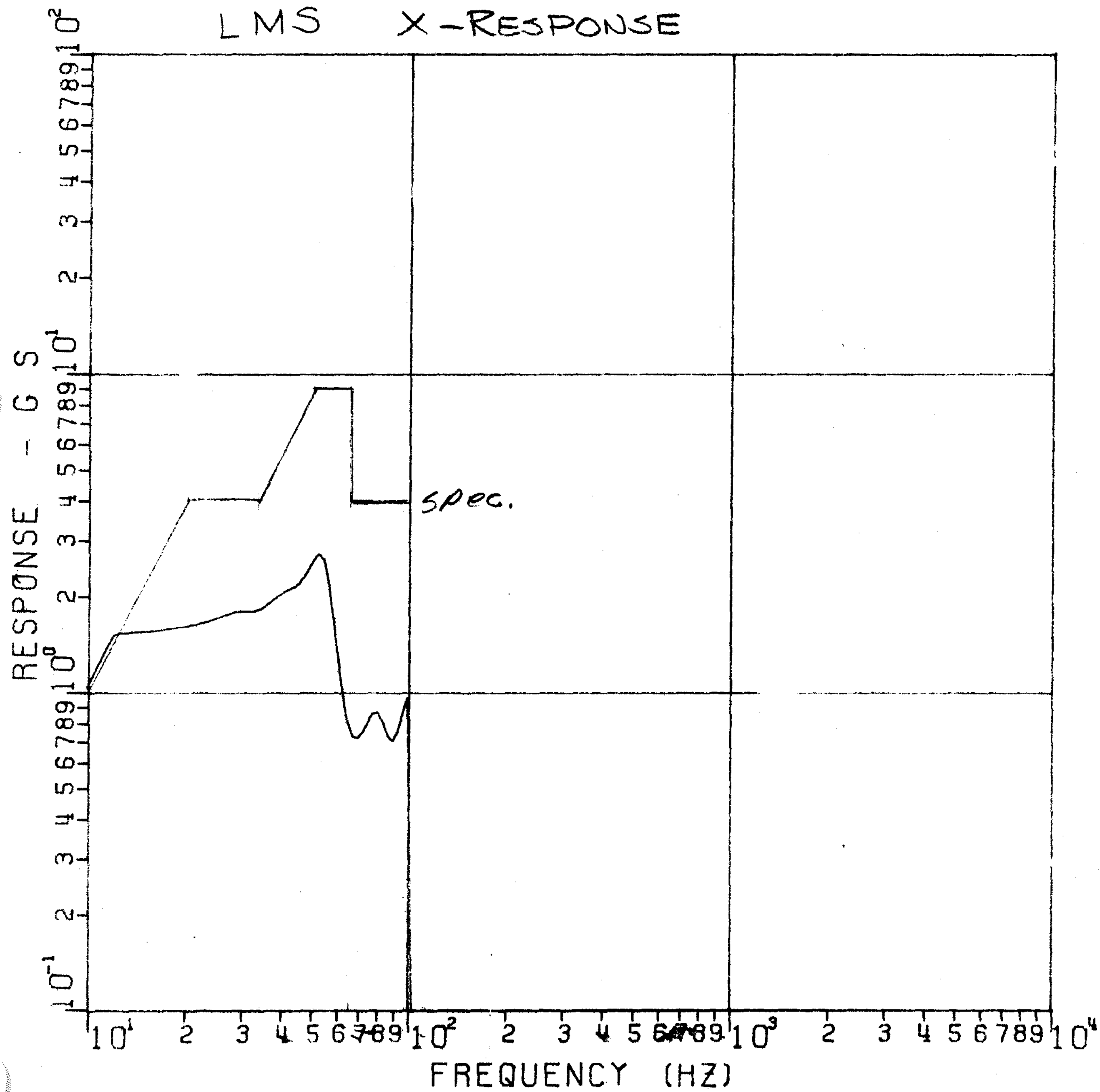


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 **

FIGURE 12b SINE RESPONSE

LOCATION 2

LMS X-RESPONSE

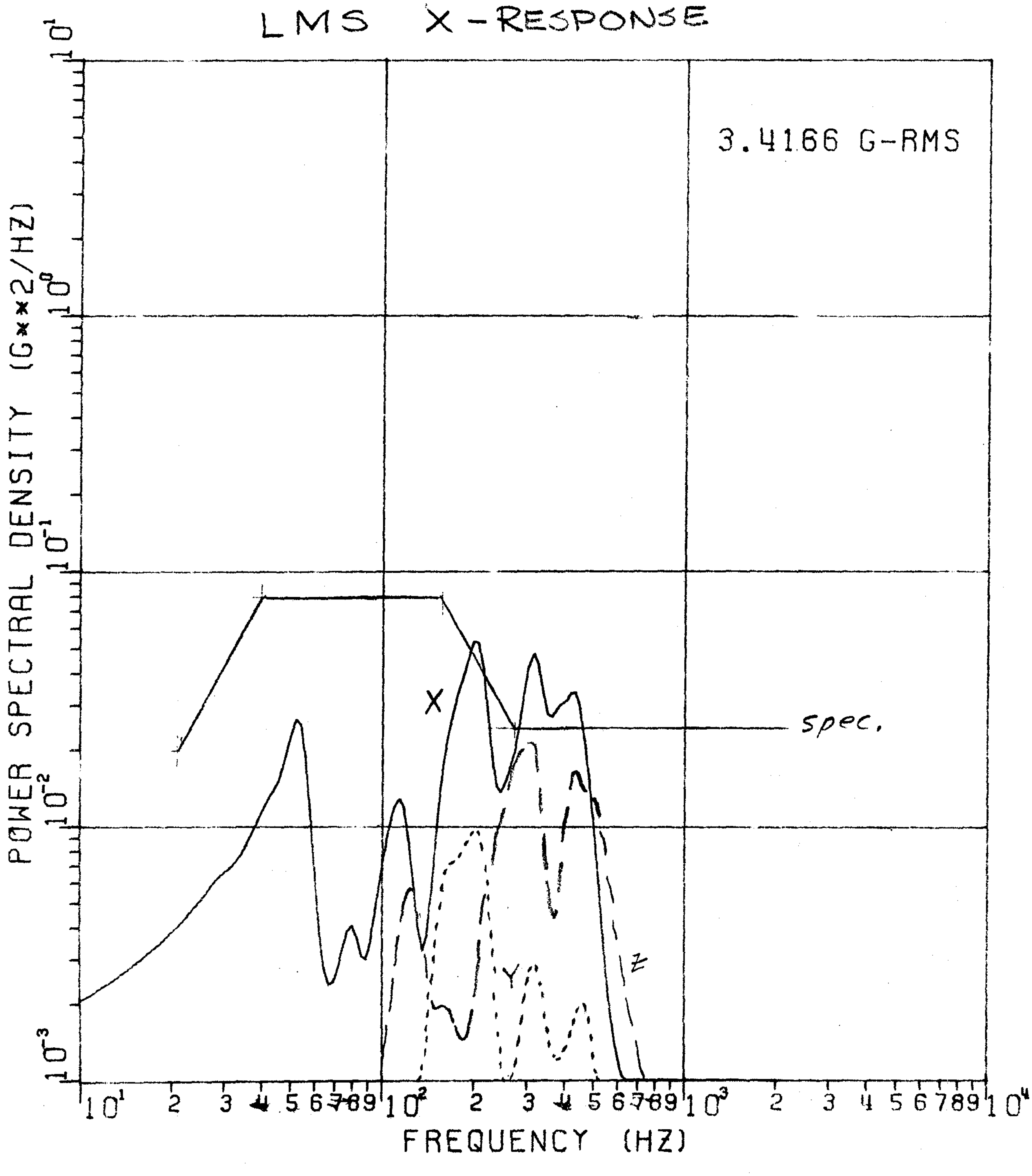


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 *

FIGURE 12C RANDOM VIBRATION SPECTRUM

LOCATION 2

LMS X-RESPONSE

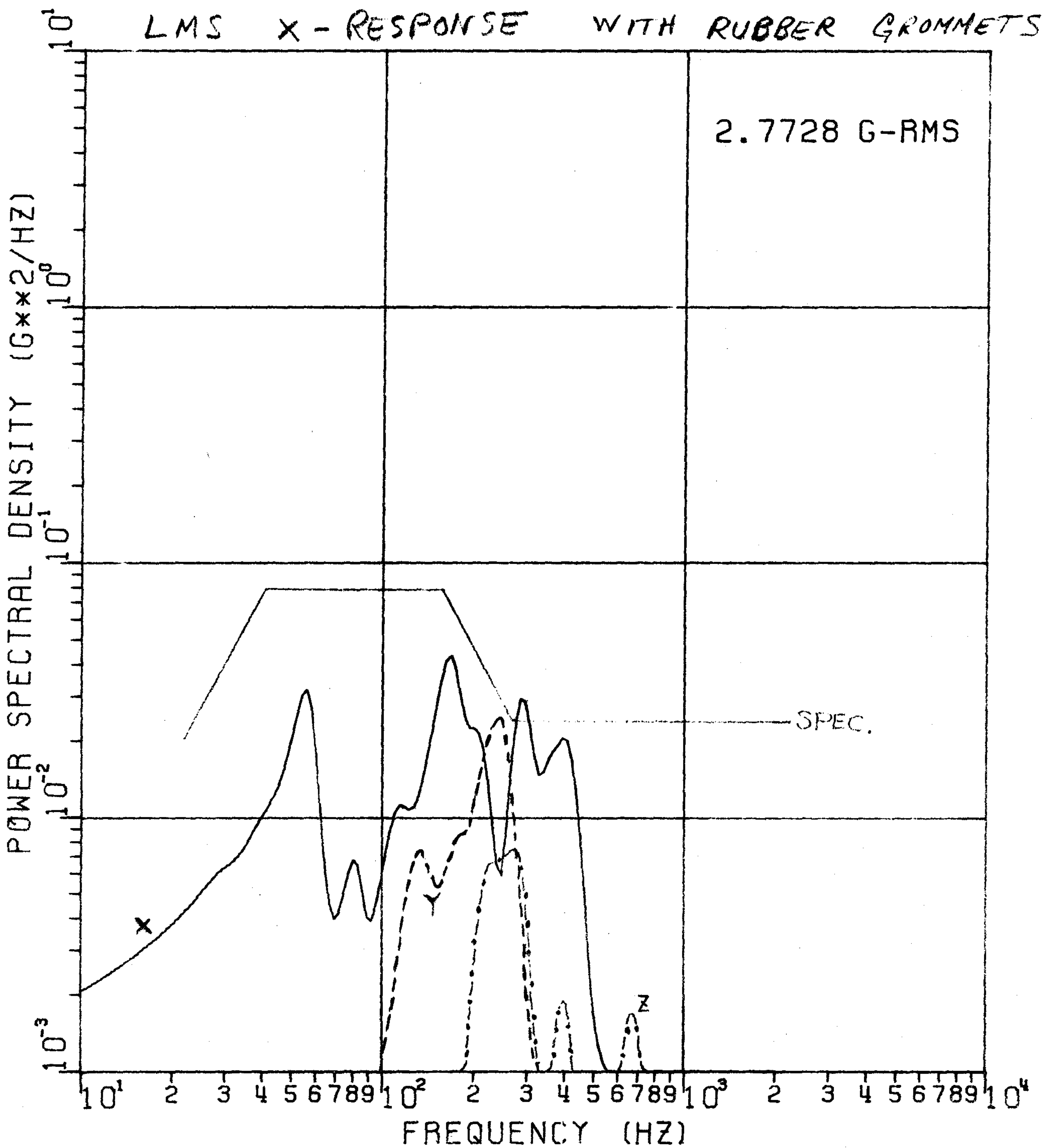


ALSEP ARRAY E/SP-1, FORCING IN X-AXIS (LSG & LMS)

FIGURE 12c* RANDOM VIBRATION SPECTRUM L&B

LOCATION 34

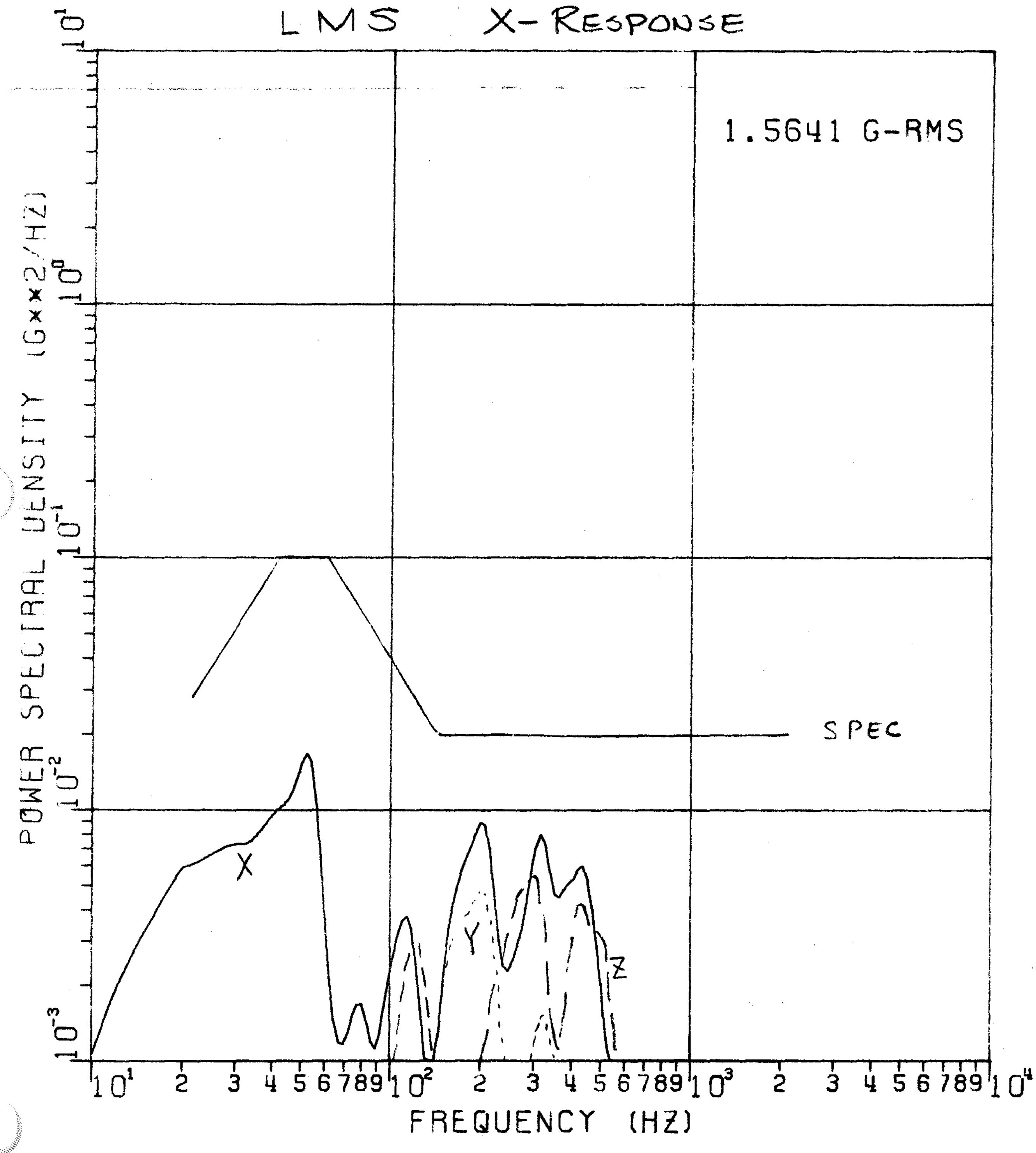
LMS X-RESPONSE WITH RUBBER GROMMETS



ALSEP ARR E/SP-1 (LSG), FOR IN X-AXIS (LUNAR DESCENT)

FIGURE 12d RANDOM VIBRATION SPECTRUM

LOCATION 2 u_2

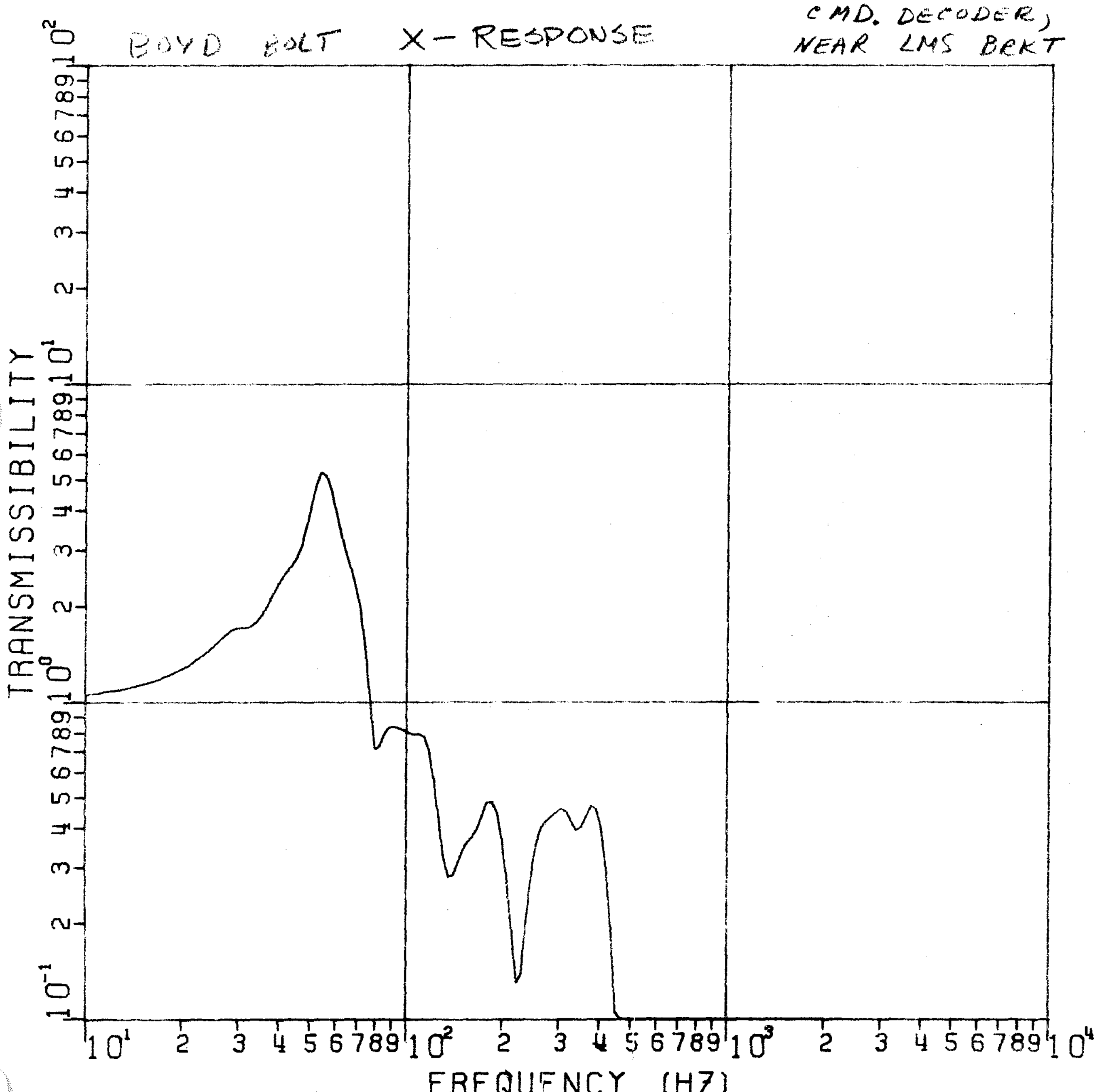


** ALSEP ARRAY E/SP-1,FORCING IN X-AXIS JAN.1971 **

FIGURE 13a TRANSMISSIBILITY

LOCATION 3, u_3 RCVR., DIPL., CMD. DECODER, NEAR LMS BRKT

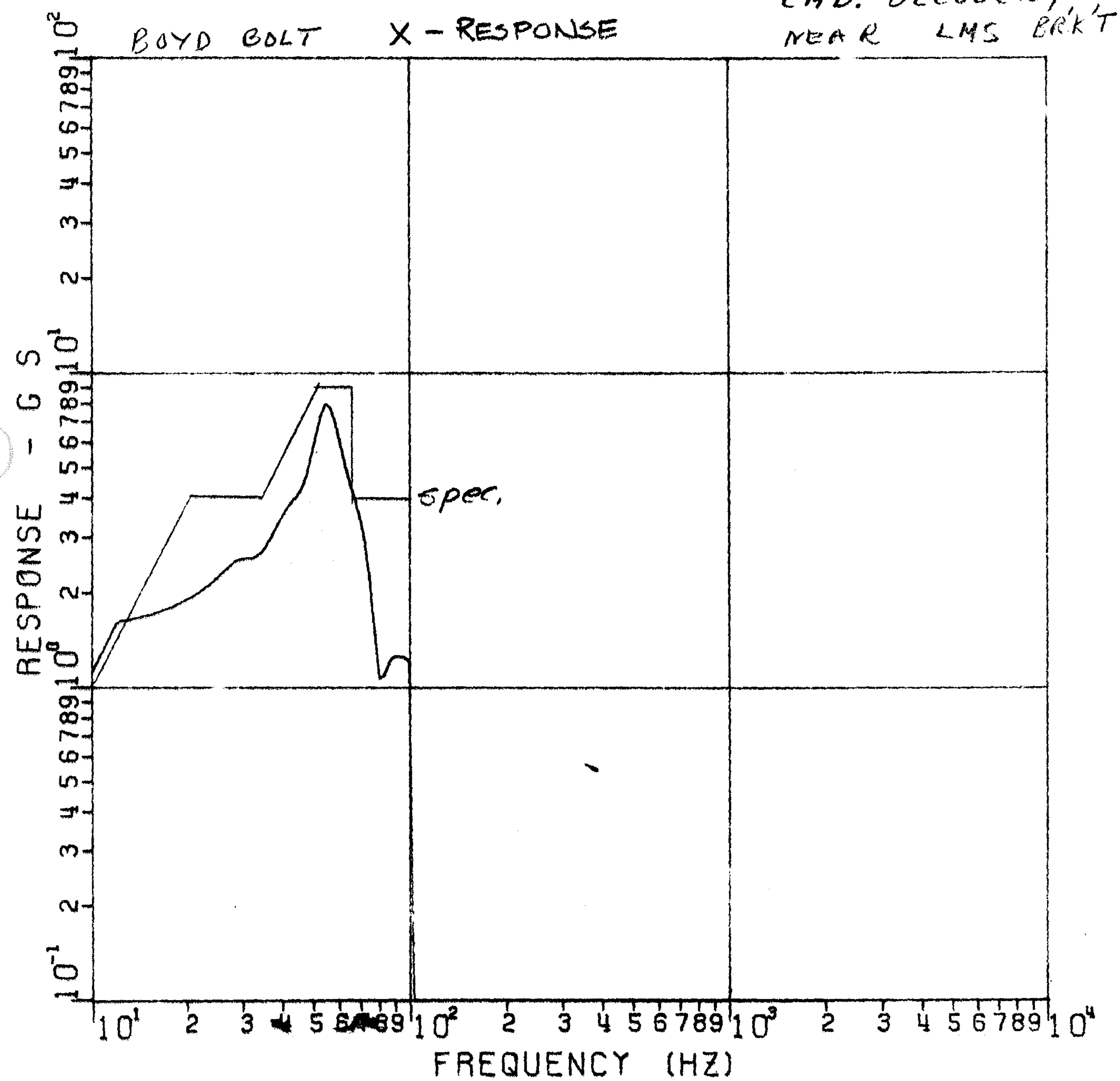
BOYD BOLT X-RESPONSE



** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 **

FIGURE 13b SINE RESPONSE

LOCATION 3, u_3 RECEIVER, DIPL., CMD. DECODER, NEAR LMS BRK'T

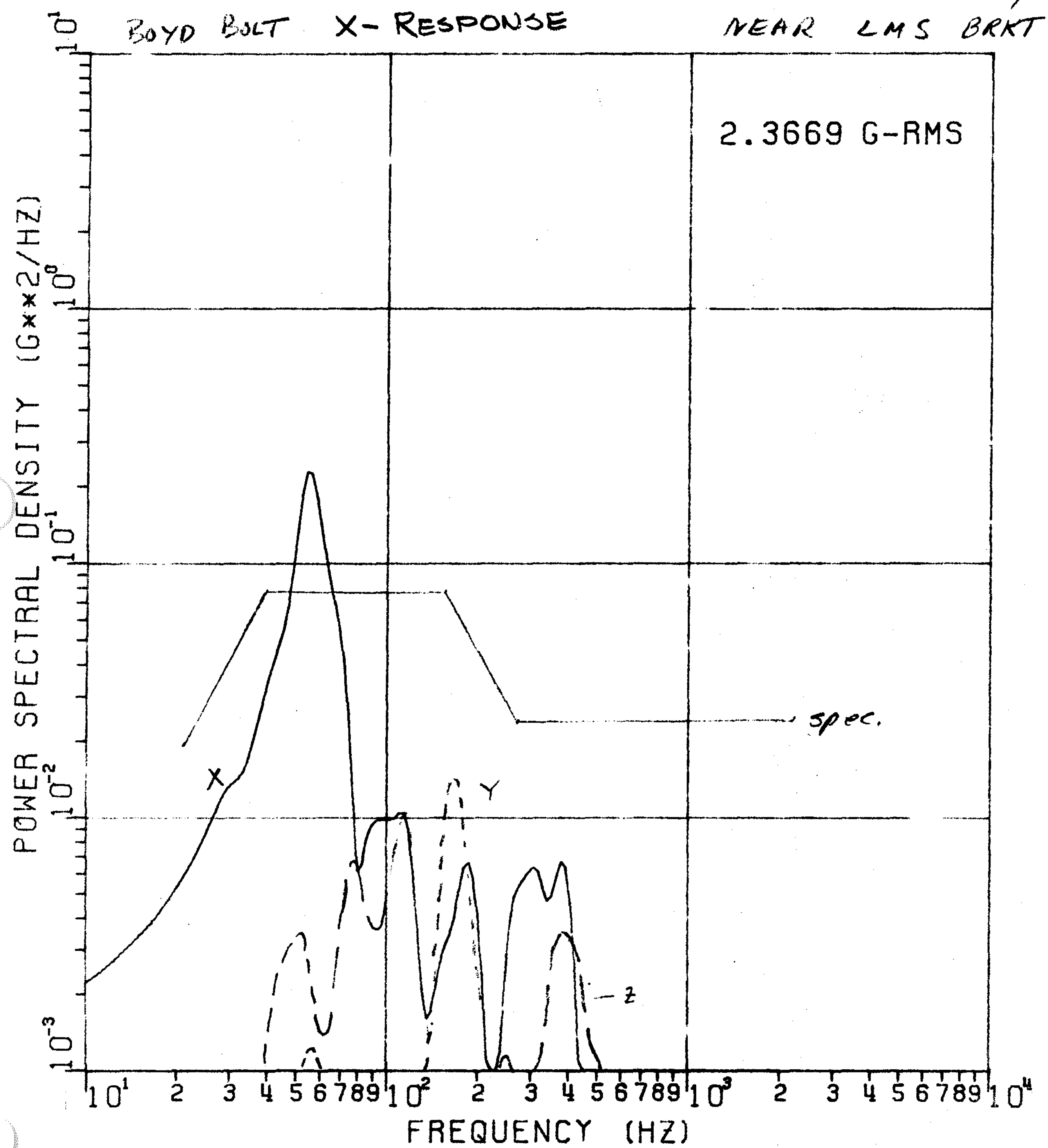


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 **

FIGURE 13c RANDOM VIBRATION SPECTRUM

LOCATION 3 RECEIVER, DIPL., CMD. DECODER, NEAR LMS BRKT

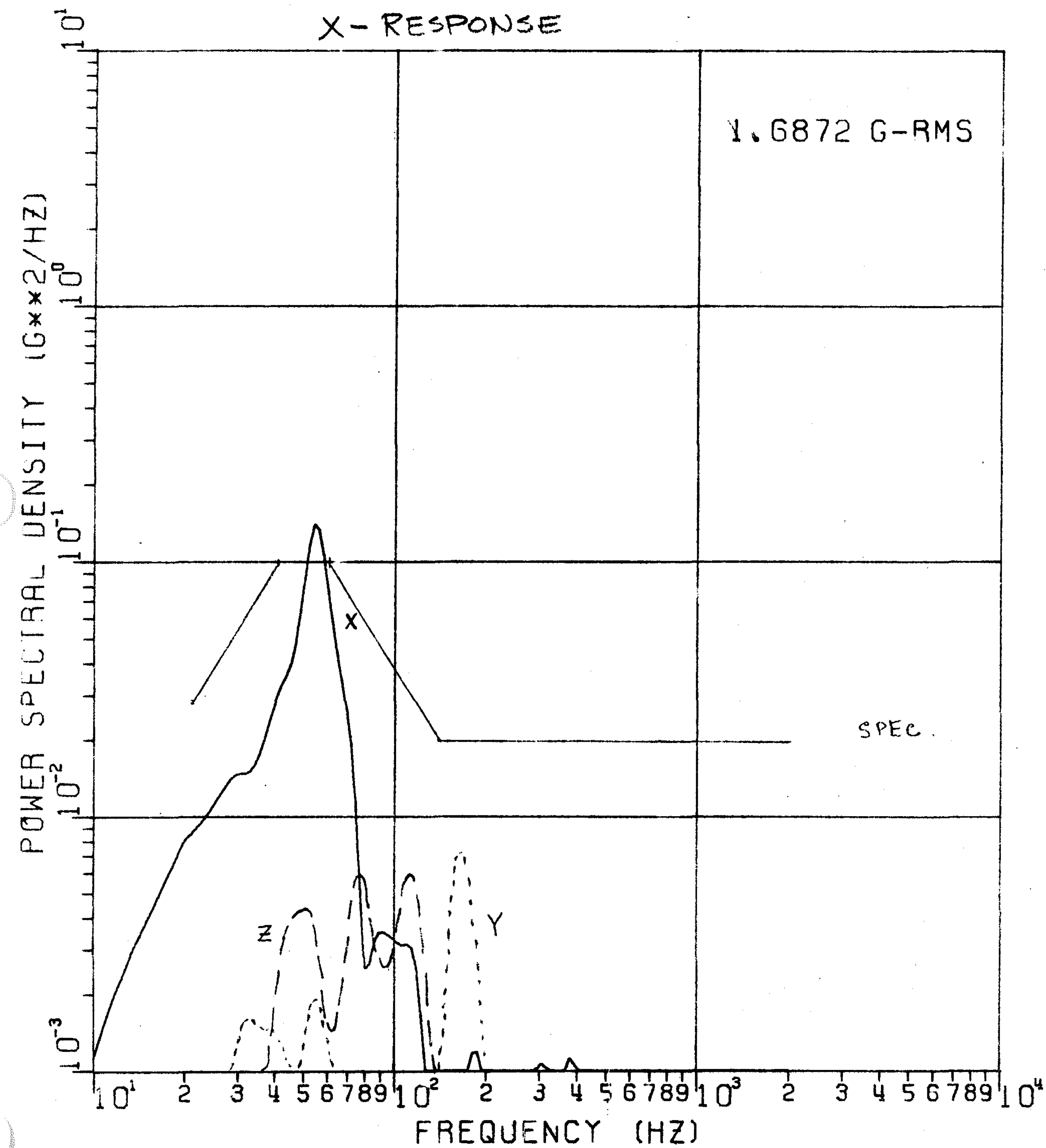
BOYD BOLT X-RESPONSE



ALSEP ARR E/SP-1 (LSG), FOR IN X-AXIS (LUNAR DESCENT)

FIGURE 13d RANDOM VIBRATION SPECTRUM

LOCATION 3

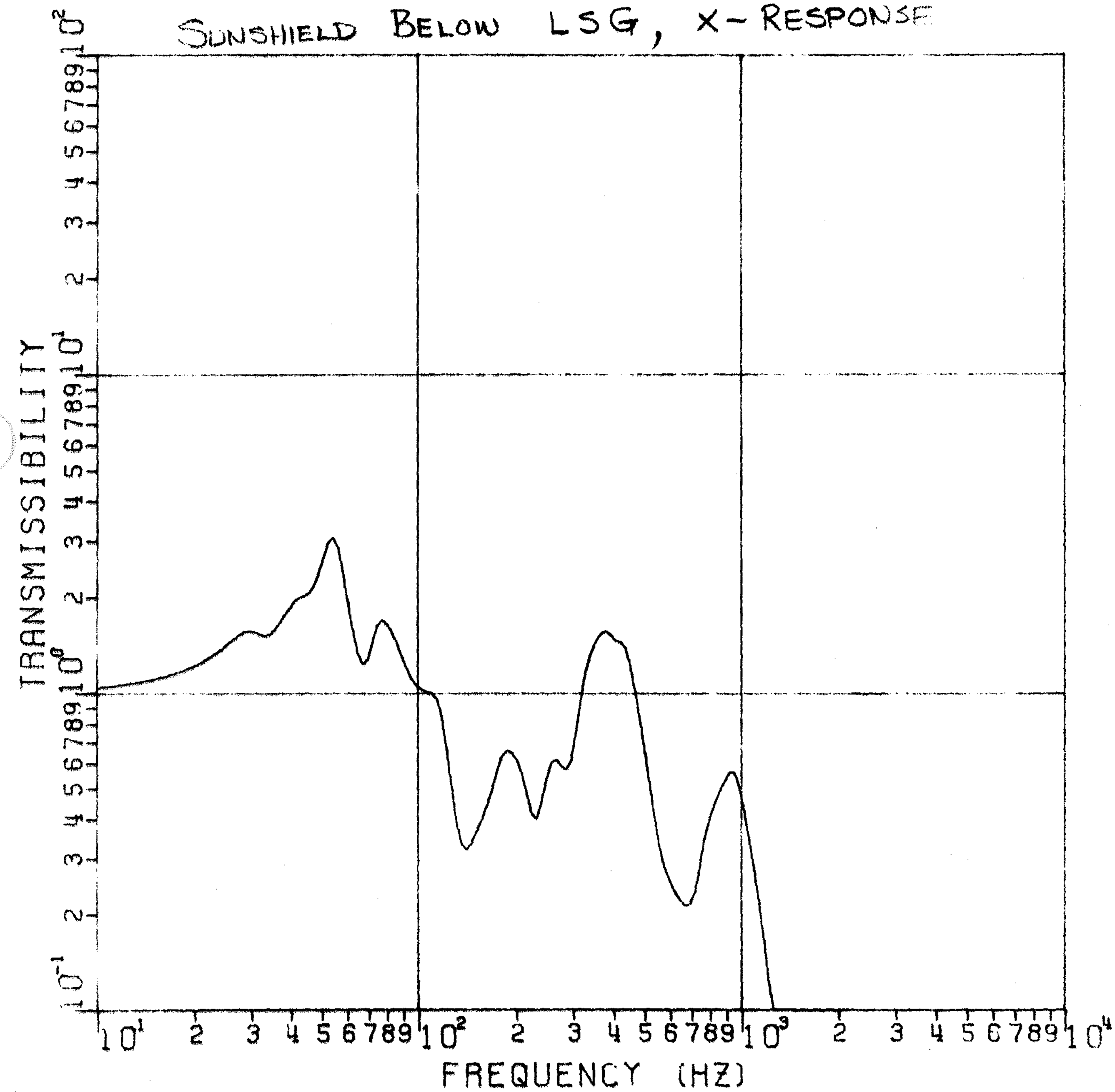


** ALSEP ARRAY E/SP-1, FØRCING IN X-AXIS JAN. 1971 **

FIGURE 14a TRANSMISSIBILITY

LØCATION 6

Sunshield Below LSG, X-Response

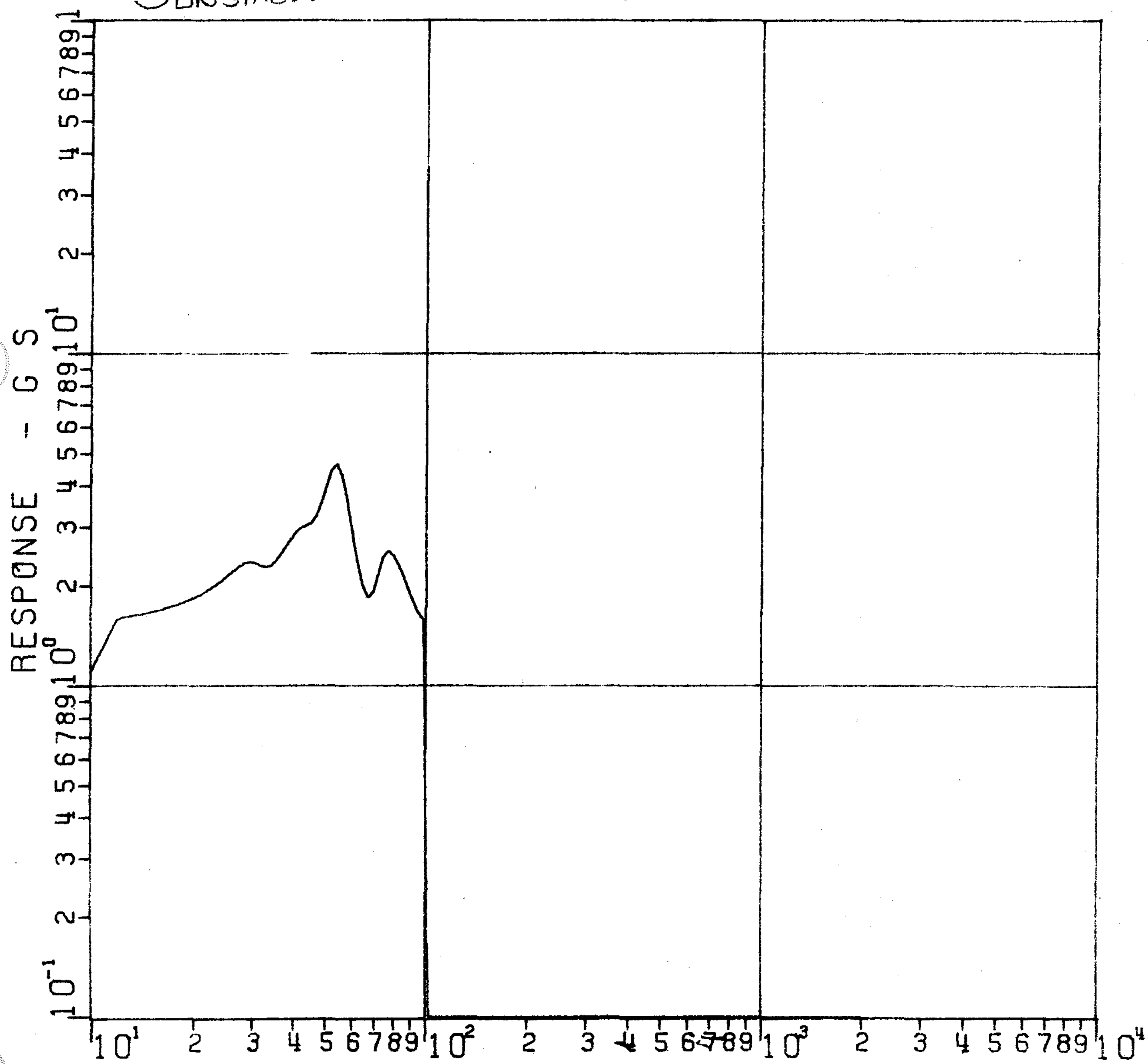


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 **

FIGURE 14b SINE RESPONSE

LOCATION 6

Sunshield Below LSG, X-Response

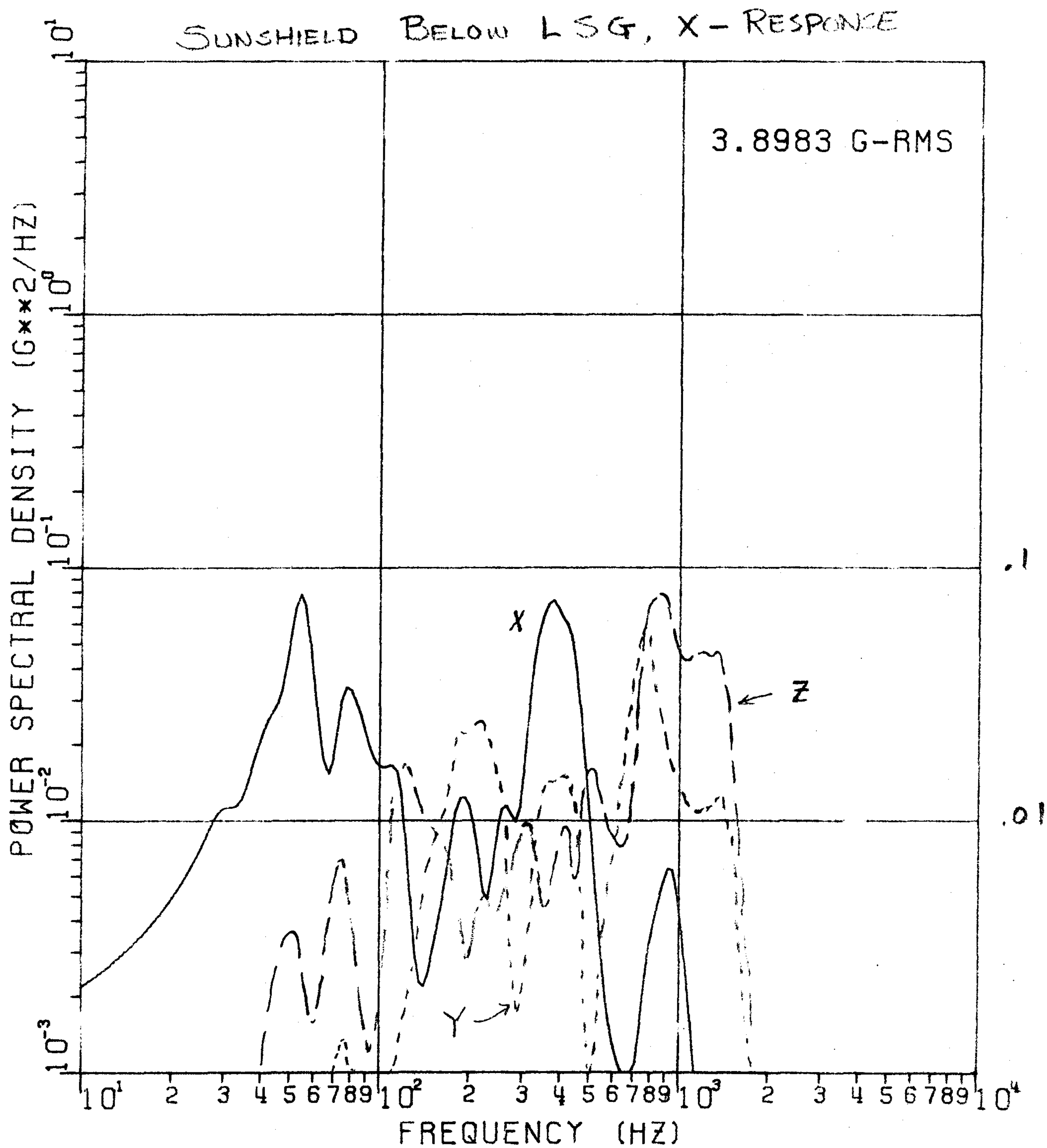


** ALSEP ARRAY E/SP-1, FØRCING IN X-AXIS JAN. 1971 **

FIGURE 14c RANDOM VIBRATIØN SPECTRUM

LØCATIØN 6

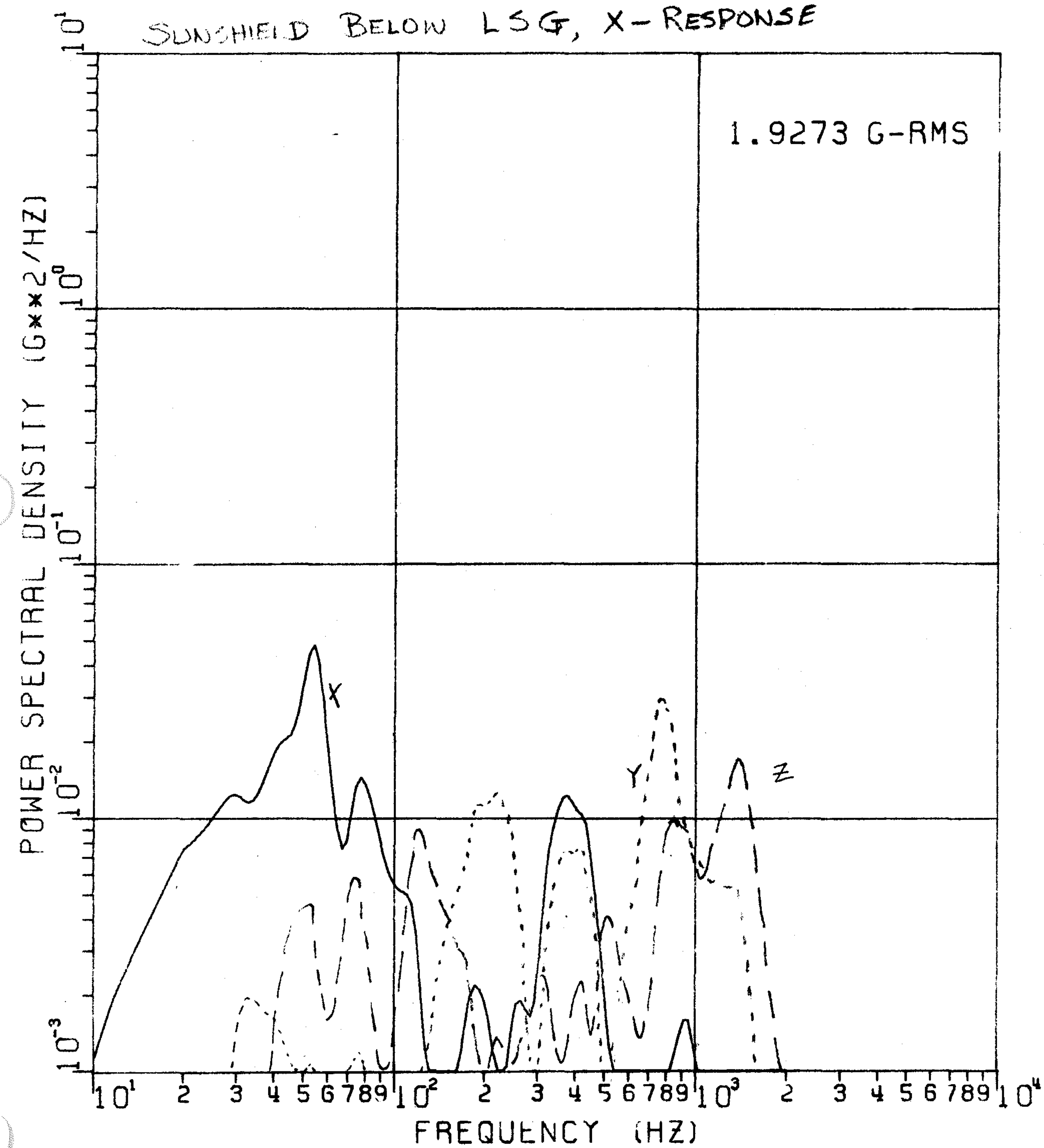
SUNSHIELD BELOW LSG, X-RESPONCE



ALSEP ARR E/SP-1 (LSG), FOR IN X-AXIS (LUNAR DESCENT)

FIGURE 14d RANDOM VIBRATION SPECTRUM

LOCATION 6

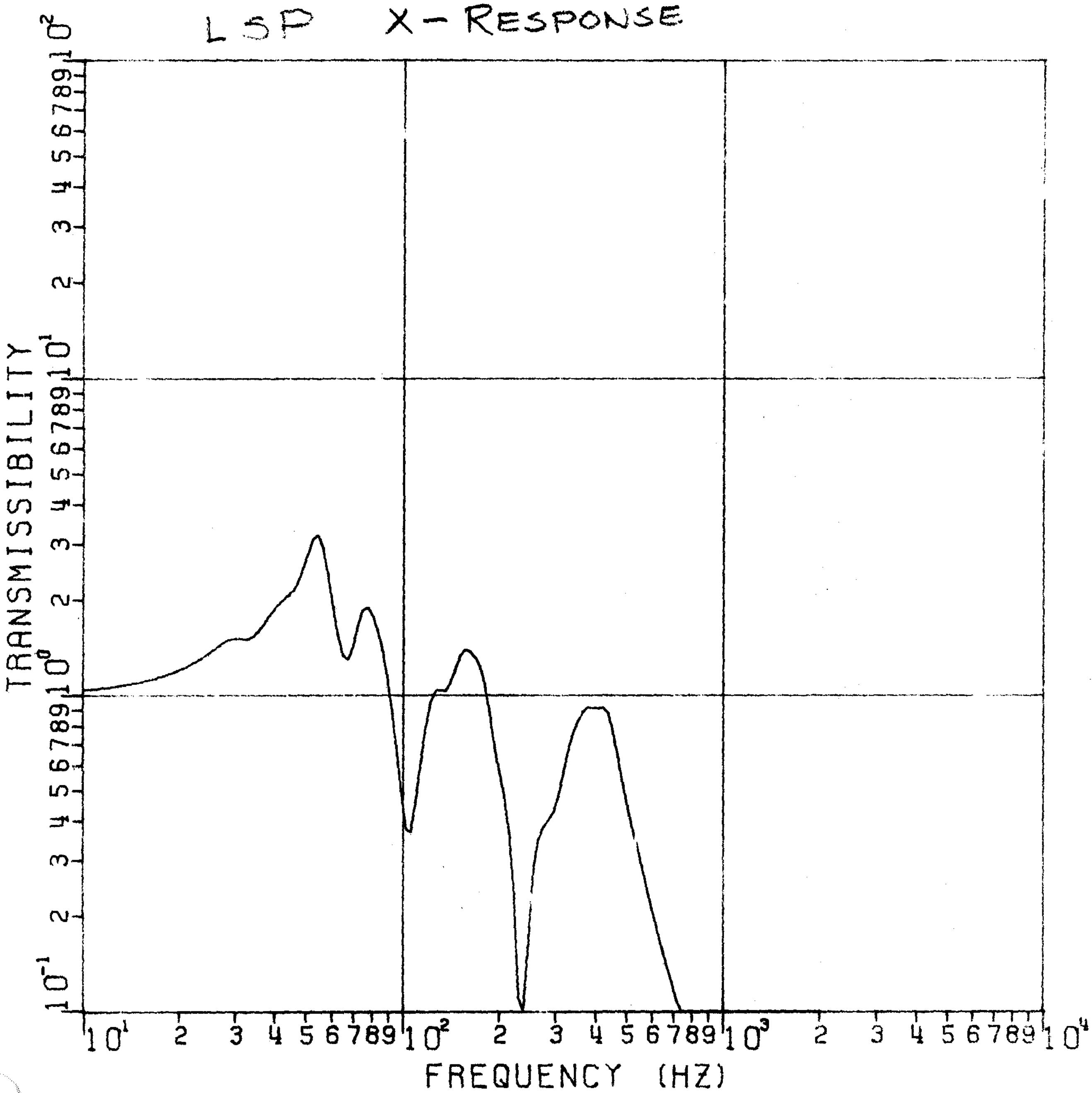


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 **

FIGURE 15a TRANSMISSIBILITY

LOCATION 12 , u+

LSP X-RESPONSE

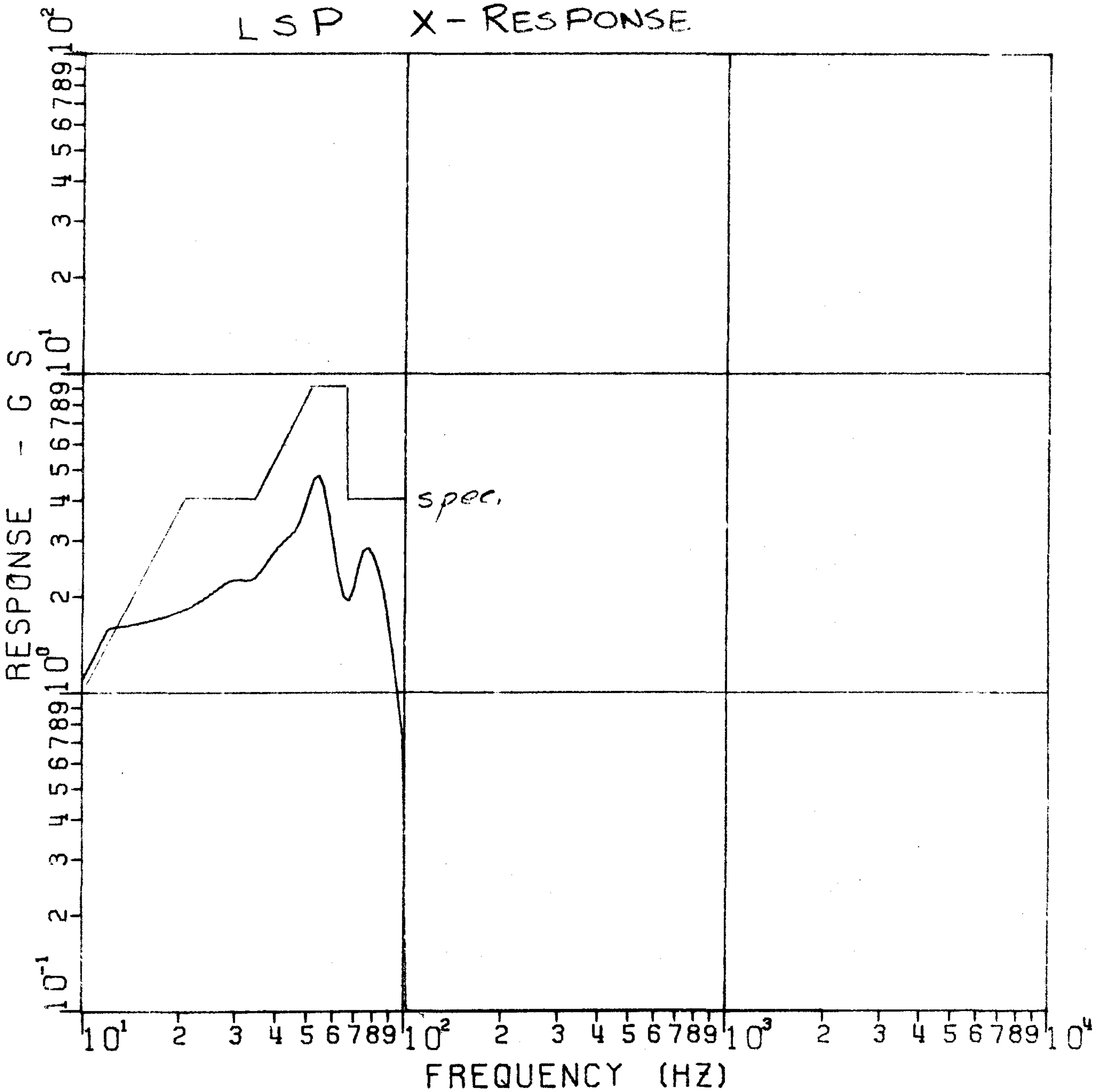


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 **

FIGURE 15b SINE RESPONSE

LOCATION 12

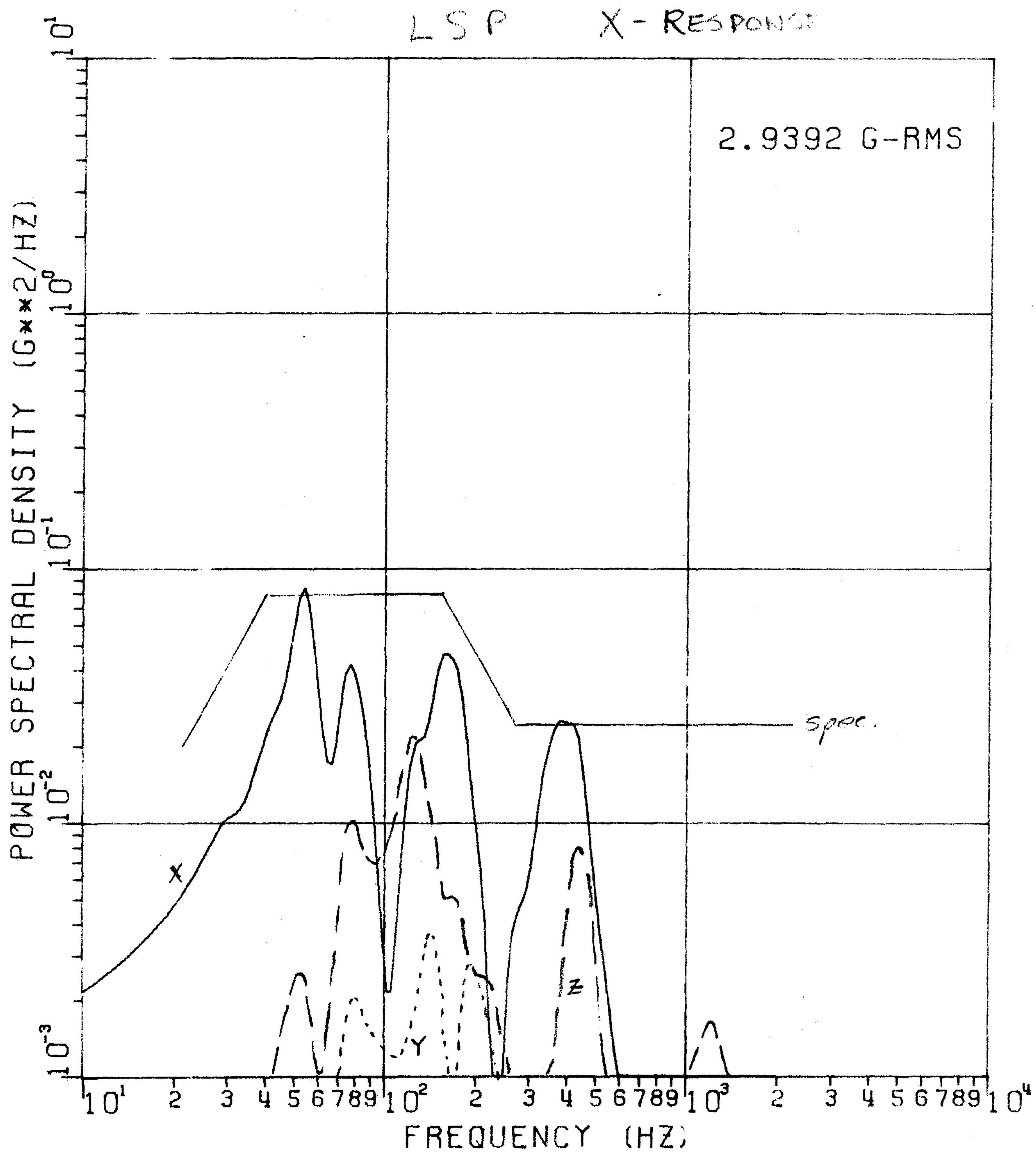
LSP X-RESPONSE



** ALSEP ARRAY E/SP-1, FØRCING IN X-AXIS JAN. 1971 **

FIGURE 15c RANDOM VIBRATION SPECTRUM L$B

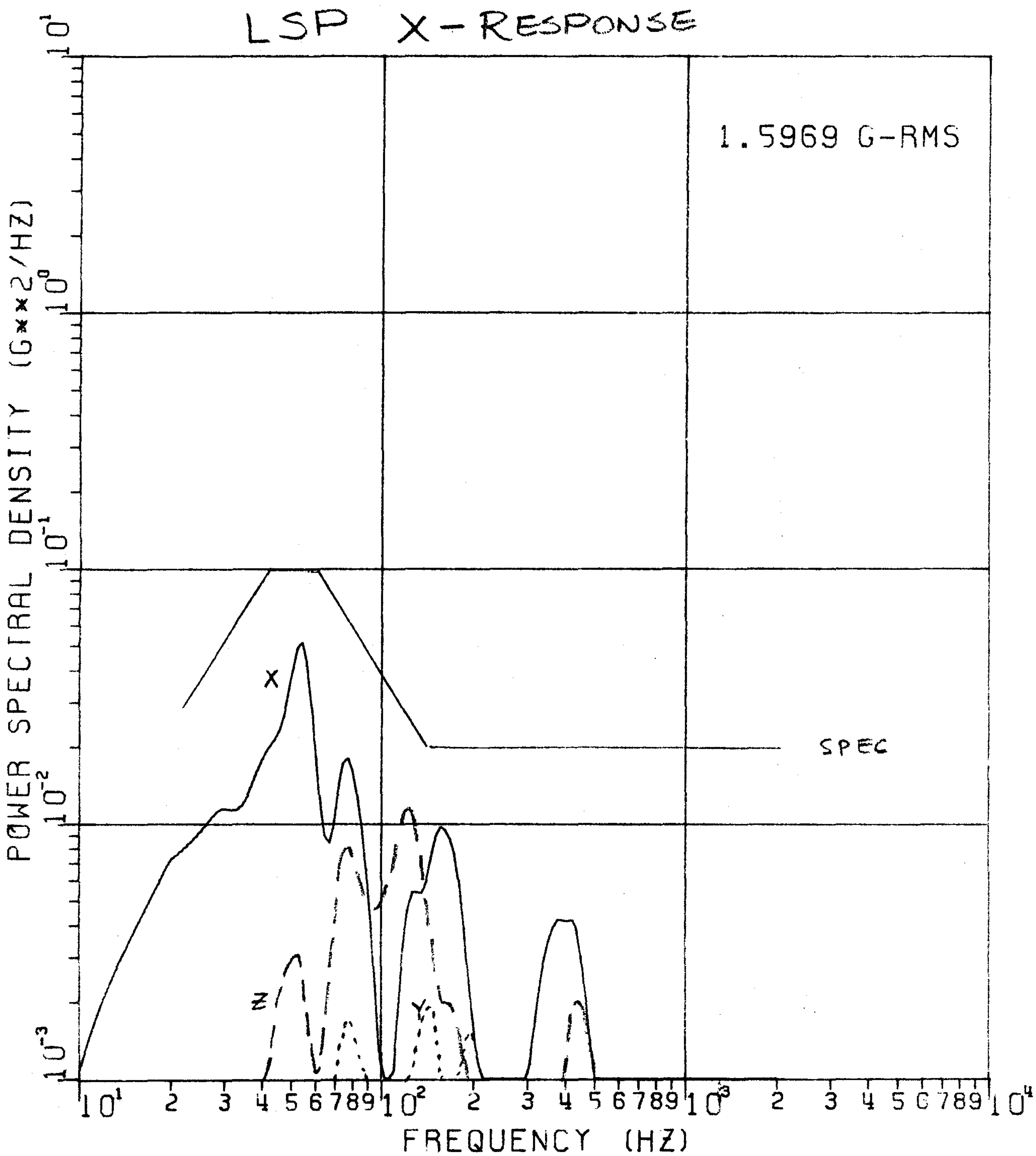
LØCATIØN 12



ALSEP ARR E/SP-1 (LSG), FØR IN X-AXIS (LUNAR DESCENT)

FIGURE 15d RANDOM VIBRATION SPECTRUM

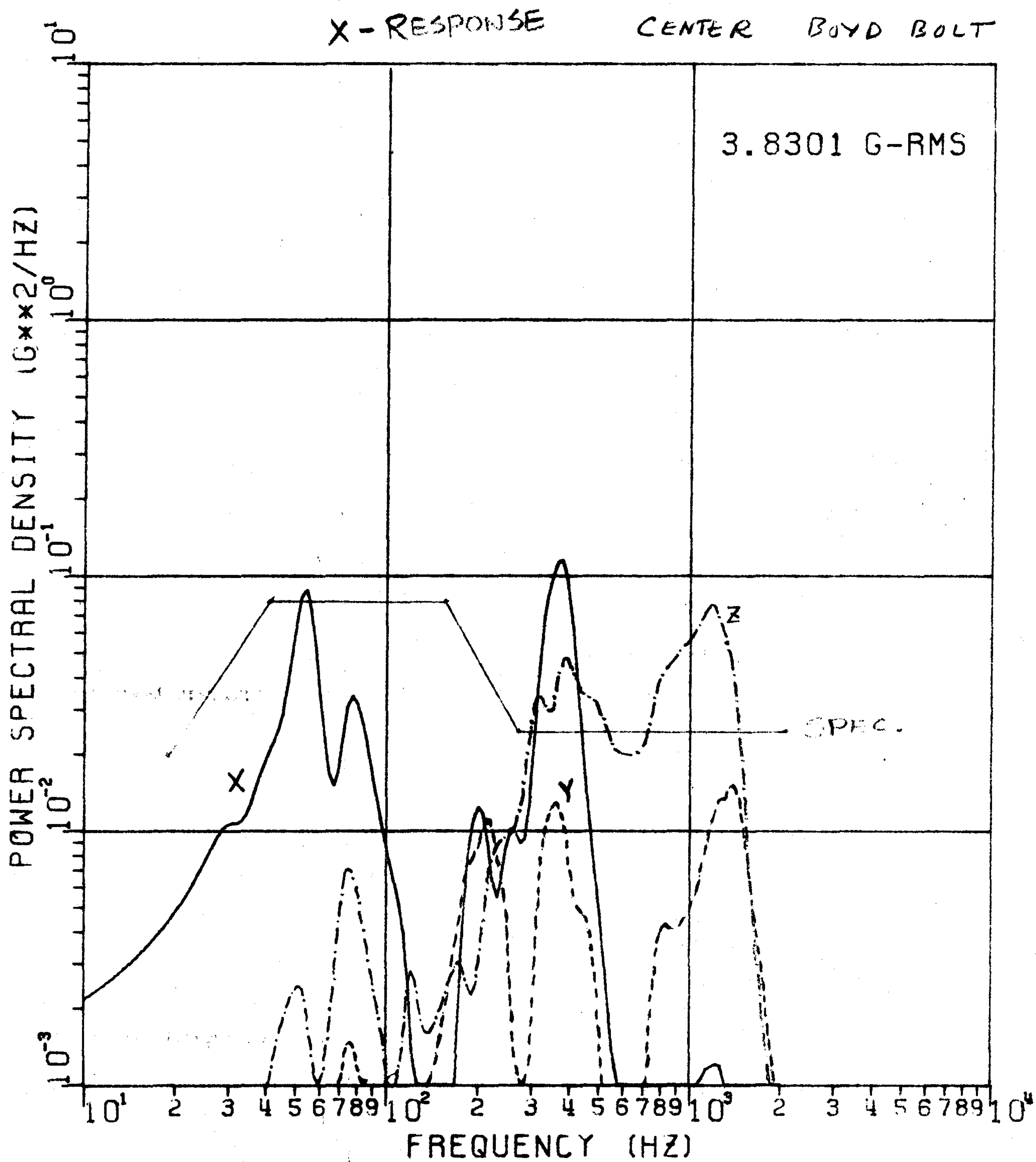
LOCATION 12 u4



ALSEP ARRAY E/SP-1, FORCING IN X-AXIS (LSG @ CG)

FIGURE 16 RANDOM VIBRATION SPECTRUM

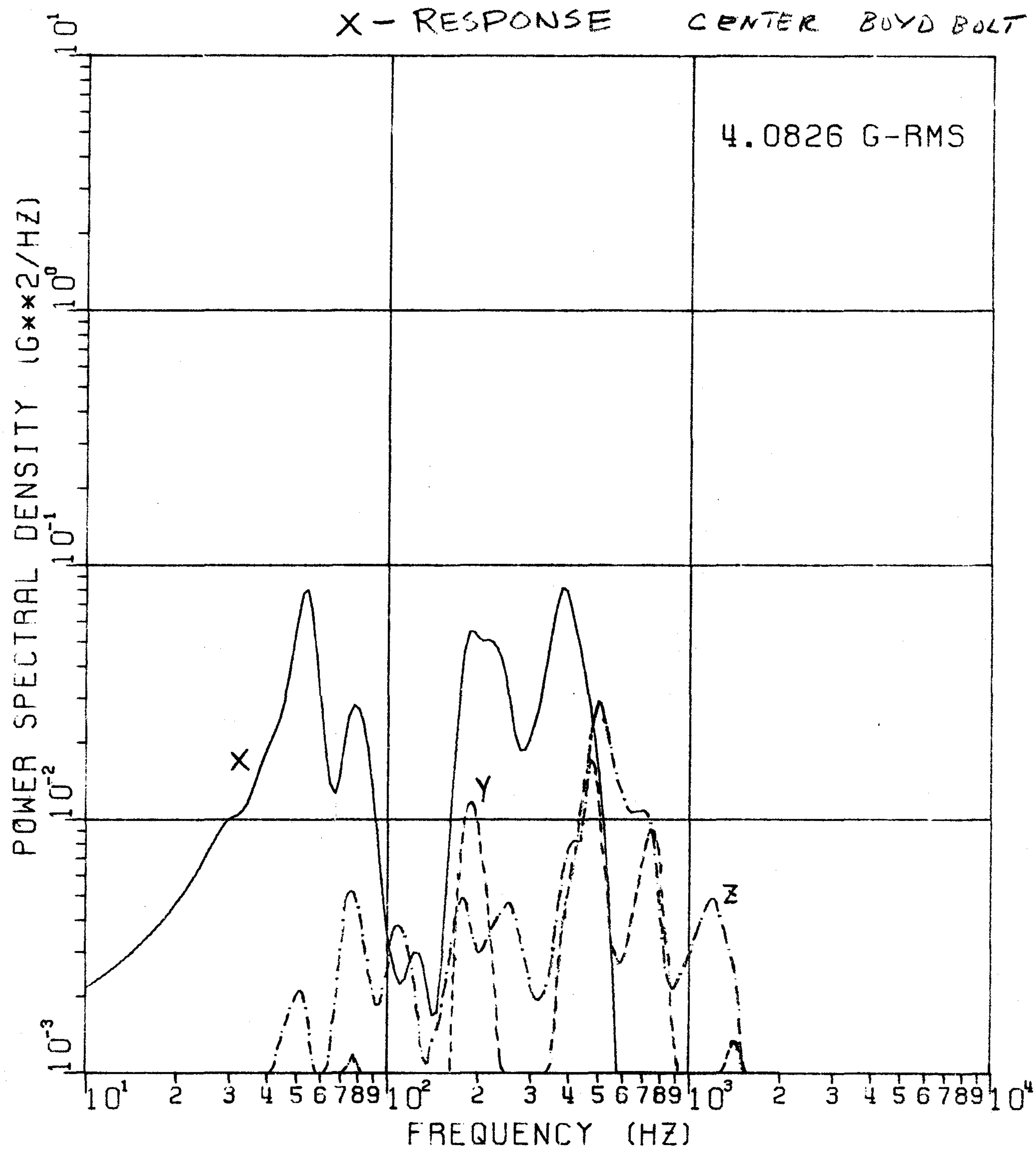
LOCATION 13



ALSEP ARRAY E/SP-1, FORCING IN X-AXIS (LSG @ CG)

FIGURE 17 RANDOM VIBRATION SPECTRUM

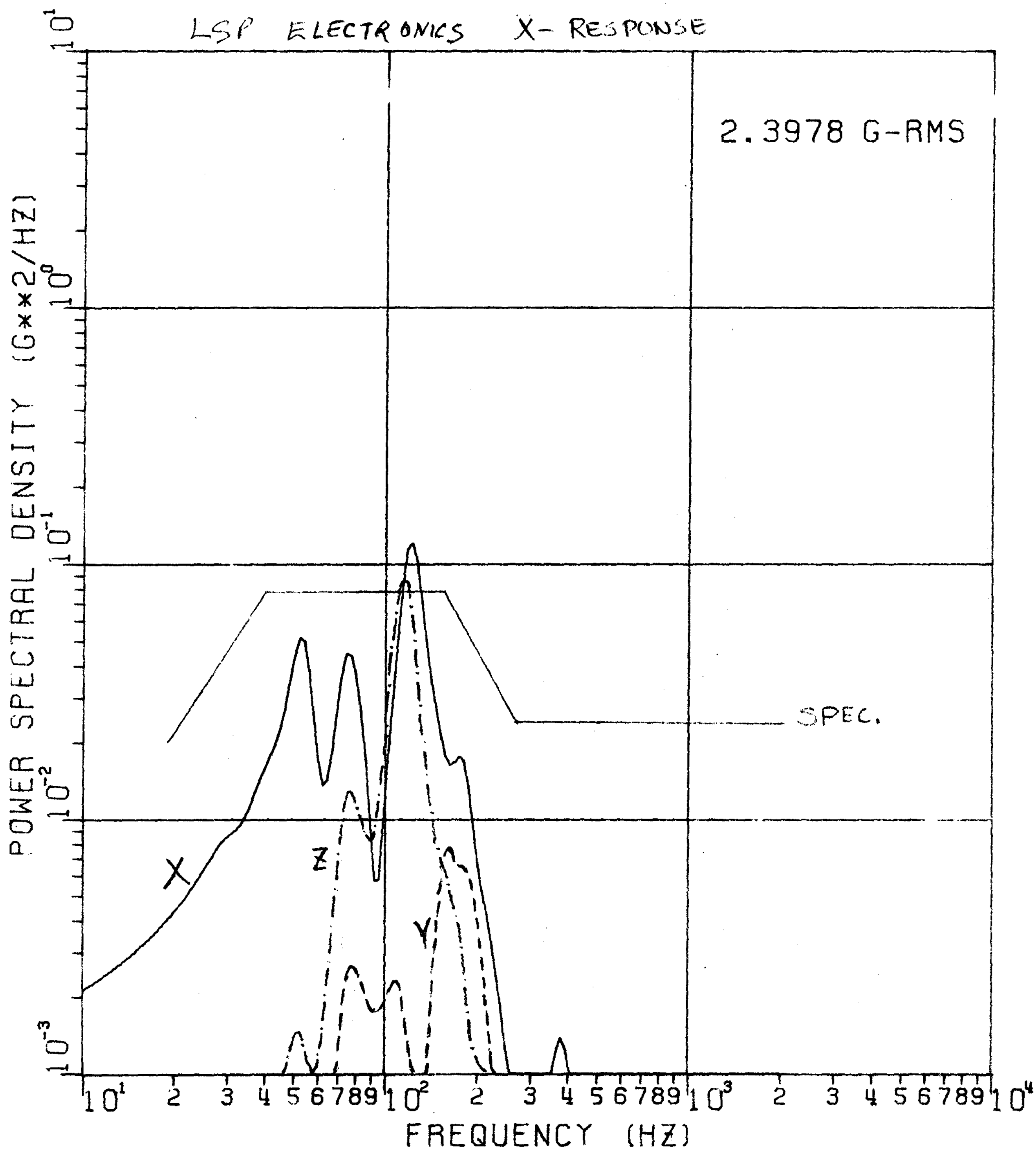
LOCATION 14



ALSEP ARRAY E/SP-1, FØRCING IN X-AXIS (LSG @ CG)

FIGURE 18 RANDØM VIBRATIØN SPECTRUM

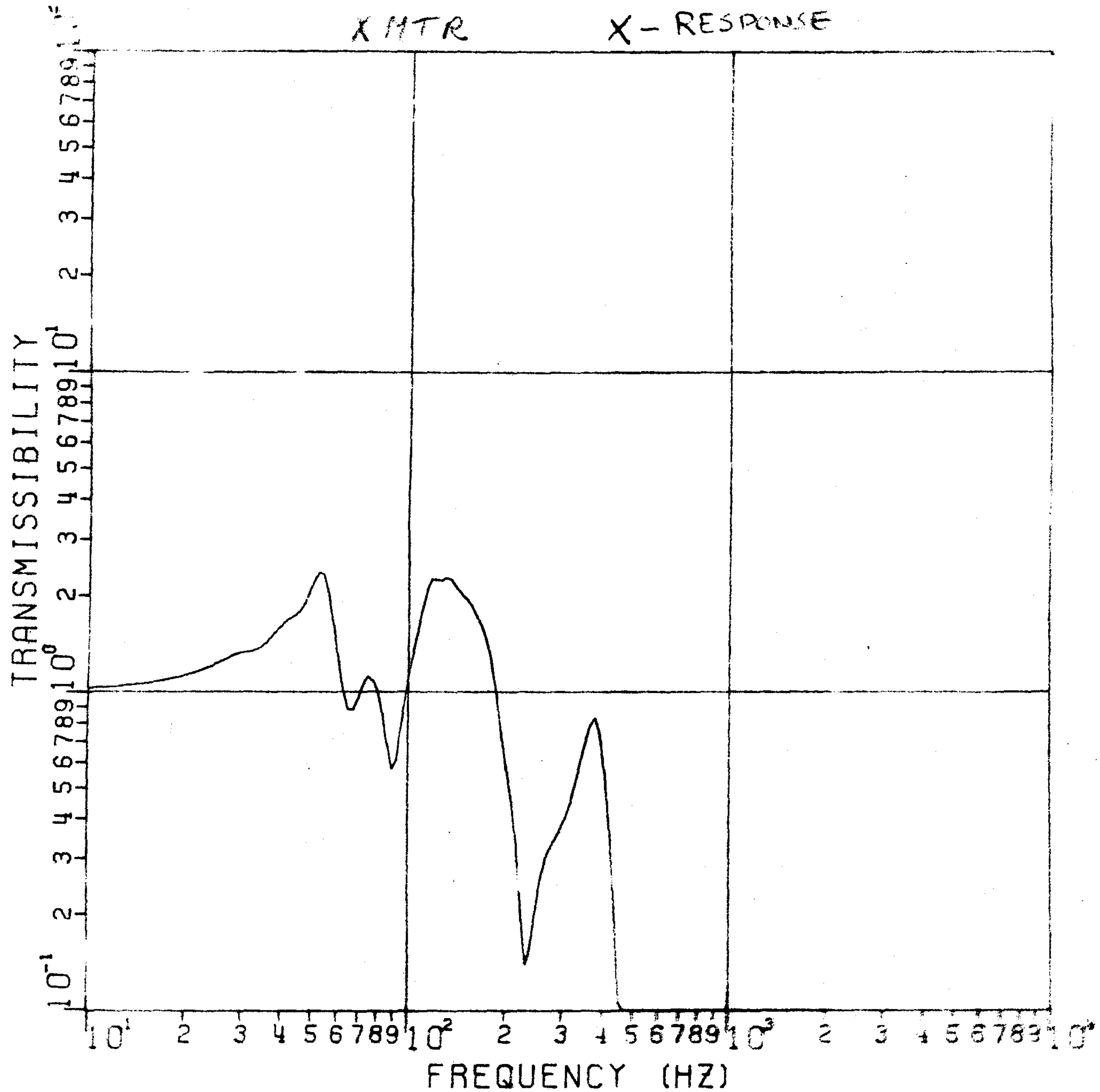
LØCATIØN 19



** ALSEP ARRAY E/SP-1,FORCING IN X-AXIS JAN.1971 **

FIGURE 19a TRANSMISSIBILITY

LOCATION 20

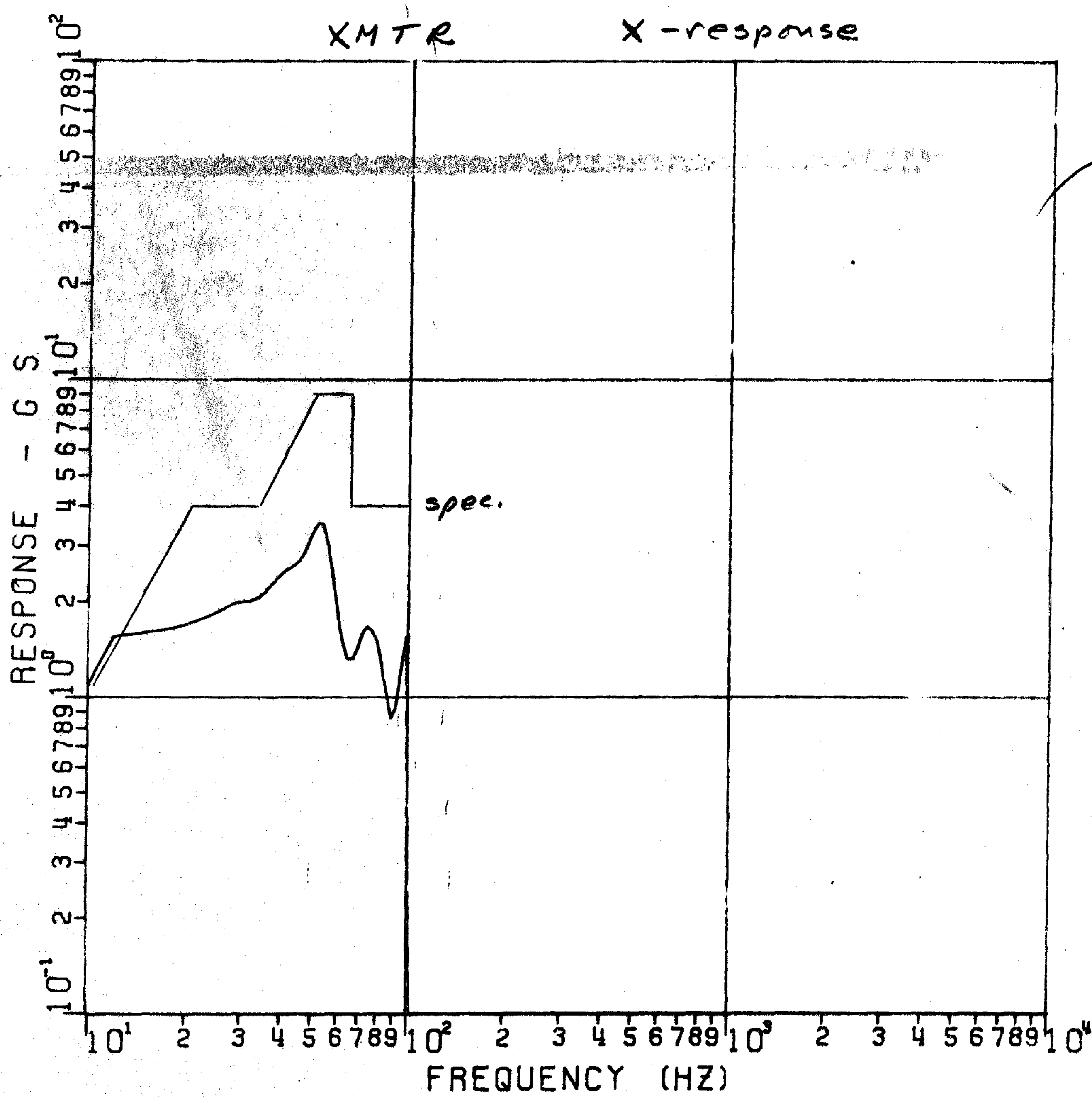


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 *

FIGURE 19b SINE RESPONSE

LOCATION 20

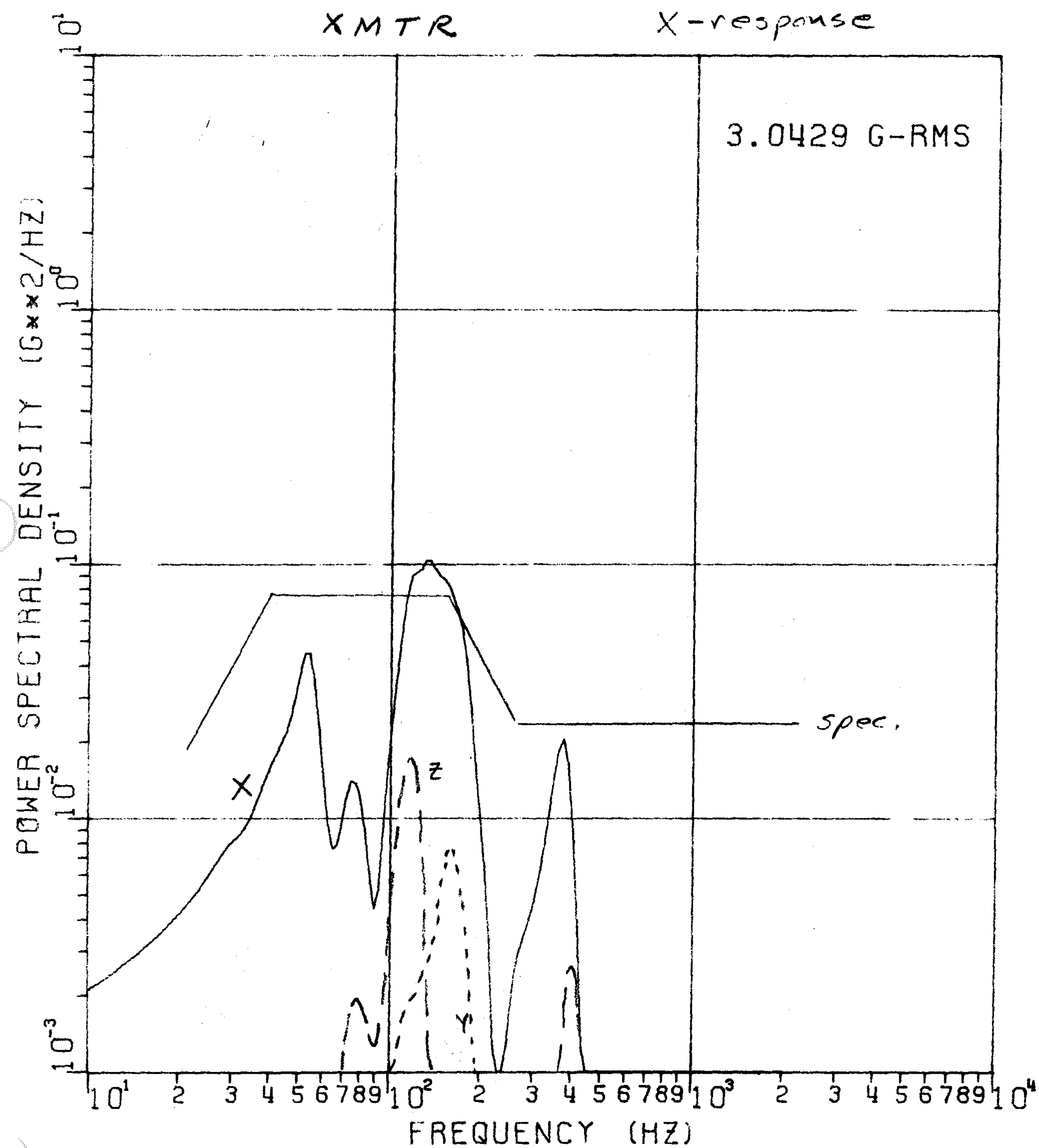
XMTR X-response



** ALSEP ARRAY E/SP-1, FØRCING IN X-AXIS JAN. 1971 **

FIGURE 19C RANDOM VIBRATION SPECTRUM

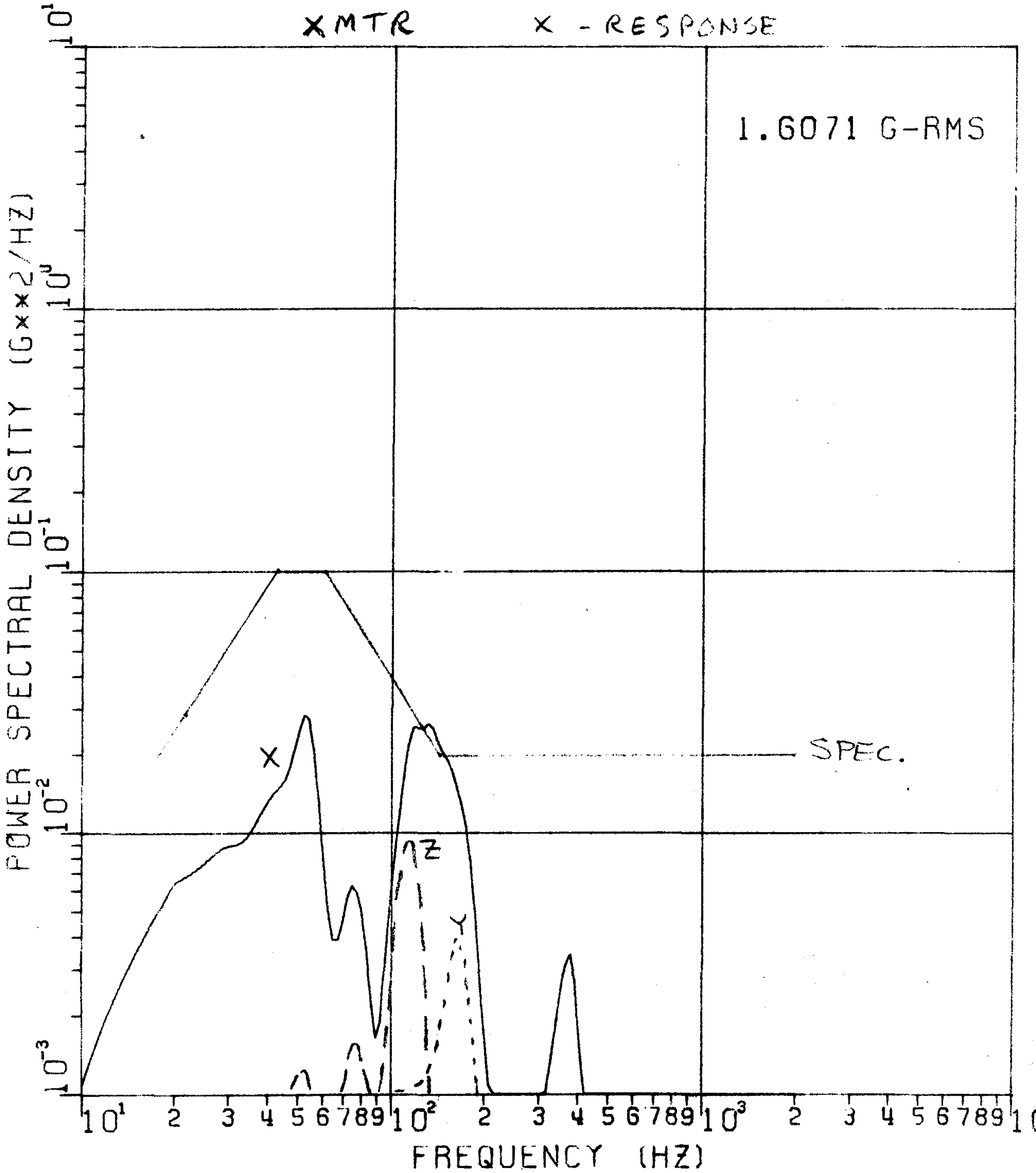
LØCATION 20



ALSEP ARR E/SP-1 (LSG), FOR IN X-AXIS (LUNAR DESCENT)

FIGURE 19d RANDOM VIBRATION SPECTRUM

LOCATION 20

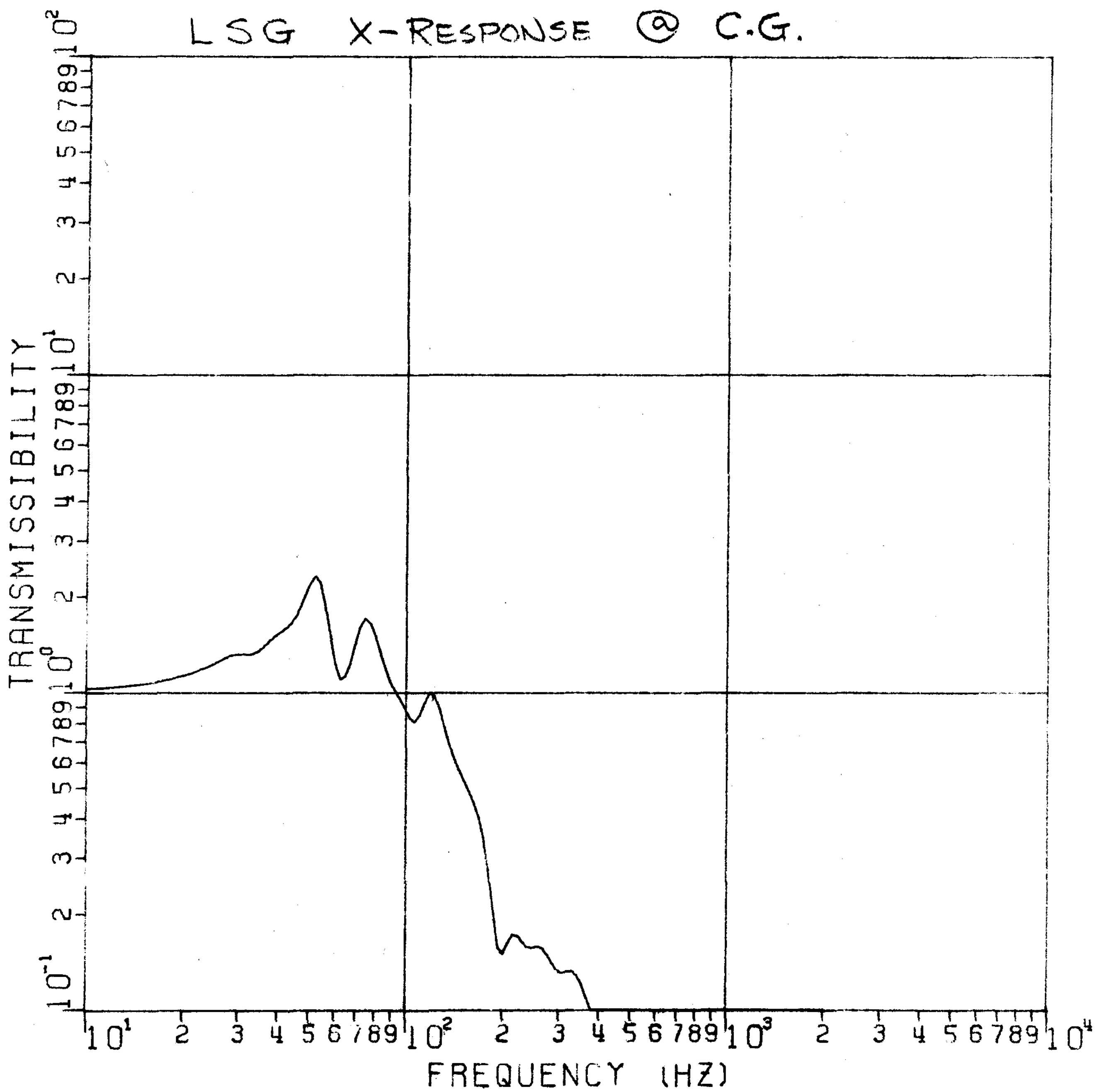


ALSEP ARRAY E/SP-1, FORCING IN X-AXIS (LSG @ CG)

FIGURE 20a TRANSMISSIBILITY

LOCATION 22*

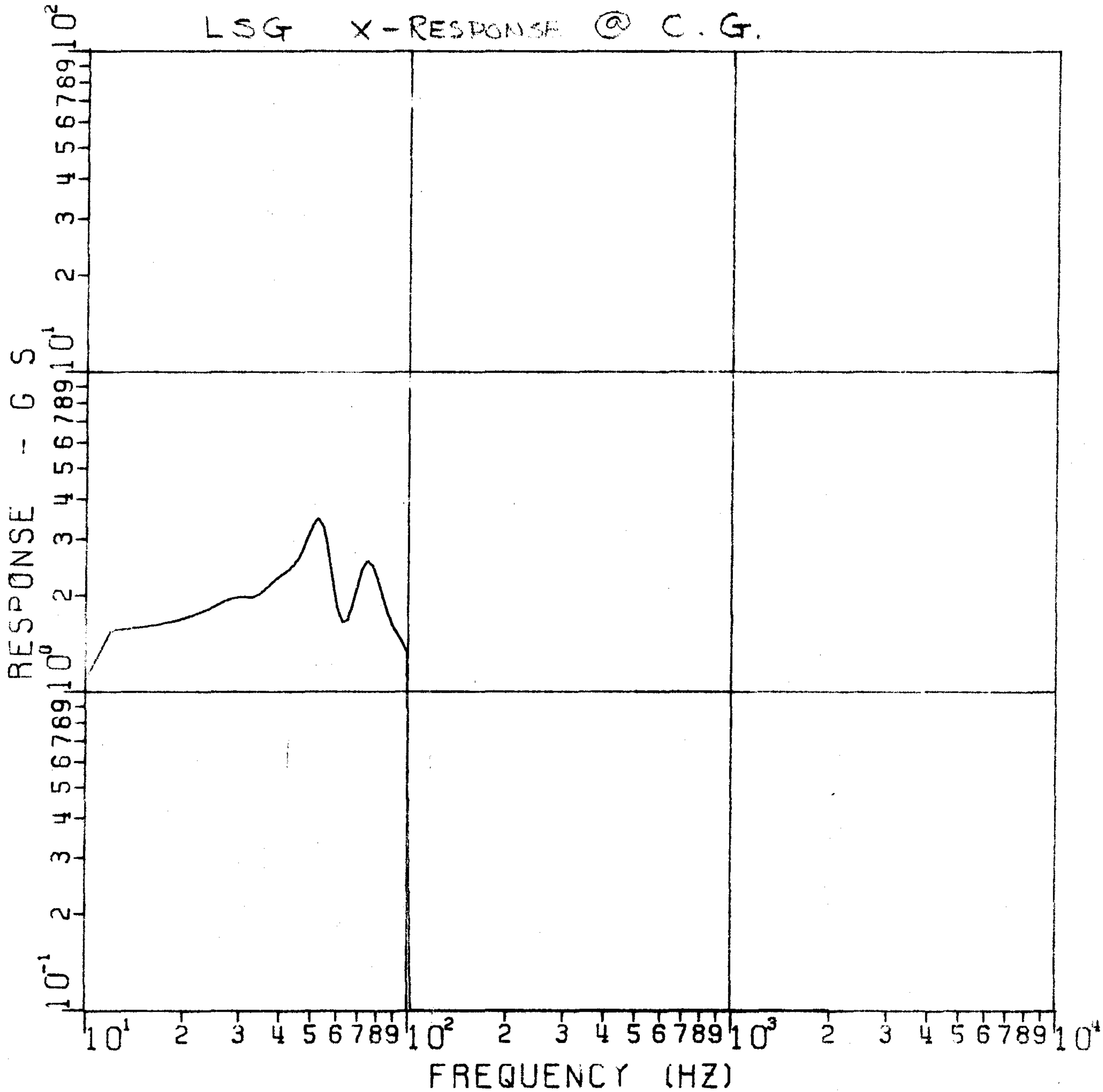
LSG X-RESPONSE @ C.G.



ALSEP ARRAY E/SP-1, FØRCING IN X-AXIS (LSG @ CG)

FIGURE 20b SINE RESPONSE

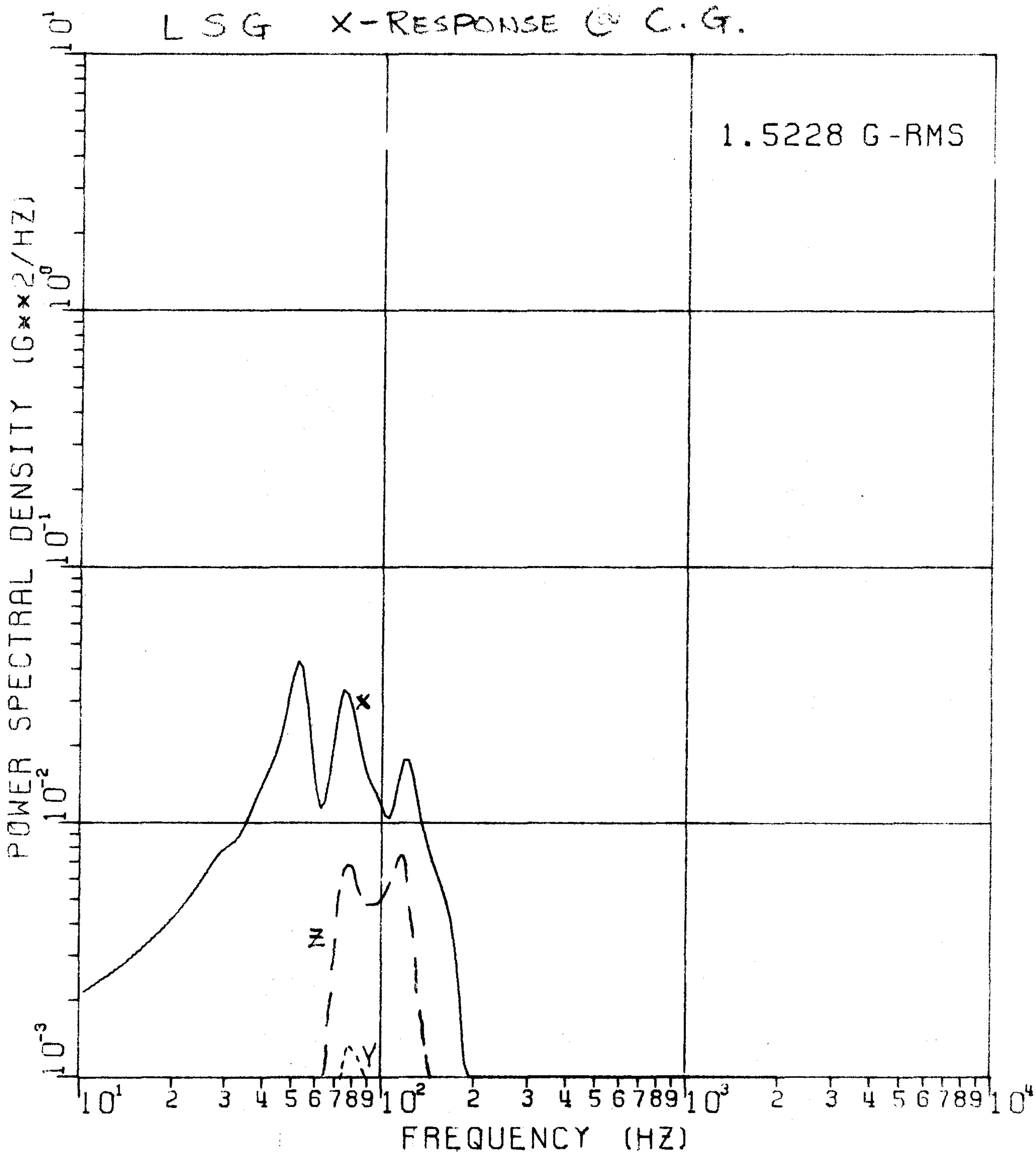
LØCATIØN 22



ALSEP ARRAY E/SP-1, FORCING IN X-AXIS (LSG @ CG)

FIGURE 20C RANDOM VIBRATION SPECTRUM

LOCATION 22

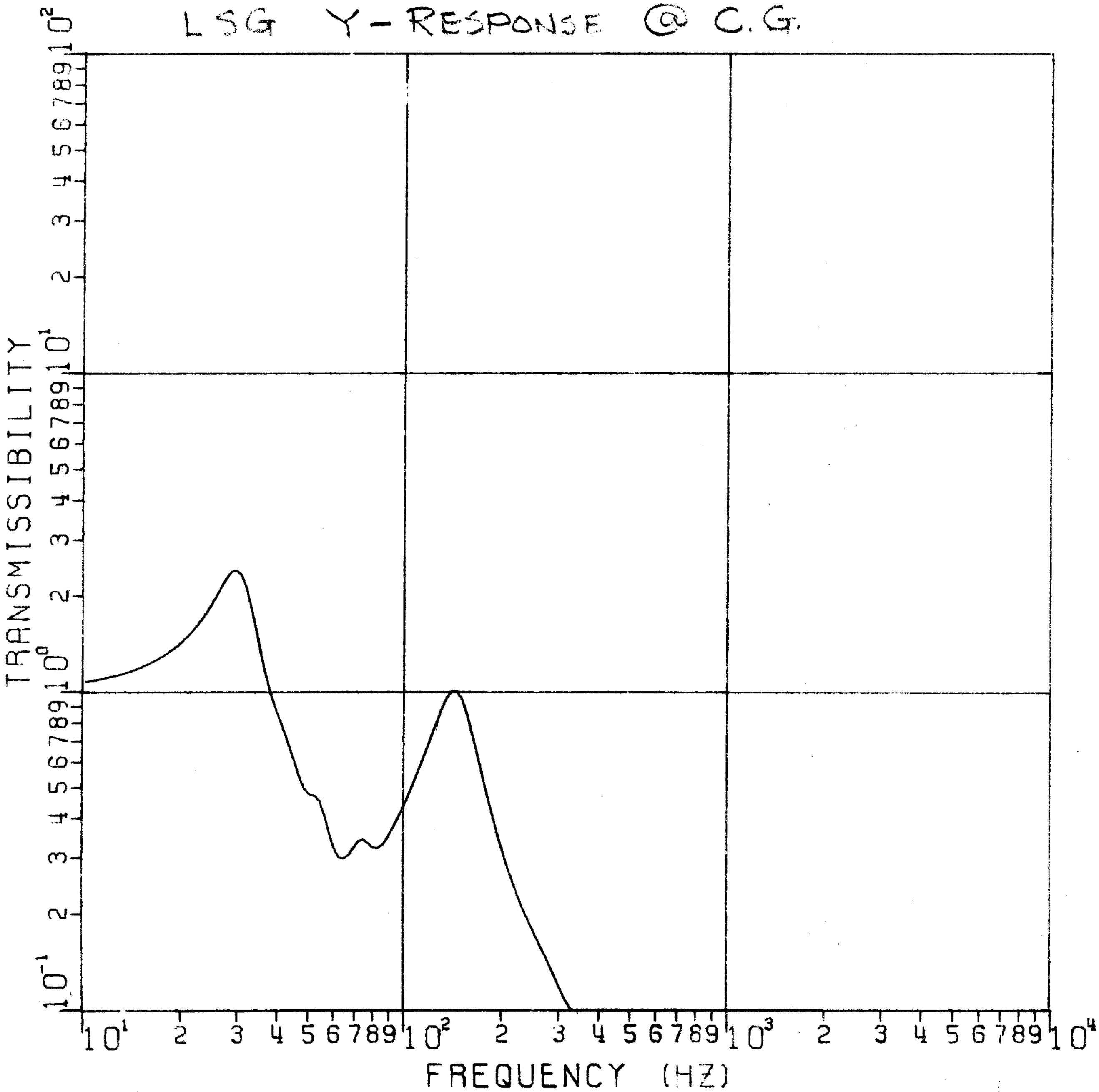


ALSEP ARRAY E/SP-1, FØRCING IN Y-AXIS (LSG @ CG)

FIGURE 21a TRANSMISSIBILITY

LØCATIØN 23

LSG Y-RESPONSE @ C.G.

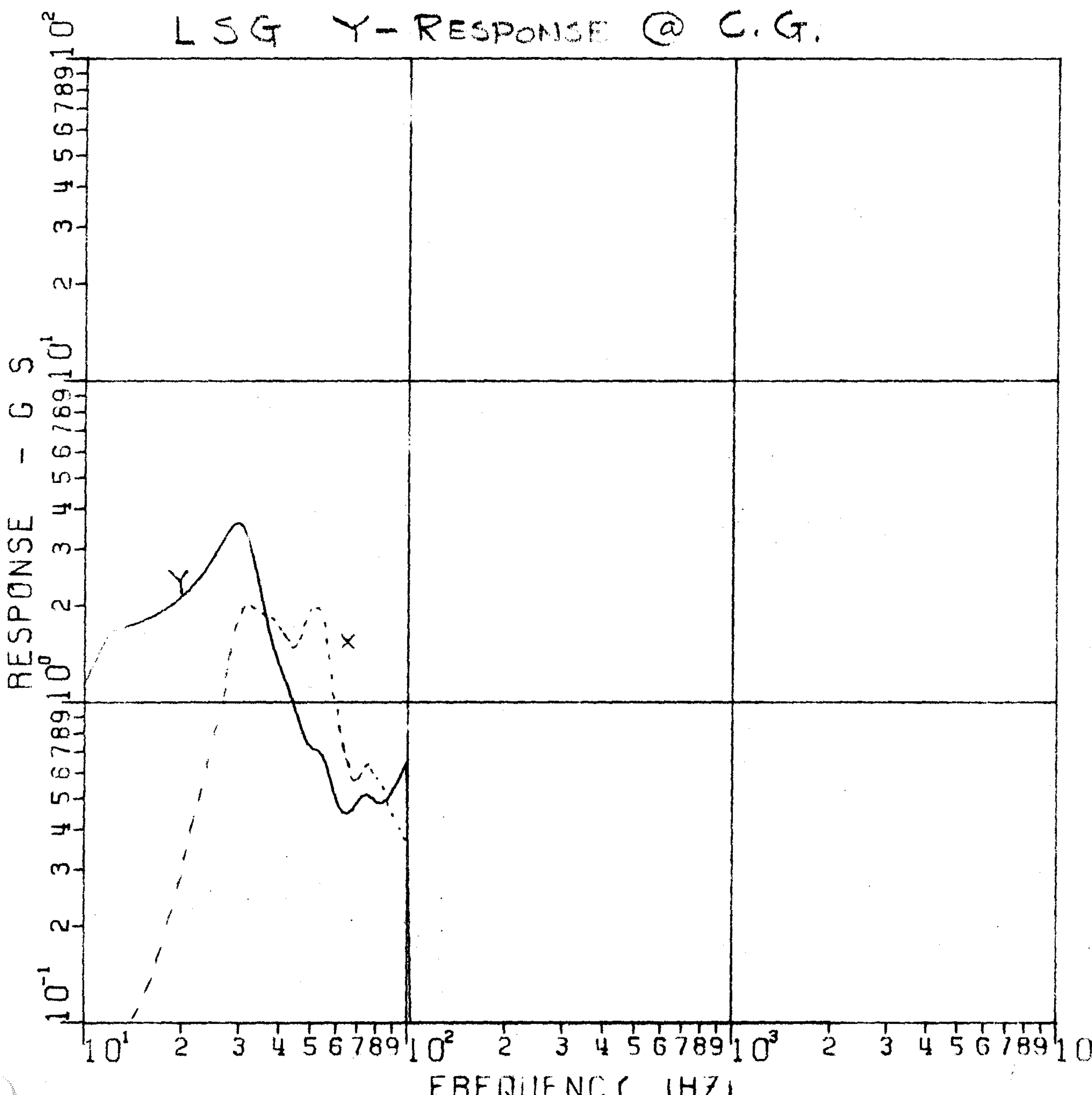


ALSEP ARRAY E/SP-1, FØRCING IN Y-AXIS (LSG @ CG)

FIGURE 21b SINE RESPONSE

LØCATIØN 23

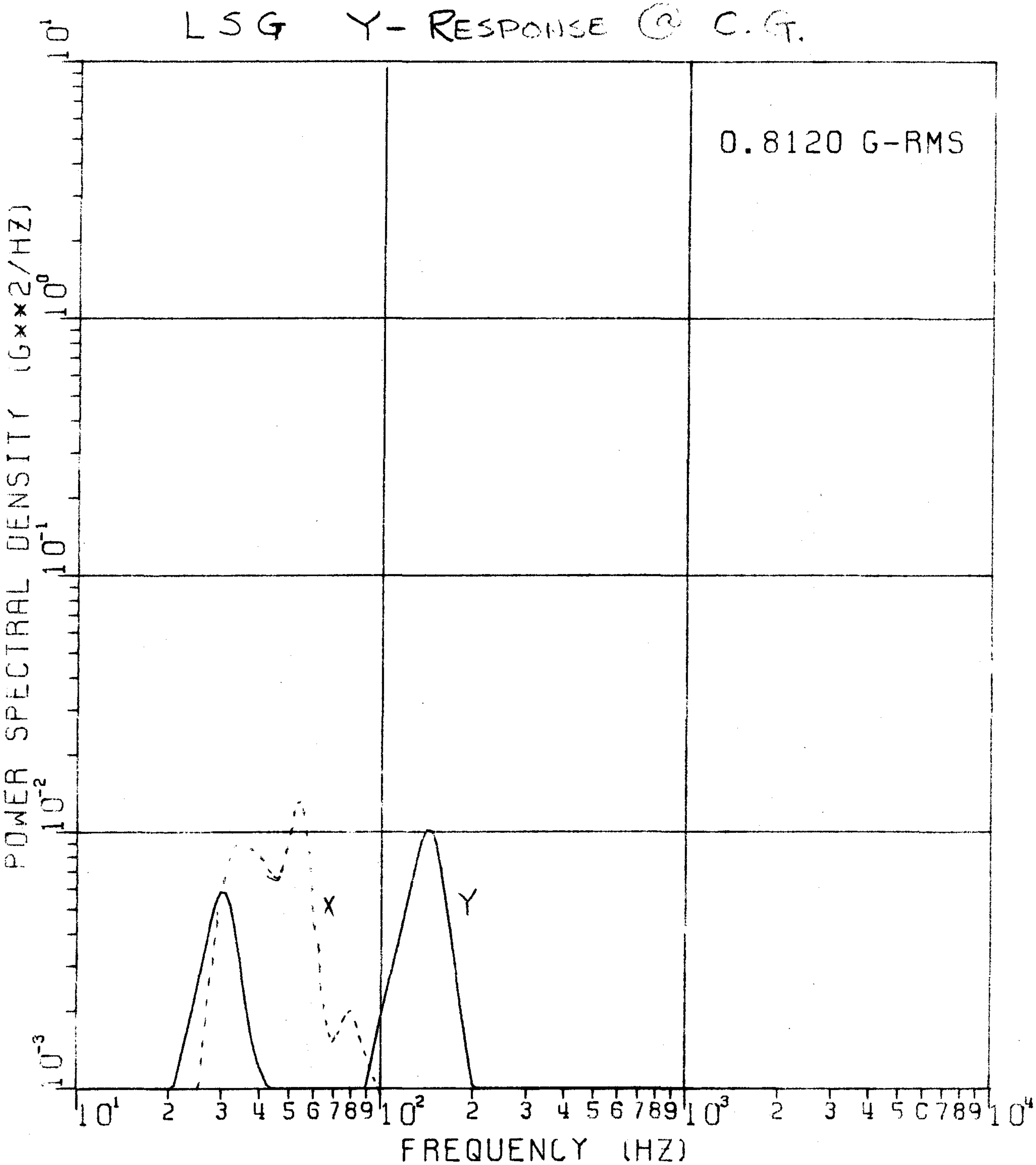
LSG Y-RESPONSE @ C.G.



ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS (LSG @ CG)

FIGURE 21C RANDOM VIBRATION SPECTRUM

LOCATION 23

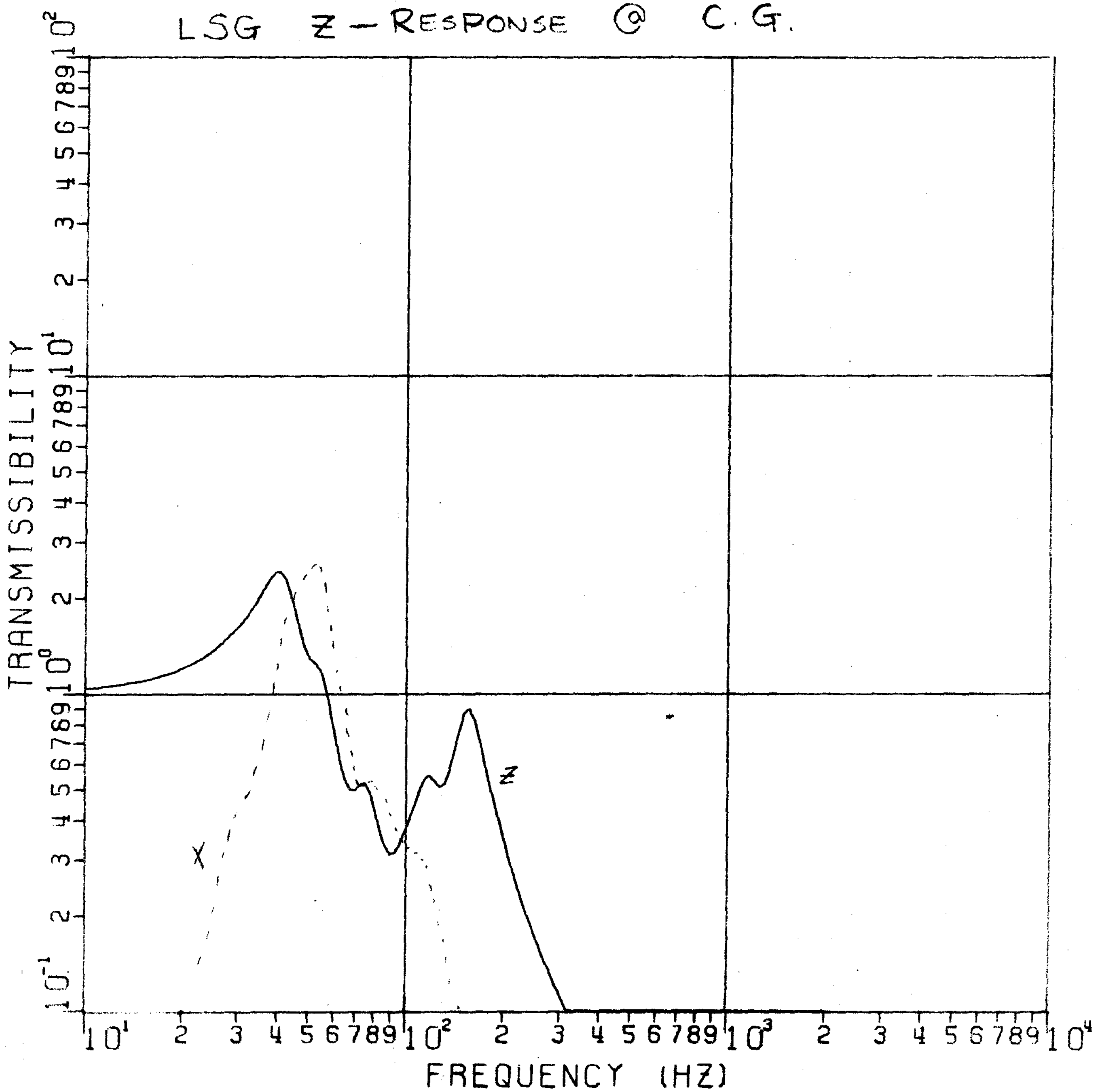


ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS (LSG @ CG)

FIGURE zza TRANSMISSIBILITY

LOCATION 24

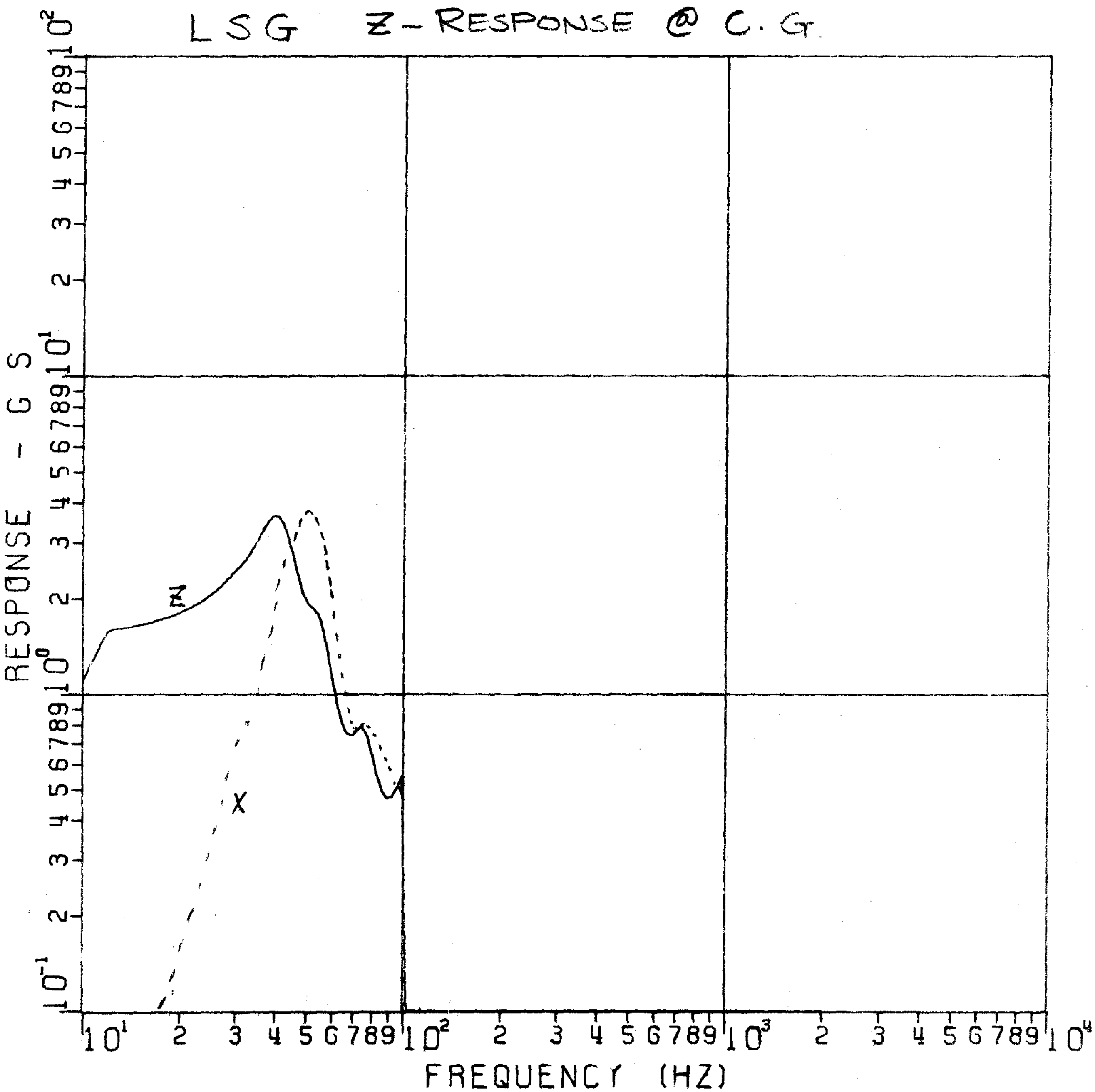
LSG Z-RESPONSE @ C.G.



ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS (LSG @ CG)

FIGURE 22b SINE RESPONSE

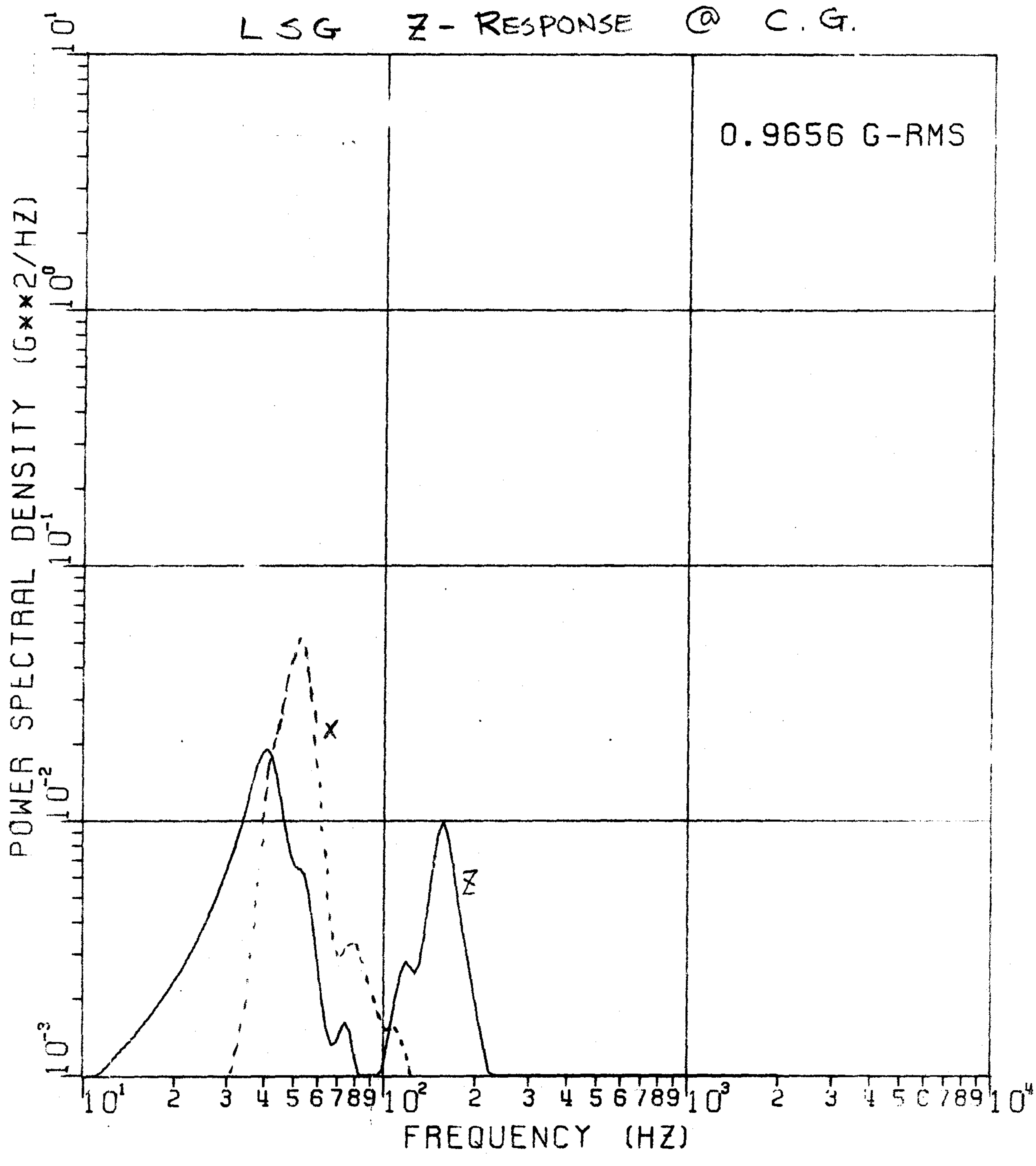
LOCATION 24



ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS (LSG @ CG)

FIGURE 22C RANDOM VIBRATION SPECTRUM

LOCATION 24

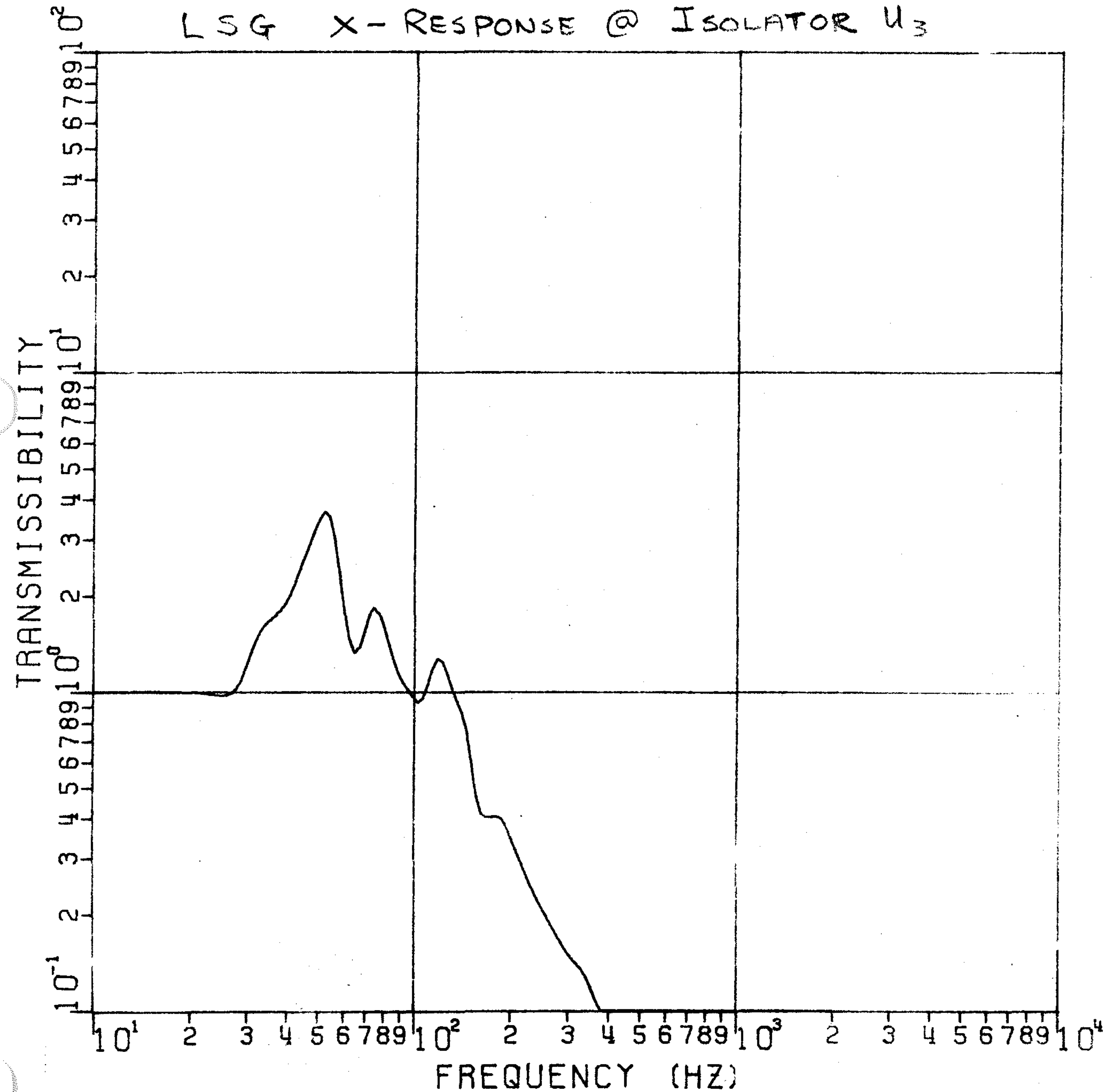


** ALSEP ARRAY E/SP-1, FØRCING IN X-AXIS JAN. 1971 **

FIGURE 23a TRANSMISSIBILITY

LØCATIØN 24

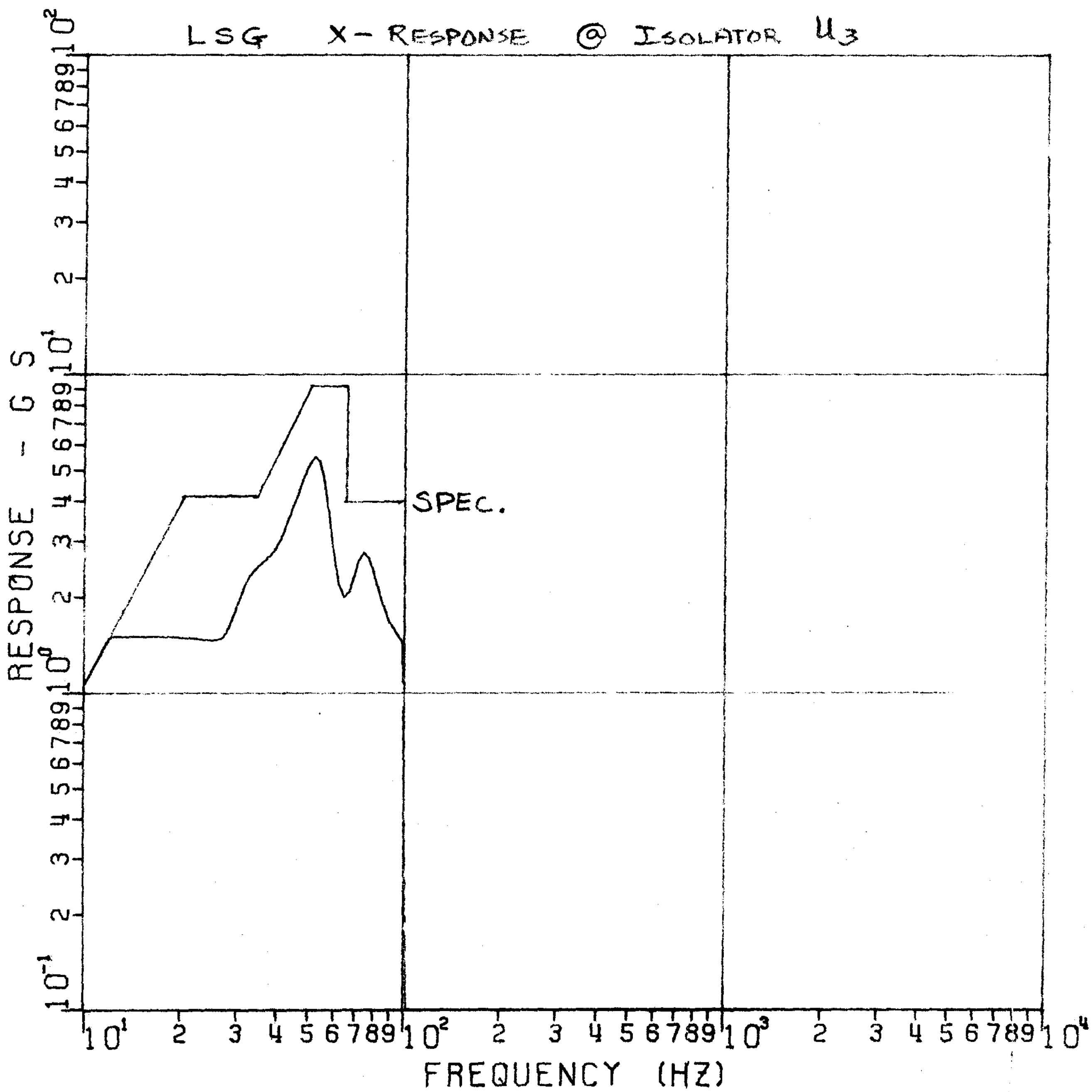
LSG X-RESPONSE @ ISOLATOR U3



** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 *

FIGURE 23b SINE RESPONSE

LOCATION 24

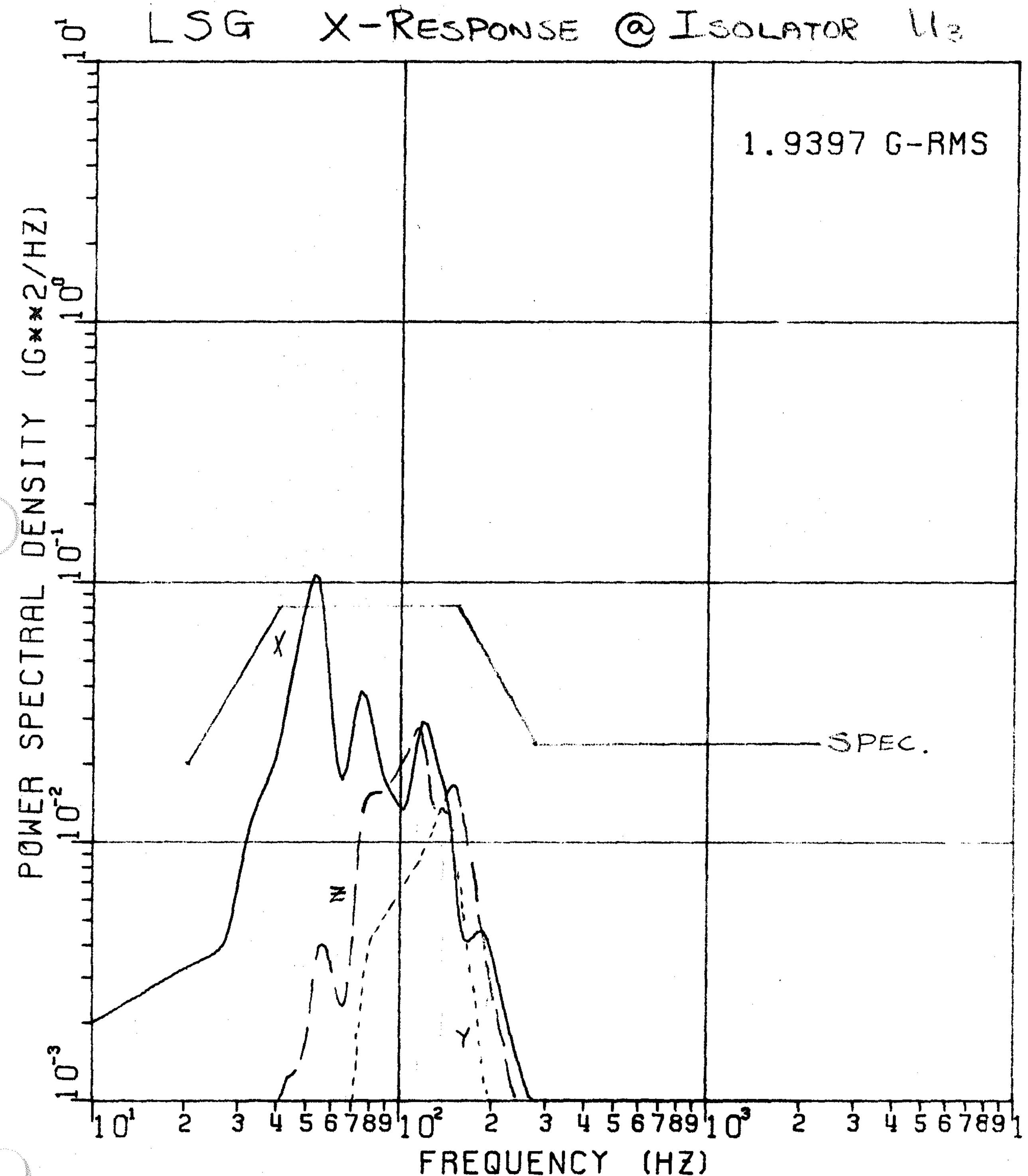


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS JAN. 1971 **

FIGURE 23C RANDOM VIBRATION SPECTRUM L&B

LOCATION 24

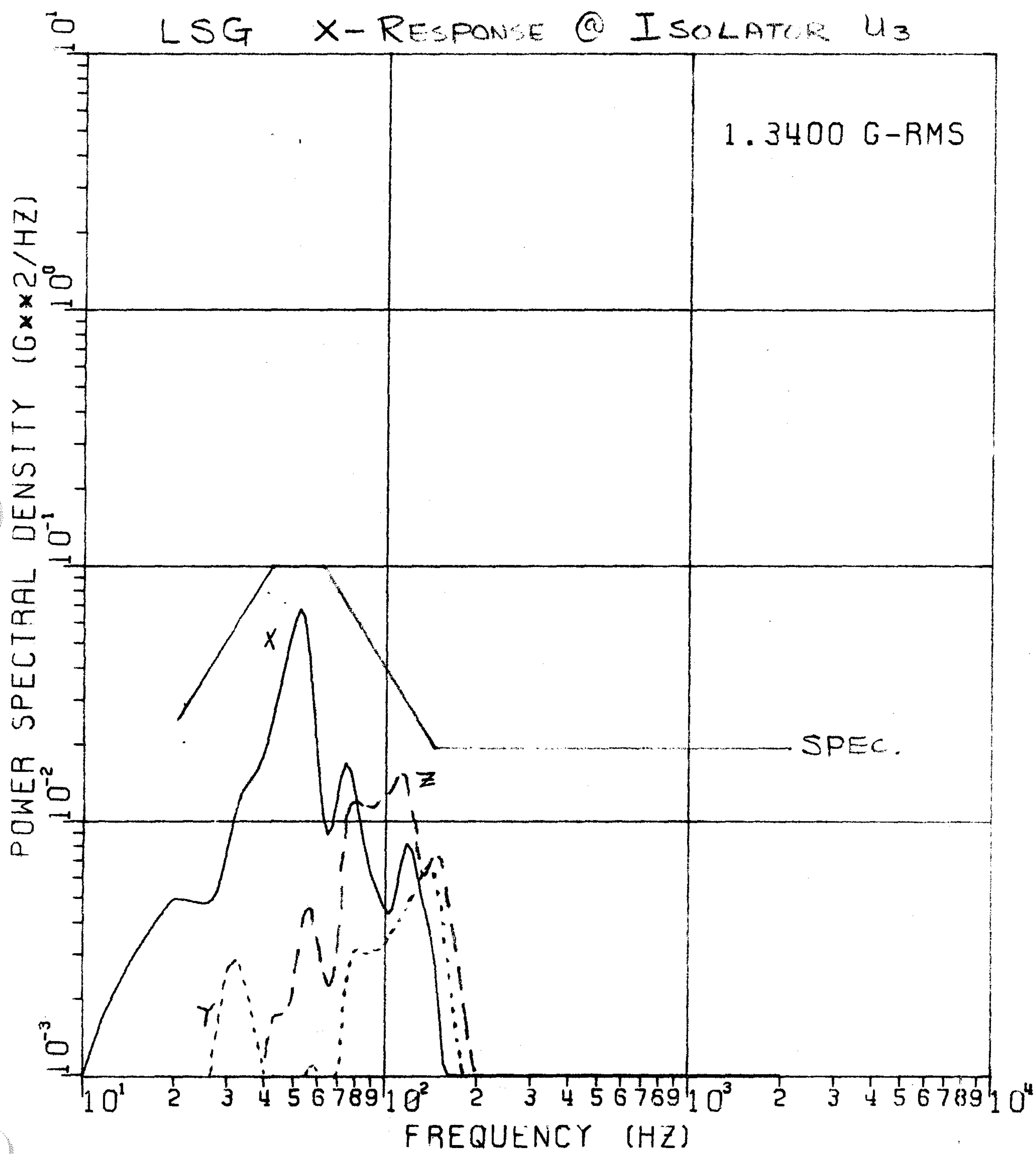
LSG X-RESPONSE @ ISOLATOR 11B



ALSEP ARR E/SP-1 (LSG), FOR IN X-AXIS (LUNAR DESCENT)

FIGURE 23d RANDOM VIBRATION SPECTRUM

LOCATION 24

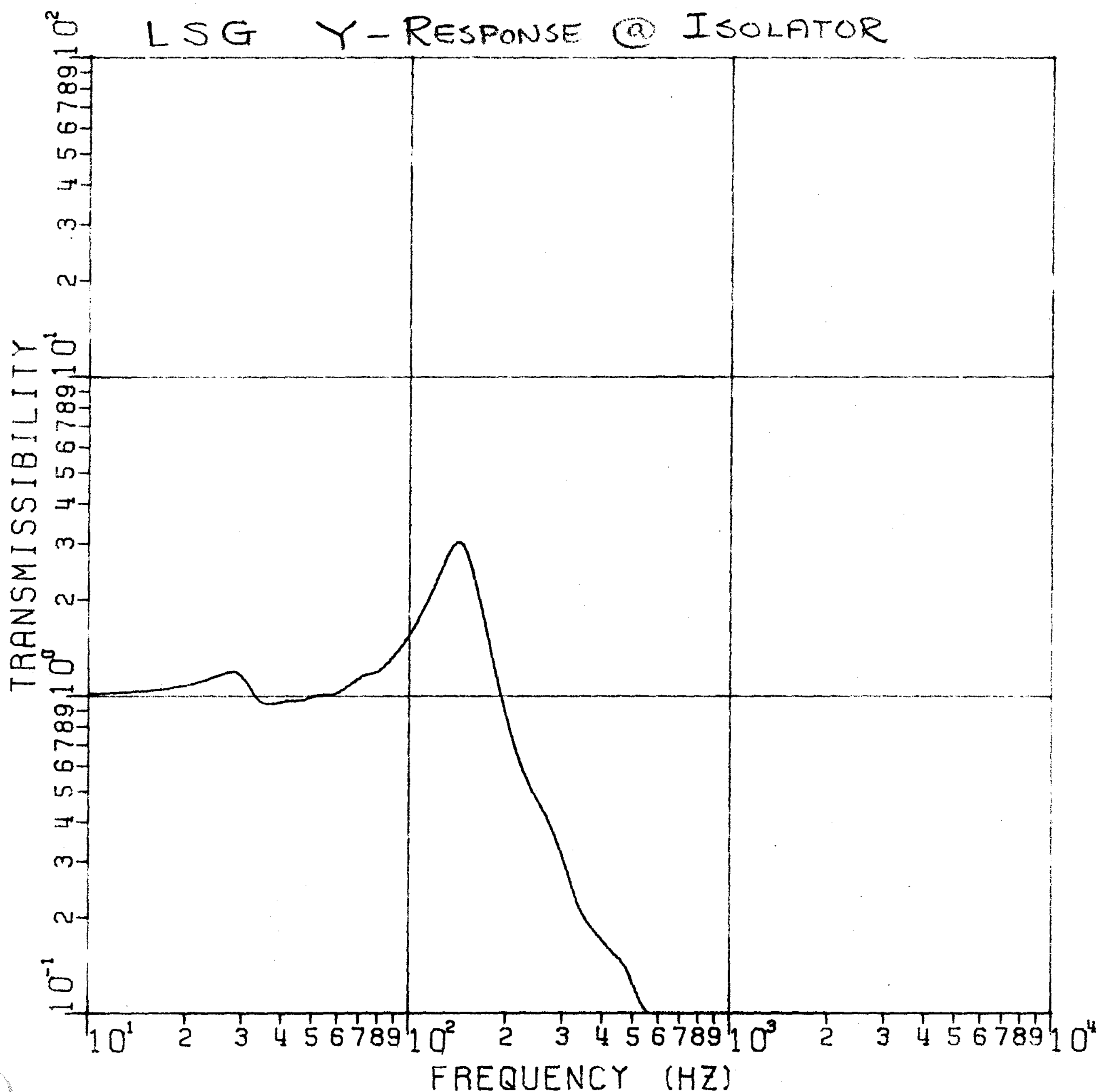


** ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS JAN. 1971 **

FIGURE 24a TRANSMISSIBILITY

LOCATION 25

LSG Y-RESPONSE @ ISOLATOR

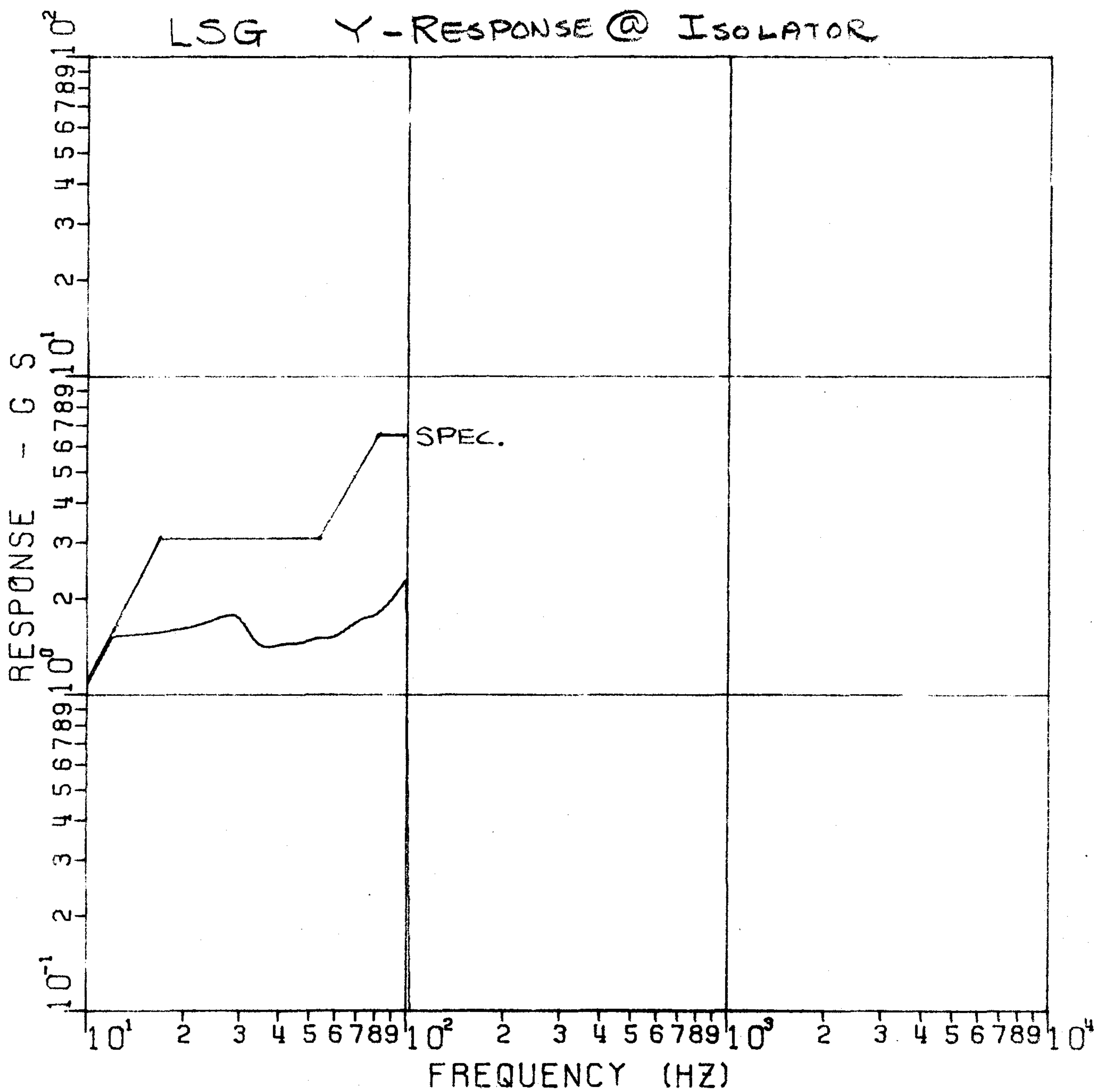


** ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS JAN. 1971 **

FIGURE 24b SINE RESPONSE

LOCATION 25

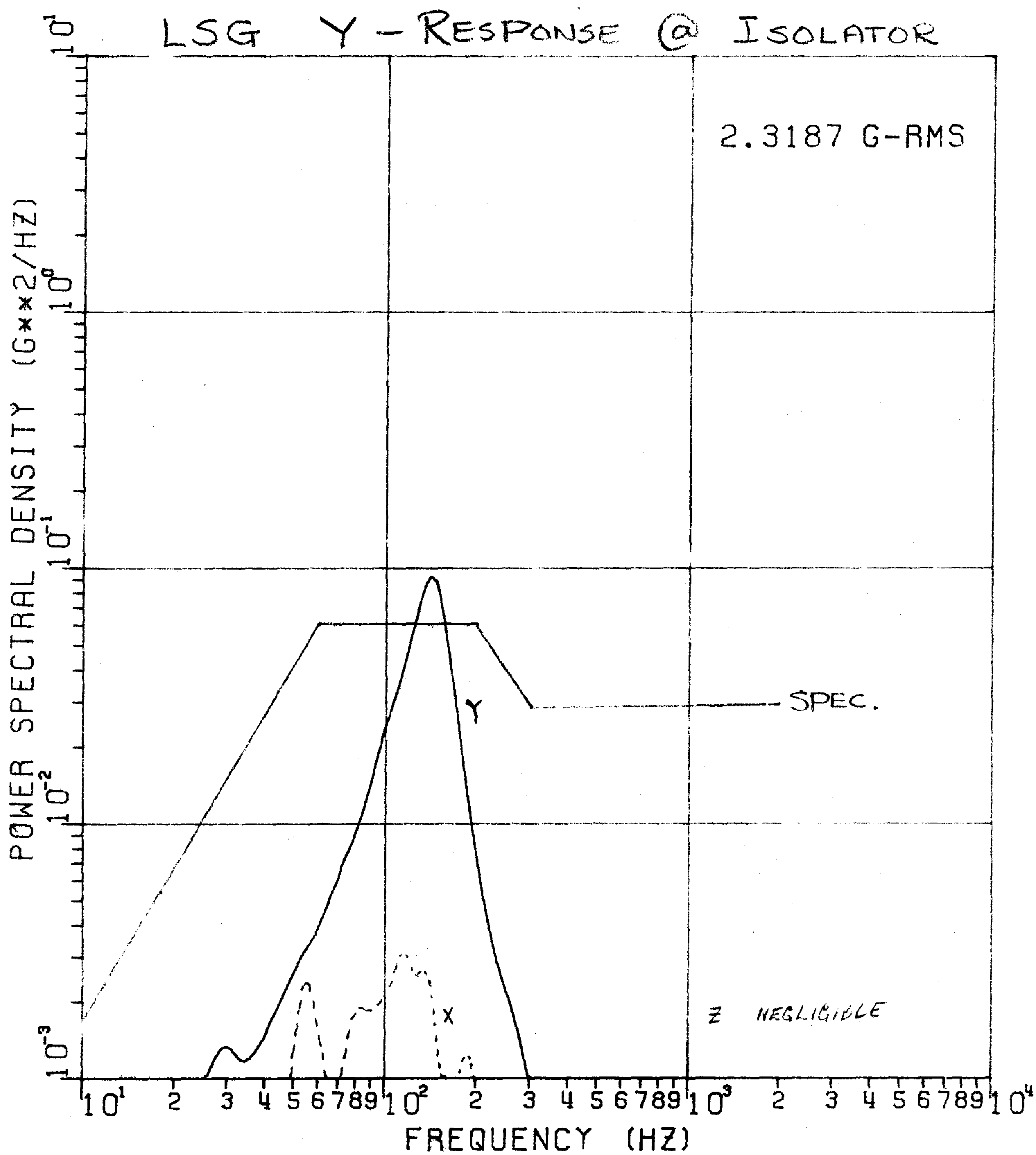
LSG Y-RESPONSE @ ISOLATOR



** ALSEP ARRAY E/SP-1, FØRCING IN Y-AXIS JAN. 1971

FIGURE 24C RANDOM VIBRATIØN SPECTRUM L&B

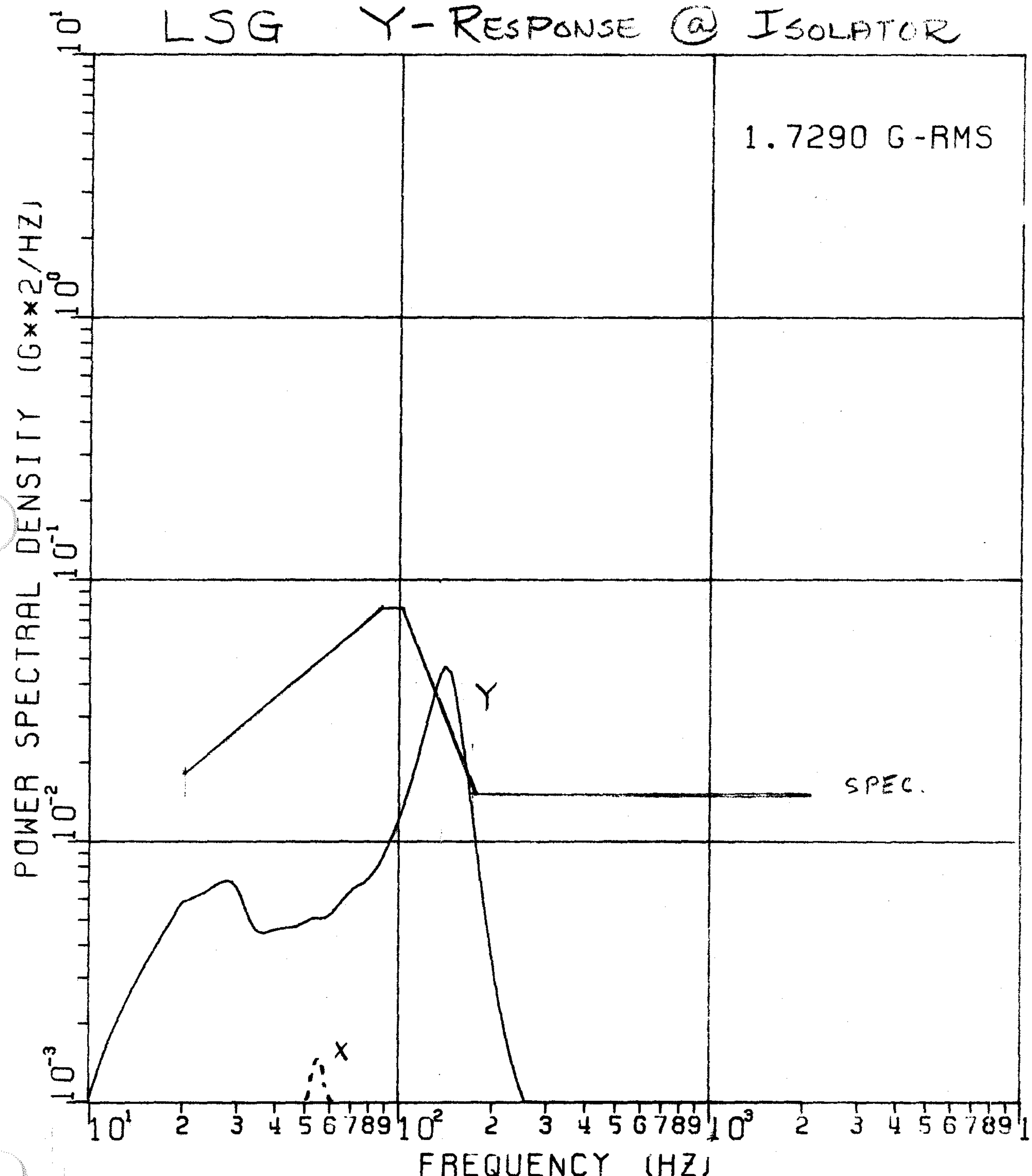
LØCATIØN 25 v,



ALSEP ARR E/SP-1 (LSG), FOR IN Y-AXIS (LUNAR DESCENT)

FIGURE 24d RANDOM VIBRATION SPECTRUM

LOCATION 25 v_1

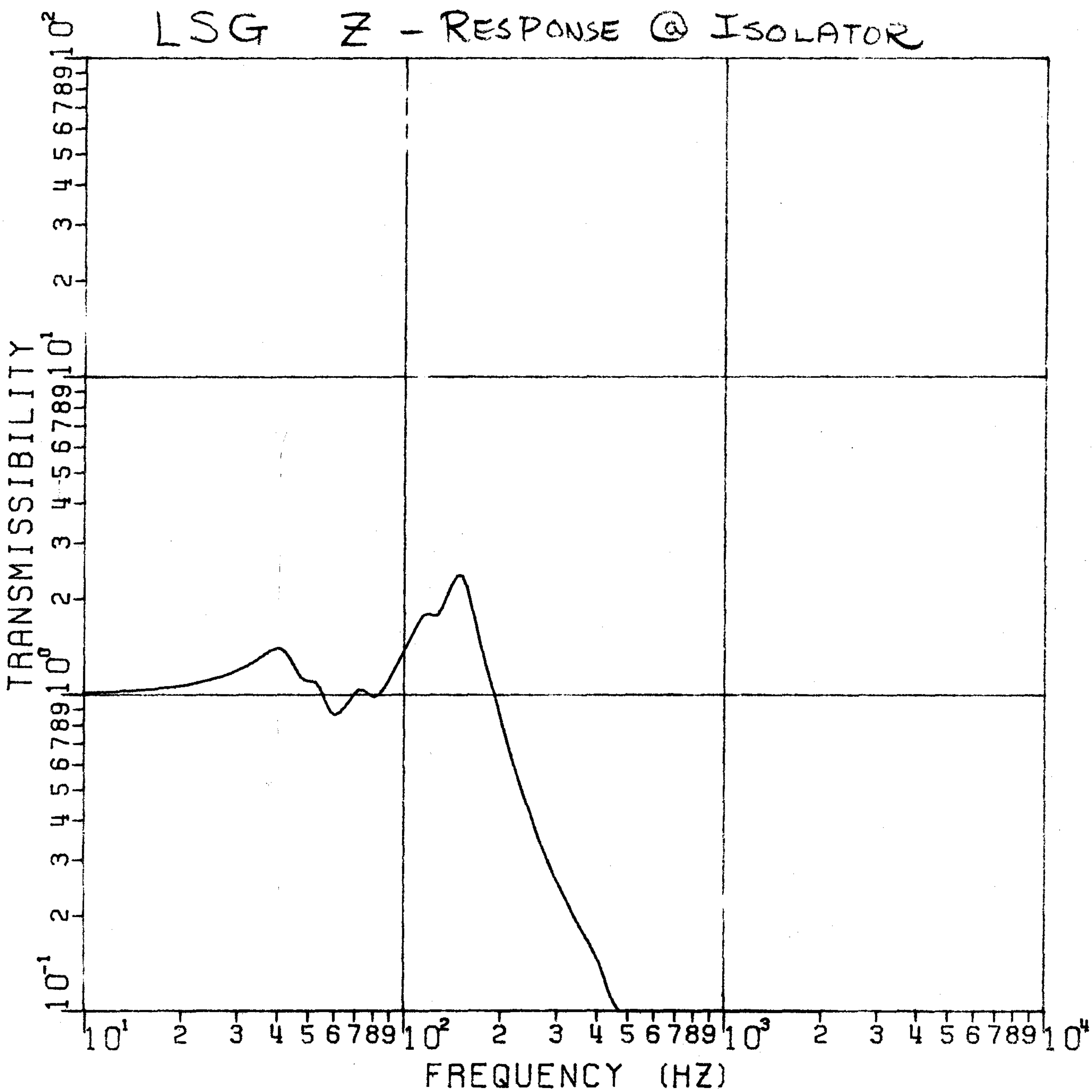


** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 ;

FIGURE 25a TRANSMISSIBILITY

LOCATION 26

LSG Z - RESPONSE @ ISOLATOR

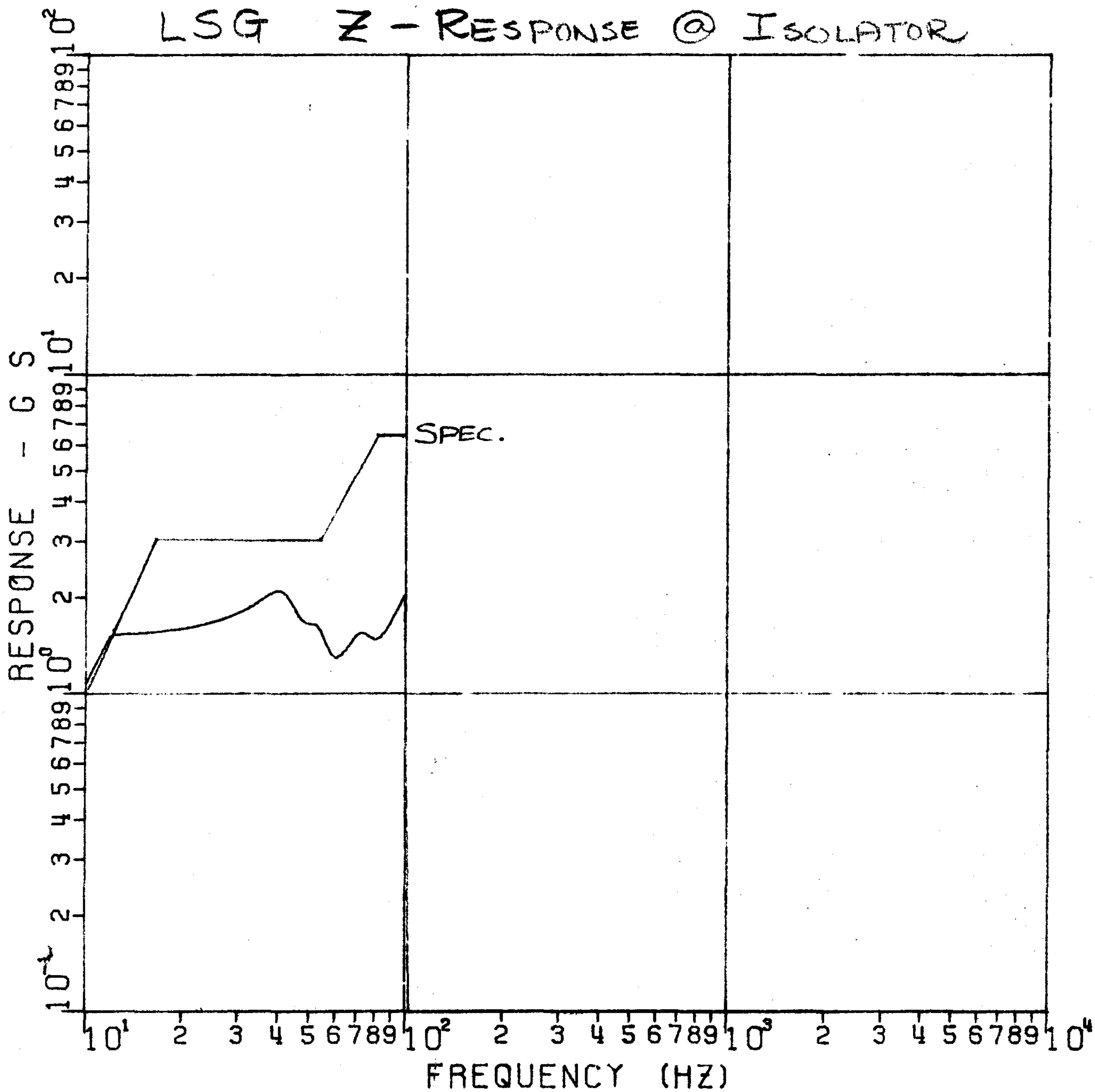


** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 *

FIGURE 25b SINE RESPONSE

LOCATION 26 w,

LSG Z - RESPONSE @ ISOLATOR

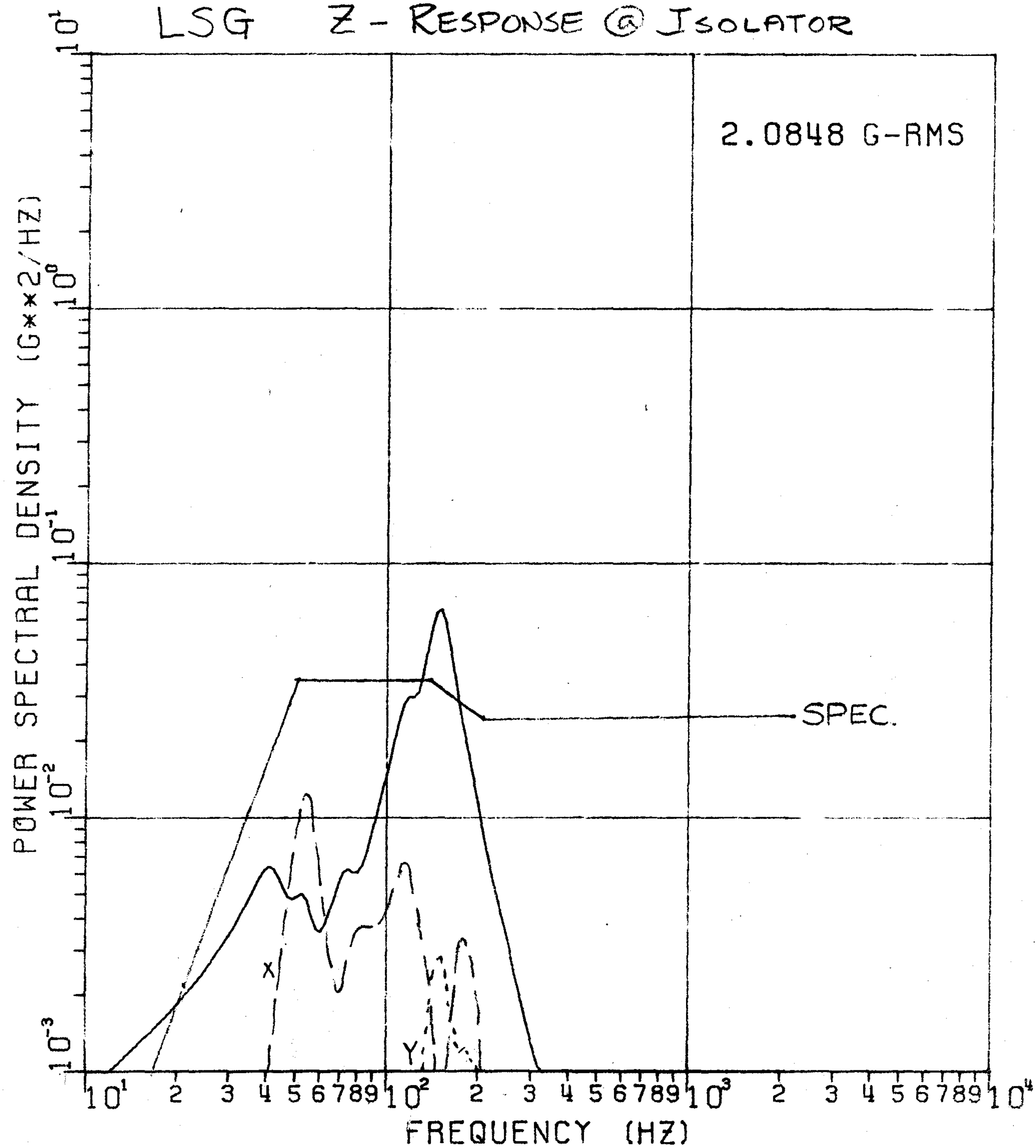


** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 **

FIGURE 25C RANDOM VIBRATION SPECTRUM L$0

LOCATION 26

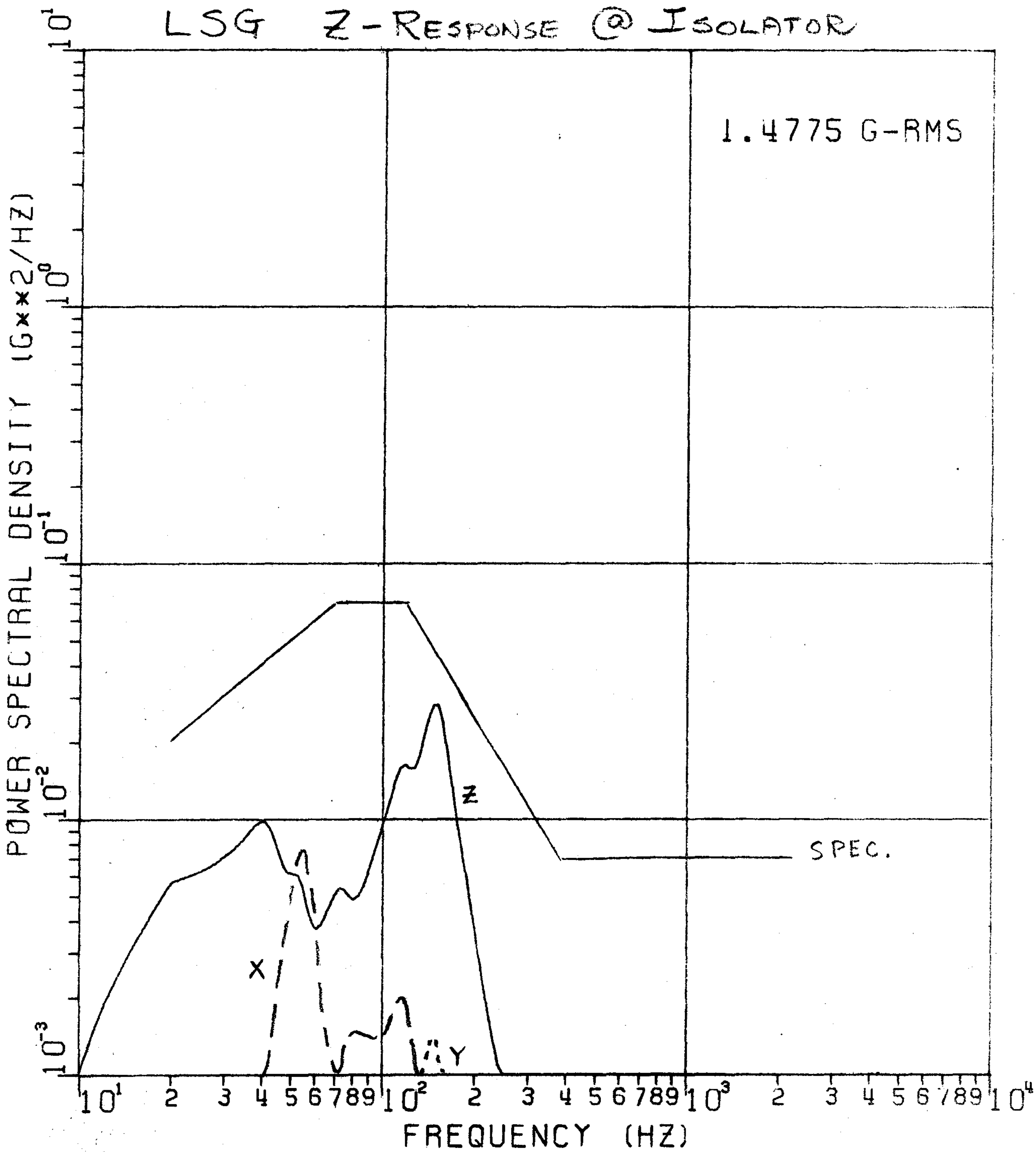
LSG Z - RESPONSE @ ISOLATOR



ALSEP ARR E/SP-1 (LSG), FOR IN Z-AXIS (LUNAR DESCENT)

FIGURE 25d RANDOM VIBRATION SPECTRUM

LOCATION 26

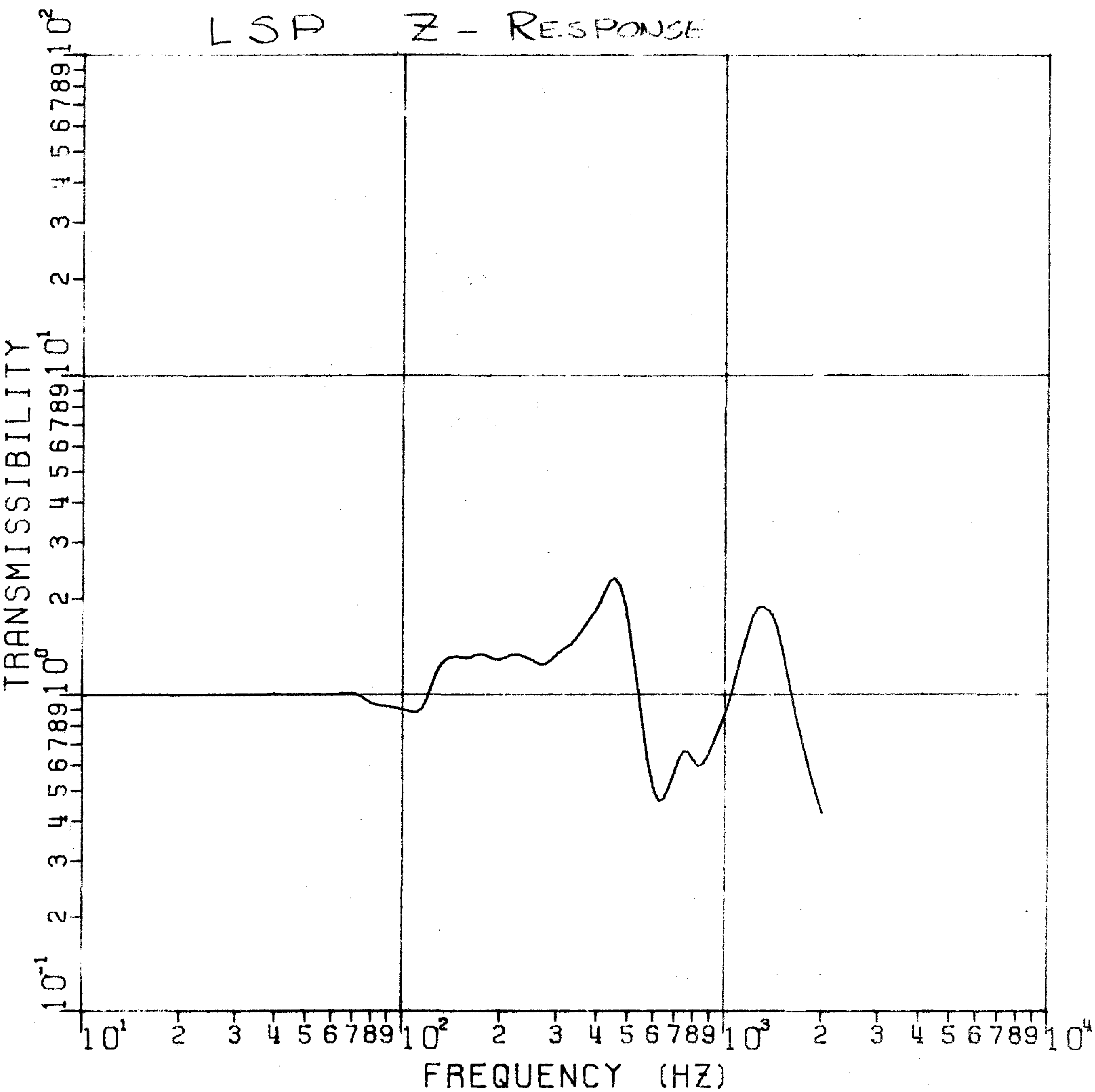


** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 **

FIGURE 26a TRANSMISSIBILITY

LOCATION 28

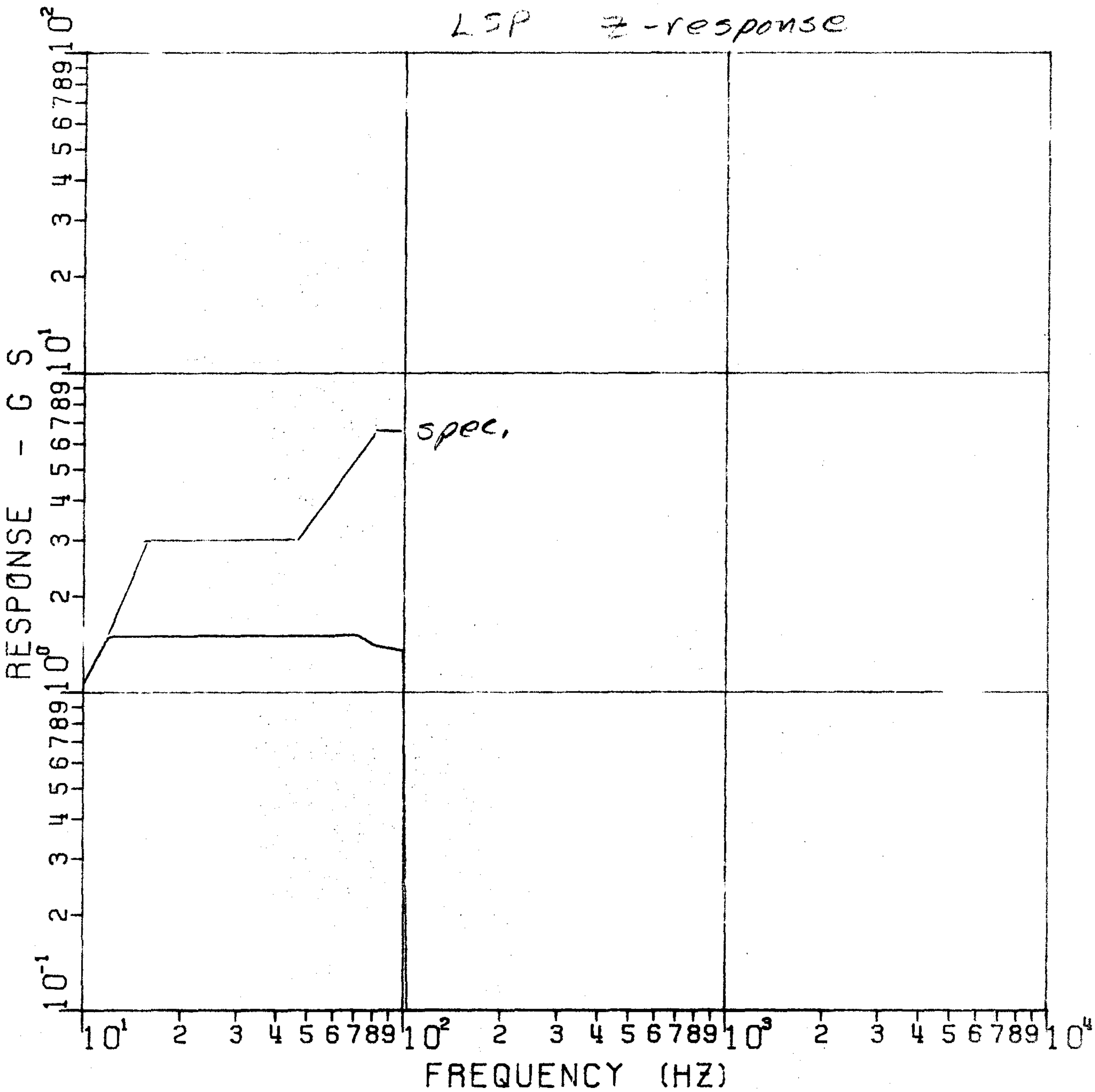
LSP Z - RESPONSE



** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 **

FIGURE 26b SINE RESPONSE

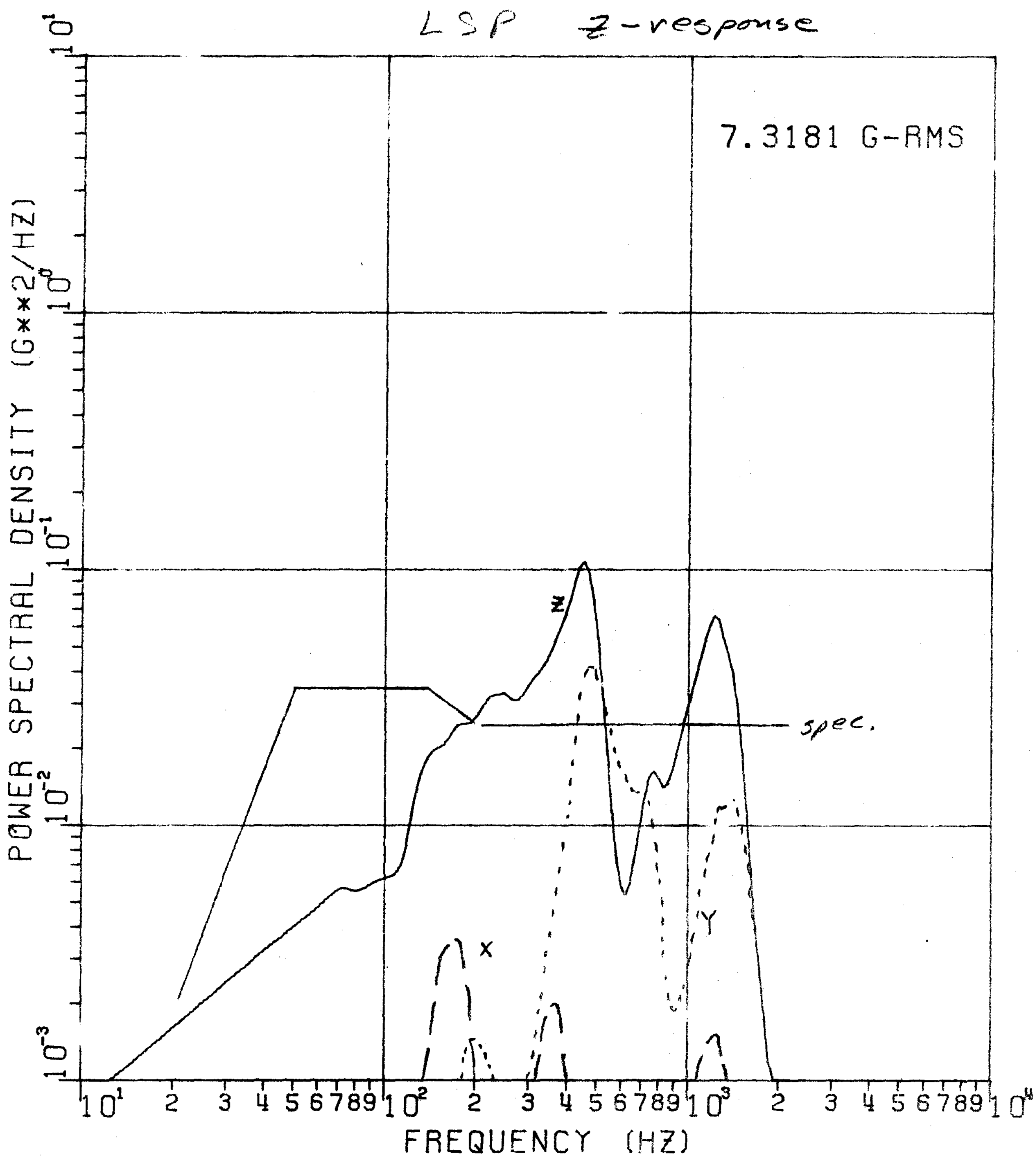
LOCATION 28



** ALSEP ARRAY E/SP-1,FORCING IN Z-AXIS JAN.1971 **

FIGURE 26C RANDOM VIBRATION SPECTRUM L#B

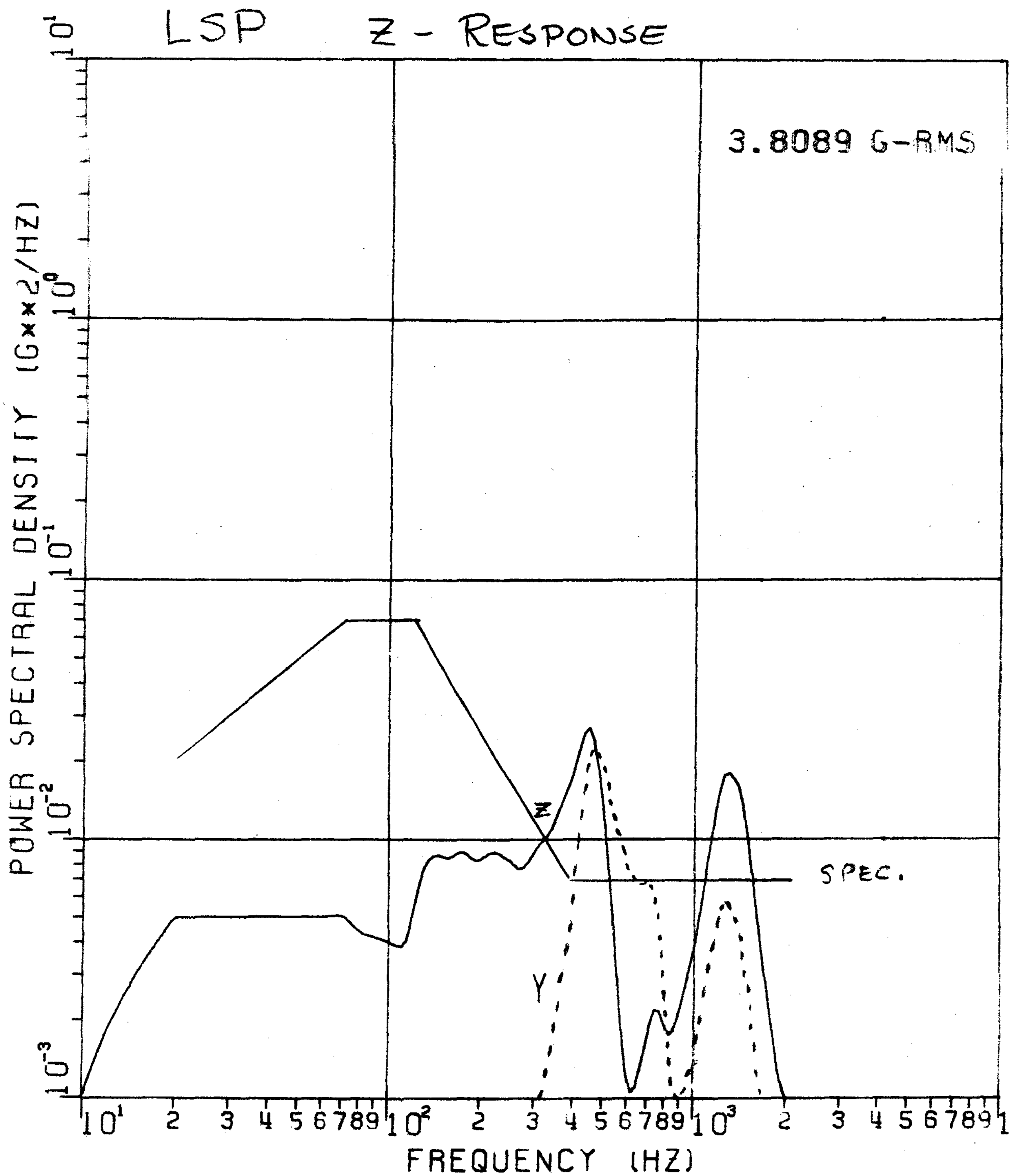
LOCATION 28



ALSEP ARR E/SP-1 (LSG), FOR IN Z-AXIS (LUNAR DESCENT)

FIGURE 26d RANDOM VIBRATION SPECTRUM

LOCATION 28 W1

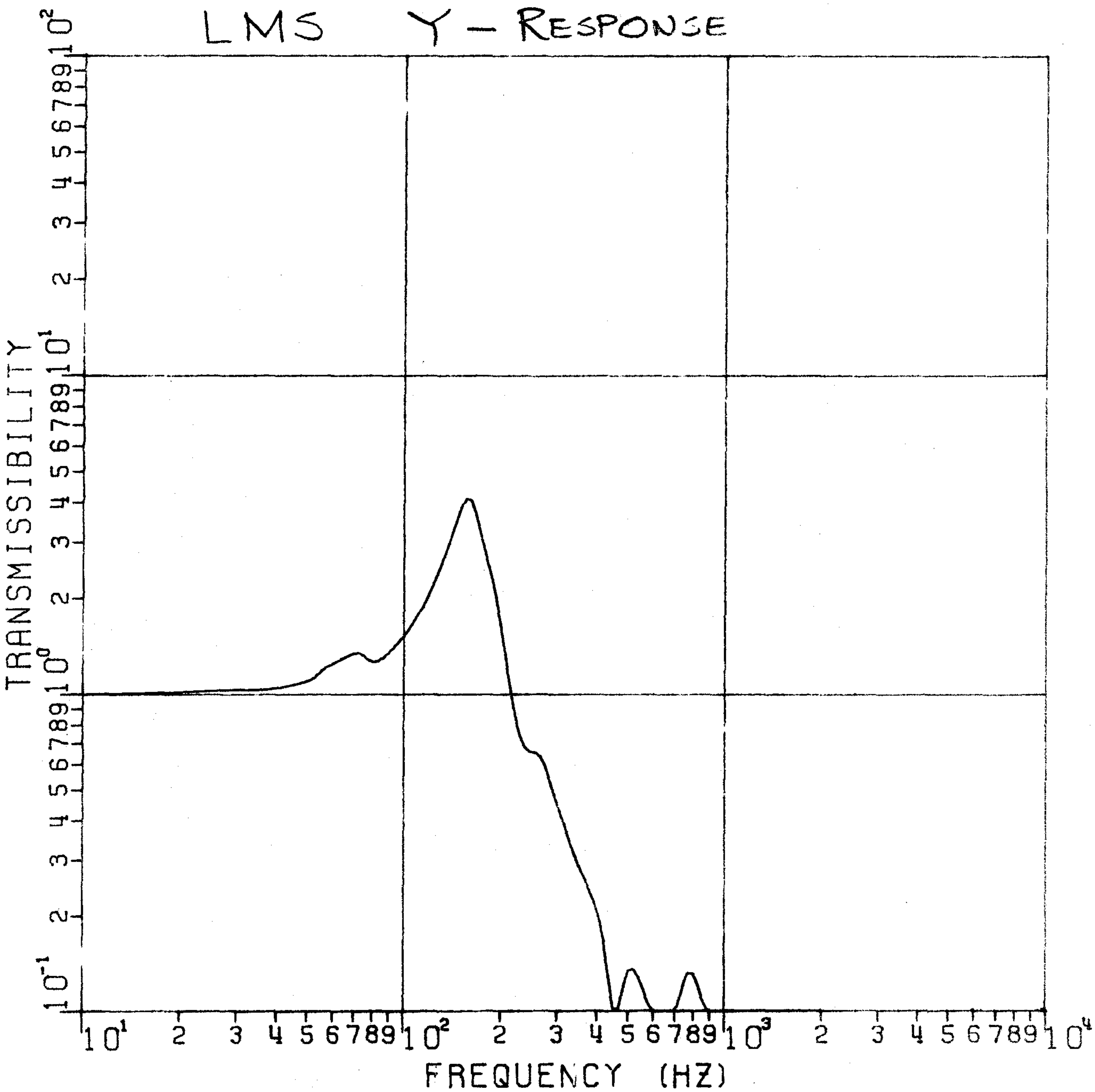


** ALSEP ARRAY E/SP-1, FØRCING IN Y-AXIS JAN. 1971 **

FIGURE 27a TRANSMISSIBILITY

LØCATIØN 29

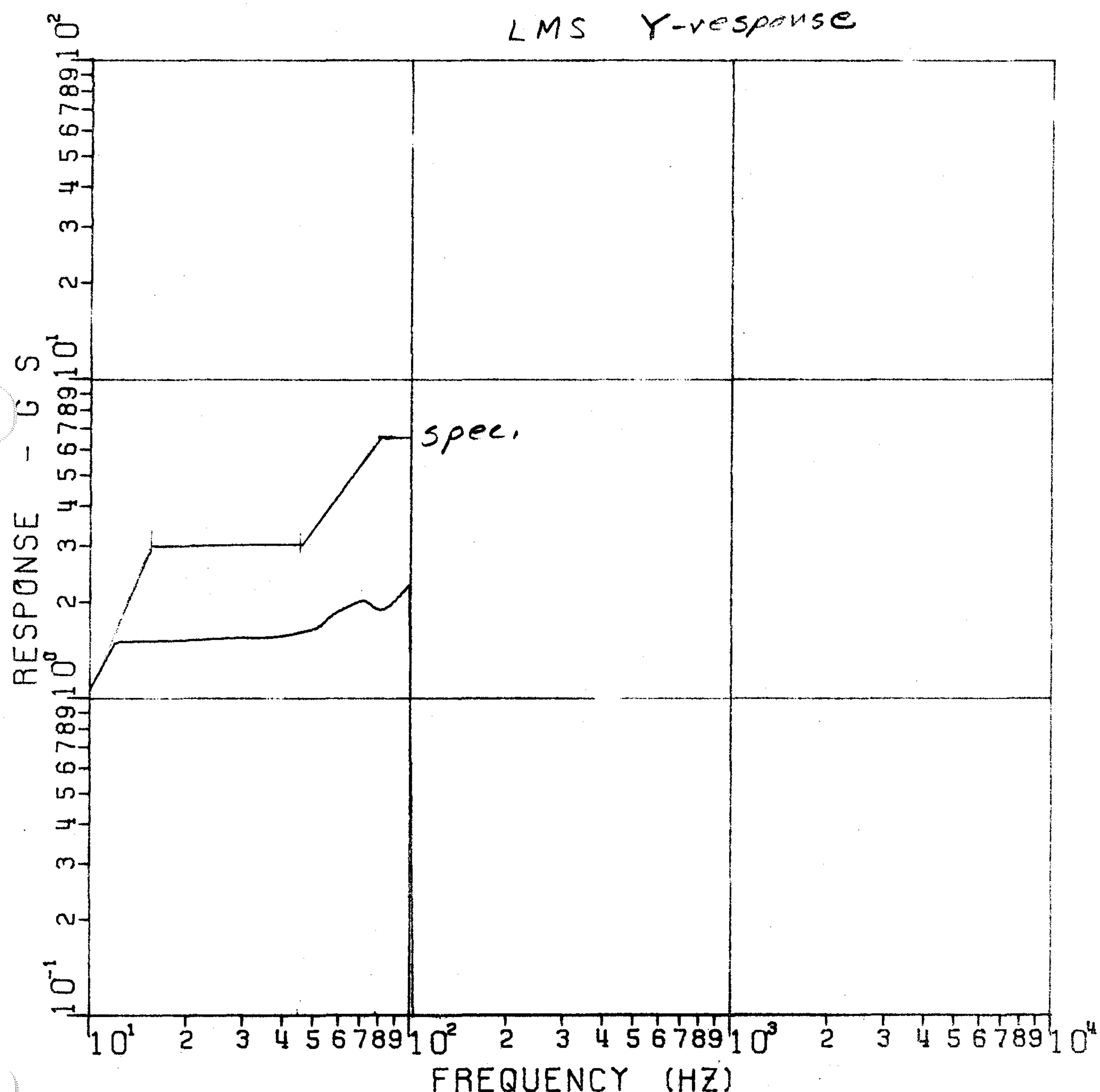
LMS Y - RESPONSE



** ALSEP ARRAY E/SP-1, FØRCING IN Y-AXIS JAN. 1971 **

FIGURE 27b SINE RESPONSE

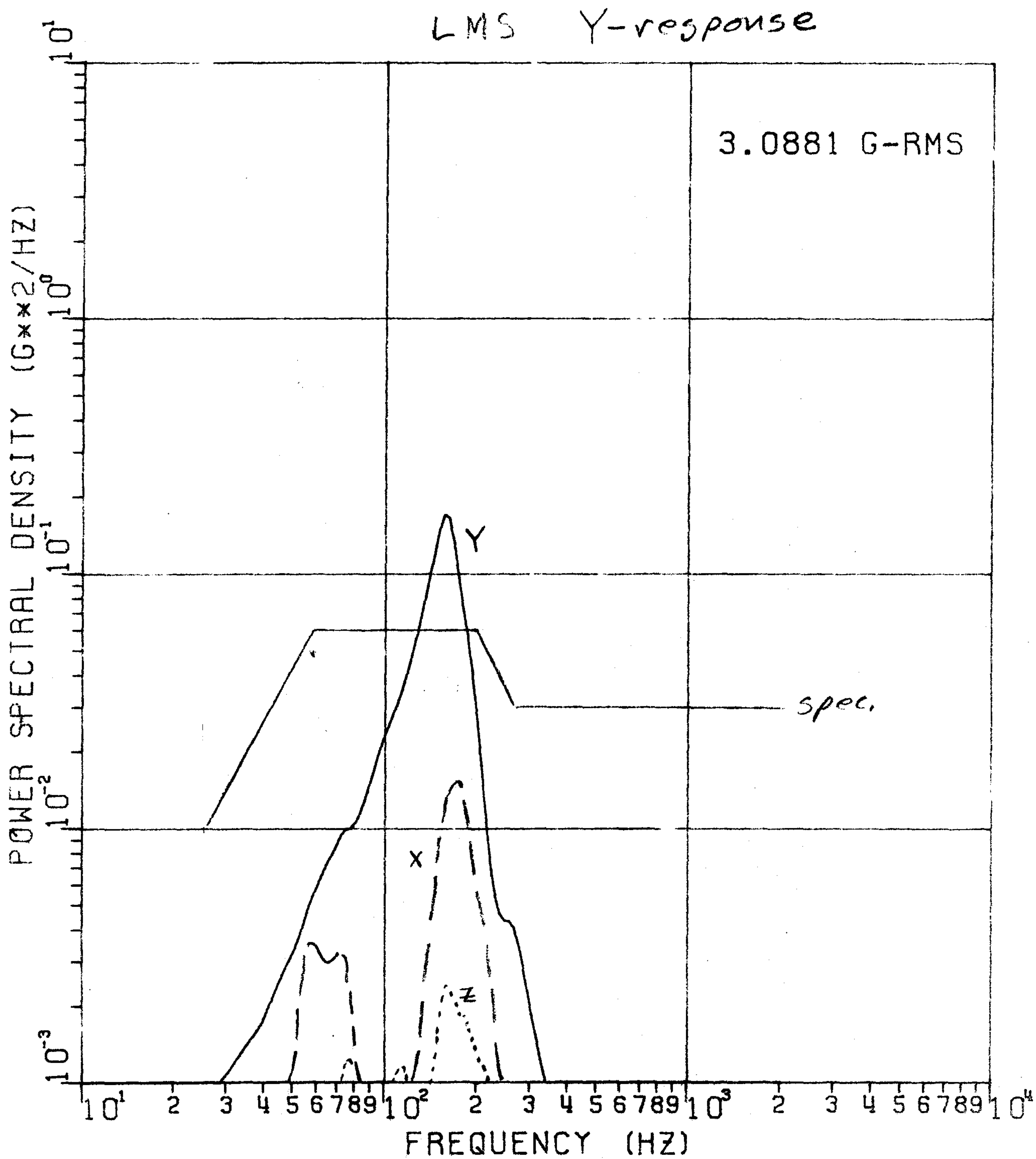
LØCATIØN 29



** ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS JAN. 1971 **

FIGURE 27C RANDOM VIBRATION SPECTRUM

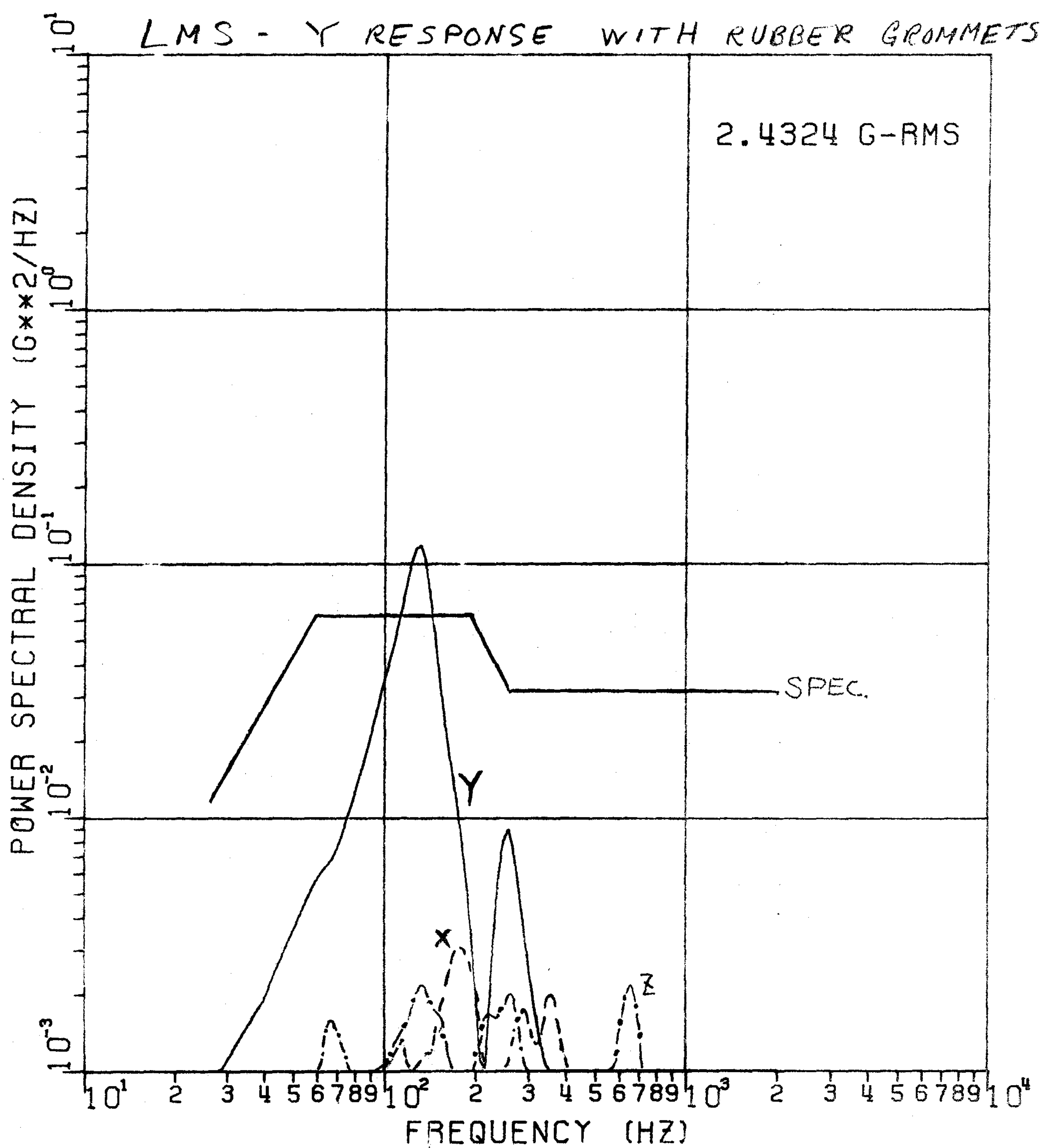
LOCATION 29



ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS (LSG & LMS)

FIGURE 27 c* RANDOM VIBRATION SPECTRUM L & B

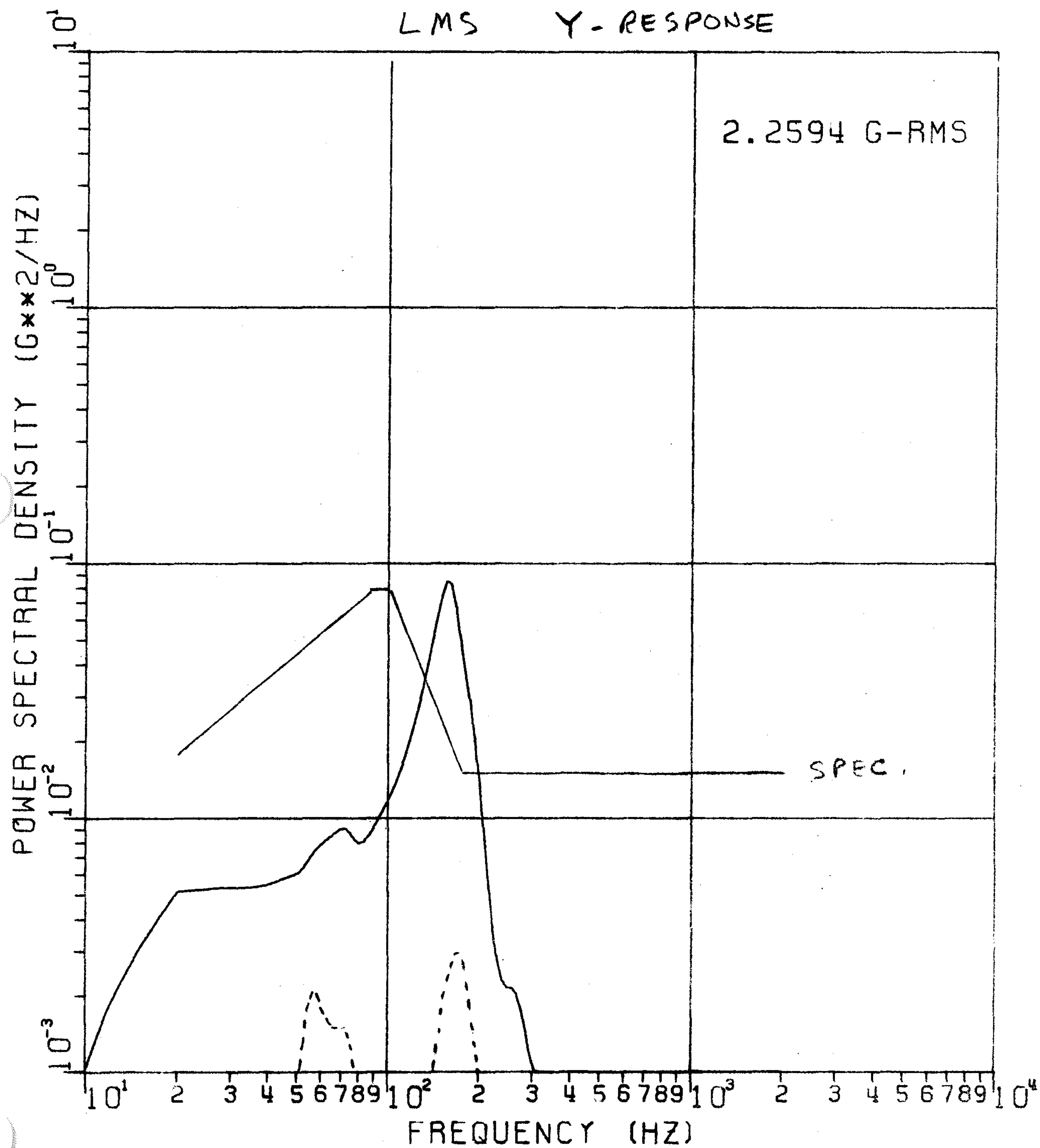
LOCATION 29



ALSEP ARR E/SP-1 (LSG), FOR IN Y-AXIS (LUNAR DESCENT)

FIGURE 27d RANDOM VIBRATION SPECTRUM

LOCATION 29 v_2

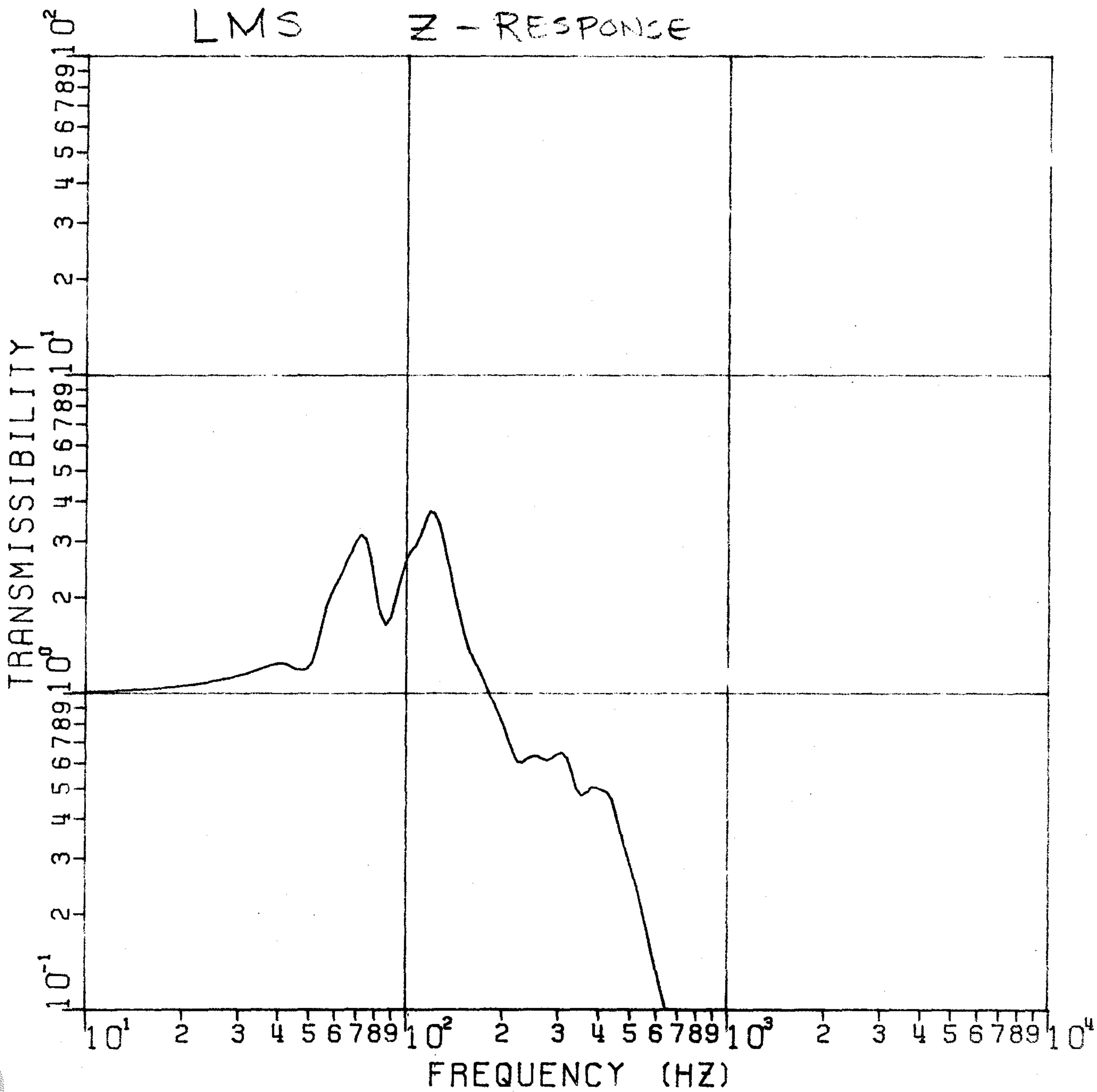


** ALSEP ARRAY E/SP-1,FORCING IN Z-AXIS JAN.1971 **

FIGURE 28a TRANSMISSIBILITY

LOCATION 30

LMS Z - RESPONSE

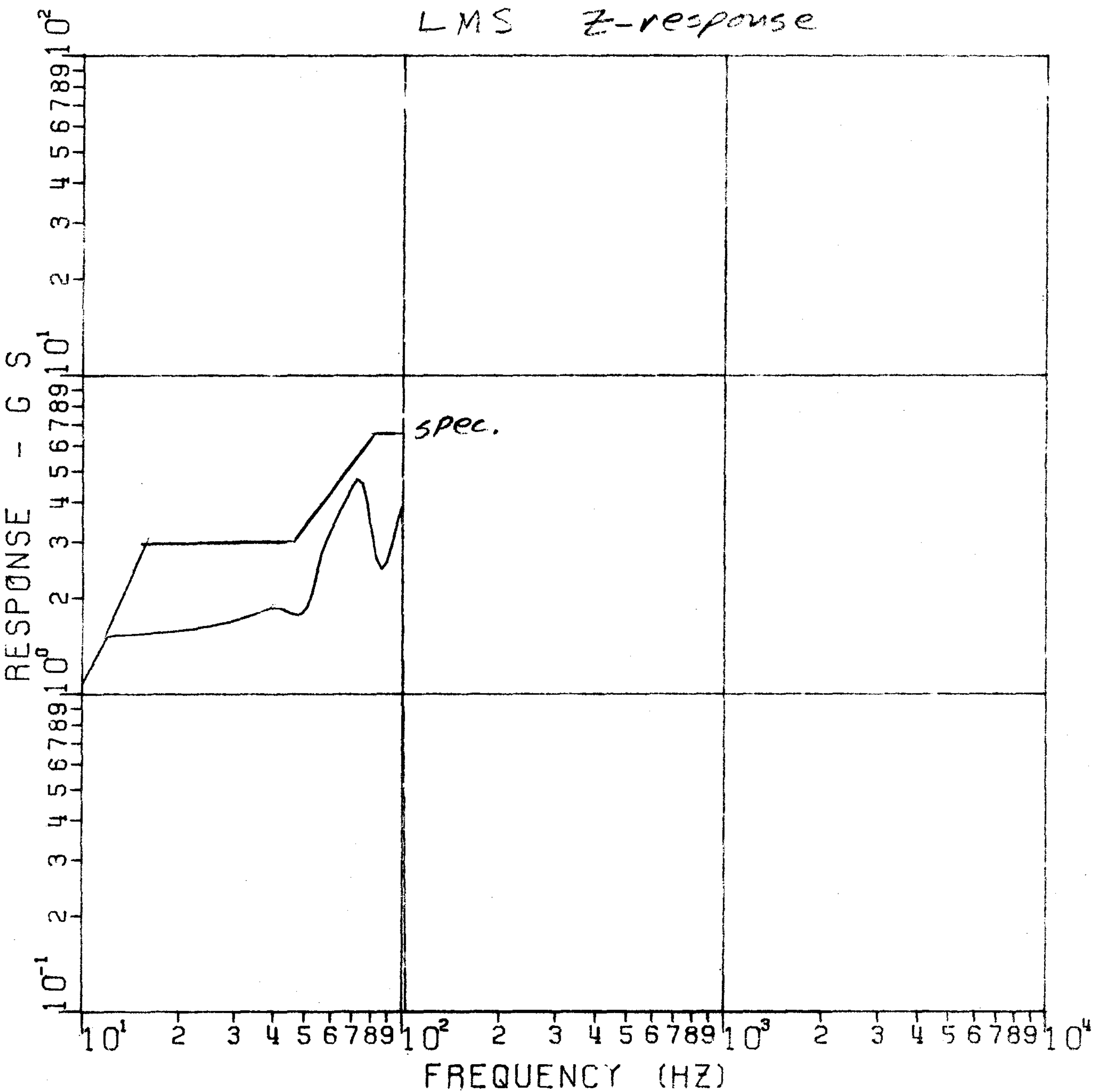


** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 **

FIGURE 28b SINE RESPONSE

LOCATION 30

LMS Z-response

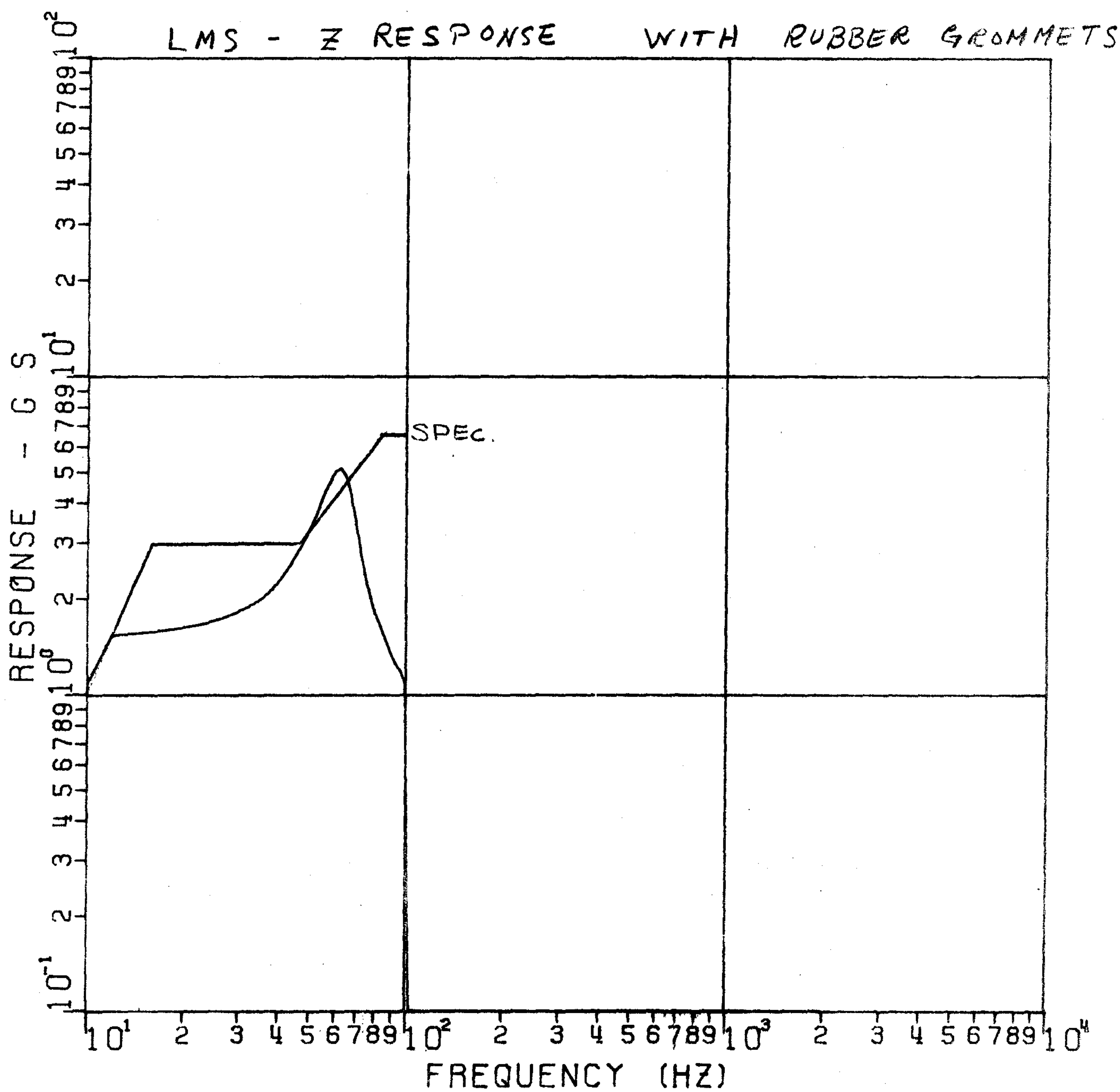


ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS (LSG & LMS)

FIGURE 28 b* SINE RESPONSE

LOCATION 30

LMS - Z RESPONSE WITH RUBBER GROMMETS

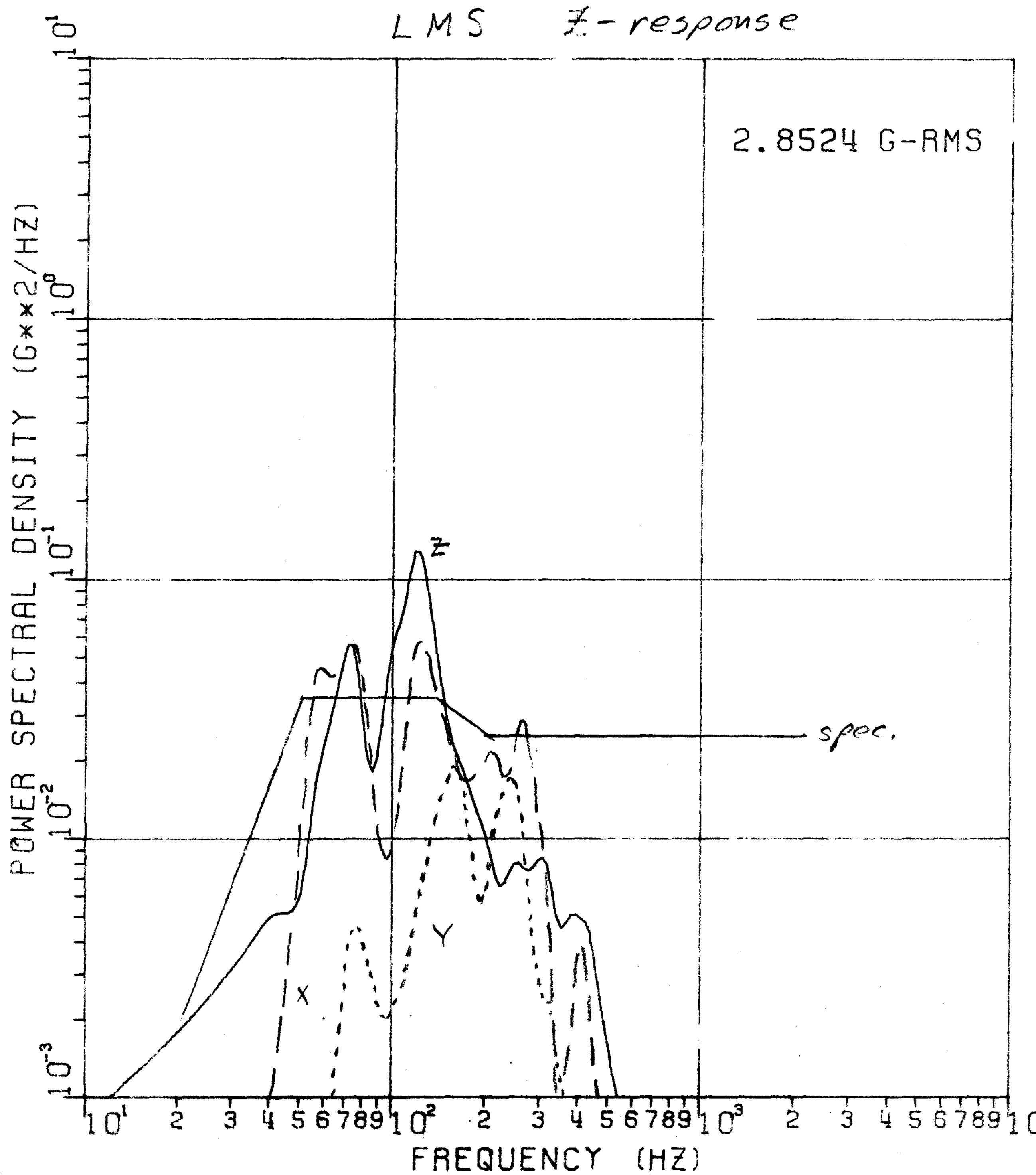


** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 **

FIGURE 28C RANDOM VIBRATION SPECTRUM

LOCATION 30 (wz)

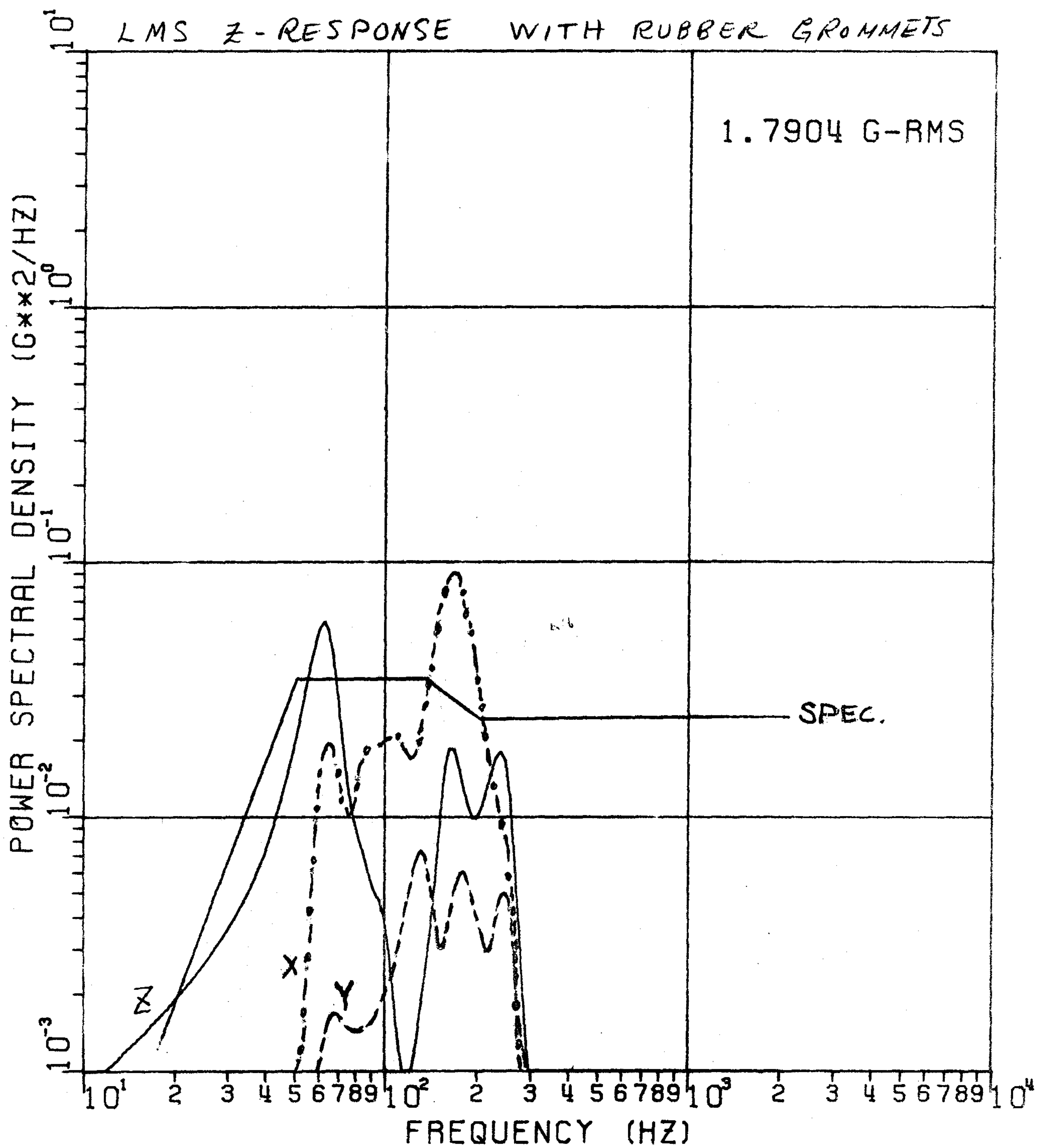
LMS Z-response



ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS (LSG & LMS)

FIGURE 28 c* RANDOM VIBRATION SPECTRUM L#8

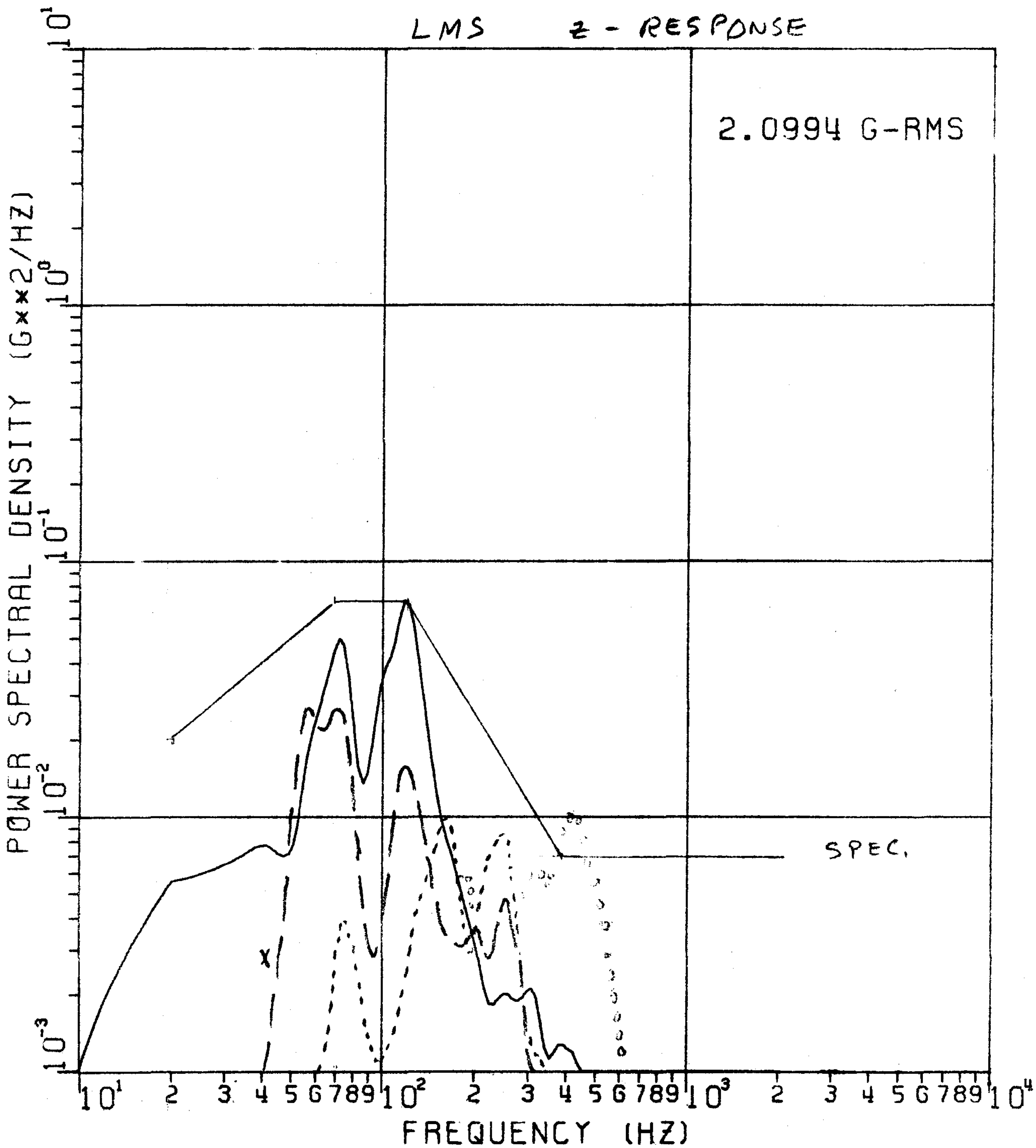
LOCATION 30



ALSEP ARR E/SP-1 (LSG), FOR IN Z-AXIS (LUNAR DESCENT)

FIGURE 28d RANDOM VIBRATION SPECTRUM

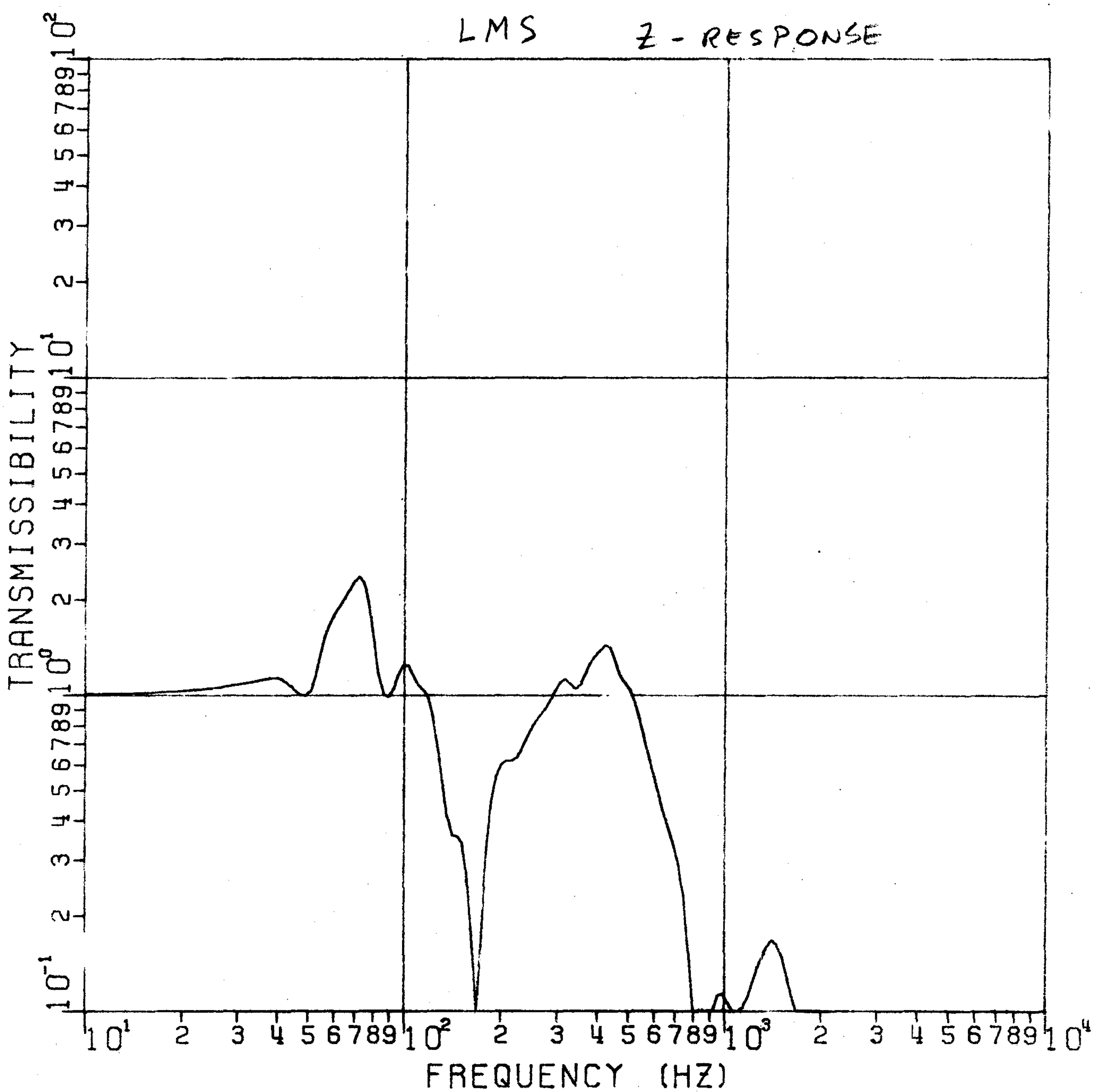
LOCATION 30 w₂



** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 **

FIGURE 29a TRANSMISSIBILITY

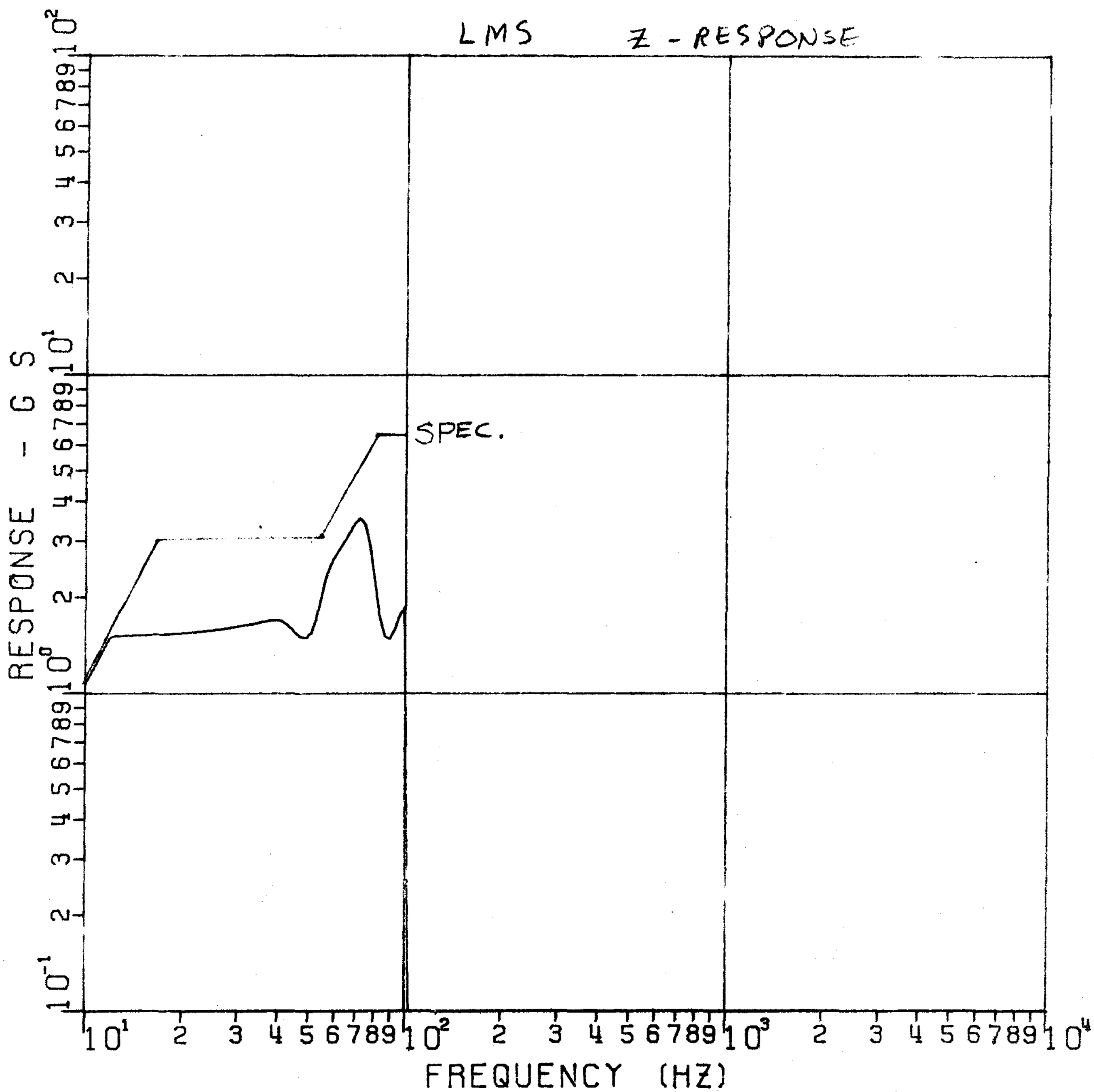
LOCATION 31 w_1, w_3



** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 **

FIGURE 29 b SINE RESPONSE

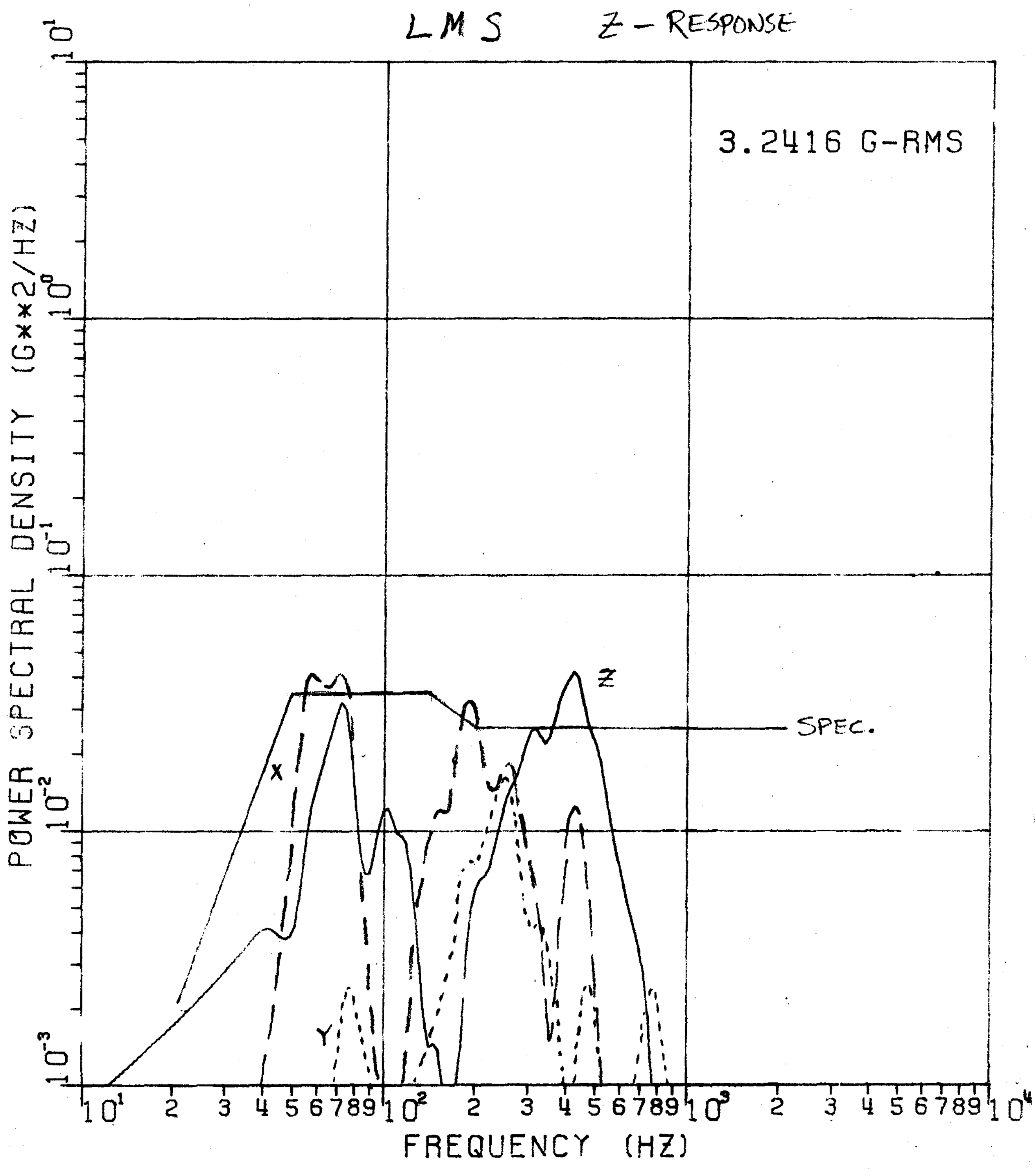
LOCATION 31 w_1, w_3



** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS JAN. 1971 **

FIGURE 29C RANDOM VIBRATION SPECTRUM

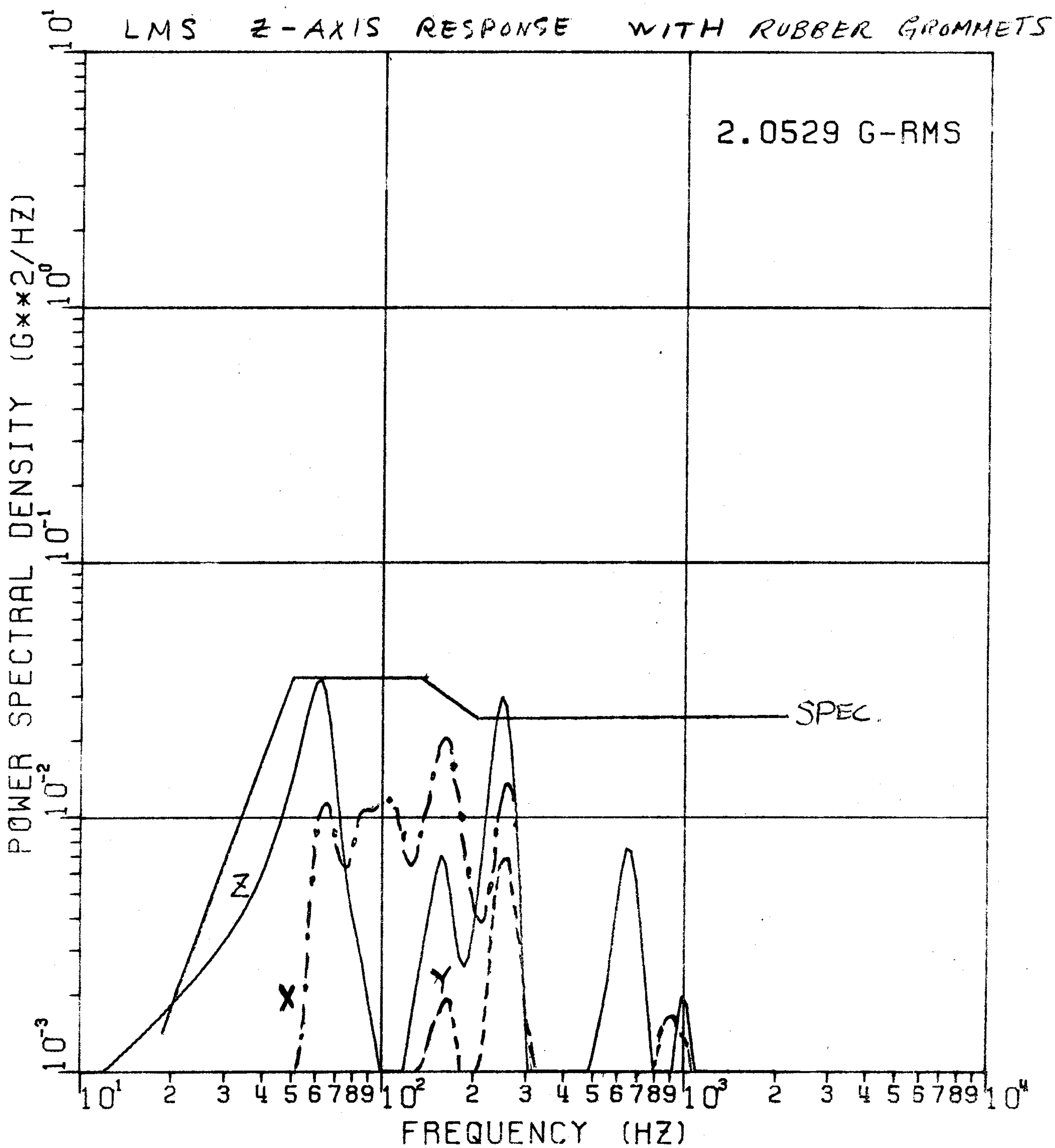
LOCATION 31 w_1, w_3



ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS (LSG & LMS)

FIGURE 29 c* RANDOM VIBRATION SPECTRUM

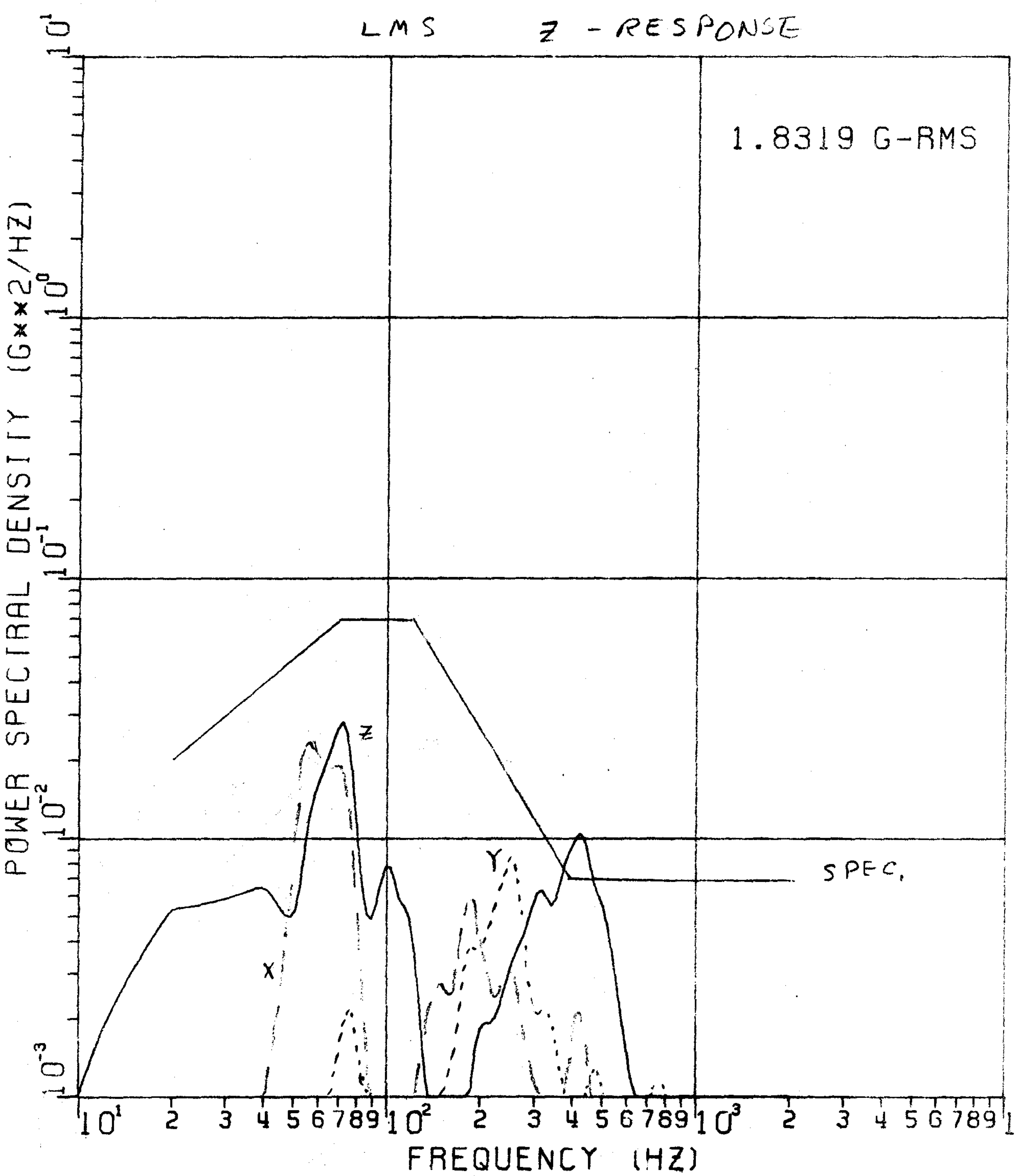
LOCATION 31



ALSEP ARR E/SP-1 (LSG), FOR IN Z-AXIS (LUNAR DESCENT)

FIGURE 29d RANDOM VIBRATION SPECTRUM

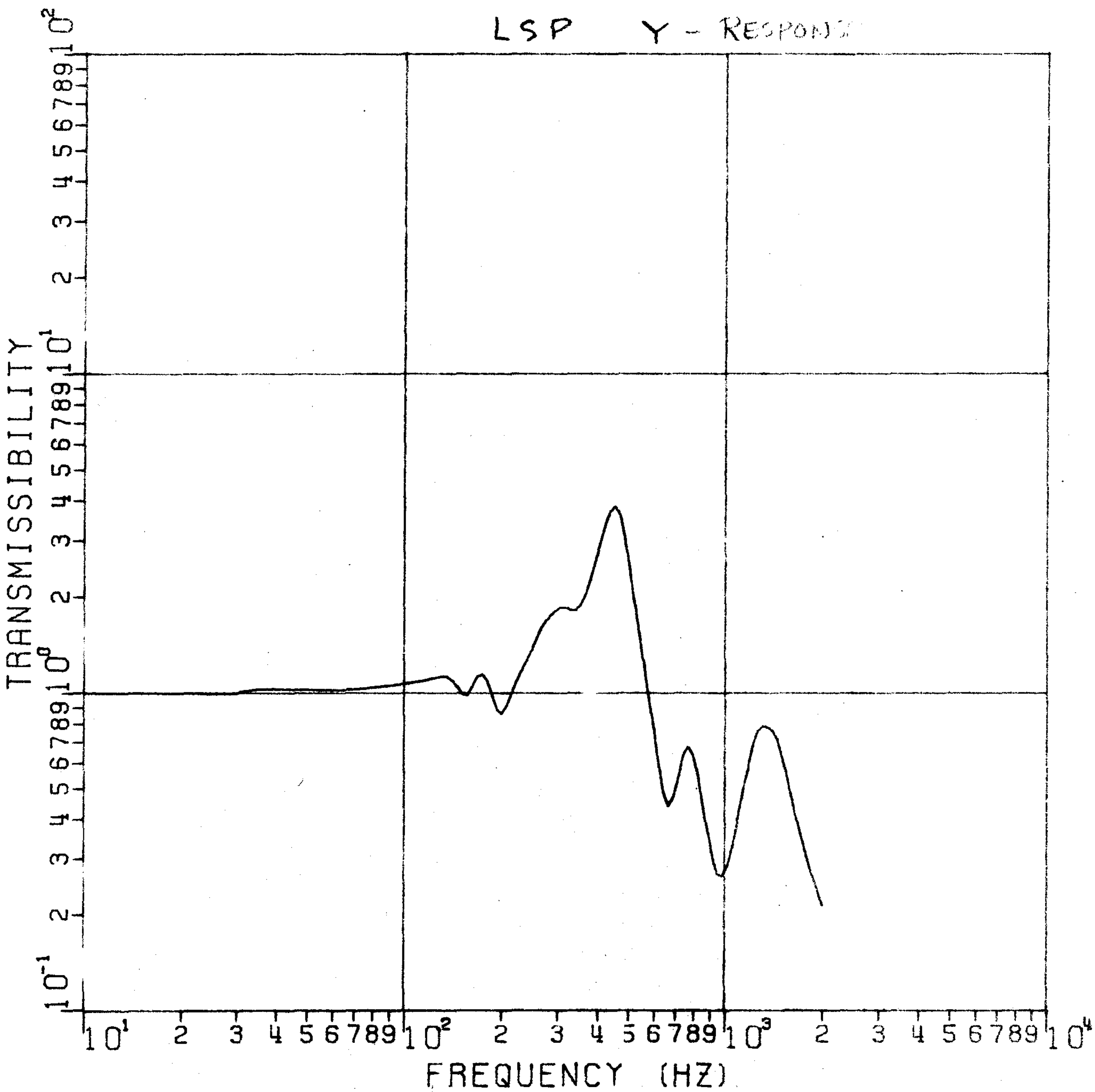
LOCATION 31 w1, w3



** ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS JAN. 1971 *

FIGURE 30a TRANSMISSIBILITY

LOCATION 32 v_2

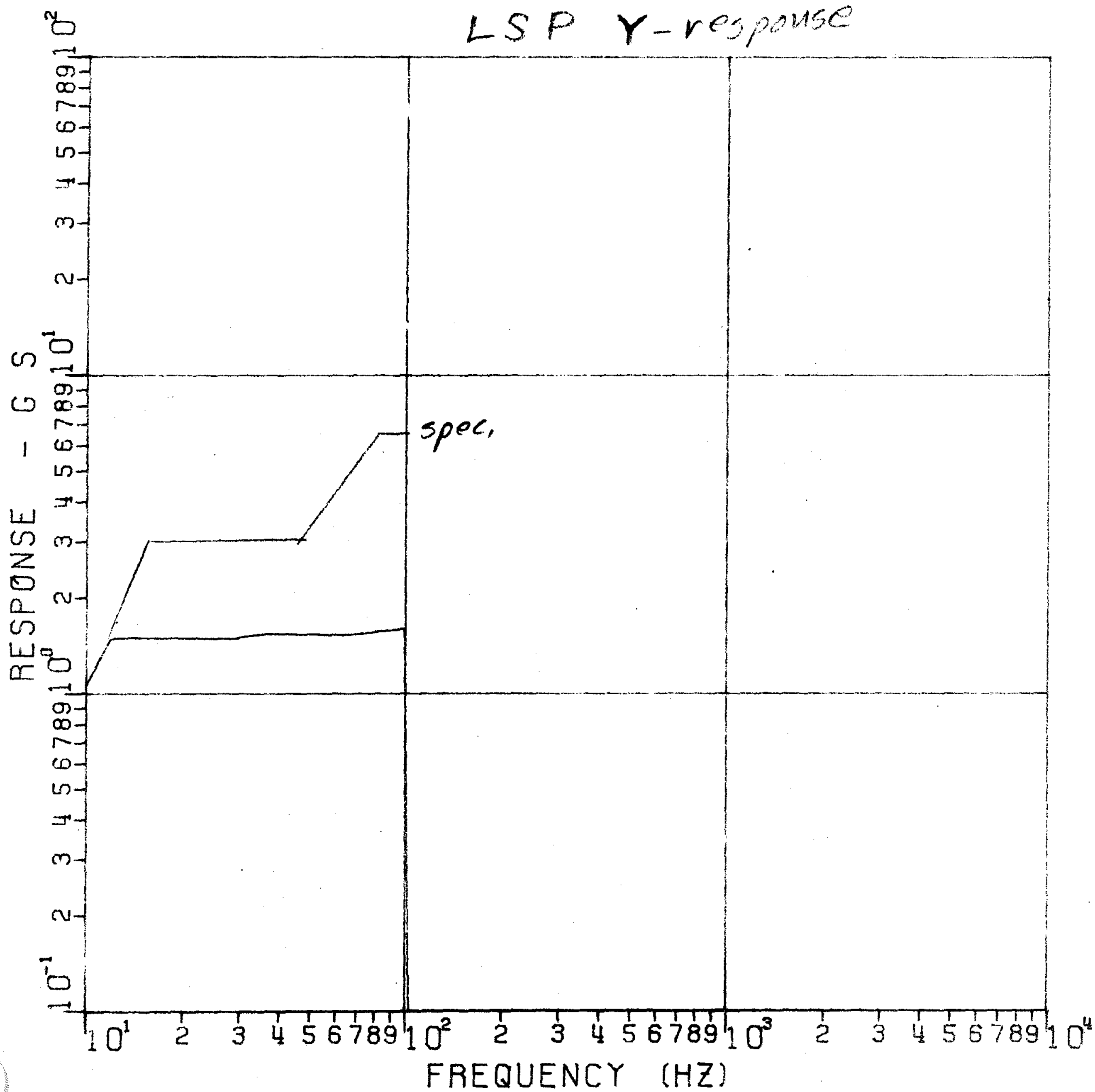


** ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS JAN. 1971 **

FIGURE 30b SINE RESPONSE

LOCATION 32 v_2

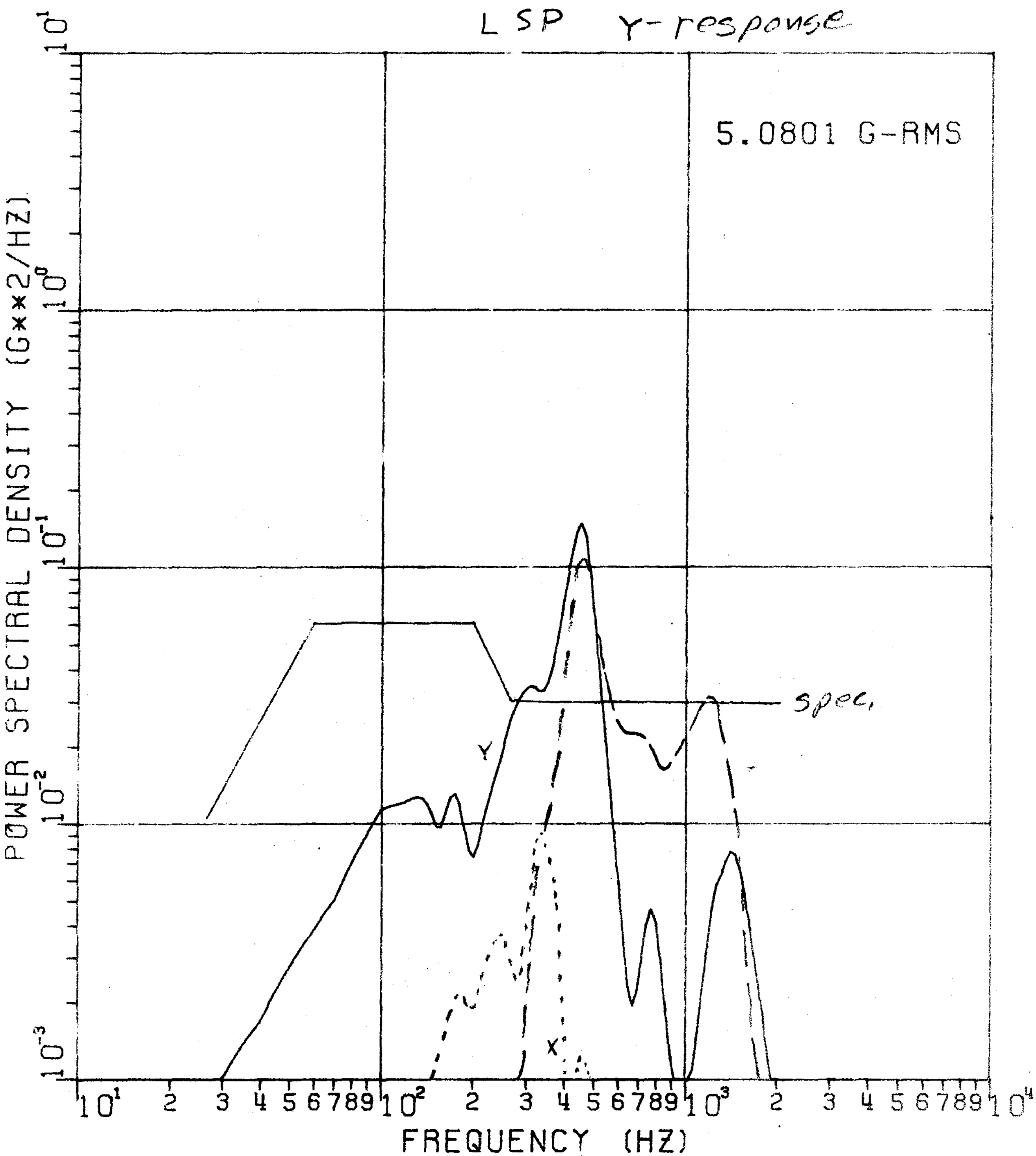
LSP Y-response



** ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS JAN. 1971 *

FIGURE 30C RANDOM VIBRATION SPECTRUM L#5

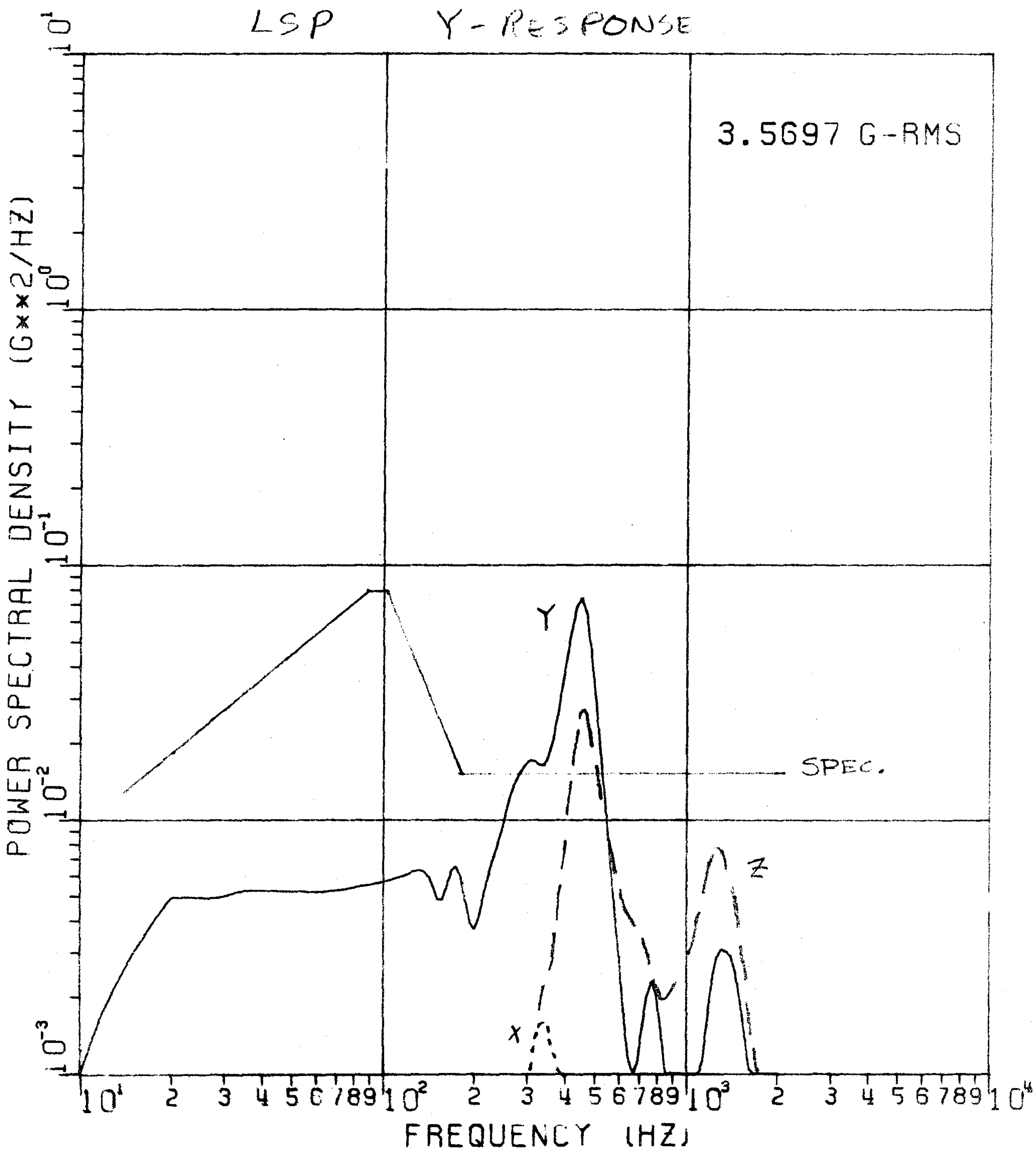
LOCATION 32 v_2



ALSEP ARR E/SP-1 (LSG), FOR IN Y-AXIS (LUNAR DESCENT)

FIGURE 30d RANDOM VIBRATION SPECTRUM

LOCATION 32

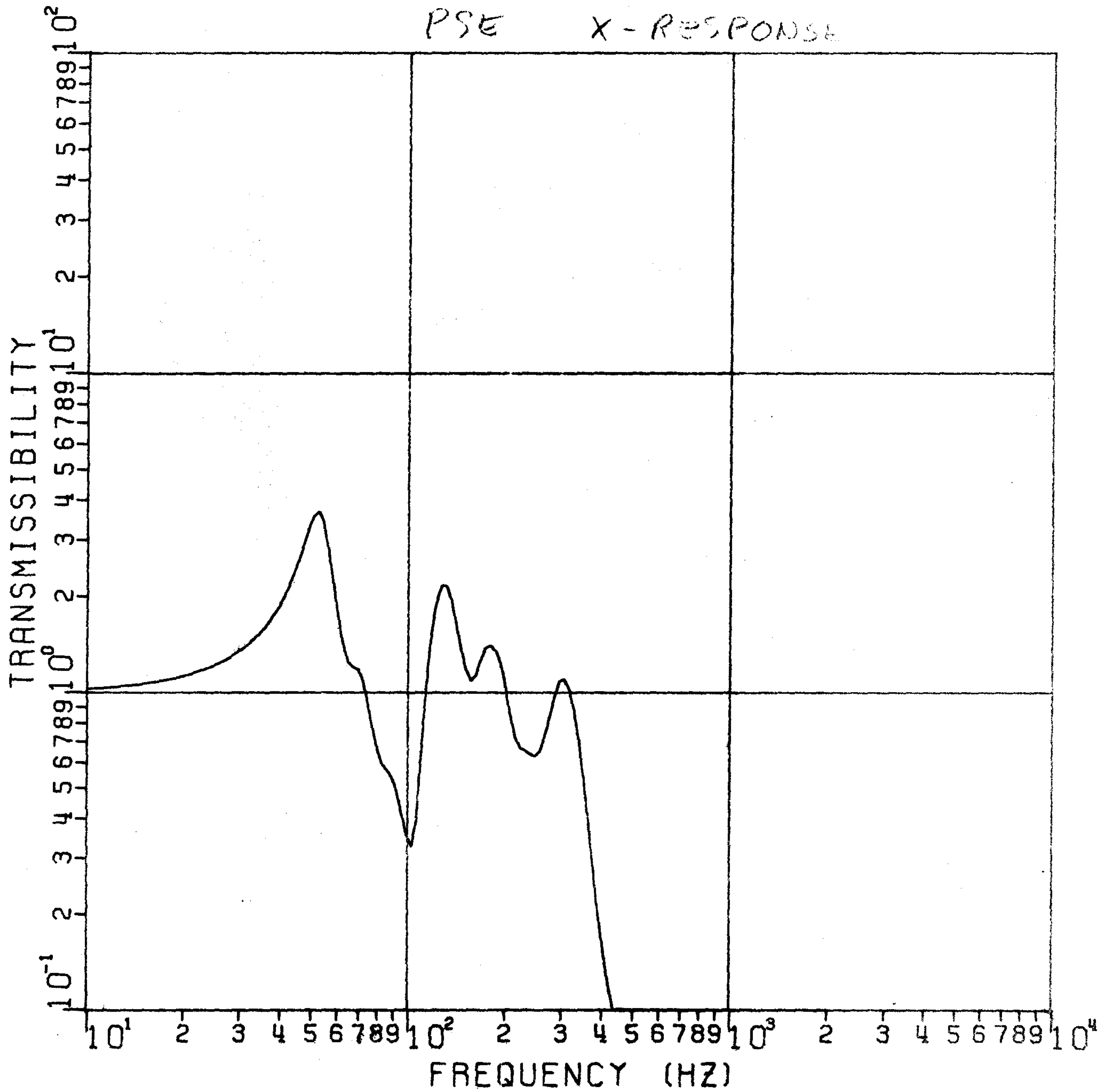


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS (PSE) **

FIGURE 31a TRANSMISSIBILITY

LOCATION 6 u_1

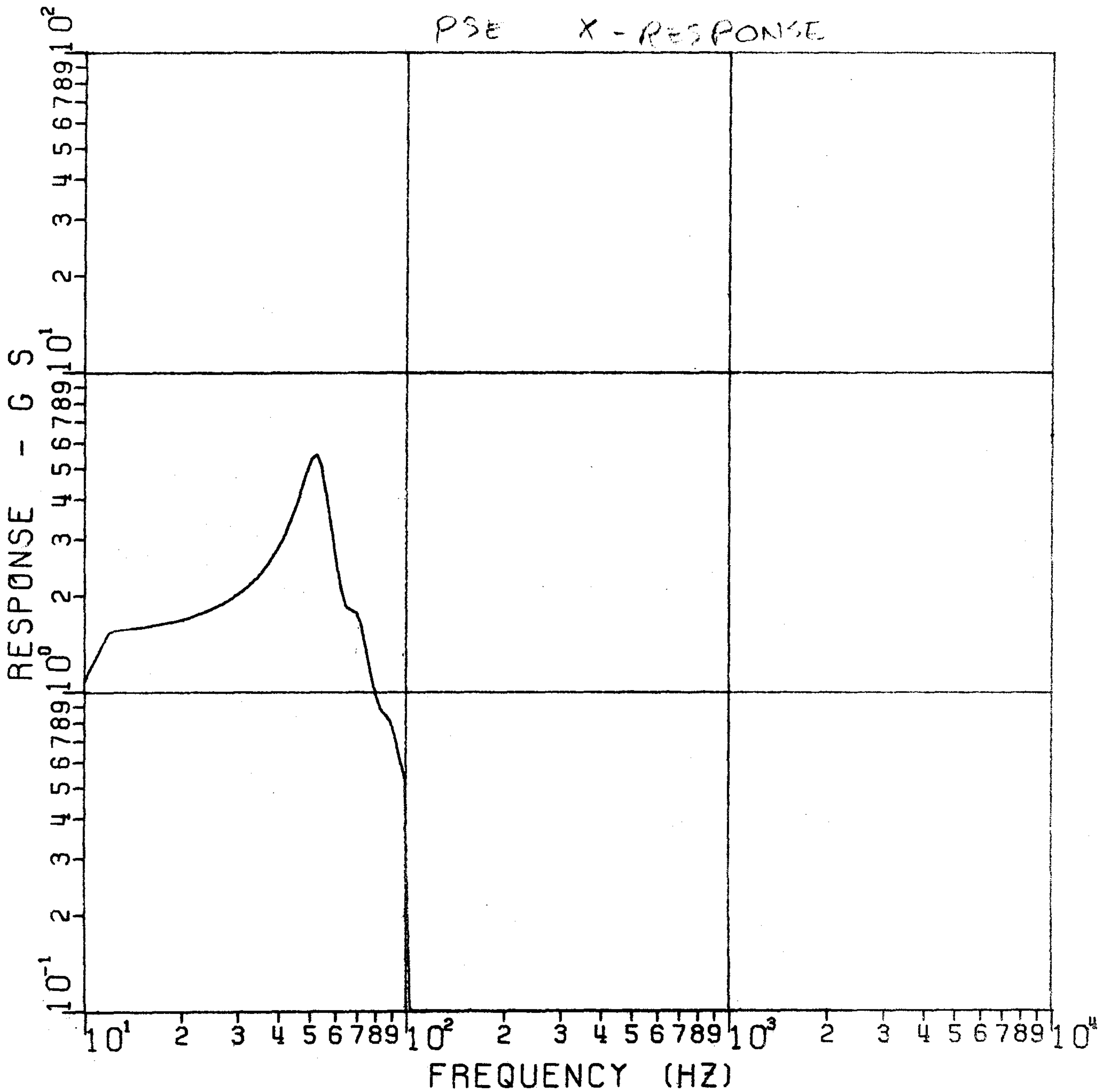
PSE X-RESPONSE



** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS (PSE) **

FIGURE 31b SINE RESPONSE

LOCATION 6

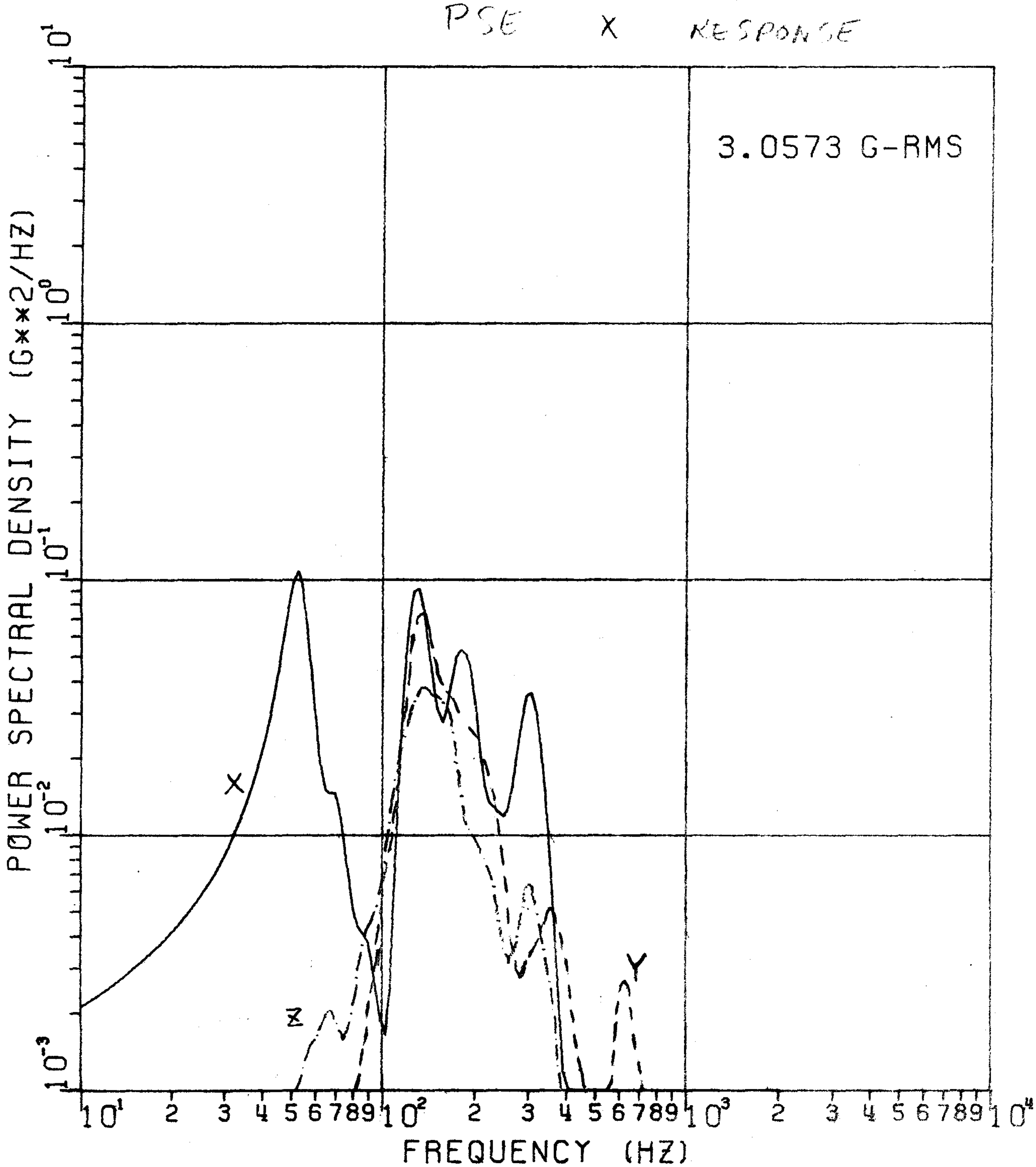


** ALSEP ARRAY E/SP-1, FORCING IN X-AXIS (PSE) **

FIGURE 31C RANDOM VIBRATION SPECTRUM L&B

LOCATION 6 u1

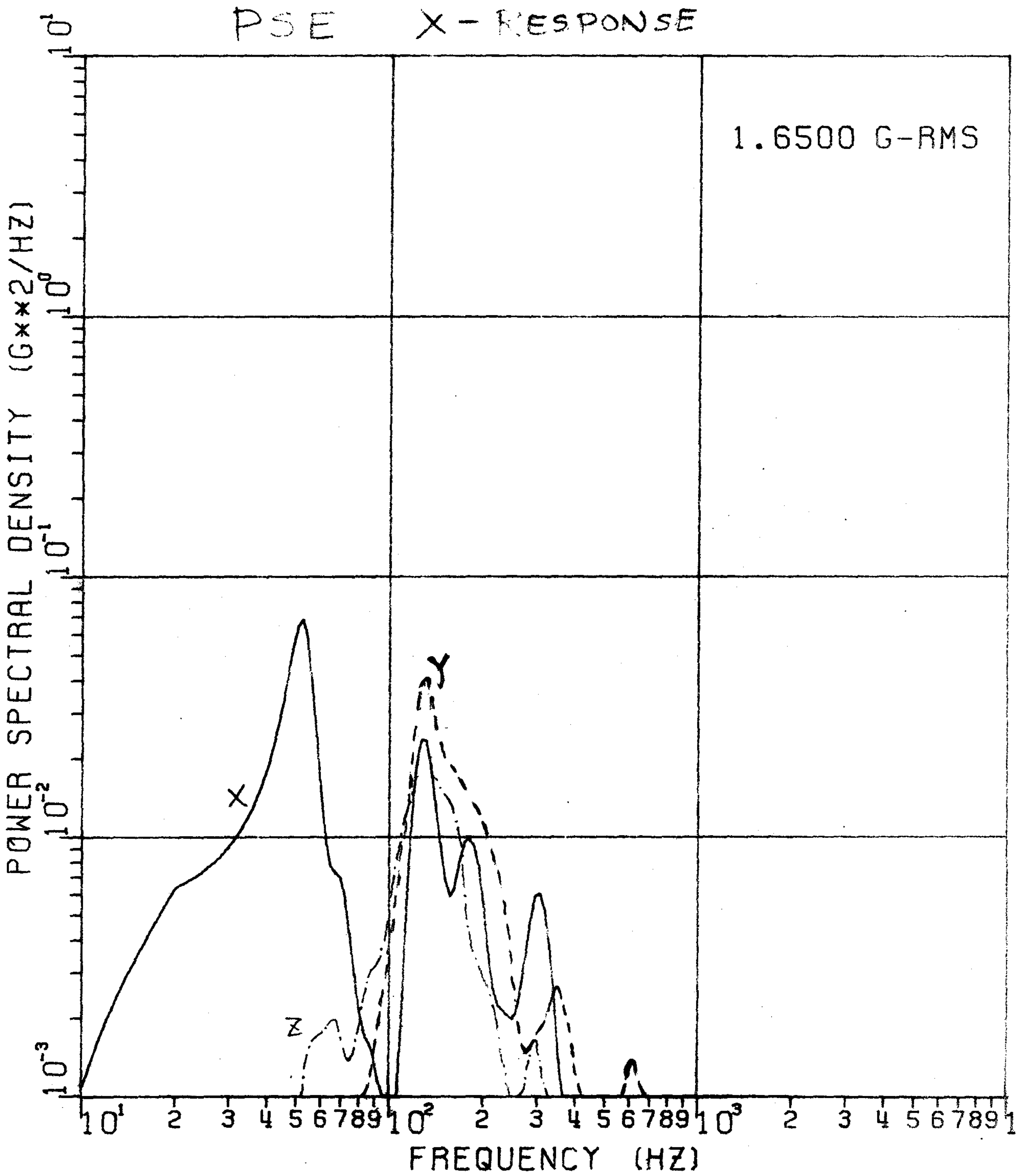
PSE X RESPONSE



ALSEP ARR E/SP-1 (PSE), FOR IN X-AXIS (LUNAR DESCENT)

FIGURE 31d RANDOM VIBRATION SPECTRUM

LOCATION 6

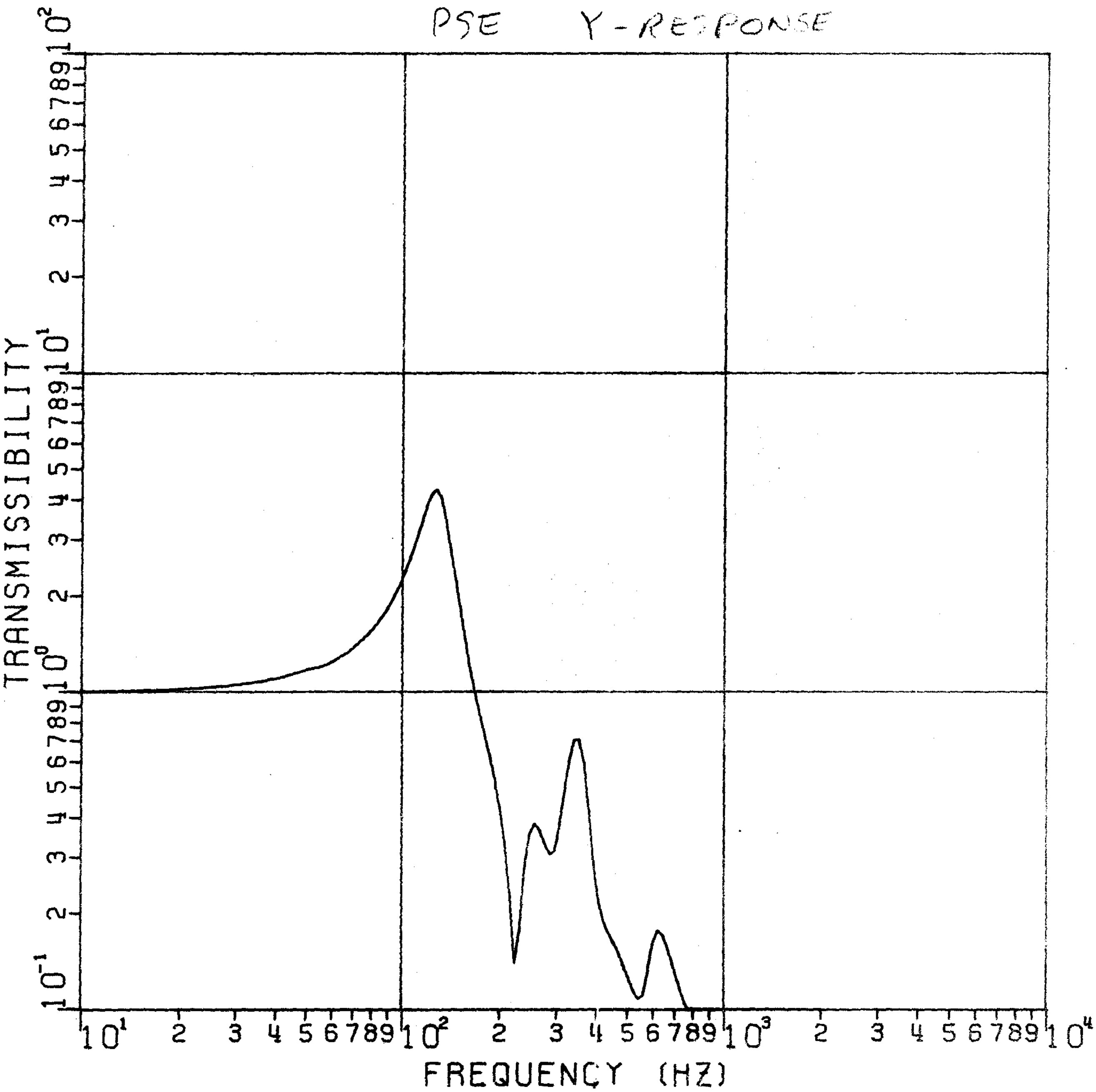


** ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS (PSE) **

FIGURE 32a TRANSMISSIBILITY

LOCATION 22 v1

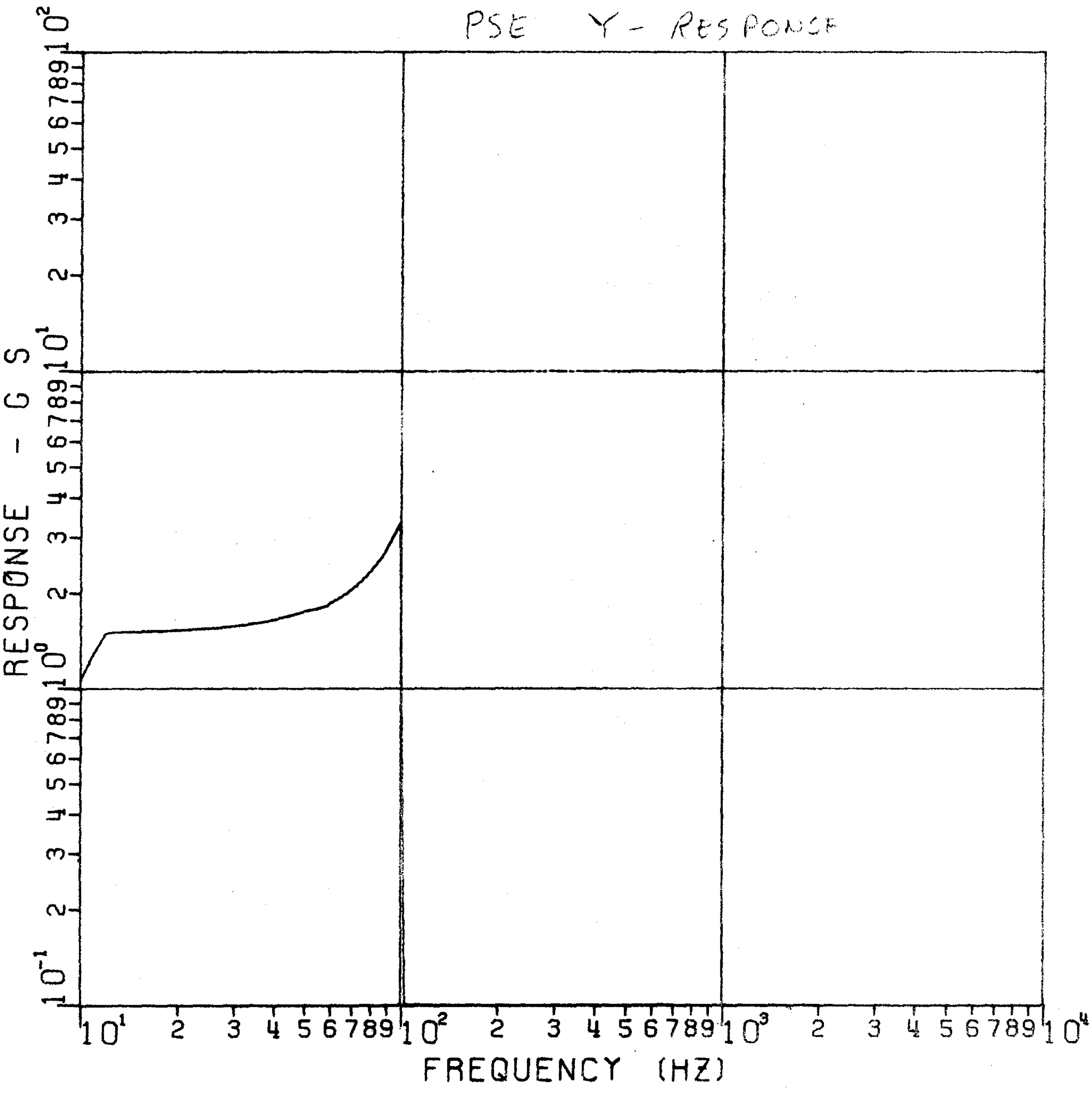
PSE Y-RESPONSE



** ALSEP ARRAY E/SP-1,FORCING IN Y-AXIS(PSE) **

FIGURE 32b SINE RESPONSE

LOCATION 22 v_1

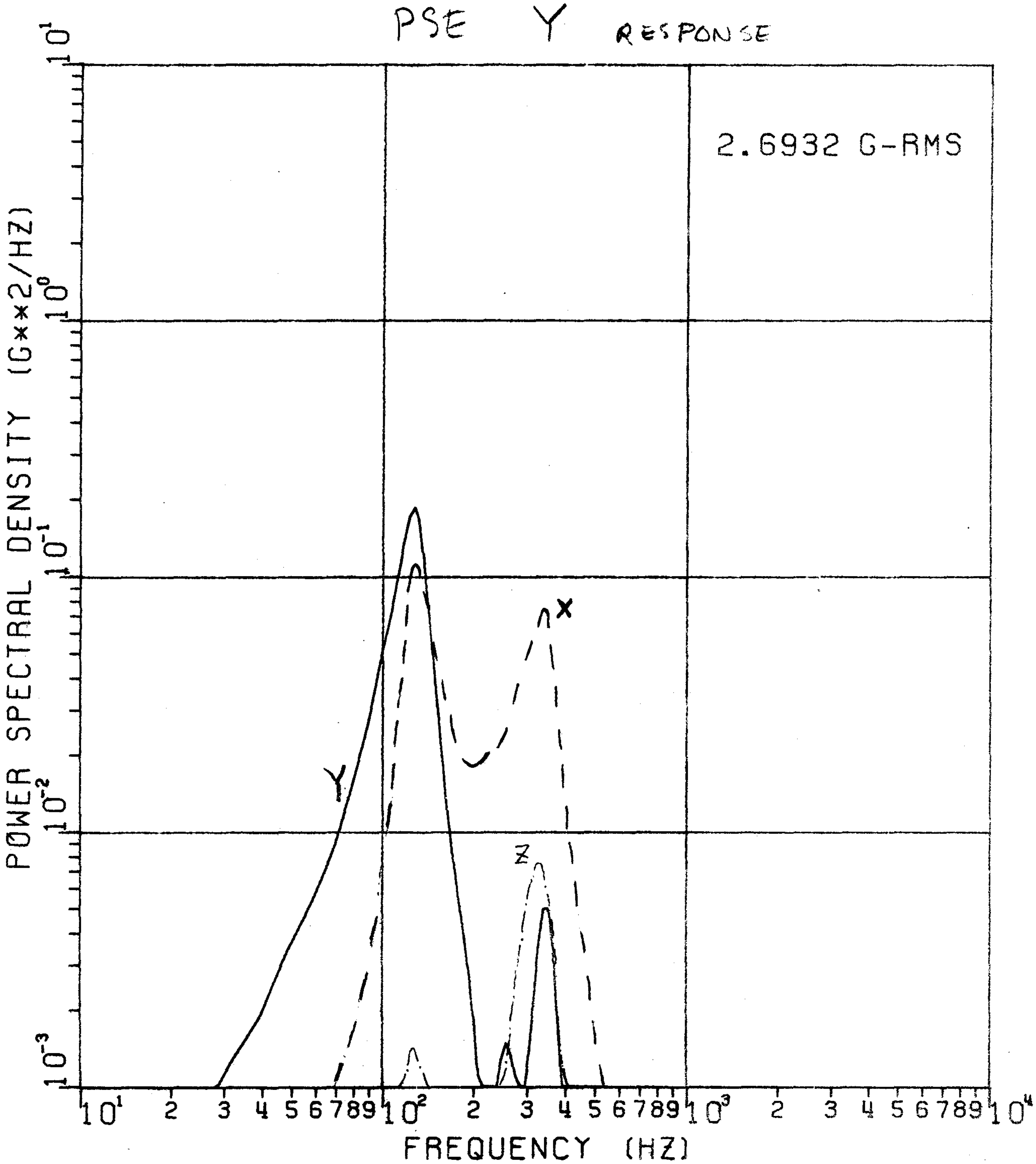


** ALSEP ARRAY E/SP-1, FORCING IN Y-AXIS (PSE) **

FIGURE 32C RANDOM VIBRATION SPECTRUM L$B

LOCATION 22 , v1

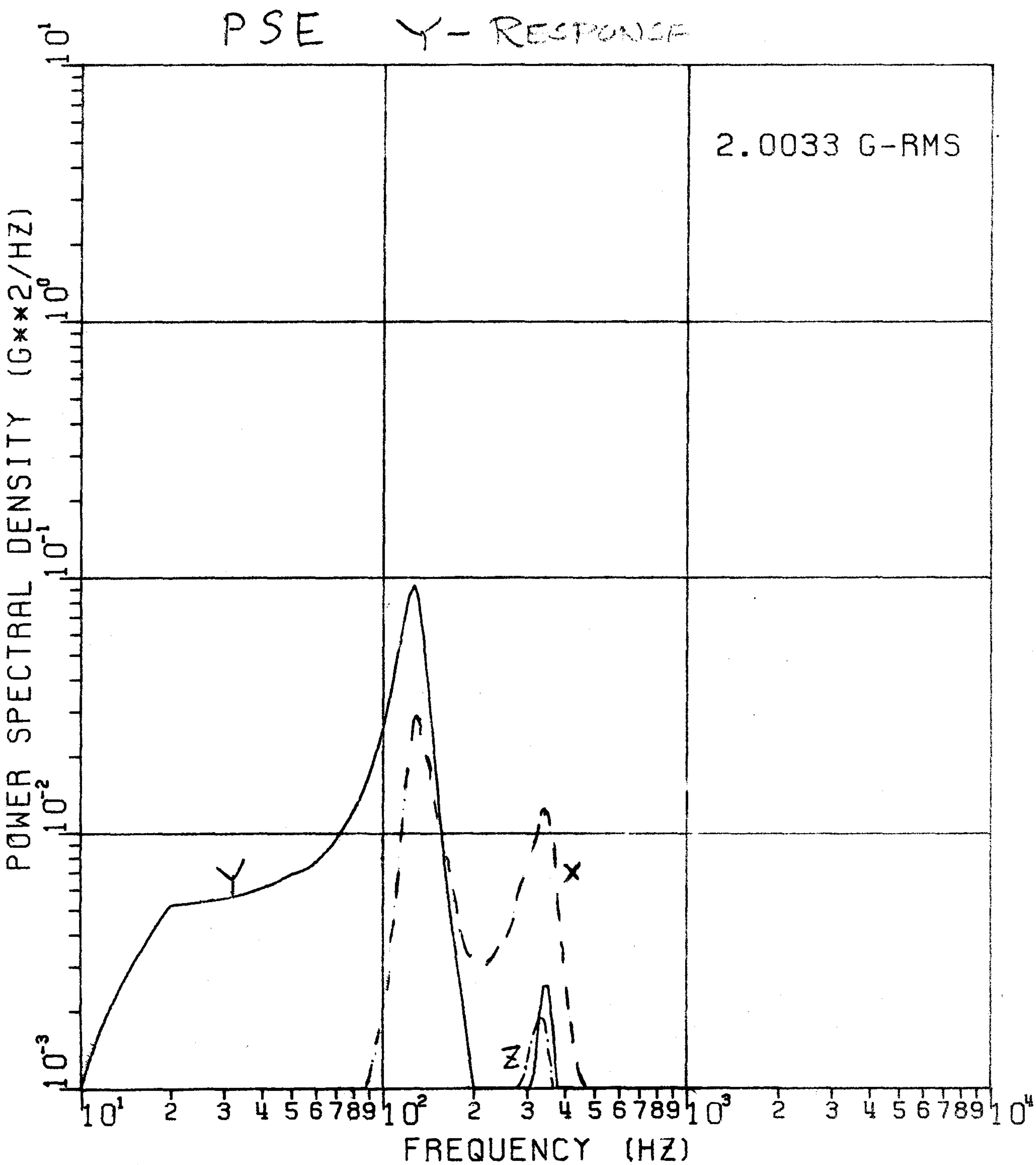
PSE Y RESPONSE



ALSEP ARR E/SP-1 (PSE), FOR IN Y-AXIS (LUNAR DESCENT)

FIGURE 32d RANDOM VIBRATION SPECTRUM

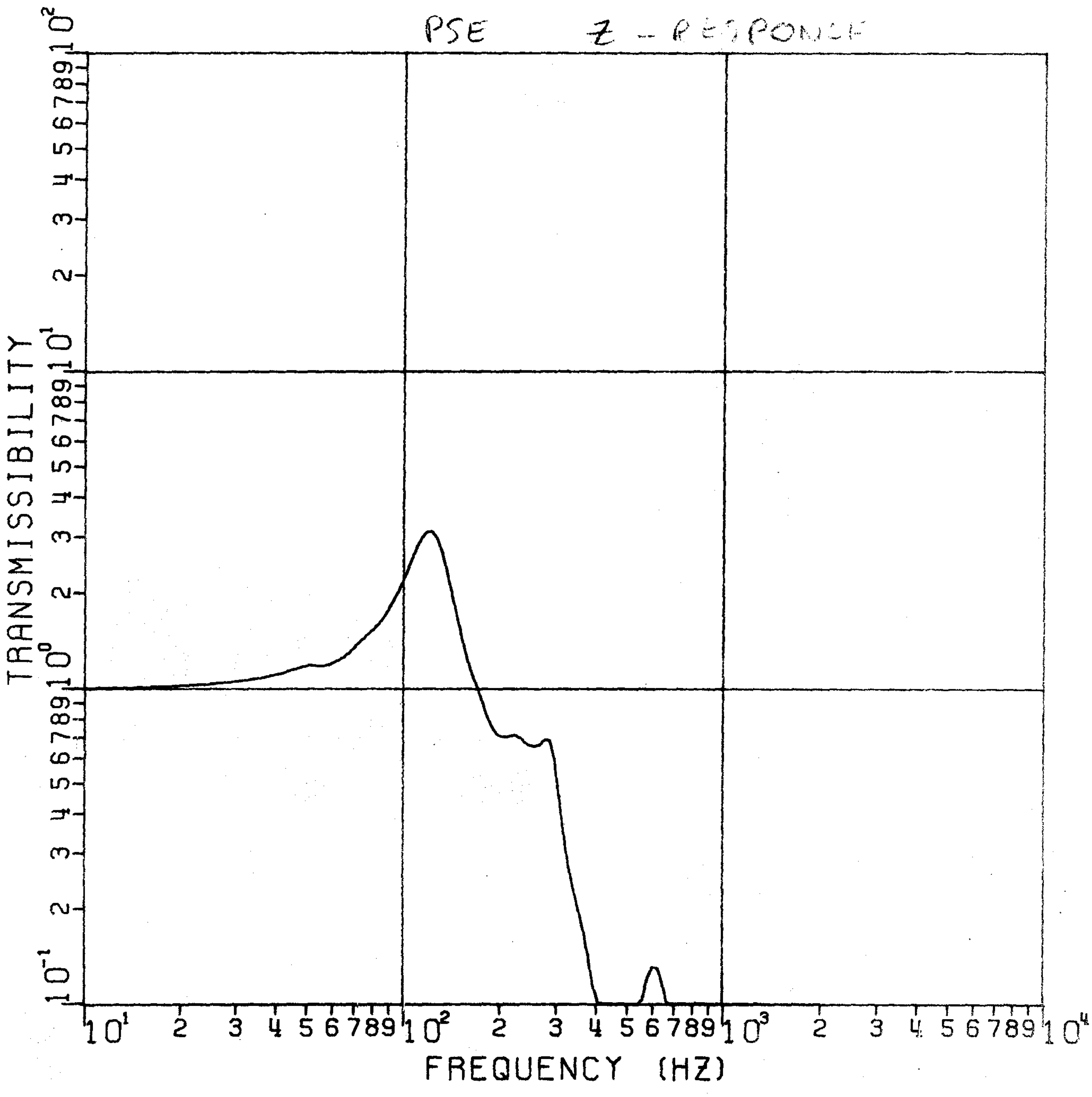
LOCATION 22



** ALSEP ARRAY E/SP-1,FORCING IN Z-AXIS (PSE) **

FIGURE 33a TRANSMISSIBILITY

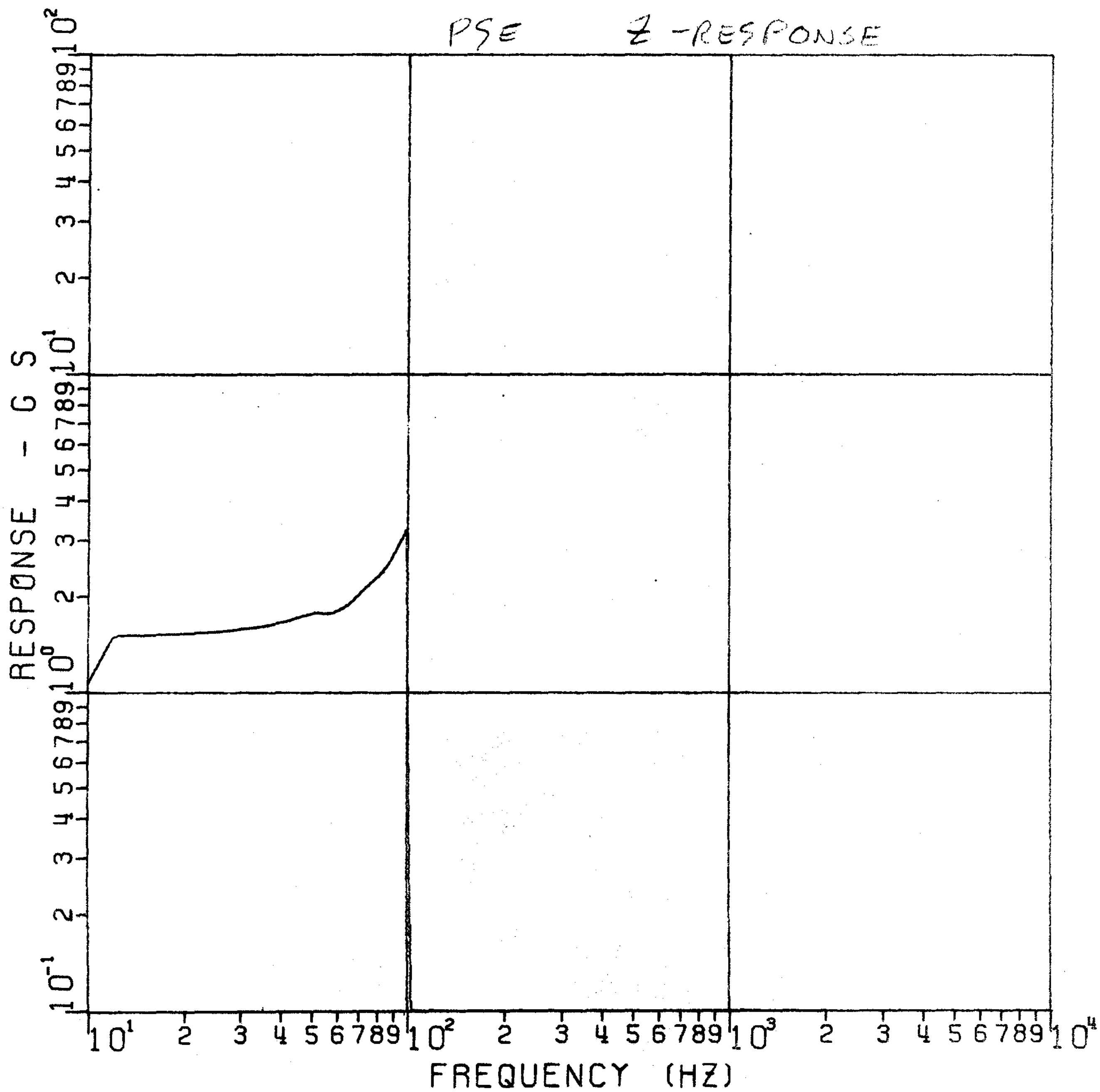
LOCATION 24 w₁



** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS (PSE) **

FIGURE 33b SINE RESPONSE

LOCATION 24 w1

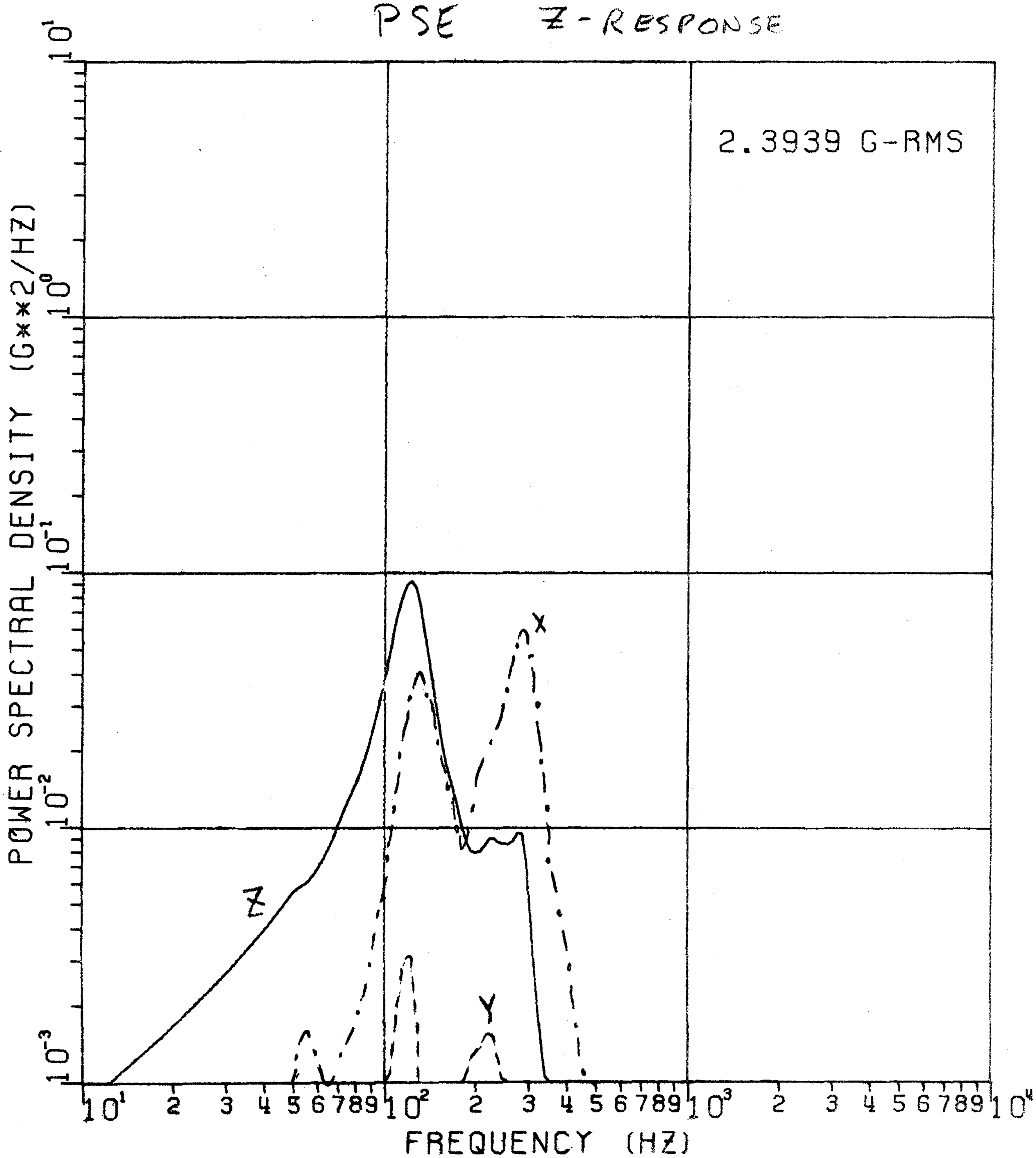


** ALSEP ARRAY E/SP-1, FORCING IN Z-AXIS (PSE) **

FIGURE 33C RANDOM VIBRATION SPECTRUM L&B

LOCATION 24 ω_1

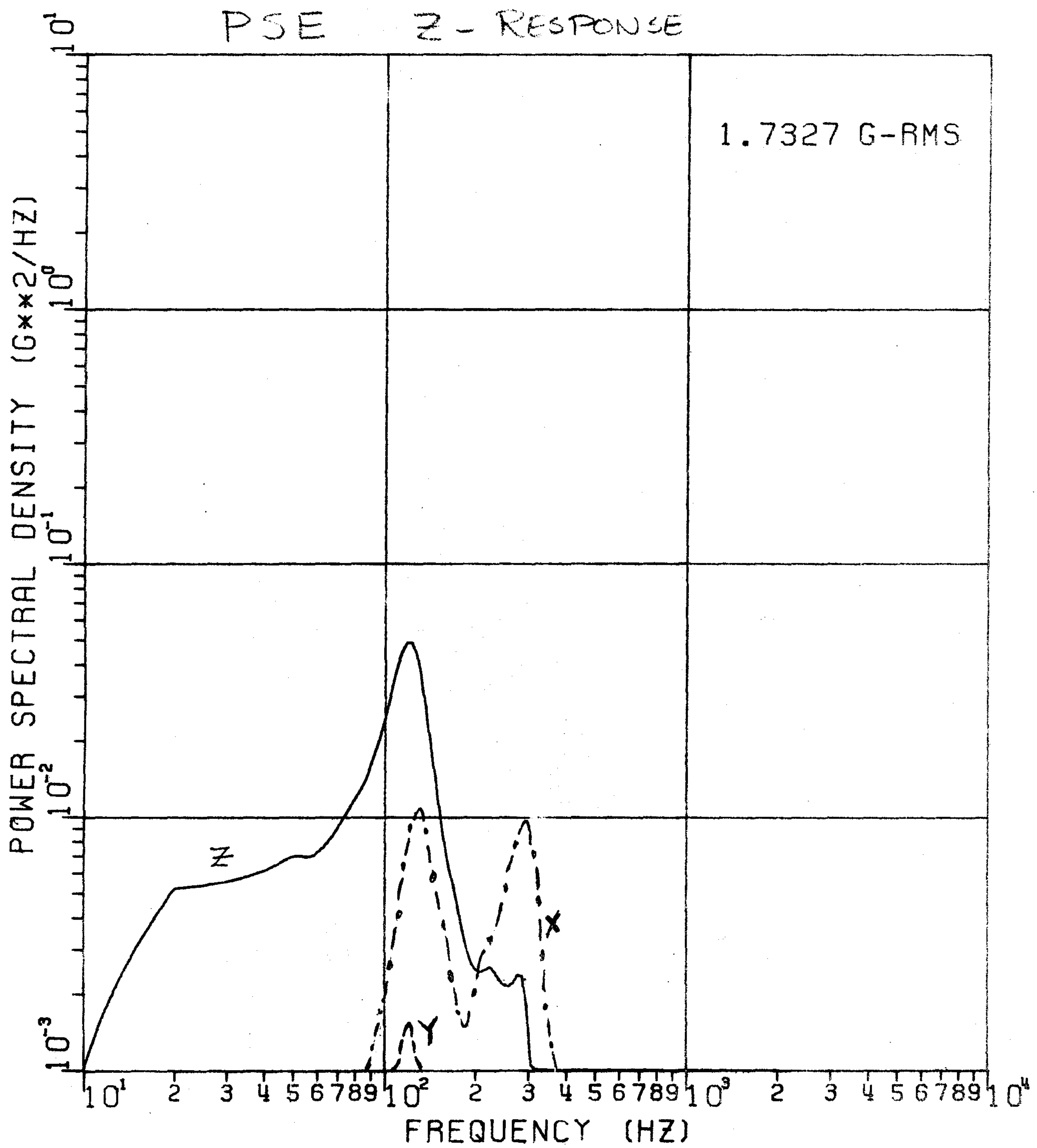
PSE Z-RESPONSE



ALSEP ARR E/SP-1 (PSE), FOR IN Z-AXIS (LUNAR DESCENT)

FIGURE 33d RANDOM VIBRATION SPECTRUM

LOCATION 24



6.0 APPENDIX

Figures A-1 Through A-8

46	32	1			
1	1	1.0			
1	29	.633571	.0057376	.044521	
2	2	1.0			
2	29	-.27869	.030791	.238919	
3	3	1.0			
3	29	.674375	.103557	.803548	
4	4	1.0			
5	5	1.0			
6	6	1.0			
7	7	1.0			
8	8	1.0			
9	9	1.0			
10	10	1.0			
10	27	-.555685	-1.79478		.444006
11	10	1.0	1.0	-1.0	
11	27	-.059843	-.152175		.0249193
12	11	1.0			
12	27	.286052	-.148462		.368746
13	12	1.0			
13	27	.0209664	-2.1876		1.23946
14	13	1.0			
15	14	1.0			
16	15	1.0			
17	16	1.0			
18	17	1.0			
19	18	1.0			
20	19	1.0			
21	20	1.0			
22	21	1.0			
23	3	1.0			
24	13	1.0			
25	14	1.0			
26	22	1.0			
27	23	1.0			
28	24	1.0			
29	22	1.0	-1.0	1.0	
30	25	1.0			
31	25	1.0			
32	26	1.0			
33	26	1.0			
34	6	1.0			
35	7	1.0			
36	8	1.0			
37	9	1.0			
38	27	1.0			
39	28	1.0			
40	29	1.0	-.20709	.20709	
41	29	1.0			
42	29	1.0	.20709	-.20709	
43	30	1.0			
44	31	1.0			
45	32	1.0			
46	27	0.557	1.0		-0.557

FIGURE A-1

THE MATRIX [B]

(LSG VERSION)

```
46    46    1 .000010    1.0
 1     10.6322D 000.5836D-01-.3110D 00-.6501D-01-.1933D-010.1620D 00-.6346D-02
 1     60.1437D-020.1817D-01-.5921D-02-.1592D-02-.4673D-030.1118D 00-.8322D-01
 1    15-.1318D 00
 2     20.5741D 000.8943D-01-.4446D-010.3194D-02-.6408D-02-.8705D-020.8302D-03
 2     9-.1152D-01-.2021D 000.3488D-010.4679D-020.3705D-010.4890D-01-.3775D 00
 3     30.9678D 00-.2540D 00-.7478D-02-.7191D 000.4751D-01-.1188D-010.8209D-02
 3    100.4672D-01-.1018D-01-.8582D-02-.1304D 000.3373D 00-.2848D 00
 4     40.4456D 00-.5852D-010.9302D-01-.2571D-020.5958D-02-.9582D-01-.4617D-02
 4    11-.8496D-03-.1895D-020.4368D-02-.1741D-010.9126D-01
 5     50.9640D 00-.5848D-040.1777D-01-.3214D-01-.2346D 00-.1236D-02-.2004D-02
 5    120.1748D-02-.6682D-020.1155D-010.6523D-02
 6     60.1260D 01-.3814D-010.4620D-02-.3056D 00-.1520D-010.4523D-010.1110D 00
 6    130.4328D 00-.1077D 01-.1241D-01
 7     70.5186D 00-.4767D-01-.6574D-01-.1209D-01-.4428D-010.1042D 000.1386D 00
 7    14-.2700D 00-.7053D-02
 8     80.7688D 00-.1359D-010.2810D-020.1272D-01-.5062D-01-.1811D-010.3500D-01
 8    150.1203D-02
 9     90.1035D 01-.4943D-020.9550D-03-.2087D-01-.1677D-010.1432D 000.4882D-01
10    100.4352D 00-.1319D 00-.5335D-01-.3373D 000.1428D 000.4418D-01
11    110.1298D 01-.2005D 00-.6211D-01-.3499D-010.3788D-01
12    120.6941D 000.6577D-01-.3364D 000.2412D-01
13    130.1683D 01-.1335D 01-.5765D 00
14    140.2046D 010.2559D 00
15    150.7771D 00
16    160.5330D-01-.1026D-010.4517D-030.1196D-02-.5473D-03-.2553D-020.1414D-03
16    230.2538D-02-.5193D-010.1619D-01
17    170.3442D-01-.1205D-010.4824D-020.1103D-03-.2091D-020.3247D-03-.7572D-02
17    240.2986D-020.4121D-02
18    180.7423D-010.3856D-03-.6656D-02-.5901D-030.1285D-02-.7018D-010.7460D-02
18    250.1860D-01
19    190.5063D-010.3979D-02-.7945D-02-.3906D-02-.3863D-010.1787D-01-.1468D-01
20    200.6947D-01-.1481D-010.1024D-010.1552D-010.1534D-02-.5698D-01
21    210.1323D 00-.1070D 000.7853D-020.1242D-01-.3234D-01
22    220.1416D 00-.3762D-020.7758D-030.3268D-02
23    230.1371D 00-.4406D-01-.2465D-01
24    240.1133D 00-.5770D-01
25    250.1276D 00
26    26  .665D-01
26    34 -.665D-01
27    27  .665D-01
27    35 -.665D-01
28    28  .665D-01
28    36 -.665D-01
29    29  .665D-01

29    37 -.665D-01
30    30  .666D-01
31    31  .666D-01
32    32  .666D-01
33    33  .666D-01
34    26 -.665D-01
34    34  .665D-01
35    27 -.665D-01
35    35  .665D-01
36    28 -.665D-01
36    36  .665D-01
37    29 -.665D-01
37    37  .665D-01
38    38 .729693   .0485912
38    45 -.257474 .0485912
39    39 .967728
39    45 .0485912  -.338266
40    40.237997   -.021336  -.006155  .0085063  -.055644
41    41 .113067  -.023272  -.0009319 -.0107422
42    42.226474   -.014054  -.0083066
43    43.137137   -.125208
44    44.262717
45    45 .729693  .0485912
46    46 .967728
```

10^5 IS FACTORED OUT

FIGURE A-2
THE MATRIX [K]
(LSG VERSION)

39	30			
1.	1	1.0		
1	28	633571	.C057376	.044521
2	2	0		
2	28	-.27869	.030791	.238519
3	3	1.0		
3	28	.674375	.103557	.803548
4	4	1.0		
5	5	1.0		
6	6	1.0		
6	22	-.58851	-.021298	-.56722
7	7	1.0		
7	22	-.14679	-.122858	-.0239347
8	6	-1.0	1.0	1.0
8	22	.05201	-.0026883	.0546953
9	8	1.0		
9	22	-.13482	.059893	-.194714
10	9	1.0		
10	25	-.555685	.44401	-1.79478
11	9	1.0	1.0	-1.0
11	25	-.059843	.024919	-.152175
12	10	1.0		
12	25	.286052	.368746	-.148462
13	11	1.0		
13	25	.0209664	1.23946	-2.1876
14	12	1.0		
15	13	1.0		
16	14	1.0		
17	15	1.0		
18	16	1.0		
19	17	1.0		
20	18	1.0		
21	19	1.0		
22	20	1.0		
23	21	1.0		
24	3	1.0		
25	12	1.0		
26	13	1.0		
27	22	1.0		
28	23	1.0		
29	24	1.0		
30	22	1.0	-1.0	1.0
31	25	1.0		
32	26	1.0		
33	27	1.0		
34	25	.557	-.557	1.0
35	281.0		-.20709	.20709
36	28	1.0		
37	28	1.0	.20709	-.20709
38	29	1.0		
39	30	1.0		

FIGURE A-3
THE MATRIX [B]
(P.S.E. VERSION)

```
39    39
 1     10.6322D 000.5636D-01-.3110D 00-.6501D-01-.1933D-010.1620D 00-.6346D-02
 1     80.1837D-020.1817D-01-.9921D-02-.1592D-02-.4693D-030.1118D 00-.8322D-01
 1    15-.1318D 00
 2     20.9741D CCC.8943D-01-.4446D-C10.3194D-02-.6408D-02-.8705D-020.8302D-03
 2     9-.1152D-C1-.2021D 000.3488D-010.4679D-020.3705D-010.4890D-01-.3775D 00
 3     30.9978D 00-.2530D 00-.7478D-C2-.7191D 000.4751D-01-.1188D-010.8209D-02
 3    100.4672D-01-.1C18D-01-.8982D-02-.1304D 000.3373D 00-.2848D 00
 4     40.4456D 00-.5682D-C10.9303D-01-.2571D-020.5958D-02-.9582D-01-.4617D-02
 4    11-.8496D-03-.1895D-020.4368D-02-.1741D-010.9126D-01
 5     50.5040D 00-.5848D-C40.1777D-01-.3214D-01-.2346D 00-.1236D-02-.2004D-02
 5    120.1748D-02-.6682D-C20.1155D-010.6523D-02
 6     60.1280D 01-.3814D-010.6620D-02-.3056D 00-.1520D-010.4523D-010.1110D 00
 6    130.4328D 00-.1C77D 01-.1241D-01
 7     70.5186D 00-.4767D-C1-.6574D-C1-.1209D-01-.4428D-010.1042D 000.1386D 00
 7    14-.2700D 00-.7053D-C2
 8     80.7688D 00-.1359D-C10.2810D-020.1272D-01-.5062D-01-.1811D-010.3500D-01
 8    150.1203D-02
 9     90.1005D 01-.4943D-020.9550D-C3-.2087D-01-.1677D-010.1432D 000.4882D-01
10    100.4352D 00-.1319D 00-.5335D-C1-.3373D 000.1428D 000.4418D-01
11    110.1298D 01-.2009D 00-.6211D-01-.3499D-010.3788D-01
12    120.6941D 000.6577D-01-.3364D 000.2412D-01
13    130.1683D 01-.1385D C1-.5785D 00
14    140.2046D 010.2539D C0
15    150.7771D C0
16    160.5332D-01-.1030D-010.5221D-030.1185D-02-.2738D-03-.2701D-020.1465D-03
16    23-.8093D-030.2254D-02-.5161D-010.1641D-01
17    170.3449D-01-.1218D-010.4846D-02-.4055D-03-.1812D-020.3150D-030.1527D-02
17    24-.6989D-020.2385D-020.3705D-02
18    180.7447D-010.3508D-C3-.5735D-02-.1088D-020.1302D-02-.2725D-02-.7113D-01
18    250.8533D-020.1934D-C1
19    190.5064D-010.3829D-02-.7863D-02-.3909D-020.4456D-03-.3848D-010.1769D-01
19    26-.1480D-01
20    200.7305D-01-.1674D-C10.1030D-C1-.1059D-010.1183D-010.5703D-02-.5410D-01
21    210.1333D 00-.1C7CD 000.5725D-020.9889D-020.1017D-01-.3390D-01
22    220.1416D 0C-.20C1D-03-.3852D-C20.8585D-030.3322D-02
23    230.3134D-010.1093D-01-.1234D-C1-.3531D-02
24    240.1409D 00-.4837D-01-.2763D-01
25    250.1182D C0-.5434D-01
26    260.1299D 00
27    27 .166631  -.C127412 -.0341232 0.0206591
28    28 .166631  .C206594  -.0341227
29    29 .162758  -.0114906
30    30 .162755
31    31 .729693   -.257474  .C485912  .0485912
32    32 .729693   .0485912  .C485912
33    33 .967728   -.338266


34    34 .967728
35    35.237997    -.021336  -.C06155  .0085063  -.055644
36    36 .113067  -.C23272  -.C0C9319 -.0107422
37    37.226474   -.C14054  -.CC83066
38    38.137137   -.125208
39    39.262717
```

10^5 IS FACTORED OUT

FIGURE A-4

THE MATRIX [K]

(P.S.E. VERSION)

39	32						
1	1	.2602	.4796	.2602			
2	1	.09576	-.1915	.09576			
2	29	1.0					
3	1	-.46235		.46235			
3	30	.4796	.5204				
4	30	.0808	-.0808				
5	1	.1951		-.1951			
6	1	.0404	-.0808	.0404			
7	4	1.0					
8	5	1.0					
9	6	1.0					
10	7	1.0					
11	8	1.0					
12	9	1.0					
13	10	.5	.5				
14	10	-.749		.749			
14	27	0.5					0.5
15	11	.4169	-.4169				
15	27	.2735	1.0				-.2735
16	11	-.11266	.11266				
17	10	-.20243		.20243			
18	13	1.0					
19	14	1.0					
20	15	1.0					
21	16	1.0					
22	17	1.0					
23	18	1.0					
24	19	1.0					
25	20	1.0					
26	21	1.0					
27	22	1.0					
28	23	1.0					
29	24	1.0					
30	25	1.0					
31	26	1.0					
32	1	1.0					
33	2	1.0					
34	3	1.0					
35	10	1.0					
36	10	1.0	1.0	-1.0			
37	11	1.0					
38	12	1.0					
39	27	-.1093					.1093

Figure A-5 [C] Matrix (LSG Version)

```
*---------*----------*----------*----------*----------*----------*----------*-------

     39   39
      1    1   .0588
      2    2   .0588
      3    3   .0588
      4    4  1.0441
      5    5   .76333
      6    6  1.43976
      7    7   .0088
      8    8   .0041
      9    9   .0052
     10   10   .0016
     11   11   .0016
     12   12   .0016
     13   13   .029
     14   14   .029
     15   15   .029
     16   16   .483
     17   17   .3602
     18   18   .01
     19   19   .01
     20   20   .0155
     21   21   .00933
     22   22   .0109
     23   23   .00249
     24   24   .0111
     25   25   .00394
     26   26   .00394
     27   27   .0678
     28   28   .0678
     29   29   .0678
     30   30  1.68216
     31   31  1.68216
     32   32   .00078
     33   33   .00233
     34   34   .01
     35   35   .00155
     36   36   .00155
     37   37   .00155
     38   38   .00518
     39   39 .3602

*---------*----------*----------*----------*----------*----------*----------*-------
```


Figure A-6 [Mp] Matrix (LSG Version)

41	30			
1	1	.2602	.4796	.2602
2	1	.09576	-.1915	.09576
2	28	1.0		
3	1	-.46235		.46235
3	29	.4796	.5204	
4	29	.0808	-.0808	
5	1	.1951		-.1951
6	1	.0404	-.0808	.0404
7	4	1.0		
8	5	1.0		
9	6	1.0		
10	7	1.0		
11	6	-1.0	1.0	1.0
12	8	1.0		
13	9	.5	.5	
14	9	-.749		.749
14	25	0.5	.5	
15	10	.4169	-.4169	
15	25	.2735	-.2735	1.0
16	25	-.1093	.1093	
17	10	-.11266	.11266	
18	9	-.20243		.20243
19	12	1.0		
20	13	1.0		
21	14	1.0		
22	15	1.0		
23	16	1.0		
24	17	1.0		
25	18	1.0		
26	19	1.0		
27	201.0			
28	21	1.0		
29	7	.5	.5	
30	6	-.444		.444
30	22	.5	.5	
31	6	-.444	.444	
31	22	.5	-.5	1.0
32	22	-.111	.111	
33	6	.111	-.111	
34	6	-.111		.111
35	1	1.0		
36	2	1.0		
37	3	1.0		
38	9	1.0		
39	9	1.0	1.0	-1.0
40	10	1.0		
41	11	1.0		

Figure A-7 [C] Matrix (PSE Version)

------------------*---------*---------*---------*---------*---------*-------

41	41	
1	1	.0588
2	2	.0588
3	3	.0588
4	4	1.0441
5	5	.76333
6	6	1.43976
7	7	.0088
8	8	.0041
9	9	.0052
10	10	.0016
11	11	.0016
12	12	.0016
13	13	.029
14	14	.029
15	15	.029
16	16	.3602
17	17	.483
18	18	.3602
19	19	.01
20	20	.01
21	21	.0155
22	22	.00933
23	23	.0109
24	24	.00249
25	25	.0111
26	26	.00394
27	27	.00394
28	28	.01087
29	29	.05777
30	30	.05777
31	31	.05777
32	32	.16616
33	33	1.30567
34	34	1.30567
35	35	.00078
36	36	.00233
37	37	.01
38	38	.00155
39	39	.00155
40	40	.00155
41	41	.00518

------------------*---------*---------*---------*---------*---------*-------

Figure A-8 [Mp] Matrix (PSE Version)