Bendix

Aerospace Systems Division

# HFE Subpallet Dynamic Analysis




This ATM presents the results of a dynamic analysis of the heat flow experiment subpallet assembly for Array D.



Prepared By: K. Wadleigh

K. Wadleigh

Approved By:

Approved By: J. Maszatics

J. Maszatics

Approved By: J. McNaughton

J. McNaughton

## 1.0 INTRODUCTION & SUMMARY

This ATM presents the results of a dynamics analysis of the heat flow experiment (H. F. E. ) subpallet being incorporated in the ALSEP Array D. Both the engineering test model and the flight model were investigated. Objectives of the analysis were (1) to relate the dynamics environment of electronics box and the heat flow probe mounted on the subpallet to that when mounted directly to the main compartment pallet and (2) to determine the dynamic loads in the subpallet structure elements.

The computations indicate that the environment at the electronics box and probe box are different, as might be expected, due to the different structure, however, the differences are primarily in frequency content and not in peak or over-all RMS g levels. These responses are shown in table form and curve form. The dynamic loads for the most severe cases were also calculated, but no large or critical values were indicated.

## 2.0 ANALYSIS MODEL

The mathematical model used in the analysis is three dimensional with 16 degrees of freedom. There is considerable coupling, both mass and stiffness, due to the angling struts and the mass asymmetries.

As shown in Figure 1 the structure consists of the heat flow probe suspended in its box, the subpallet and the heat flow experiment electronics box. The subpallet is attached with two brackets to the ALSEP pallet plus the two strut attachments from the top of the subpallet to the ALSEP pallet.

The mass of the heat flow probe is essentially concentrated at the ends of container box. Therefore the dynamic model of the folded probe parts is a dumb-bell shaped mass, i. e., two masses connected by a weightless rod.

The heat flow electronics was assumed to be a rigid mass attached at four points having flexibility in all directions.

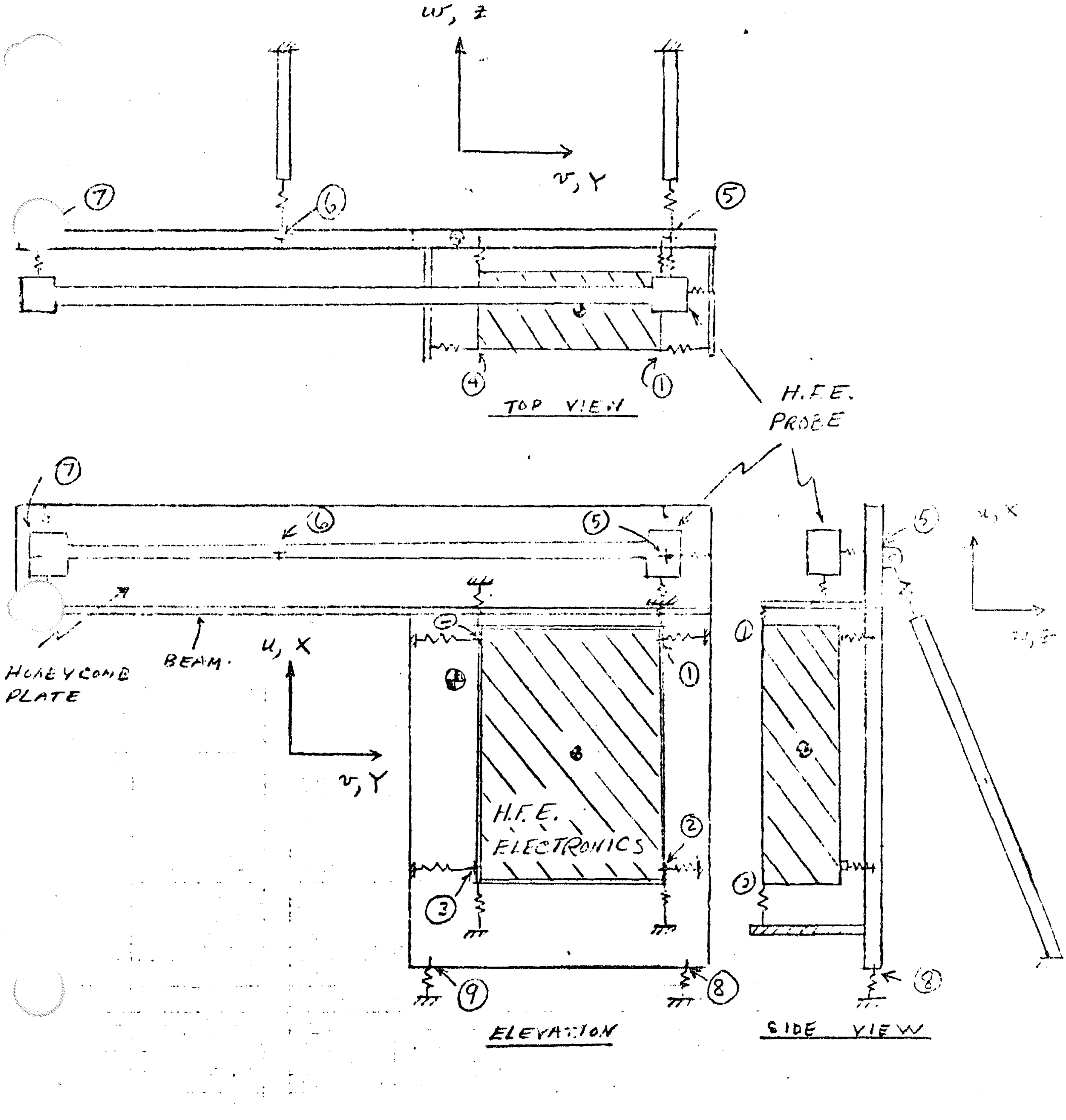



FIGURE 1. DYNAMICS ANALYSIS MODEL OF H.F.E. SUBPALLET ASSEMBLY

The subpallet was considered rigid in the in-plane directions, but flexible perpendicular to its plane. The flexibility influence coefficients were computed by assuming that the plate can be represented by a set of beams having equivalent stiffness. Figure 2 shows this representation for the engineering model. The effect of the probe box is to stiffen the free end of the plate overhang by constraining the slope to zero during bending. Determining the flexibility and stiffness matrices for the subpallet and other structural members is a rather long and detailed procedure, and consequently is not included here. Only the final stiffness matrix is given in this memo. However, the details are on file.

Referring to the axis system shown in Figure 1, the following independent degrees of freedom were chosen:

| Location | Coordinate Designation | Description | Orientation |
|---|---|---|---|
| 1 | U7p | Probe | X |
| 2 | U5p | Probe | X |
| 3 | V7p | Probe | Y |
| 4 | W7p | Probe | Z |
| 5 | W5p | Probe | Z |
| 6 | W7 | Overhang | Z |
| 7 | Ur5 | Subp. Attachment | X |
| 8 | Ur6 | Subp. Attachment | X |
| 9 | Wr5 | Subp. Attachment | Z |
| 10 | Wr6 | Subp. Attachment | Z |
| 11 | U4 | Electronics | X |
| 12 | V1 | Electronics | Y |
| 13 | V2 | Electronics | Y |
| 14 | W1 | Electronics | Z |
| 15 | W2 | Electronics | Z |
| 16 | W4 | Electronics | Z |

The first five coordinates apply to the probe mass motion in its suspension; location 6, W7, is the "Z" motion of the free end of the subpallet overhang; locations 7-10 are the motions of the two subpallet/strut interfaces; and the remaining six coordinates are the electronics box attachment motions.

D. Chang
5/21/76
7/10/70

# HFE SUBPALLET ASSY - Eng Model

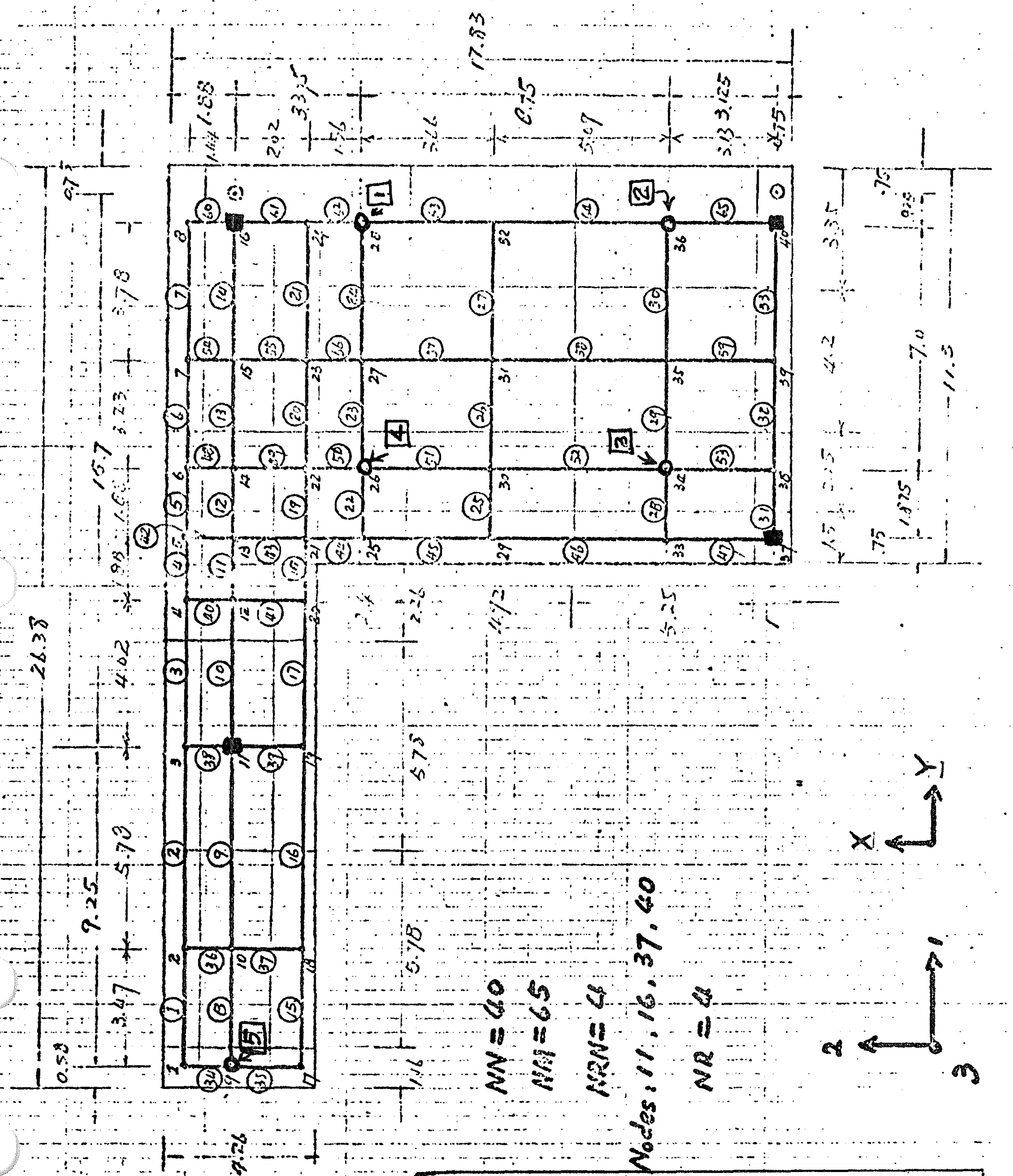



FIGURE 2. EQUIVALENT BEAM REPRESENTATION OF PLATE

The mass and stiffness matrices for the analysis model are given in Figures 3 and 4. For the subpallet and the electronics box these masses have been transformed from their c. g. values of mass and moments of inertia to the attachment coordinate system.

The stiffness values are for the generalized coordinates chosen. This matrix has been reduced from a 39 x 39 matrix of stiffness values which represent the internal motions and stiffnesses before the various parts are connected together. The large matrix was used also in the calculation of the internal loads in the manner of Reference 1.

## 3.0 COMPUTED RESPONSES

The natural frequencies and mode shapes for the model are shown in Figure 5. The first five natural frequencies pertain to the probe mass in its suspension and are quite low (15 to 19 Hz). The next eleven frequencies and eigen vectors apply to the subpallet mass and electronics box, the last two being the modes resulting from the attachment bracket stiffness between the subpallet and the main ALSEP pallet.

Input values for the three different axes are shown in Figures 6 and 7 for the sine and random input levels. These are the same values as the test values for the engineering model and come from Reference 2.

Computed acceleration responses are presented in the three part figures consisting of plots of transmissibility, sine response and random response at the location designated. In most cases the in-axis responses are the largest, and these are mainly the ones included here. However, there was considerable cross-axis response indicated as well, especially the response of $w_7$ (location 6) when the excitation was in the X direction.

Damping in the system was assumed to be 10% of critical viscous damping in any one mode. This value is based upon measured transmissibilities of similar structural elements.

A typical probe mass response is shown in Figure 8. The probes are essentially isolated above 25 Hz. The probe resonances are the only ones below 100 Hz.

S MATRIX

FIGURE 3. MASS MATRIX [m]

| Row | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 0.38900D-02 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 2 | 0.0 | 0.38900D-02 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 3 | 0.0 | 0.0 | 0.77300D-02 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 4 | 0.0 | 0.0 | 0.0 | 0.38900D-02 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.38900D-02 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.12940D-02 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.61820D-02 | -0.15760D-02 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | -0.15760D-02 | 0.80690D-02 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.43435D-02 | -0.13741D-02 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | -0.13741D-02 | 0.48873D-02 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.17090D-01 | -0.10670D-01 |
| | 0.10670D-01 | -0.41990D-02 | 0.41990D-02 | 0.0 | | |
| 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | -0.10670D-01 | 0.15700D-01 |
| | -0.71540D-02 | 0.94000D-03 | -0.25220D-02 | 0.16820D-02 | | |
| 13 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.10670D-01 | -0.71540D-02 |
| | 0.15700D-01 | -0.43030D-02 | 0.25220D-02 | 0.16820D-02 | | |
| 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | -0.41990D-02 | 0.94000D-03 |
| | -0.43030D-02 | 0.63570D-02 | -0.42820D-02 | -0.20760D-02 | | |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.41990D-02 | -0.26220D-02 |
| | 0.26220D-02 | -0.42820D-02 | 0.85540D-02 | 0.42730D-02 | | |
| 16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.16820D-02 |
| | 0.16820D-02 | -0.20760D-02 | 0.42730D-02 | 0.63480D-02 | | |

## SMALL K MATRIX

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ROW 1 | 0.5529999D 02 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3699569D 02 | -0.9229566D 02 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ROW 2 | 0.0 | 0.5529999D 02 | 0.0 | 0.0 | 0.0 | 0.0 | -0.5529999D 02 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ROW 3 | 0.0 | 0.0 | 0.6900000D 02 | 0.0 | 0.0 | 0.0 | 0.7865996D 02 | -0.7865996D 02 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ROW 4 | 0.0 | 0.0 | 0.0 | 0.5229999D 02 | 0.0 | -0.5229999D 02 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ROW 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5229999D 02 | 0.0 | 0.0 | 0.0 |
| | -0.5229999D 02 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ROW 6 | 0.0 | 0.0 | 0.0 | -0.5229999D 02 | 0.0 | 0.2511300D 04 | 0.0 | 0.0 |
| | -0.1620955D 04 | -0.1620955D 04 | 0.0 | 0.0 | 0.0 | 0.3900000D 02 | -0.6662000D 03 | 0.1180000D 04 |
| ROW 7 | 0.3699569D 02 | -0.5529999D 02 | 0.7865996D 02 | 0.0 | 0.0 | 0.0 | 0.2419598D 06 | 0.1168254D 04 |
| | -0.3400000D 05 | 0.0 | -0.3440782D 05 | 0.5530314D 05 | -0.1942794D 05 | 0.0 | 0.0 | 0.0 |
| ROW 8 | -0.9229566D 02 | 0.0 | -0.7865996D 02 | 0.0 | 0.0 | 0.0 | 0.1168254D 04 | 0.1470352D 06 |
| | 0.0 | -0.3400000D 05 | -0.1381618D 05 | -0.2516314D 05 | -0.1071206D 05 | 0.0 | 0.0 | 0.0 |
| ROW 9 | 0.0 | 0.0 | 0.0 | 0.0 | -0.5229999D 02 | -0.1620955D 04 | -0.3400000D 05 | 0.0 |
| | 0.1983571D 05 | 0.3523407D 04 | 0.0 | 0.0 | 0.0 | -0.6657195D 04 | 0.3948175D 04 | -0.1559547D 04 |
| ROW 10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.1620955D 04 | 0.0 | -0.3400000D 05 |
| | 0.3523407D 04 | 0.1977341D 05 | 0.0 | 0.0 | 0.0 | -0.6657195D 04 | 0.3948175D 04 | -0.1559547D 04 |
| ROW 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.3440782D 05 | -0.1381618D 05 |
| | 0.0 | 0.0 | 0.4822400D 05 | -0.3014000D 05 | 0.3014000D 05 | 0.0 | 0.0 | 0.0 |
| ROW 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5530314D 05 | -0.2516314D 05 |
| | 0.0 | 0.0 | -0.3014000D 05 | 0.6727500D 05 | -0.3767500D 05 | 0.0 | 0.0 | 0.0 |
| ROW 13 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.1942794D 05 | -0.1071206D 05 |
| | 0.0 | 0.0 | 0.3014000D 05 | -0.3767500D 05 | 0.6727500D 05 | 0.0 | 0.0 | 0.0 |
| ROW 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3900000D 02 | 0.0 | 0.0 |
| | -0.6657195D 04 | -0.6657195D 04 | 0.0 | 0.0 | 0.0 | 0.4327300D 05 | -0.2915700D 05 | -0.1642400D 05 |
| ROW 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.6662000D 03 | 0.0 | 0.0 |
| | 0.3948175D 04 | 0.3948175D 04 | 0.0 | 0.0 | 0.0 | -0.2915700D 05 | 0.3392600D 05 | 0.8291000D 04 |
| ROW 16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1180000D 04 | 0.0 | 0.0 |
| | -0.1559547D 04 | -0.1559547D 04 | 0.0 | 0.0 | 0.0 | -0.1642400D 05 | 0.8291000D 04 | 0.1600400D 05 |



FIGURE 4. STIFFNESS MATRIX [k]

## FIGURE 5. NATURAL FREQUENCIES AND MODE SHAPES

| MODE 1 | MODE 2 | MODE 3 | MODE 4 |
|---|---|---|---|
| EIGENVALUE= 0.11319D-03 | EIGENVALUE= 0.76321D-04 | EIGENVALUE= 0.74767D-04 | EIGENVALUE= 0.70664D-04 |
| FREQUENCY= 0.14960D 02 | FREQUENCY= 0.18218D 02 | FREQUENCY= 0.18406D 02 | FREQUENCY= 0.18933D 02 |
| EIGENVECTOR | EIGENVECTOR | EIGENVECTOR | EIGENVECTOR |
| 0.12283D-01 | 0.17759D-01 | -0.29716D-01 | 0.10000D 01 |
| -0.22655D-02 | 0.52836D-02 | 0.17166D-01 | -0.17972D 00 |
| 0.10000D 01 | -0.15058D-02 | 0.37380D-02 | -0.62464D-02 |
| 0.34856D-02 | 0.10000D 01 | -0.10609D 00 | -0.20135D-01 |
| -0.66577D-02 | 0.10653D 00 | 0.10000D 01 | 0.30750D-01 |
| 0.12136D-02 | 0.25440D-01 | -0.55188D-03 | 0.11257D-02 |
| -0.10834D-02 | 0.37803D-03 | 0.10184D-02 | -0.80328D-03 |
| 0.22754D-02 | 0.10190D-02 | -0.64865D-03 | 0.24001D-02 |
| -0.22824D-02 | 0.27127D-02 | 0.51847D-02 | -0.16173D-02 |
| 0.46081D-02 | 0.35926D-02 | -0.14791D-02 | 0.48335D-02 |
| 0.86833D-03 | 0.75204D-03 | 0.50074D-04 | 0.10600D-02 |
| 0.28330D-02 | 0.53933D-03 | -0.14078D-02 | 0.27062D-02 |
| 0.12480D-02 | 0.23723D-03 | -0.62038D-03 | 0.11927D-02 |
| 0.92344D-03 | 0.18395D-02 | 0.15546D-02 | 0.12981D-02 |
| 0.32136D-03 | 0.13683D-02 | 0.46597D-03 | 0.43552D-03 |
| 0.92475D-03 | -0.79591D-04 | 0.17612D-02 | 0.13492D-02 |

| MODE 5 | MODE 6 | MODE 7 | MODE 8 |
|---|---|---|---|
| EIGENVALUE= 0.70370D-04 | EIGENVALUE= 0.16553D-05 | EIGENVALUE= 0.11222D-05 | EIGENVALUE= 0.67594D-06 |
| FREQUENCY= 0.18973D 02 | FREQUENCY= 0.12370D 03 | FREQUENCY= 0.15024D 03 | FREQUENCY= 0.19358D 03 |
| EIGENVECTOR | EIGENVECTOR | EIGENVECTOR | EIGENVECTOR |
| 0.17996D 00 | -0.15118D-01 | 0.10180D-01 | -0.25155D-03 |
| 0.10000D 01 | 0.17315D-02 | -0.40089D-02 | -0.35471D-03 |
| -0.15716D-05 | -0.71134D-02 | 0.60069D-02 | 0.44149D-04 |
| -0.71467D-02 | -0.92891D-02 | 0.20152D-04 | -0.91711D-02 |
| -0.12582D-01 | 0.20594D-02 | -0.15318D-01 | -0.13331D-02 |
| 0.37968D-03 | 0.40812D 00 | -0.14374D-02 | 0.10000D 01 |
| 0.36743D-03 | -0.71833D-01 | 0.24722D 00 | 0.36557D-01 |
| 0.19326D-03 | 0.34702D 00 | -0.27693D 00 | 0.30186D-01 |
| 0.71703D-03 | -0.90444D-01 | 0.10000D 01 | 0.14541D 00 |
| 0.38019D-03 | 0.10000D 01 | -0.58533D 00 | 0.12181D 00 |
| 0.26739D-03 | 0.17395D 00 | -0.61636D-01 | 0.75153D-01 |
| -0.14708D-03 | 0.42069D 00 | -0.56781D 00 | -0.28268D-01 |
| -0.64841D-04 | 0.20473D 00 | -0.28496D 00 | -0.24518D-01 |
| 0.44384D-03 | 0.71730D 00 | 0.89679D 00 | 0.87222D-02 |
| 0.15027D-03 | 0.38327D 00 | 0.66204D 00 | 0.25303D-01 |
| 0.45853D-03 | 0.84356D 00 | 0.91543D 00 | -0.12521D 00 |

FIGURE 5. (CONTINUED)

MODE 9

EIGENVALUE= 0.45556D-06
FREQUENCY= 0.23580D 03

EIGENVECTOR

| |
|---|
| 0.88288D-03 |
| 0.68487D-03 |
| 0.63256D-04 |
| -0.61657D-02 |
| -0.55832D-03 |
| 0.10000D 01 |
| -0.10508D 00 |
| -0.12317D 00 |
| 0.90746D-01 |
| -0.87805D-01 |
| -0.36032D 00 |
| -0.47030D-01 |
| -0.33638D-01 |
| 0.17092D 00 |
| -0.24226D 00 |
| 0.14024D 00 |

MODE 10

EIGENVALUE= 0.35974D-06
FREQUENCY= 0.26535D 03

EIGENVECTOR

| |
|---|
| -0.17121D-03 |
| -0.16802D-03 |
| -0.39017D-06 |
| -0.30317D-02 |
| -0.48616D-02 |
| 0.62408D 00 |
| 0.32710D-01 |
| 0.33081D-01 |
| 0.10000D 01 |
| -0.79285D 00 |
| 0.99737D-01 |
| 0.83309D 00 |
| 0.83265D 00 |
| -0.54261D 00 |
| -0.67208D 00 |
| 0.49716D 00 |

MODE 11

EIGENVALUE= 0.25329D-06
FREQUENCY= 0.31623D 03

EIGENVECTOR

| |
|---|
| -0.77108D-03 |
| -0.71739D-03 |
| -0.23134D-04 |
| 0.28389D-02 |
| -0.34196D-02 |
| -0.83070D 00 |
| 0.19850D 00 |
| 0.20737D 00 |
| 0.10000D 01 |
| 0.75817D 00 |
| 0.21941D 00 |
| -0.93501D-01 |
| -0.10308D 00 |
| 0.16968D 00 |
| -0.66296D 00 |
| 0.20695D 00 |

MODE 12

EIGENVALUE= 0.15577D-06
FREQUENCY= 0.40325D 03

EIGENVECTOR

| |
|---|
| -0.94773D-03 |
| 0.27458D-03 |
| -0.51974D-03 |
| 0.26007D-03 |
| -0.50837D-03 |
| -0.12302D 00 |
| -0.12376D 00 |
| 0.20628D 00 |
| 0.24220D 00 |
| -0.26923D 00 |
| 0.10000D 01 |
| 0.89151D 00 |
| -0.82583D 00 |
| 0.22446D 00 |
| 0.43937D 00 |
| -0.40072D 00 |

MODE 13

EIGENVALUE= 0.10542D-06
FREQUENCY= 0.49019D 03

EIGENVECTOR

| |
|---|
| -0.42615D-03 |
| 0.51357D-04 |
| -0.20345D-03 |
| 0.39133D-03 |
| -0.52578D-03 |
| -0.27568D 00 |
| -0.34191D-01 |
| 0.15633D 00 |
| 0.37056D 00 |
| 0.17809D 00 |
| -0.41007D 00 |
| 0.20328D 00 |
| 0.46347D 00 |
| 0.31647D 00 |
| 0.10000D 01 |
| -0.97318D 00 |

MODE 14

EIGENVALUE= 0.83336D-07
FREQUENCY= 0.55132D 03

EIGENVECTOR

| |
|---|
| -0.15199D-03 |
| 0.85684D-04 |
| -0.10112D-03 |
| -0.67195D-04 |
| 0.36034D-03 |
| 0.60078D-01 |
| -0.72241D-01 |
| 0.47807D-01 |
| -0.32096D 00 |
| -0.35808D 00 |
| 0.21627D 00 |
| 0.25831D 00 |
| 0.33950D 00 |
| 0.10000D 01 |
| 0.20524D 00 |
| -0.18732D 00 |

MODE 15

EIGENVALUE= 0.47252D-07
FREQUENCY= 0.73217D 03

EIGENVECTOR

| |
|---|
| -0.12154D-02 |
| 0.13996D-03 |
| -0.57745D-03 |
| -0.38440D-04 |
| 0.62091D-04 |
| 0.60333D-01 |
| -0.20822D 00 |
| 0.10000D 01 |
| -0.98185D-01 |
| -0.44408D 00 |
| -0.20098D 00 |
| -0.44868D 00 |
| -0.16358D 00 |
| -0.34522D 00 |
| -0.33889D 00 |
| 0.34688D 00 |

MODE 16

EIGENVALUE= 0.22043D-07
FREQUENCY= 0.10720D 04

EIGENVECTOR

| |
|---|
| 0.29591D-04 |
| -0.31347D-03 |
| 0.14617D-03 |
| -0.24103D-05 |
| 0.71204D-04 |
| 0.81001D-02 |
| 0.10000D 01 |
| 0.34409D 00 |
| -0.24034D 00 |
| -0.13518D 00 |
| -0.35217D-01 |
| 0.83530D-01 |
| 0.26377D-01 |
| 0.21989D-01 |
| 0.87010D-01 |
| -0.81723D-01 |

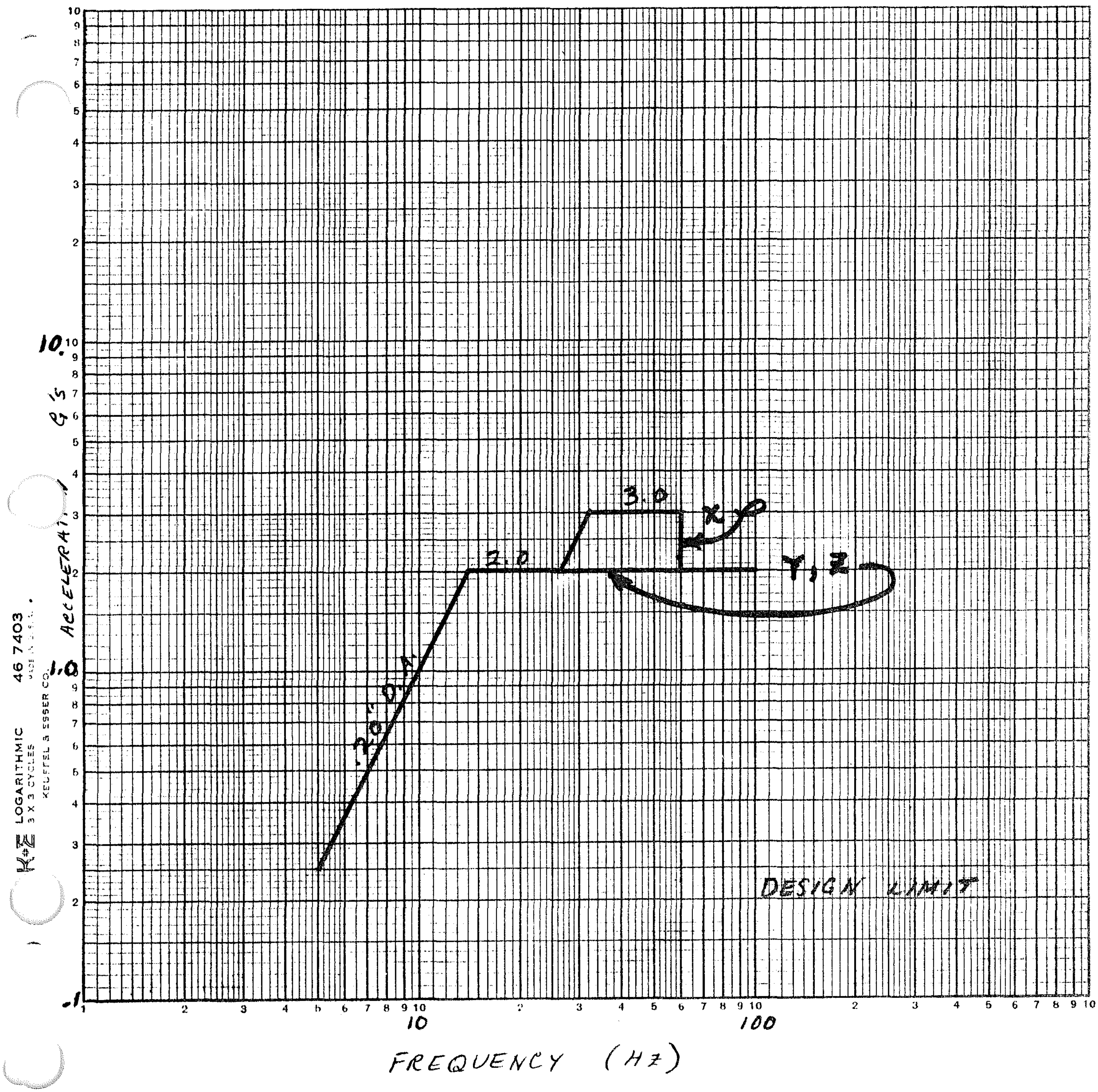



FIGURE 6 SINE INPUTS

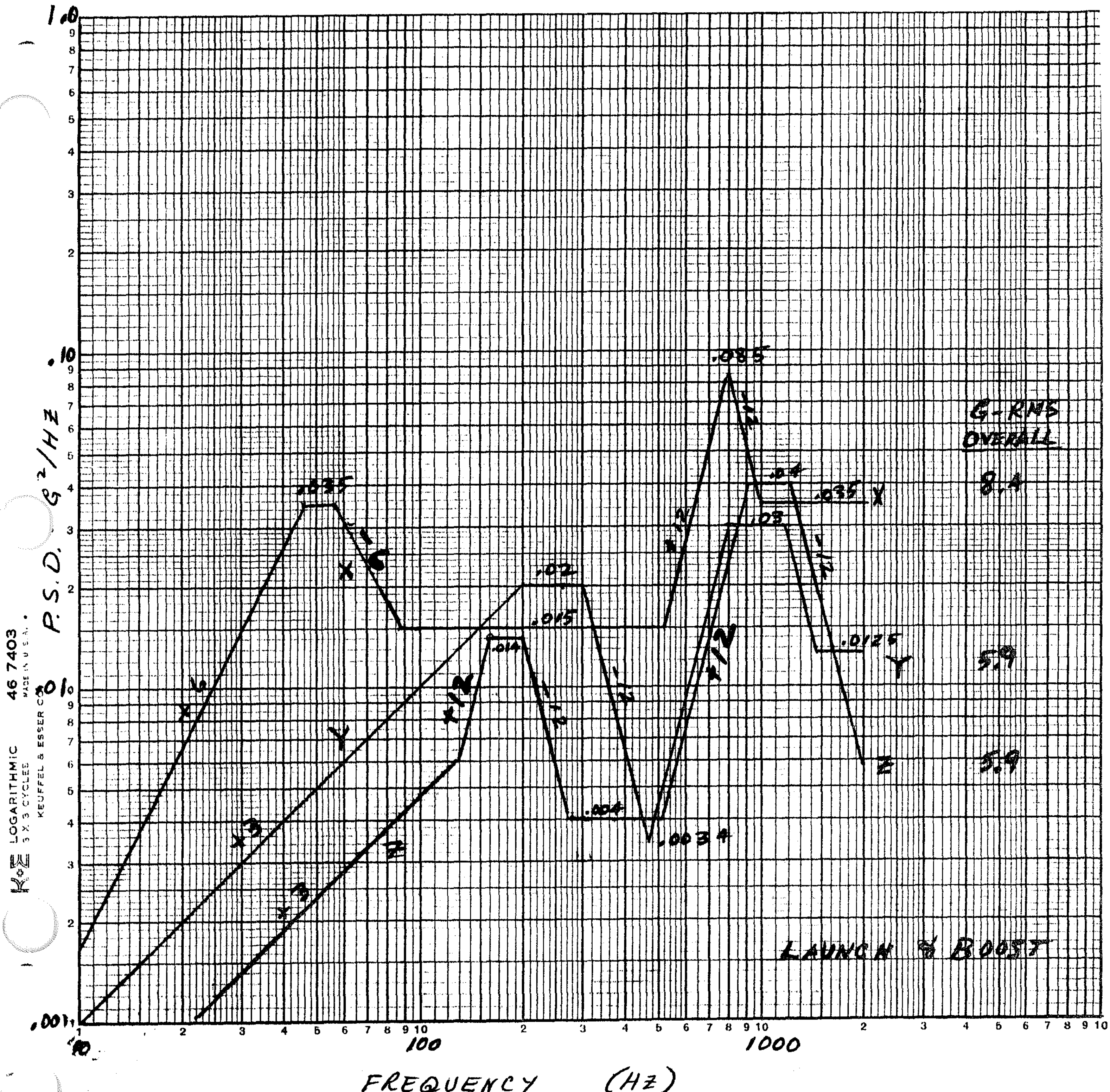



FIGURE 7 RANDOM INPUTS

A tabulation for the random responses for all locations computed for the engineering model is given in Table 1.

TABLE 1

RANDOM RESPONSES G-RMS

| | | X | Y | Z |
|---|---|---|---|---|
| 1 | U71 | .95 | | .03 |
| 2 | U5p | .95 | | .1 |
| 3 | V7p | .07 | | .2 |
| 4 | W7p | .04 | | .34 |
| 5 | W5p | .09 | | .34 |
| 6 | W7 | 5.4 | 3.5 | 4.3 |
| 7 | Ur5 | 17.0 | | 4.3 |
| 8 | Ur6 | 10.1 | | 2.8 |
| 9 | Wr5 | 4.6 | | 4.6 |
| 10 | Wr6 | 4.6 | | 4.5 |
| 11 | U4 | 5.3 | .92 | 1.4 |
| 12 | V1 | 3.4 | 3.5 | 1.5 |
| 13 | V2 | 1.3 | 3.6 | .91 |
| 14 | W1 | 2.9 | | 4.0 |
| 15 | W2 | 3.2 | | 2.7 |
| 16 | W4 | 3.1 | | 3.9 |

Figures 9 through 16 present the frequency response curves for the locations of most interest.

## 4.0 FLIGHT MODEL

A simulation of the flight model hardware was also carried out with only slight differences in the responses resulting. Therefore these curves are not included in this memo but are on file.

## 5.0 REFERENCES

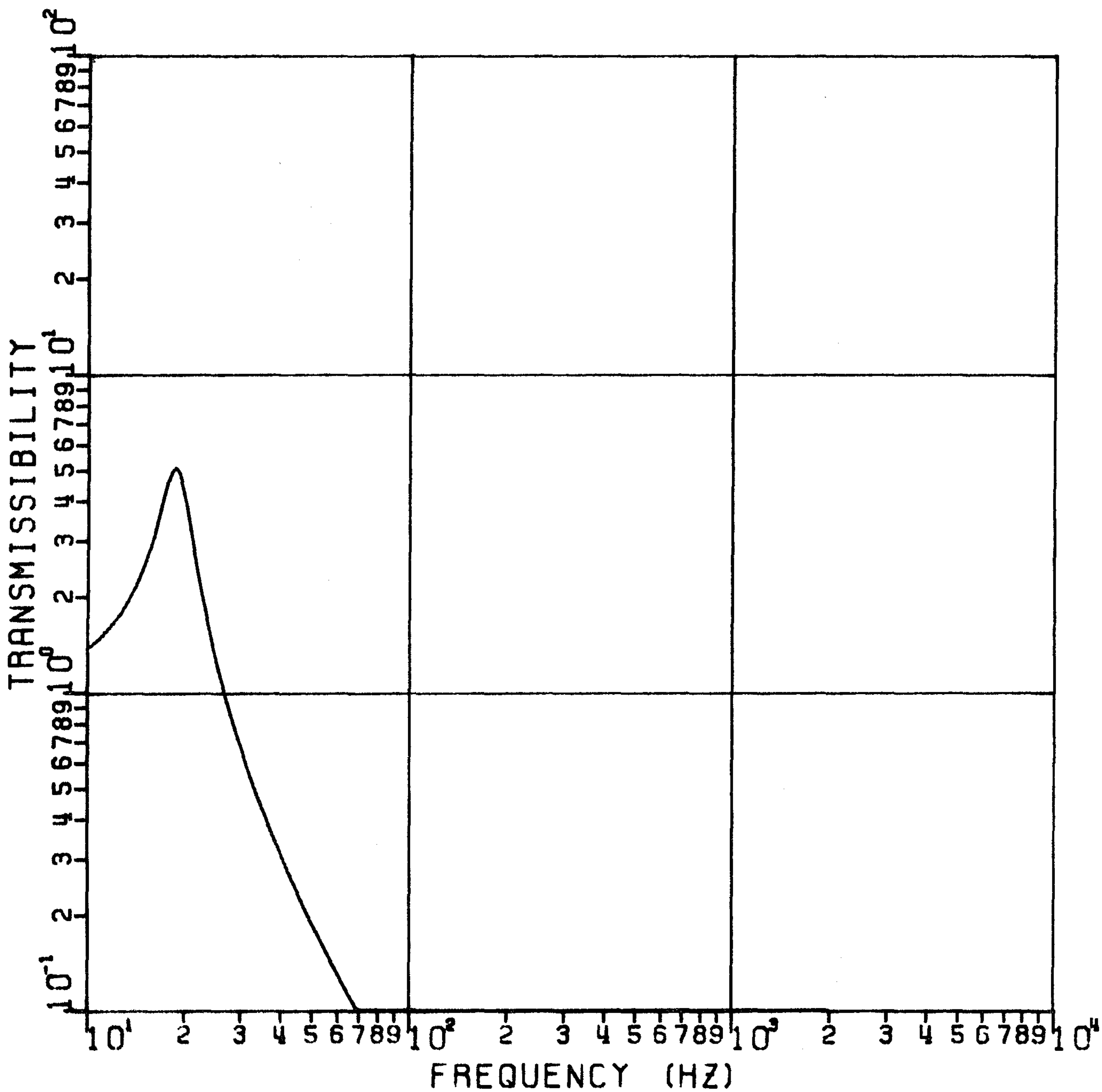

1. ATM-871 Structural/Dynamics Analysis Report - Apollo 14 LRRR, May 15, 1970.

2. Letter No. 971-JM-64, Array-D HFE Subpallet Engineering Vibration Test Levels, June 12, 1970.

1 X AXIS H.F.E. SUBPALLET ENG. MOD. JUNE 1970

FIGURE 8 *a* TRANSMISSIBILITY

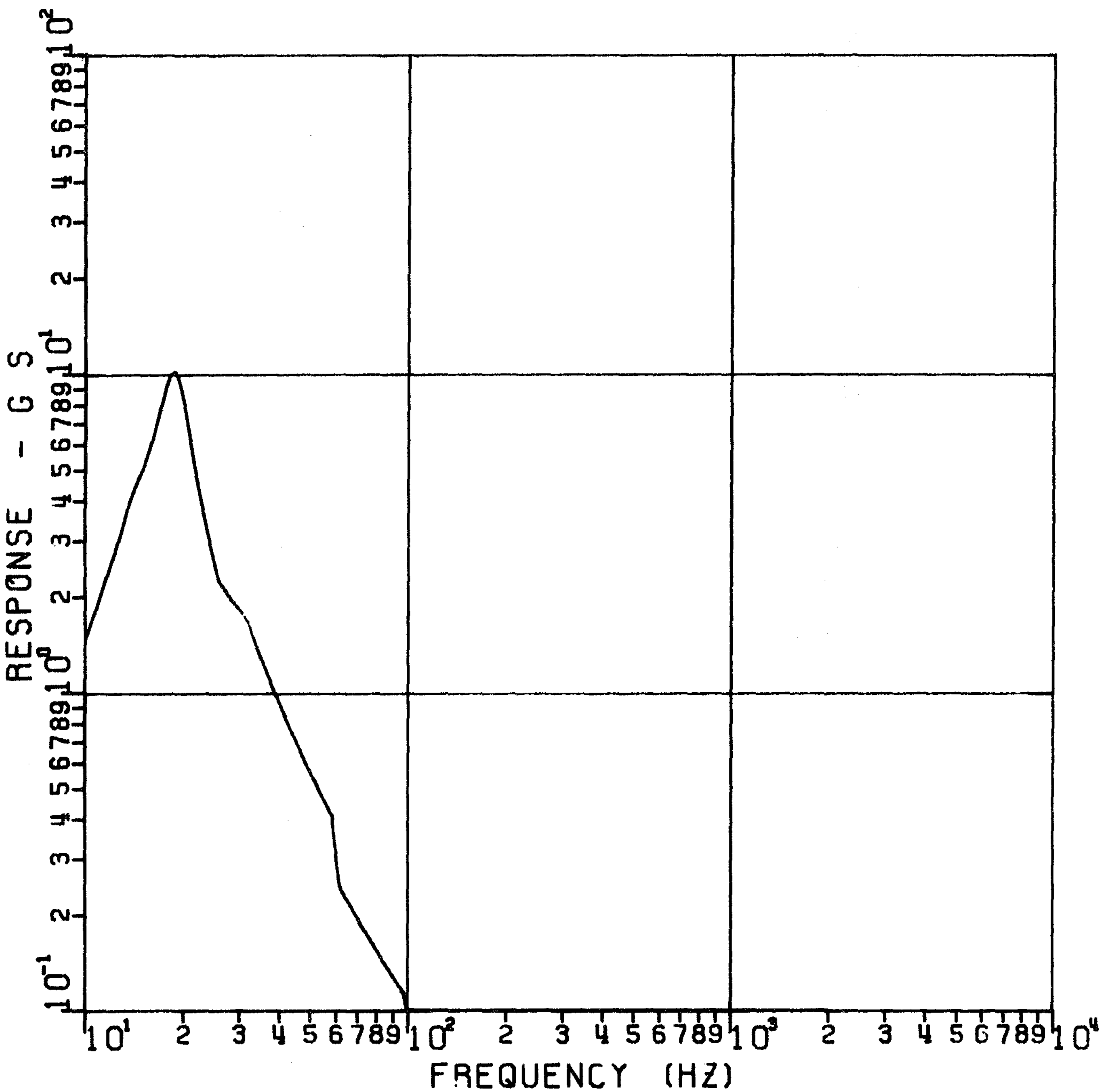
LOCATION 1



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JUNE 1970

FIGURE 8 b SINE RESPONSE

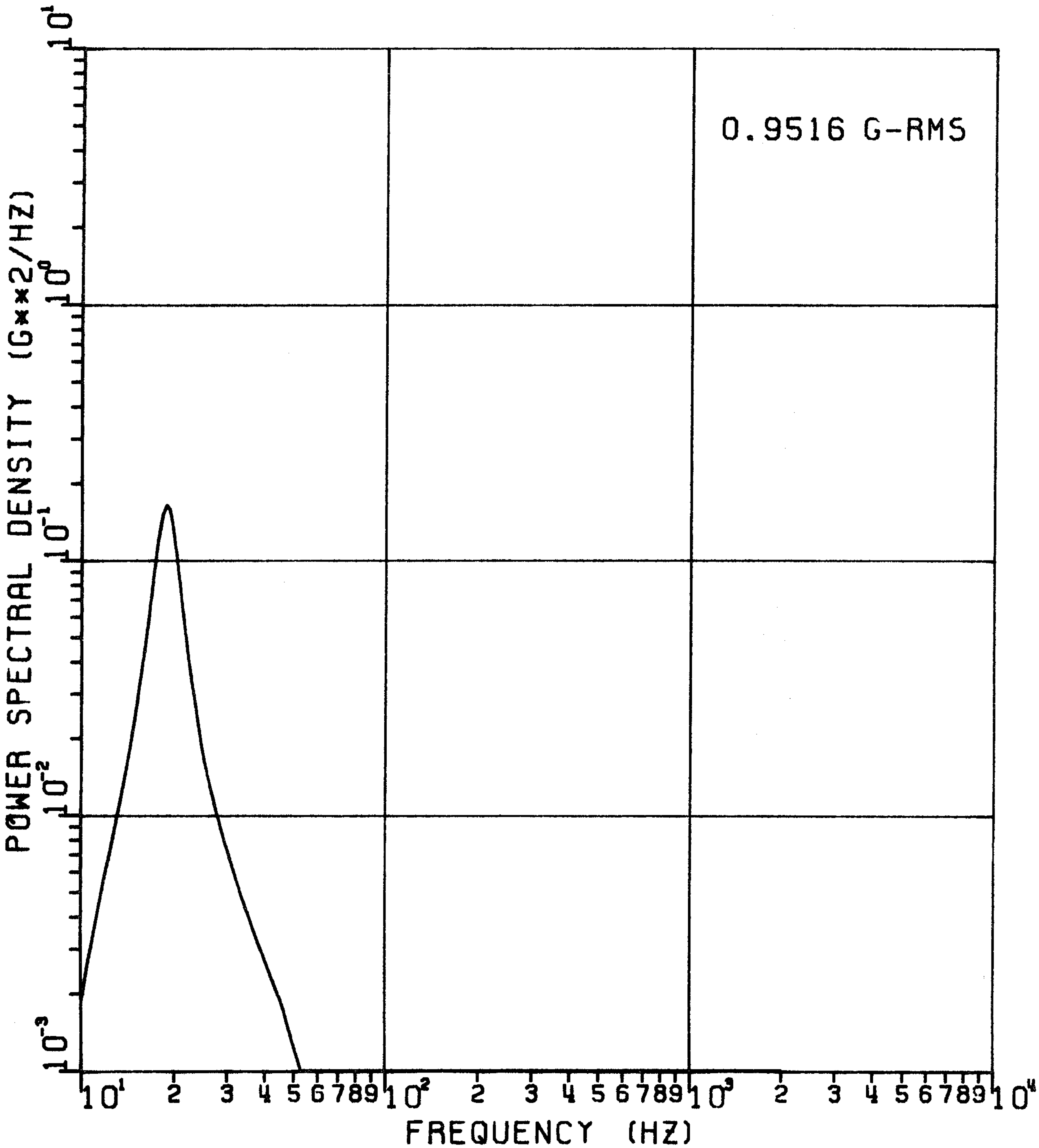
LOCATION 1



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JUNE 1970

FIGURE 8c RANDOM VIBRATION SPECTRUM

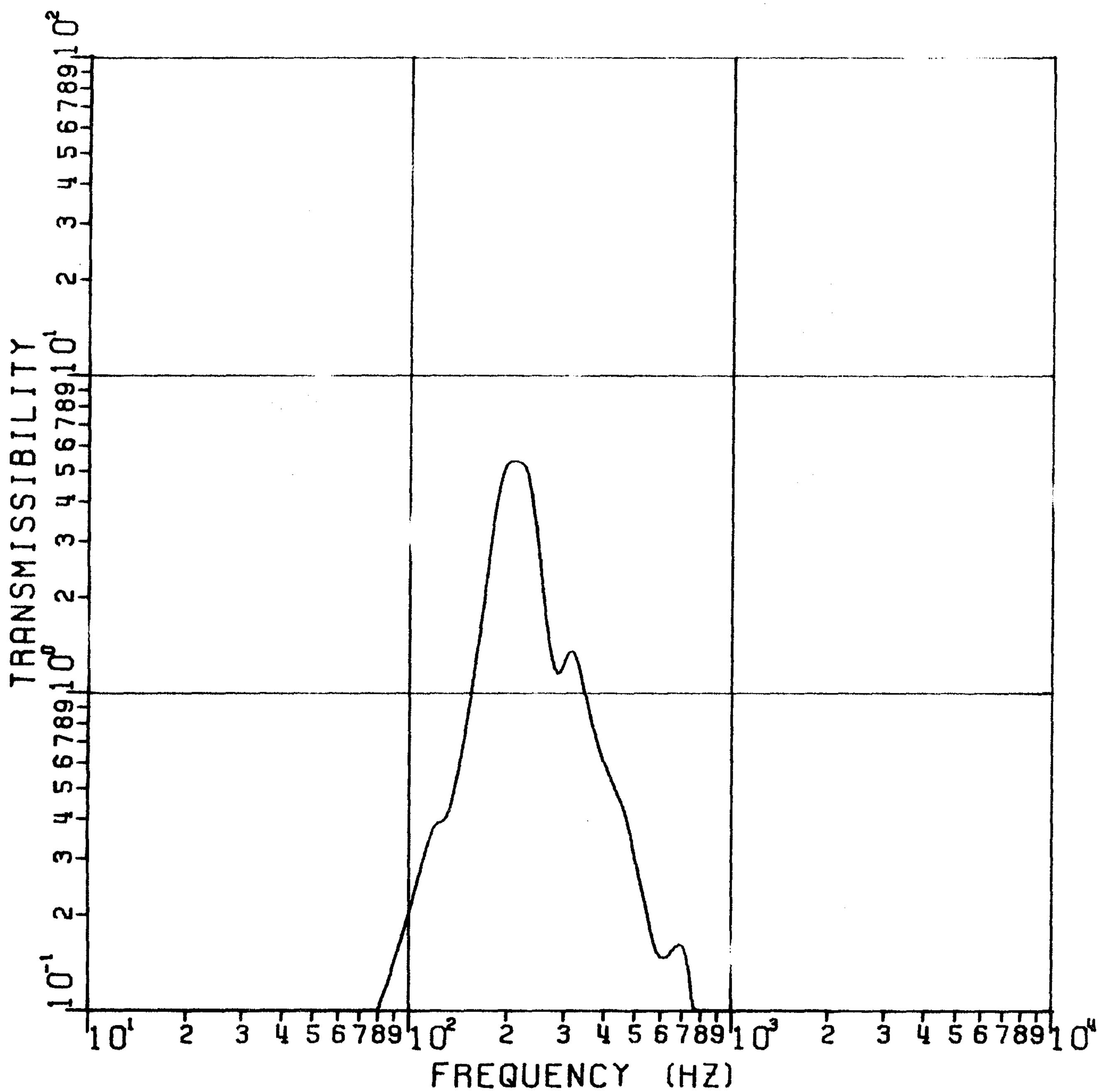
LOCATION 1



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JULY,1970

FIGURE 9a TRANSMISSIBILITY

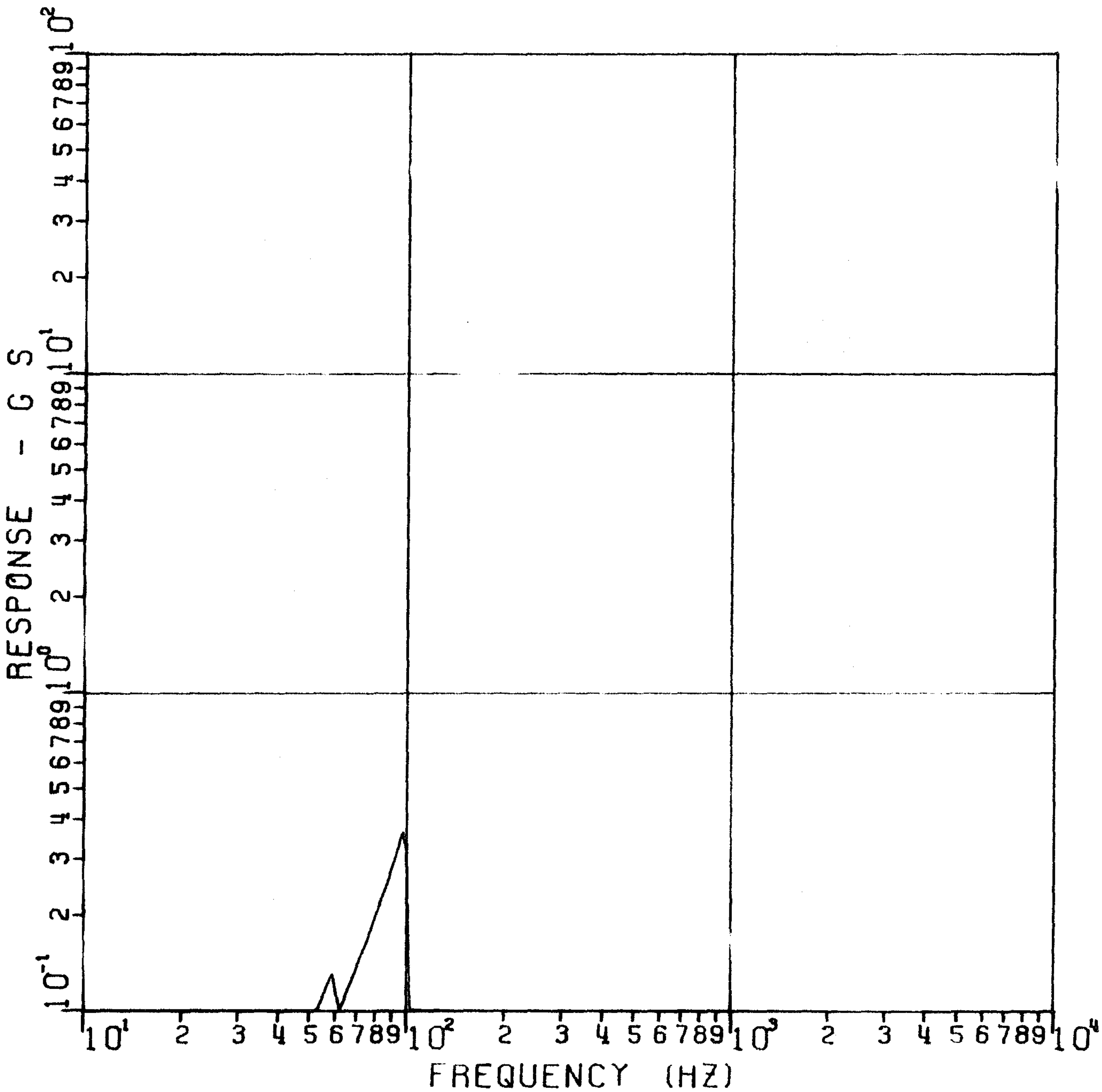
LOCATION 6



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 9b SINE RESPONSE

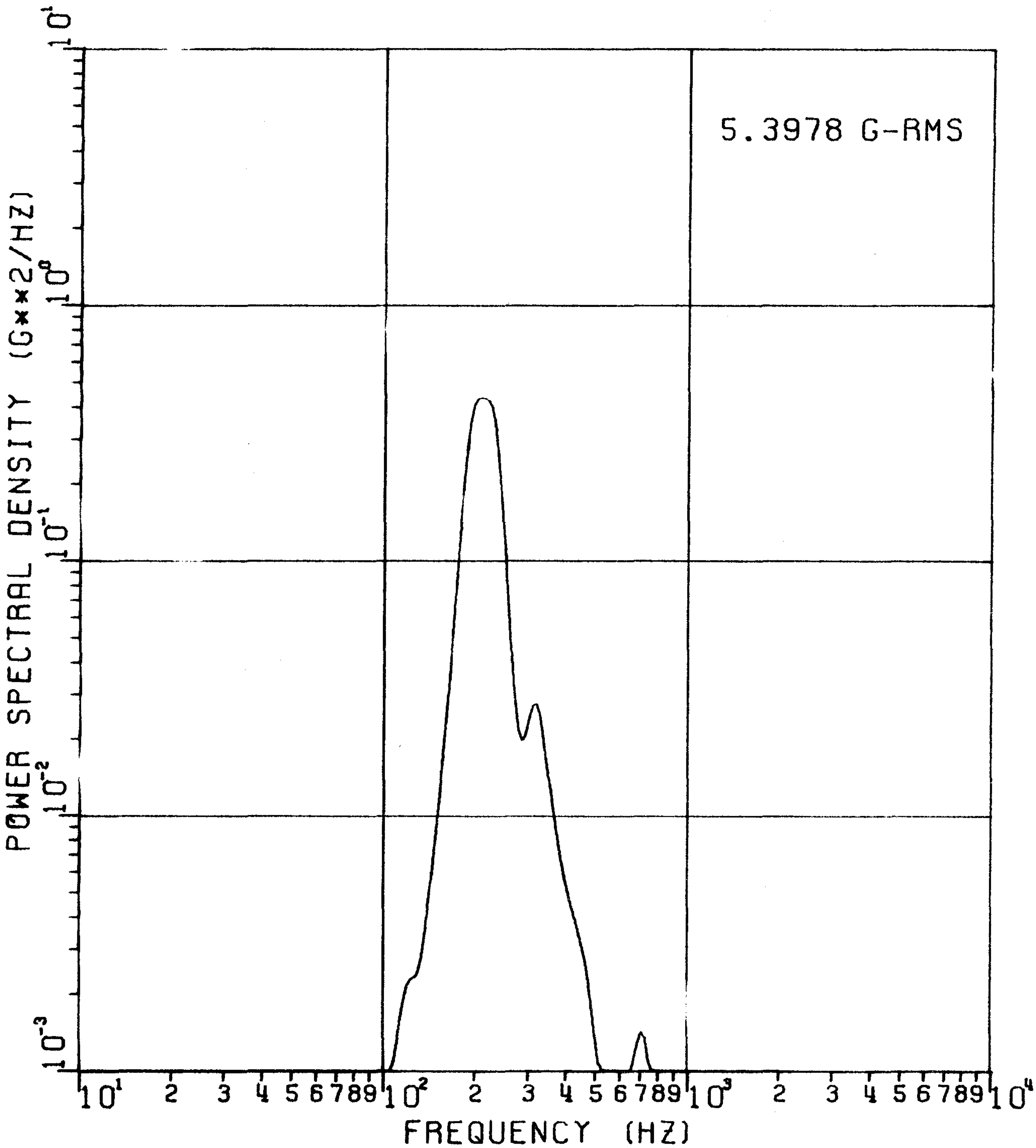
LOCATION 6



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JULY,1970

FIGURE 9c RANDOM VIBRATION SPECTRUM

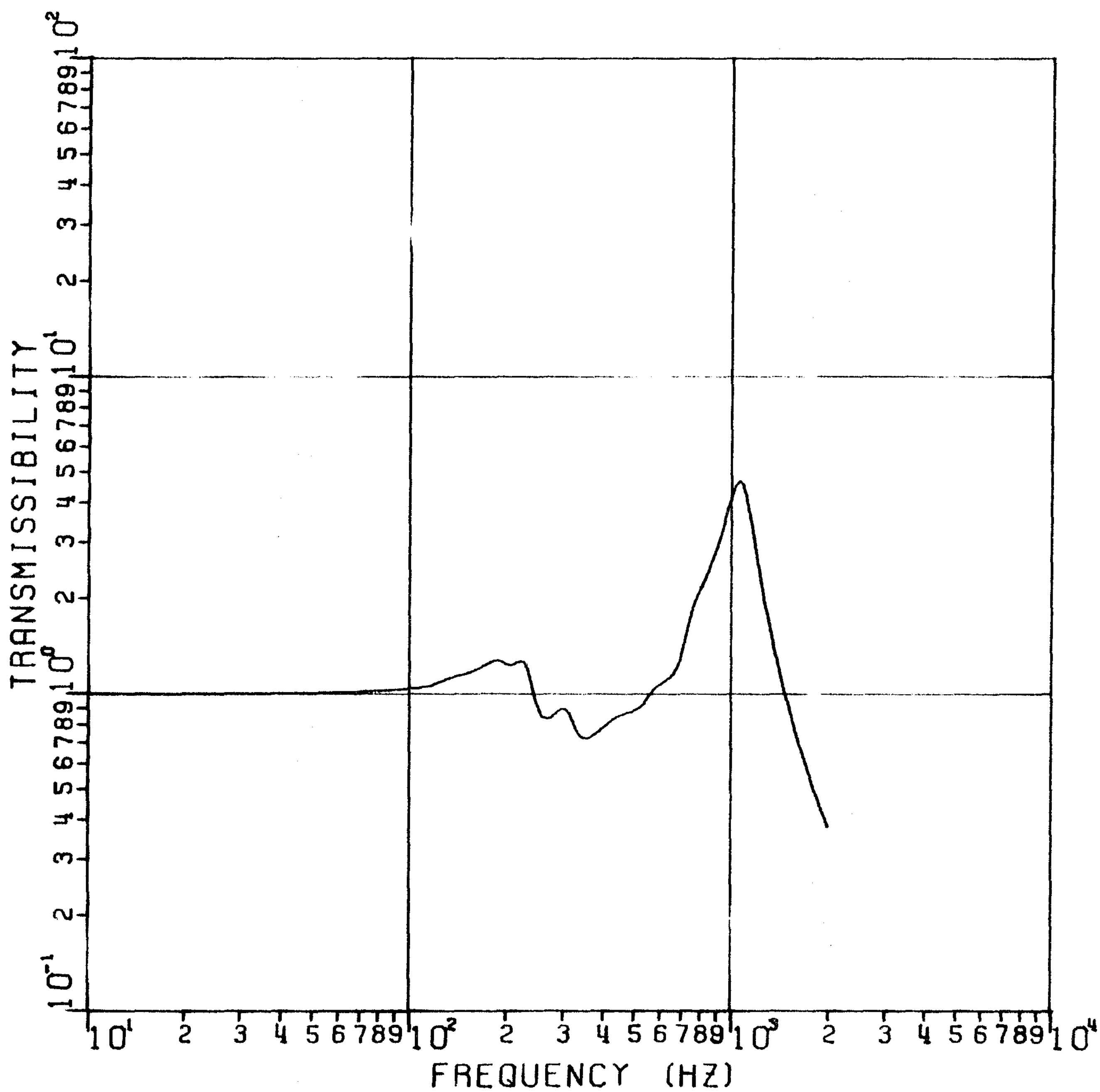
LOCATION 6



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 10a TRANSMISSIBILITY

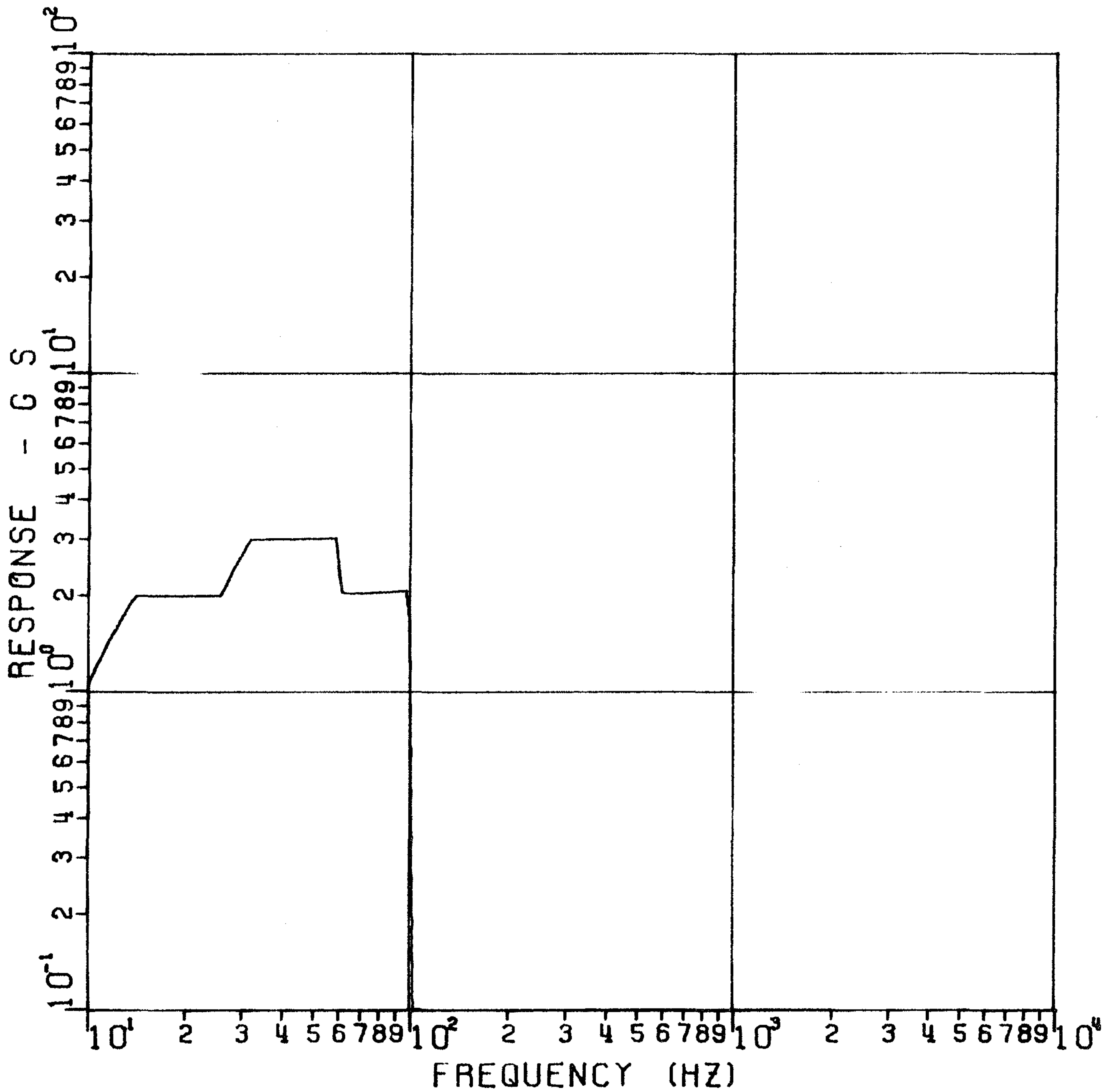
LOCATION 7



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 10b SINE RESPONSE

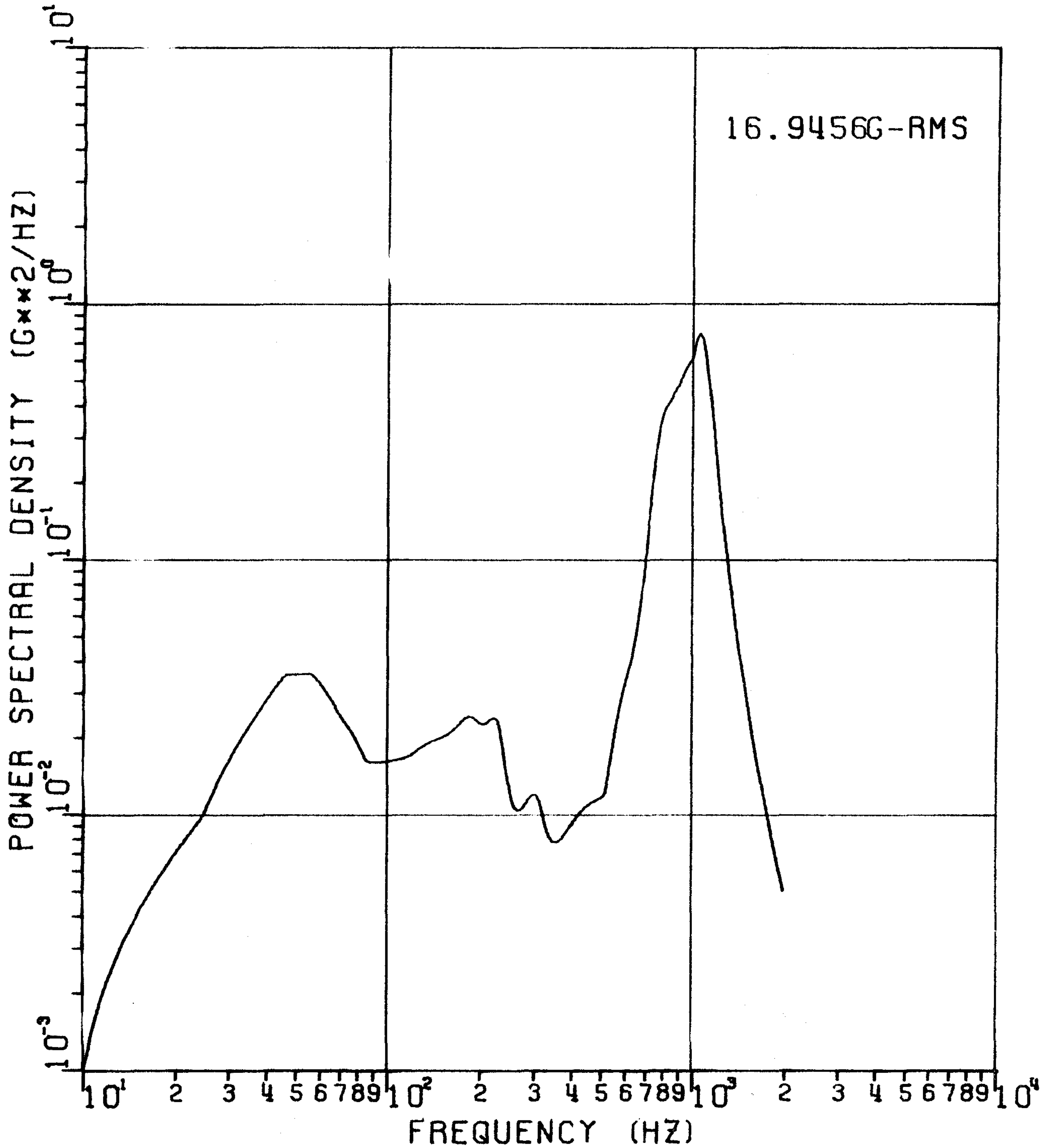
LOCATION 7



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 10c RANDOM VIBRATION SPECTRUM

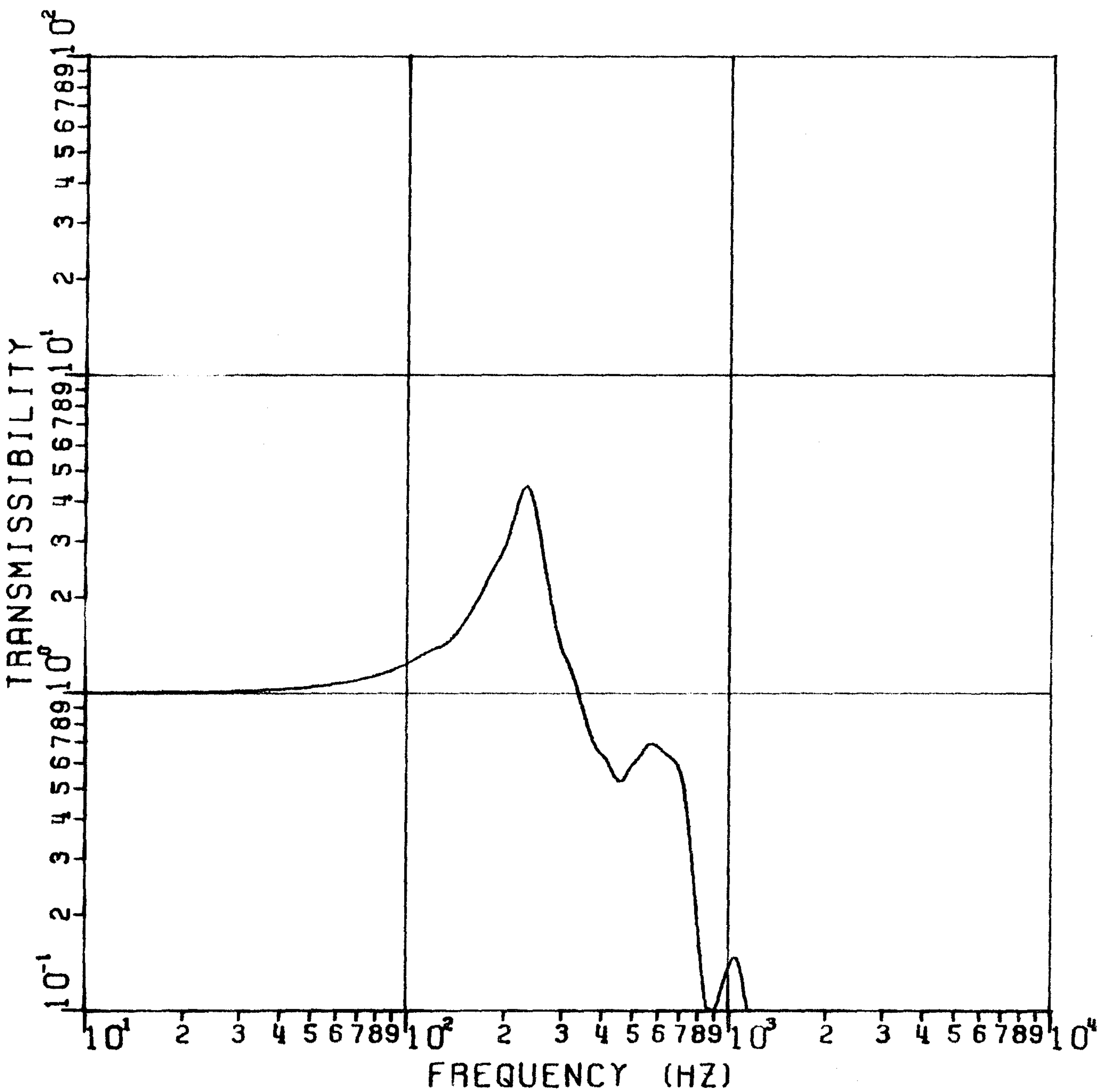
LOCATION 7



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JULY,1970

FIGURE 11a TRANSMISSIBILITY

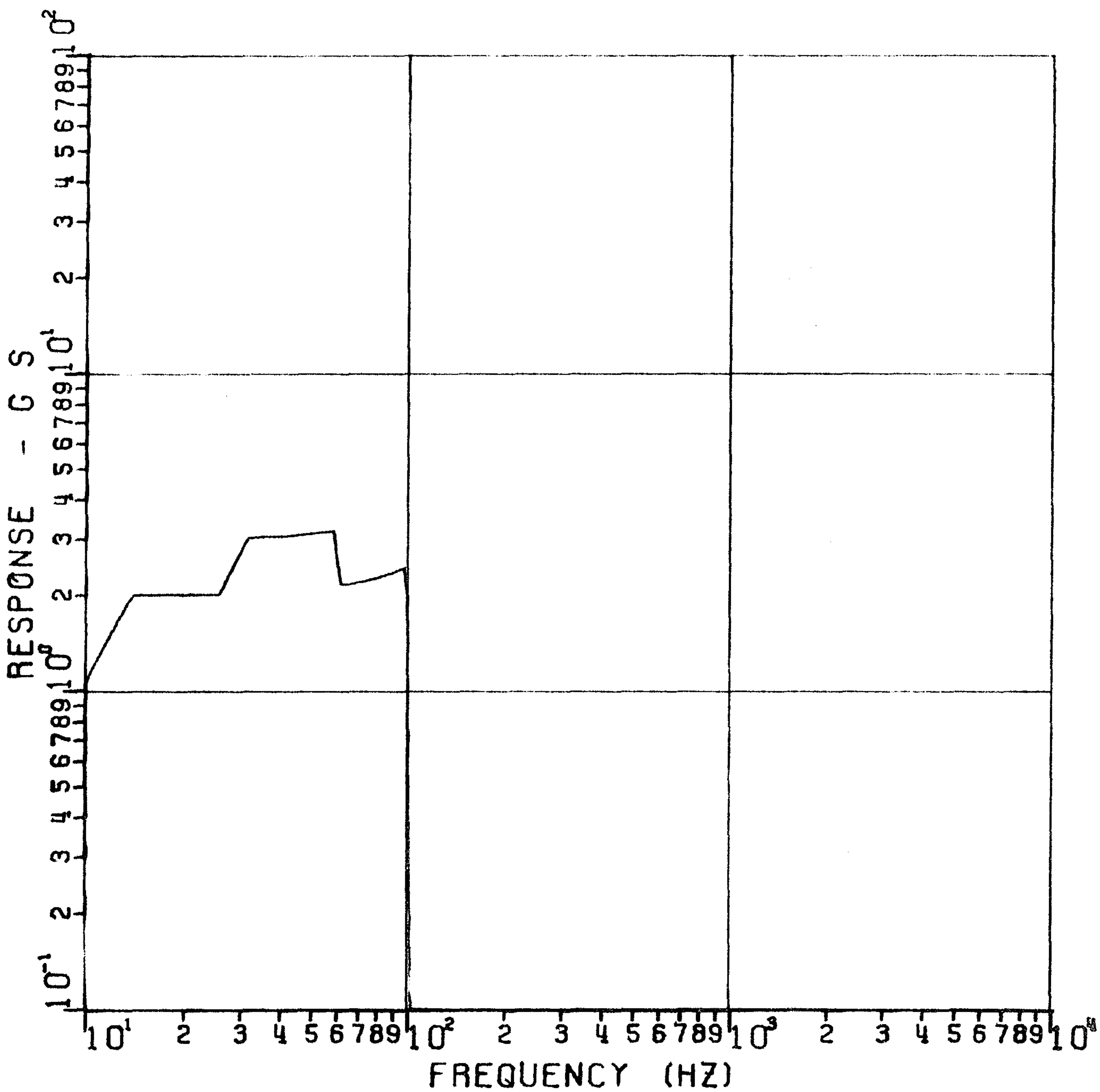
LOCATION 11



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 11 b SINE RESPONSE

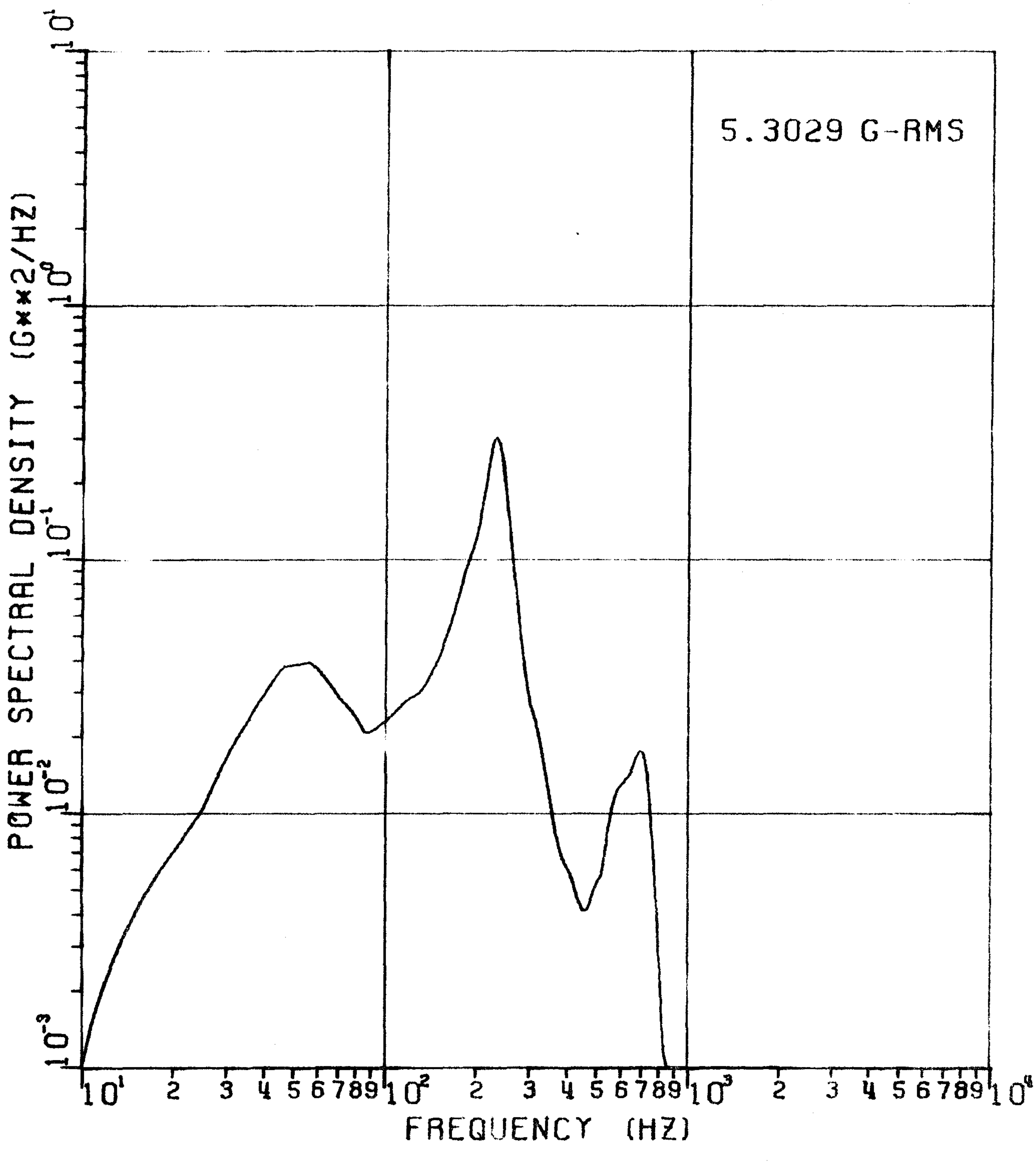
LOCATION 11



1 X AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 11c RANDOM VIBRATION SPECTRUM

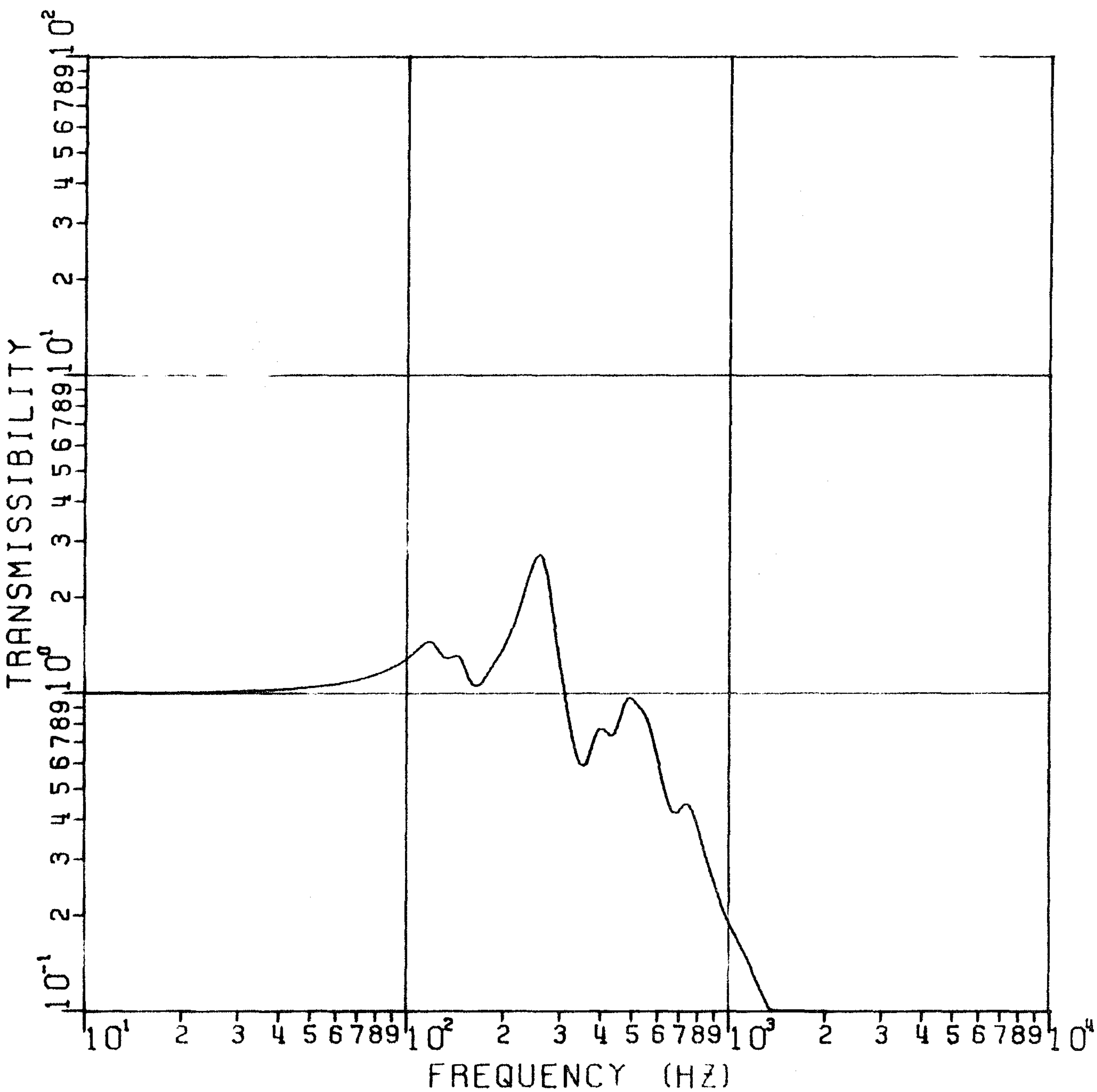
LOCATION 11



1 Y AXIS H.F.E. SUBPALLET ENG. MOD. JULY 1970

FIGURE 12a TRANSMISSIBILITY

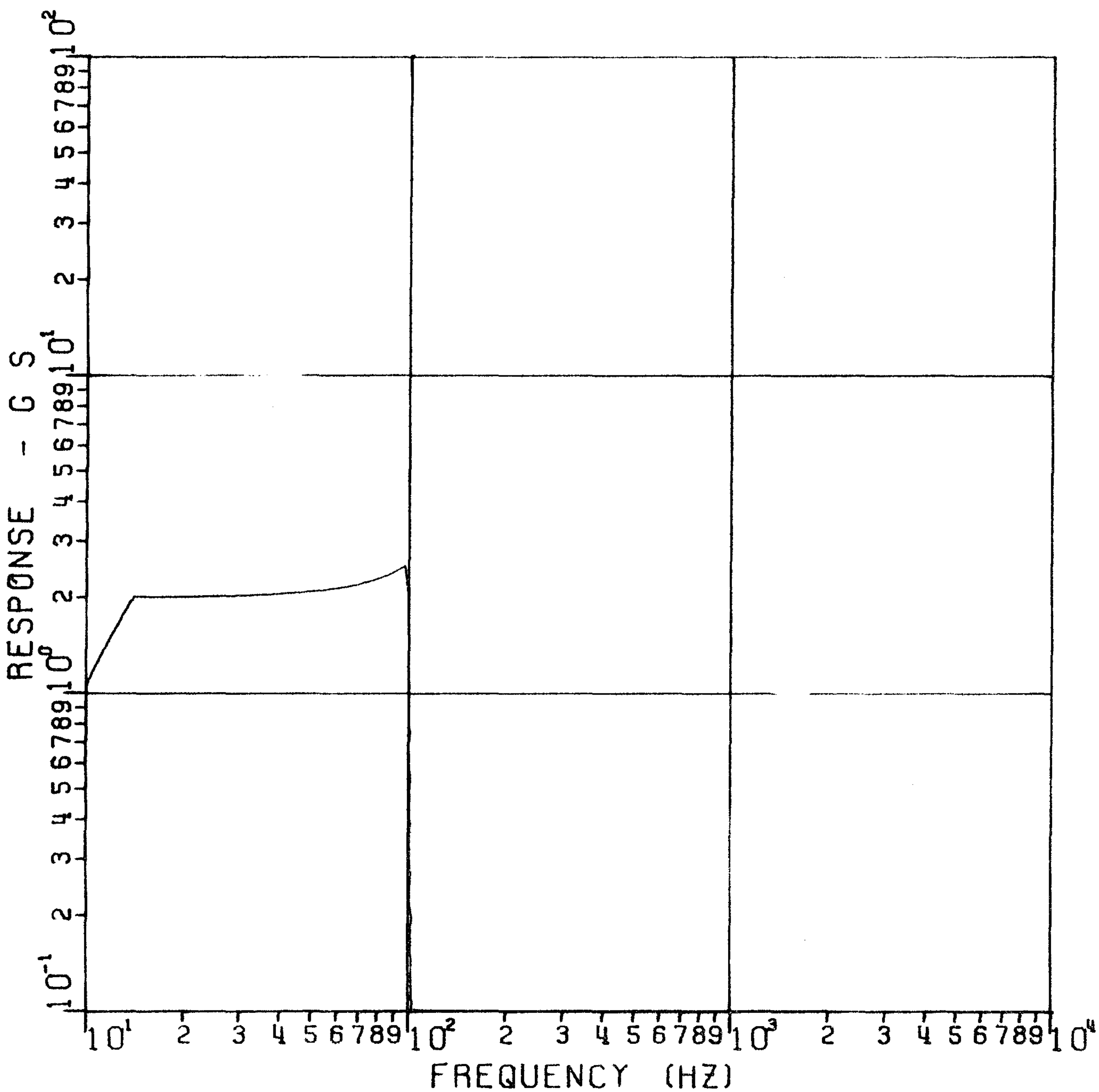
LOCATION 13



1 Y AXIS H.F.E. SUBPALLET ENG. MOD. JULY 1970

FIGURE 12.6 SINE RESPONSE

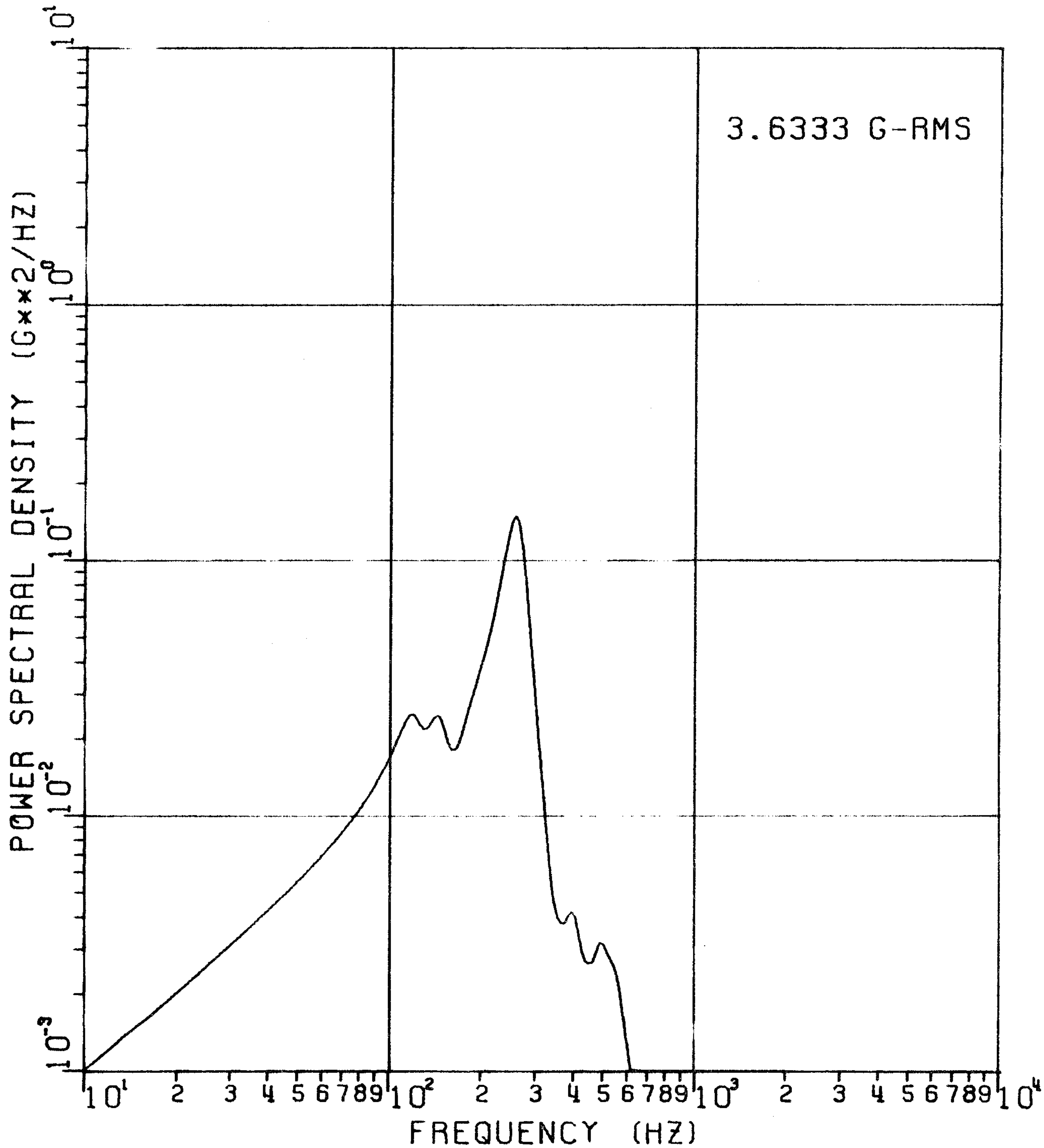
LOCATION 13



1 Y AXIS H.F.E. SUBPALLET ENG. MOD. JULY 1970

FIGURE 12c RANDOM VIBRATION SPECTRUM

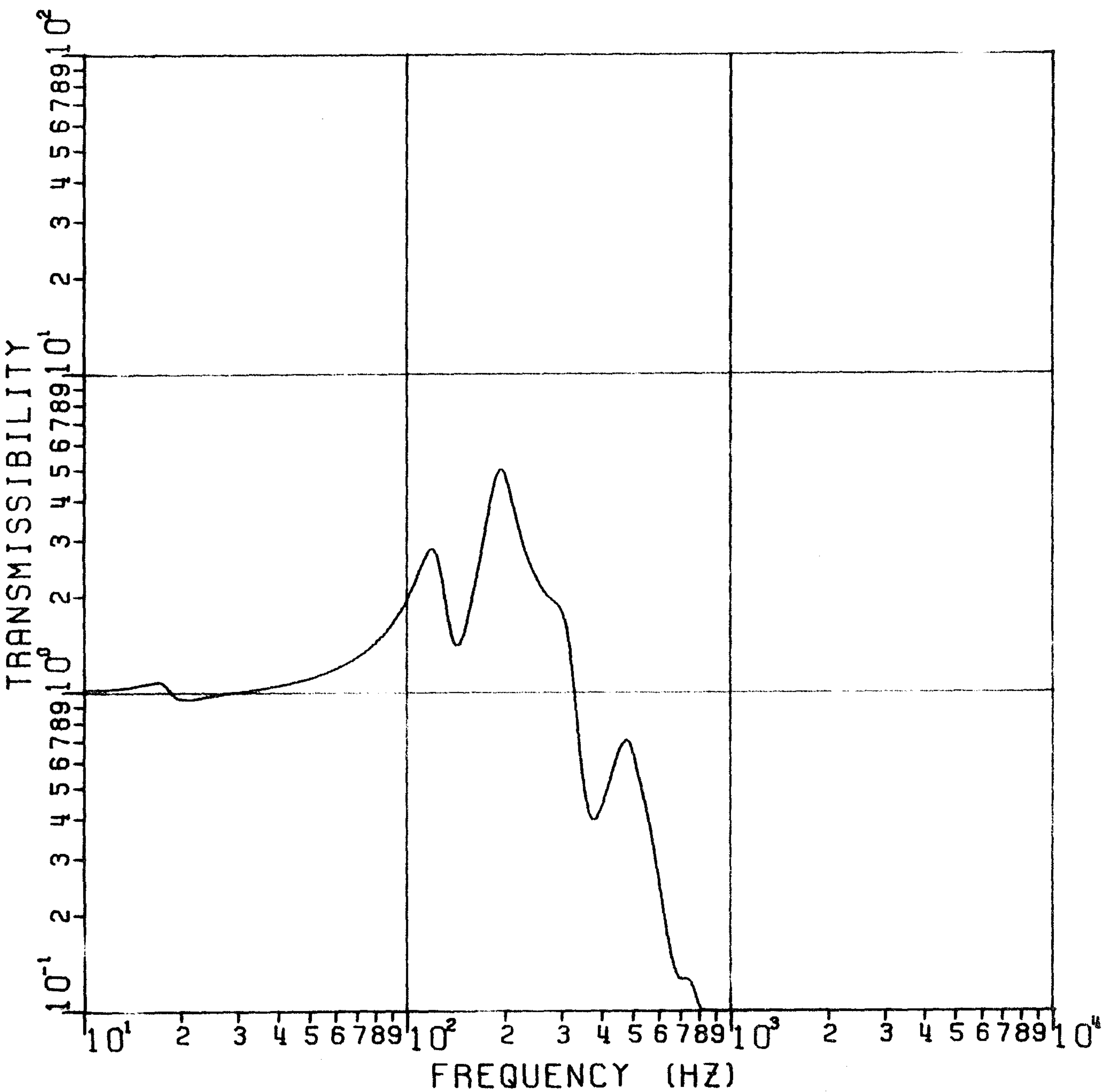
LOCATION 13



1 Z AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 13a TRANSMISSIBILITY

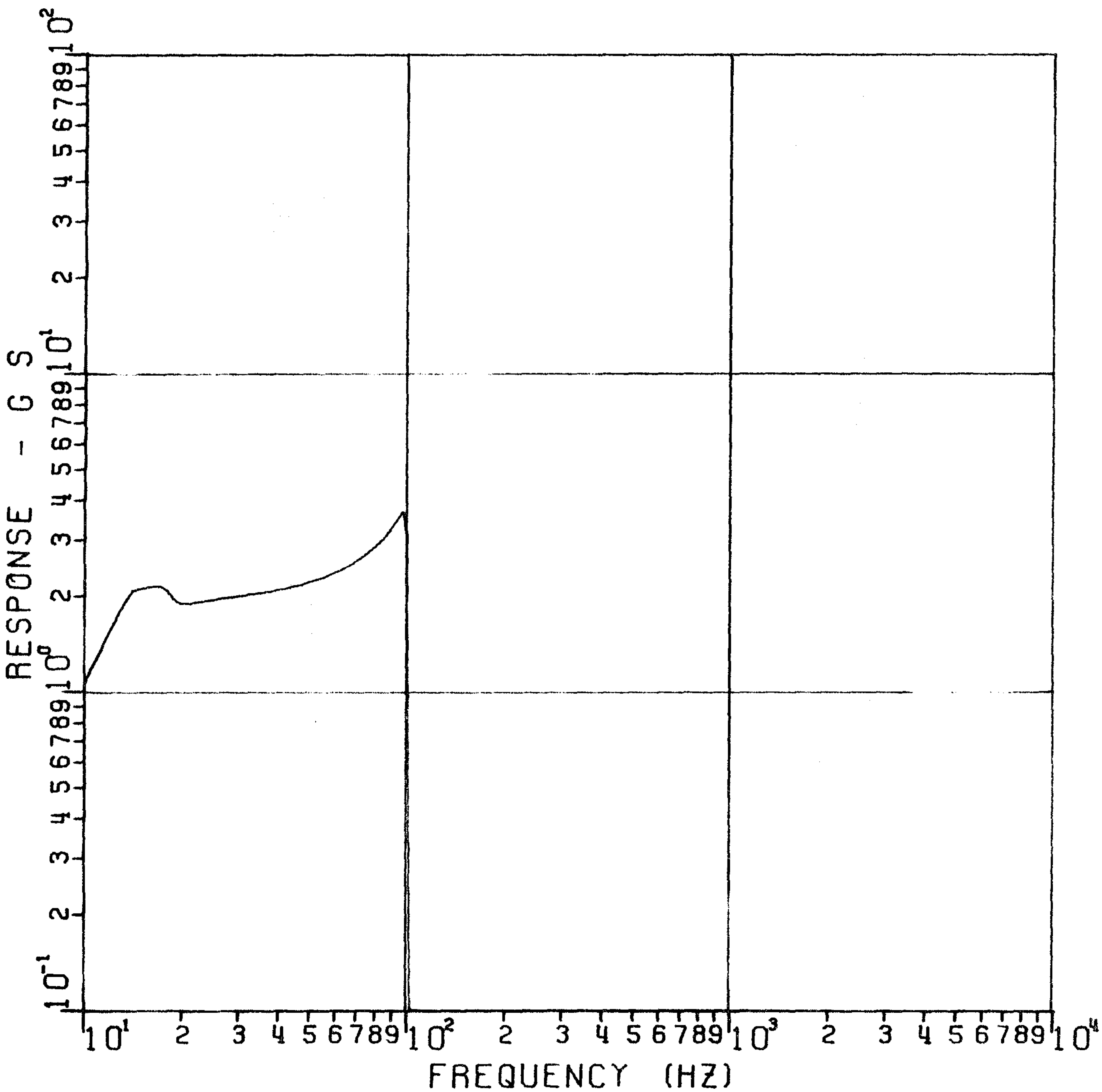
LOCATION 6



1 Z AXIS H.F.E. SUBPALLET ENG. MOD. JULY,1970

FIGURE 13b SINE RESPONSE

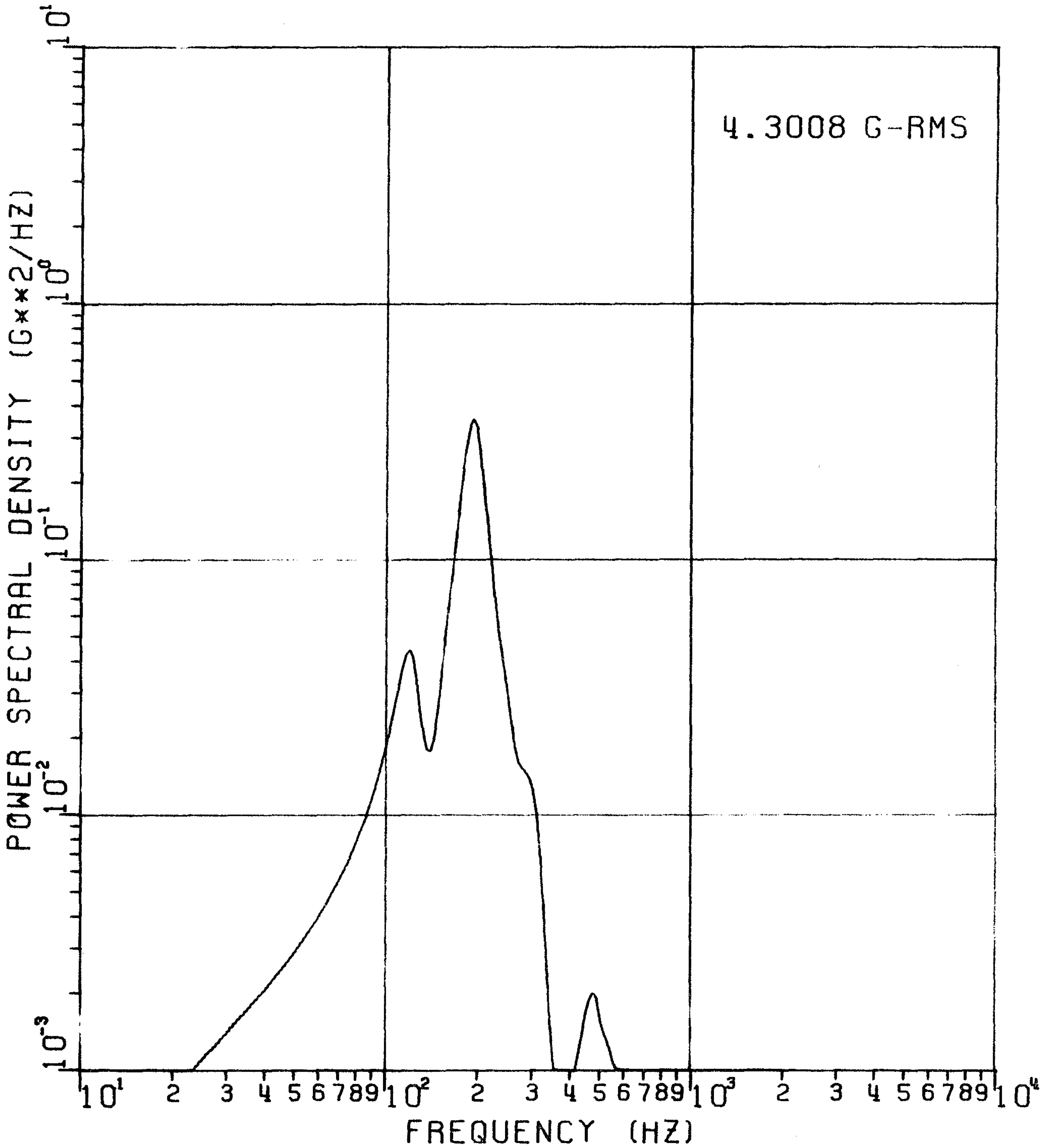
LOCATION 6



1 Z AXIS H.F.E. SUBPALLET ENG. MOD. JULY,1970

FIGURE 13c RANDOM VIBRATION SPECTRUM

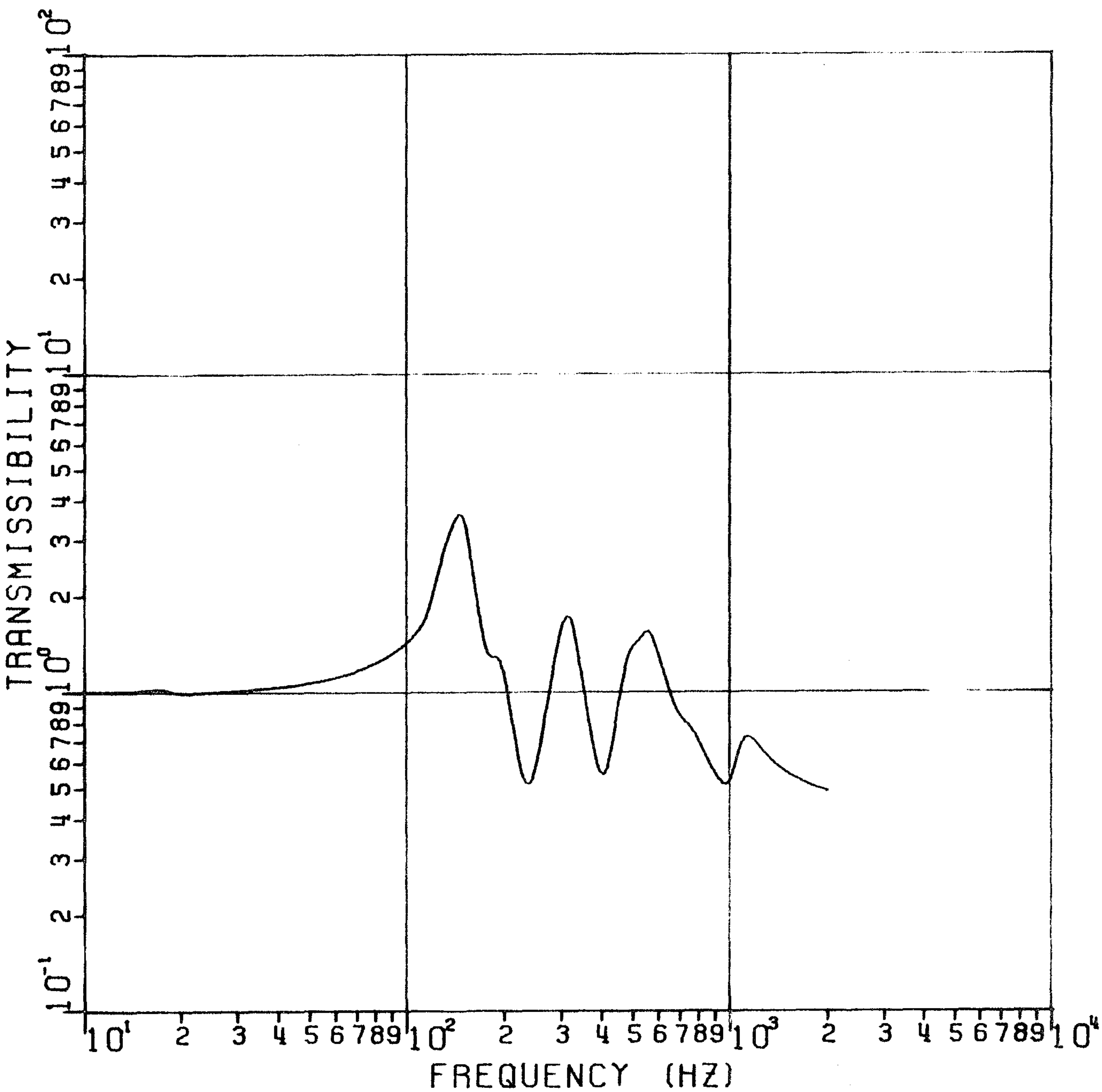
LOCATION 6



1 Z AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE *14a* TRANSMISSIBILITY

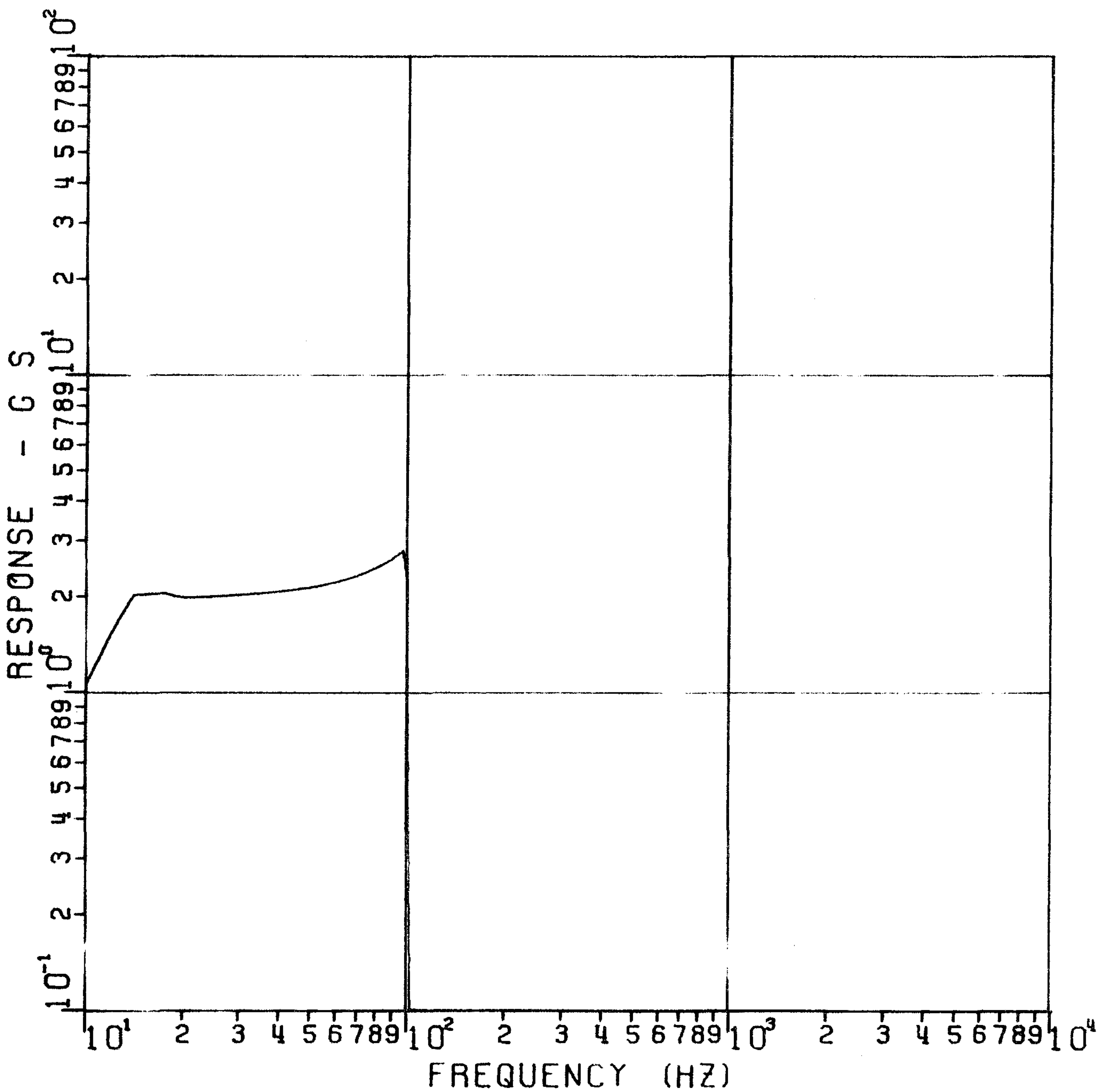
LOCATION 9



1 Z AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 14b SINE RESPONSE

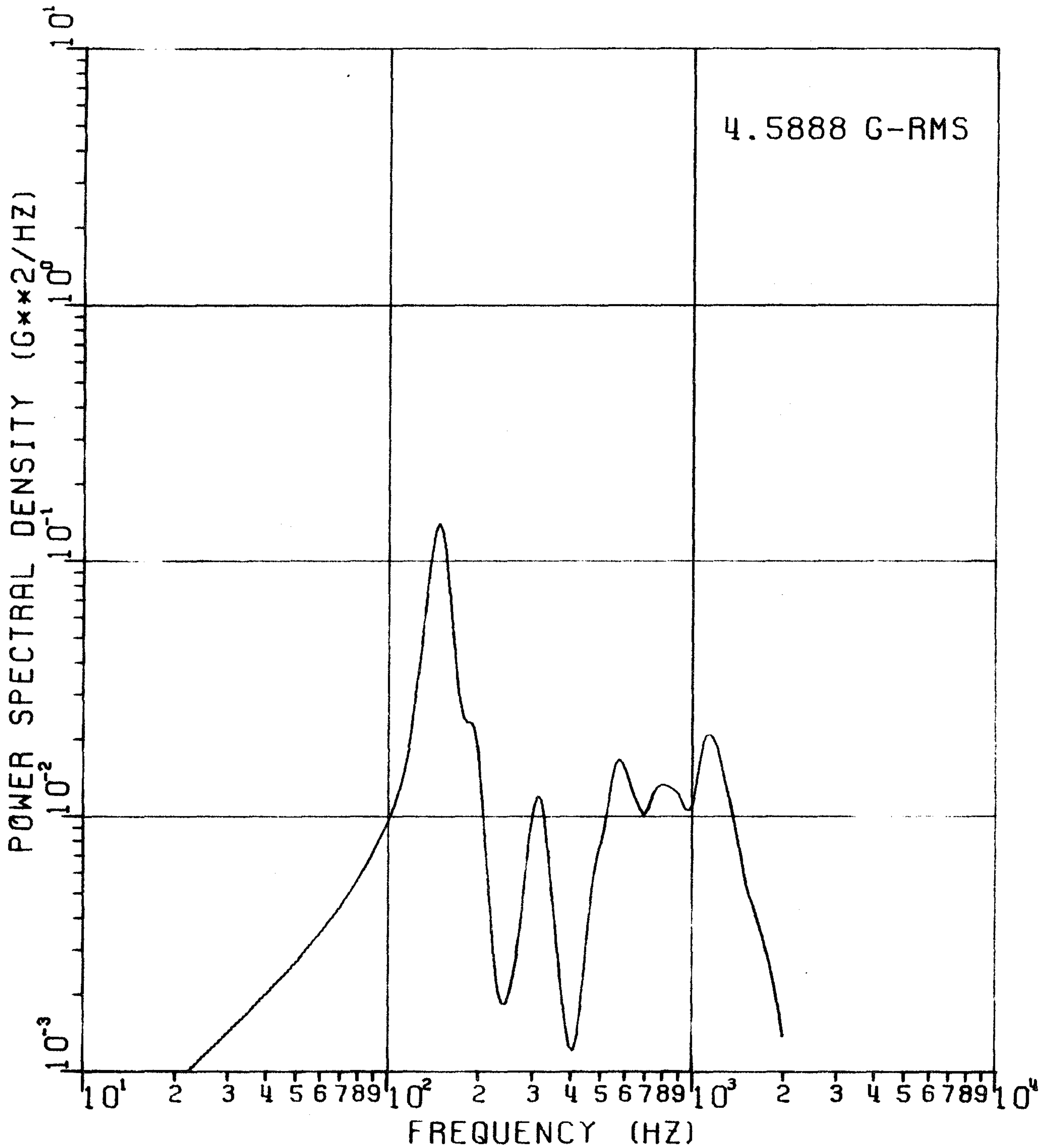
LOCATION 9



1 Z AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 14c RANDOM VIBRATION SPECTRUM

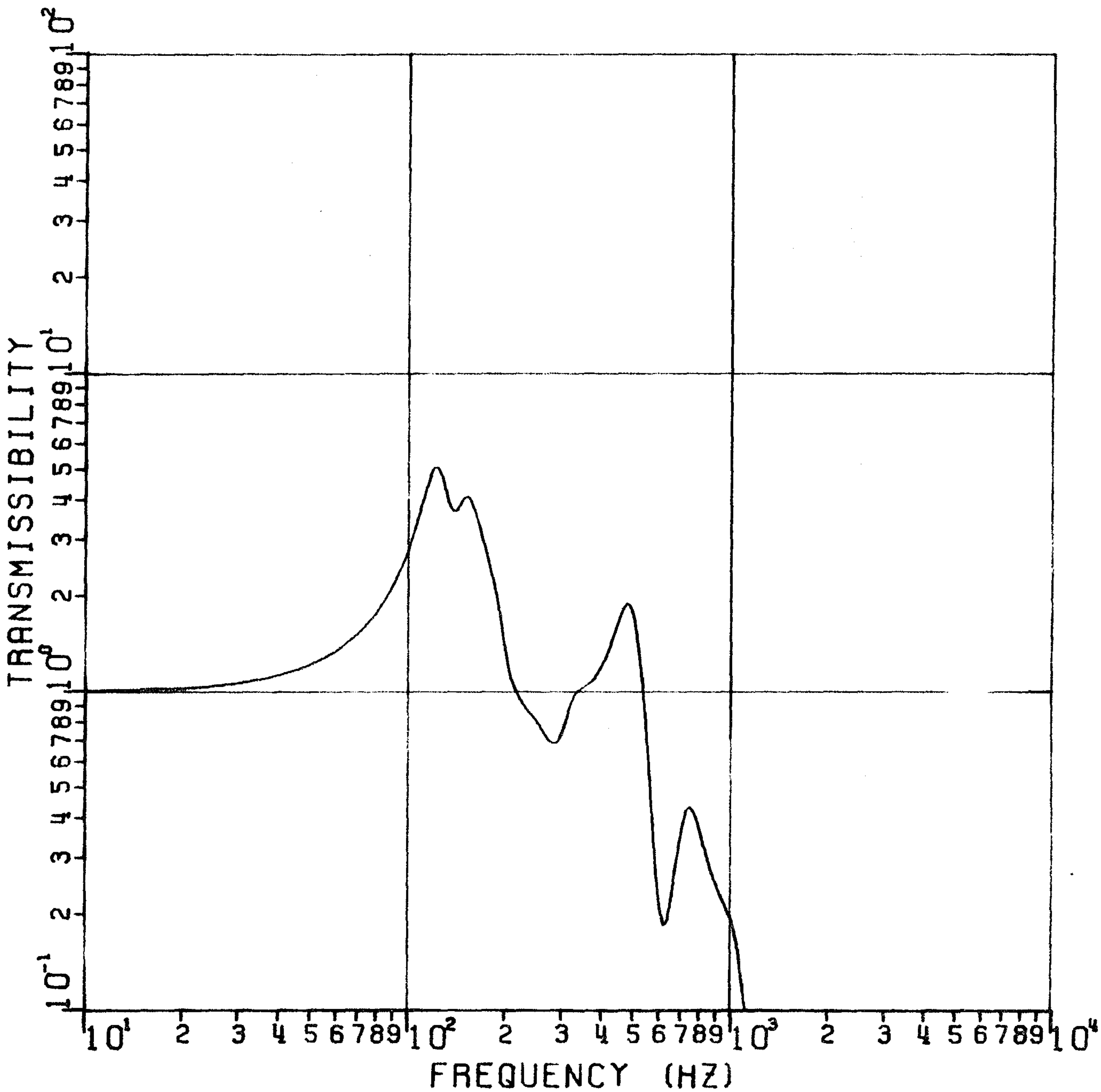
LOCATION 9



1 Z AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 15a TRANSMISSIBILITY

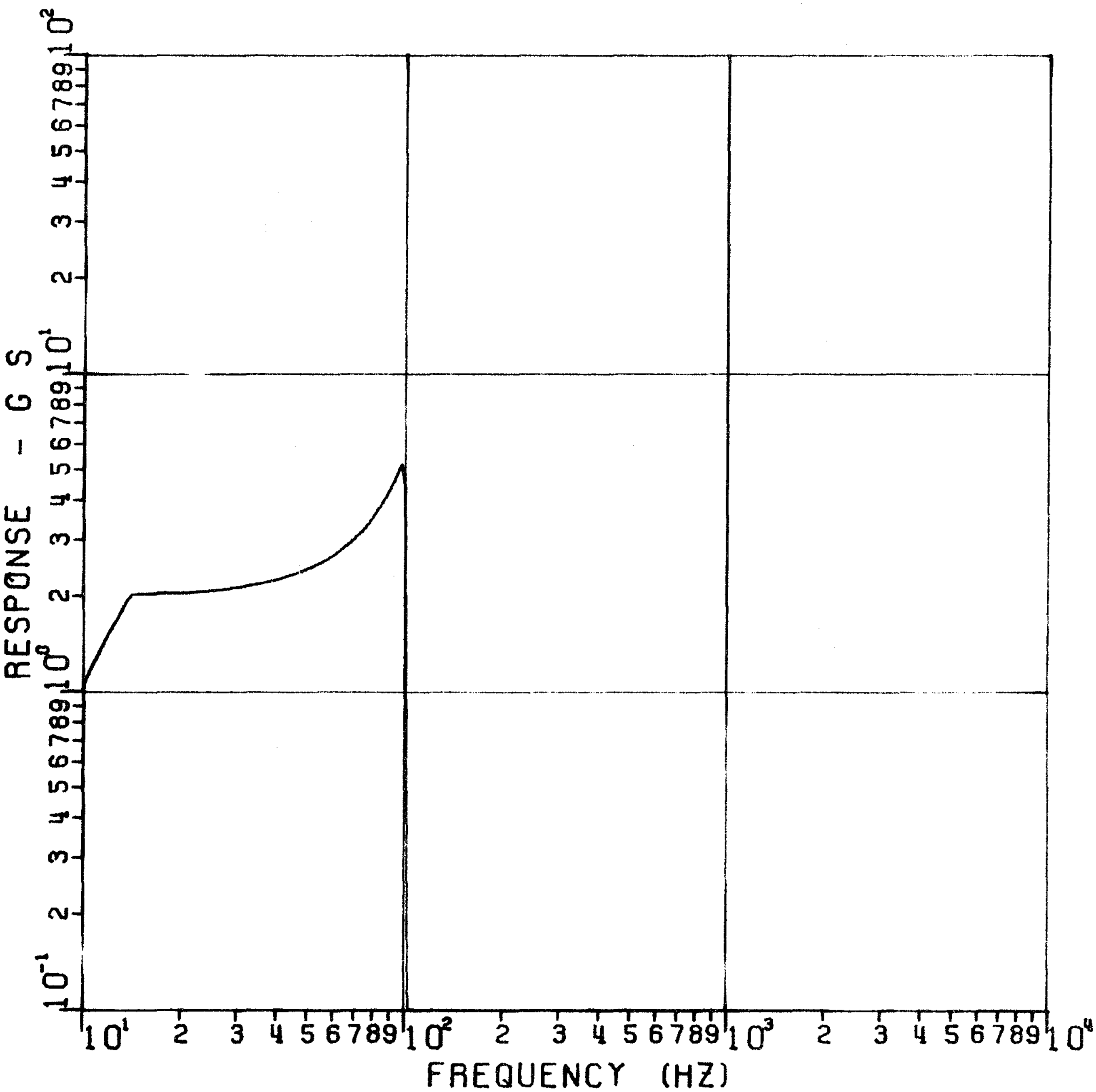
LOCATION 16



1 Z AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 15b SINE RESPONSE

LOCATION 16



1 Z AXIS H.F.E. SUBPALLET ENG. MOD. JULY, 1970

FIGURE 15c RANDOM VIBRATION SPECTRUM

LOCATION 16