The Foxboro Company Foxboro, Massachusetts, U.S.A. 02035 • Telephone (617) 543-8750

January 8, 1975

Transmittal Letter: Test Report No. T4-1025; Seismic Vibration Test of 2ES-N SPEC 200 Rack

The attached test report presents results of ten-cycle sine beat tests of the 2ES-N rack, conducted in accordance with IEEE 344-1971. Peak acceleration values of the applied sine beats were 1.0g and 2.0g at each integer frequency from 1-35 Hz, following a resonant search at 0.5g.

Test results at the 1.0g level were satisfactory in all respects.

Limited problems encountered at the 2.0g level are noted in the report. In our judgement these would not contribute to "functional impairment" of equipment mounted in the rack. However, corrective measures have been determined, and are to be documented and confirmed in future testing.

This report is applicable where user requirements specify input acceleration values equal to or below 1.0g or 2.0g. In such cases required input acceleration values (or curves) may be compared directly with those of Diagram No. 2, which follows page 5 of this report.

Where seismic requirements are specified by a curve of floor response spectra (see attached example, Figure 1), the peak values of the input acceleration of this report, i.e., 1.0g or 2.0g, may be compared to the zero period acceleration (ZPA) of the response curve. In the interest of conservatism, the acceleration values at 33 Hz are more commonly used (per attached example .356g-Horizontal and .202g-Vertical).

Several floor response spectra are normally given in user specifications. The "safe shutdown earthquake" curve or the "required response spectrum" curve for the specified location based on an assumed .04 damping factor generally applies for welded instrumentation racks. It is sometimes specified that curves based on damping factors of .03 or .02 be used; however, it should be recognized that this provides added conservatism.

FOXBORO - J. C. Childs - D370
Staff Engineer
Nuclear Power Products and Standards

jd

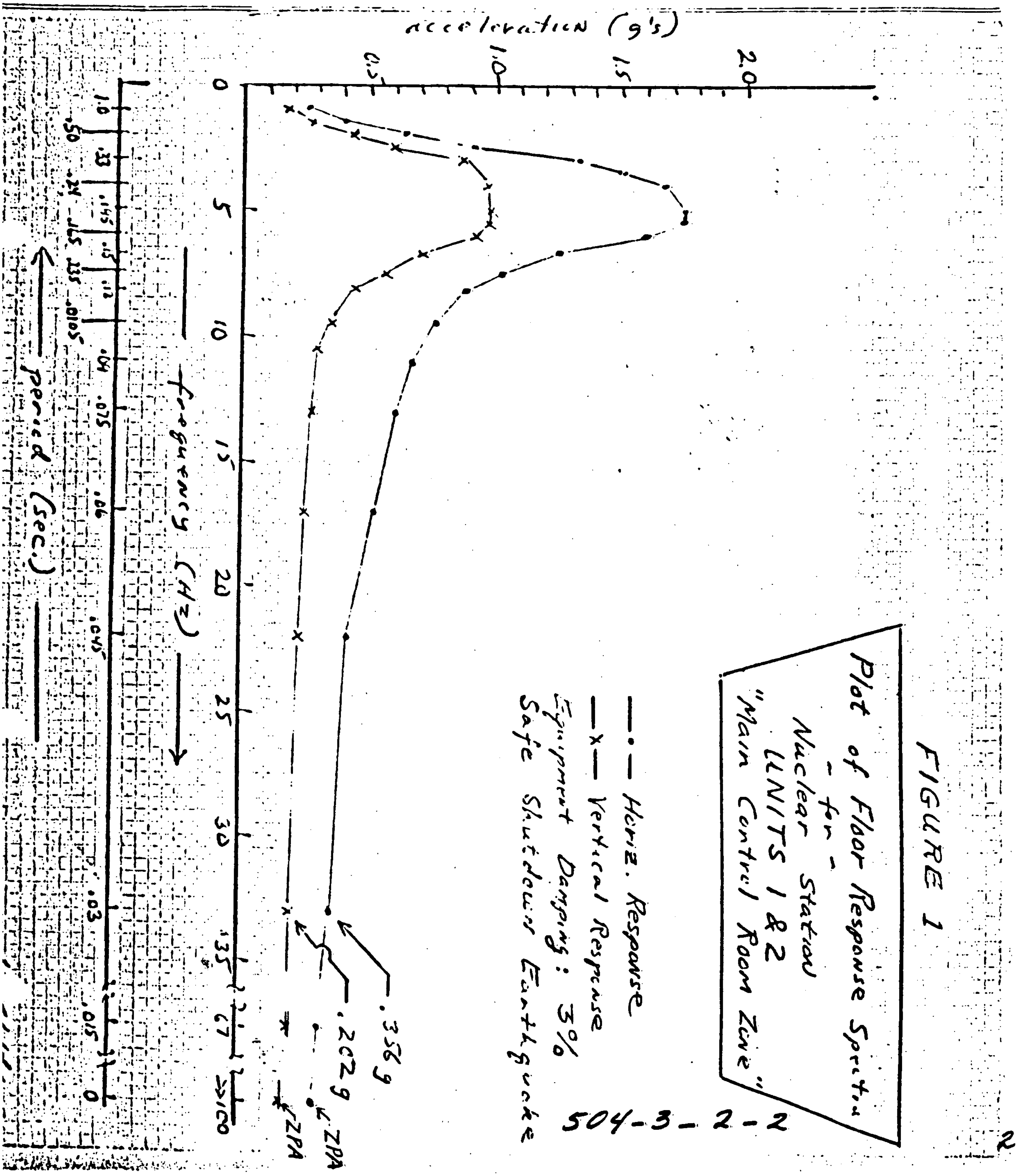
SØ23-504-3-2-2 SCE#0503

FOXBORO

8103060619

THE FOXBORO COMPANY
FOXBORO, MASS.
ENGINEERING DEPARTMENT
FOXBORO
COMPUTATION SKETCH | FOR *Customer Specification*

NAME *Nuclear Station - Units 1 & 2*
CUSTOMER'S ORDER NO.
OUR ORDER NO. *75N-XXXXX*
BY *JCC* CHECKED
DATE *12-2-74*



The Foxboro Company
Test Report No. T4-1025

Seismic Vibration Test
of
2ES-N SPEC 200 Rack

- Tested at -
Acton Environmental Testing
Corporation, Acton, Mass.

IMPORTANT
If the price or schedule is affected by this document approval, Bechtel must be notified prior to fabrication or such claims are waived.
Approval of documents involving calculation, analysis or test report is only an acceptance of the method used by the supplier. Supplier retains full responsibility for design.
Approval of this document does not relieve the supplier from full responsibility for contract or purchase order requirements including, but not limited to, adequacy and suitability of materials and/or equipment represented thereon for the intended function.

DATE RECEIVED 6-2-76	DOC STATUS BY G K Nagary
DOCUMENT STATUS 1 ☒ APPROVED - MANUFACTURER MAY PROCEED 3 ☐ APPROVED EXCEPT AS NOTED. MAKE CHANGES AND RESUBMIT. MANUFACTURER MAY PROCEED AS APPROVED. 4 ☐ NOT APPROVED - CORRECT AND RESUBMIT 7 ☐ INFORMATION ONLY ☐ DISTRIBUTION REQUIRED	DATE 6/25/76 BECHTEL PF-1218 (10079) 12/75

MICROFILM QUALITY ACCEPTABLE

Requested by: J. C. Childs, Dept. 370
F. Riggs, Dept. 368

Reviewed by: J. C. Childs, Staff Engineer
Nuclear Power Products

Approved by: K. G. McCasland, Supervisor
Test & Evaluation Laboratory
Dept. 383

Report Written by: L. Hewey

Tests Conducted by:
L. Hewey and J. Sears
Senior Test & Evaluation Engineers
Test & Evaluation Laboratory
Dept. 383

504-3-2-2

INDEX

504-3-2-2

1.0 Description of Items Tested

Seismic design, double sided SPEC 200 Rack, Model 2ES-N, capable of mounting 19" equipment on both front and back, Drawing No. 10105BJ, Revision A.

2.0 Objective

Determine the effect of seismic vibration on a dummy loaded 2ES-N rack.

3.0 Test Procedure

3.1 Stage 1 -- Resonance Search

a. The dummy loaded rack (per Dwg. No. 10105BJ) was vibrated at a constant acceleration of 0.5g at 1 octave/min from 1 to 35 Hz in three mutually perpendicular axes. The rack and its load were monitored with triaxial accelerometers located as in Diagram No. 4. Two load configurations were tested in each plane. See Diagram No. 1 for a drawing of both loads.

3.2 Stage 2 -- Sine Beat

a. This test consists of vibrating the rack in three mutually perpendicular axes from 1 to 35 Hz. At each test frequency, sine beats (amplitude modulation of the test frequency) of peak acceleration corresponding to levels shown in Diagram No. 2 are applied such that each beat contains ten cycles of the test frequency.

The test period for each frequency was 10 beats followed by a pause between beats of 10 times the beat period. See Diagram No. 3. The rack was loaded in the unbalanced configuration for all sine beat tests. All tests were monitored with a video tape system.

4.0 Conclusions and Recommendations

The rack was subjected to a resonant search at 0.5g, 1 to 35 Hz, and to sine beat acceleration of 1.0 and 2.0g peak amplitude applied at the base of the rack.

Test results at the 1.0g level were satisfactory in all respects.

The results indicate that with minor modifications the rack will be suitable for seismic environments of up to 2.0g's for the loading configurations tested.

Slight deformation of the rack base and of the external base mounting plate occurred during testing in the side-to-side direction at 2g's. This would not be expected to occur in installations where two or more racks are joined together side-by-side.

Strengthening of these members may be required. Alternatively, redimensioning the external base mounting plate such that the plate covers the complete base mounting area and moving the outside mounting holes further outward (towards the side of the rack) are suggested for consideration.

Also, the door latching mechanisms proved to be a problem as well as the doors themselves. The latching mechanisms at the top and bottom of the door became bent. Spot welds on the door stiffener broke due to fatigue under vibration, necessitating removal of the doors for the remaining tests.

Other than the above, the integrity of the rack structure, of the mounting hardware for the rack-mounted modules, and of the modules (nests, cards, power supplies) was maintained throughout the test. That is, no slipping or sliding of the rack-mounted equipment or internal mechanical failures of individual modules were noted.

The predominant resonance of the rack in the front-to-back and side-to-side directions occurred at 22 Hz and 12 Hz, respectively, during the resonant search at 0.5g input. There was no obvious resonance in the vertical plane within the 1 to 35 Hz frequency range. The maximum amplification factor as measured at the top of the rack itself was 10, occurring at both 22 and 12 Hz.

The continuous sine input applied during the resonant search would, of course, be expected to produce greater amplification factors than the sine beat inputs applied at the 1.0 and 2.0g levels.

During the tests at the 1.0g level, the predominant resonant frequencies in the front-to-back and side-to-side directions dropped to 18 Hz and 10 to 11 Hz, respectively. The maximum amplification factor measured at the top of the rack itself was 6 at both frequencies. At the rear of a nest located at the top level of the rack, amplification factors of 6.5 (front-to-back) and 8.0 (side-to-side) were obtained.

4.0 Conclusions and Recommendations (Cont.)

Significant amplification factors were also measured at 1.0g input at the rear of a power supply located at the 3rd level front location of the rack. This is the highest position anticipated for location of power supplies in racks for seismic applications. Amplification factors measured were 6.5 (front-to-back, 18 Hz), 5.0 (side-to-side, 11 Hz), and 6.5 (vertical, 22 Hz).

Testing at the 2.0g level produced a marked lowering of resonant frequencies measured on the rack itself. The predominant resonance in the front-to-back direction occurred at 15 Hz with an amplification factor of 2.2 measured at the top of the rack.

In the side-to-side direction the most significant resonance occurred at 8 Hz with an amplification factor of 6.0 at the top of the rack. On the nest located at the top level of the rack, amplification factors of 6.0 (front-to-back) and 7.5 (side-to-side) were obtained. The maximum amplification factor measured on the power supply was 4.0 (in the vertical direction).

The damping of the rack was found to be approximately 0.05 during the resonant search and approximately .08 during the sine beat tests at 1 and 2g's.

It should be noted that one rack was subjected to the entire testing sequence (three series of single frequency tests in each of three axis at three acceleration levels). The endurance testing aspect of this sequence of tests should be taken into account in evaluating these test results relative to a short duration seismic event.

5.0 Summary of Test Results

5.1 Resonance Search

a. Vertical Plane

1. Balanced Configuration (refer to Diagram No. 1)

   Refer to Graph No's. 6, 12, 18 & 24

2. Unbalanced Configuration (refer to Diagram No. 1)

   Refer to Graph No's. 5, 11, 17 & 23

b. Horizontal Plane (Front-to-Back)

1. Balanced Configuration

   Refer to Graph No's. 2, 8, 14 & 20

2. Unbalanced Configuration

   Refer to Graph No's. 1, 7, 13 & 19

c. Horizontal Plane (Side-to-Side)

1. Balanced Configuration

   Refer to Graph No's. 4, 10, 16 & 22

2. Unbalanced Configuration

   Refer to Graph No's. 3, 9, 15 & 21

5.2 Sine Beat at 1g

a. Horizontal Plane (Front-to-Back)

Refer to Graph No's. 25, 28, 31 & 34

b. Horizontal Plane (Side-to-Side)

Refer to Graph No's. 26, 29, 32 & 35

c. Vertical Plane

Refer to Graph No's. 27, 30, 33 & 36

504-3-2-2

5.0 Summary of Test Results (Cont.)

5.3 Sine Beat at 2g's

a. Horizontal Plane (Front-to-Back)

Refer to Graph No's. 37, 40, 43 & 46

b. Horizontal Plane (Side-to-Side)

Refer to Graph No's. 38, 41, 44 & 47

c. Vertical Plane

Refer to Graph No's. 39, 42, 45 & 48

504-3-2-2

6.0 GRAPH NO. INDEX

Point of Acceleration Measurement	Table Excitation	Graph No. at the following Acceleration Levels 0.5g	1.0g	2.0g
Front Top Center of Rack	F-B	1, 2	25	37
Front Top Center of Rack	S-S	3, 4	26	38
Front Top Center of Rack	V	5, 6	27	39
Center Side of Rack	F-B	7, 8	28	40
Center Side of Rack	S-S	9, 10	29	41
Center Side of Rack	V	11, 12	30	42
Rear of Top Nests	F-B	13, 14	31	43
Rear of Top Nests	S-S	15, 16	32	44
Rear of Top Nests	V	17, 18	33	45
Rear of Power Supply	F-B	19, 20	34	46
Rear of Power Supply	S-S	21, 22	35	47
Rear of Power Supply	V	23, 24	36	48

504-3-2-2

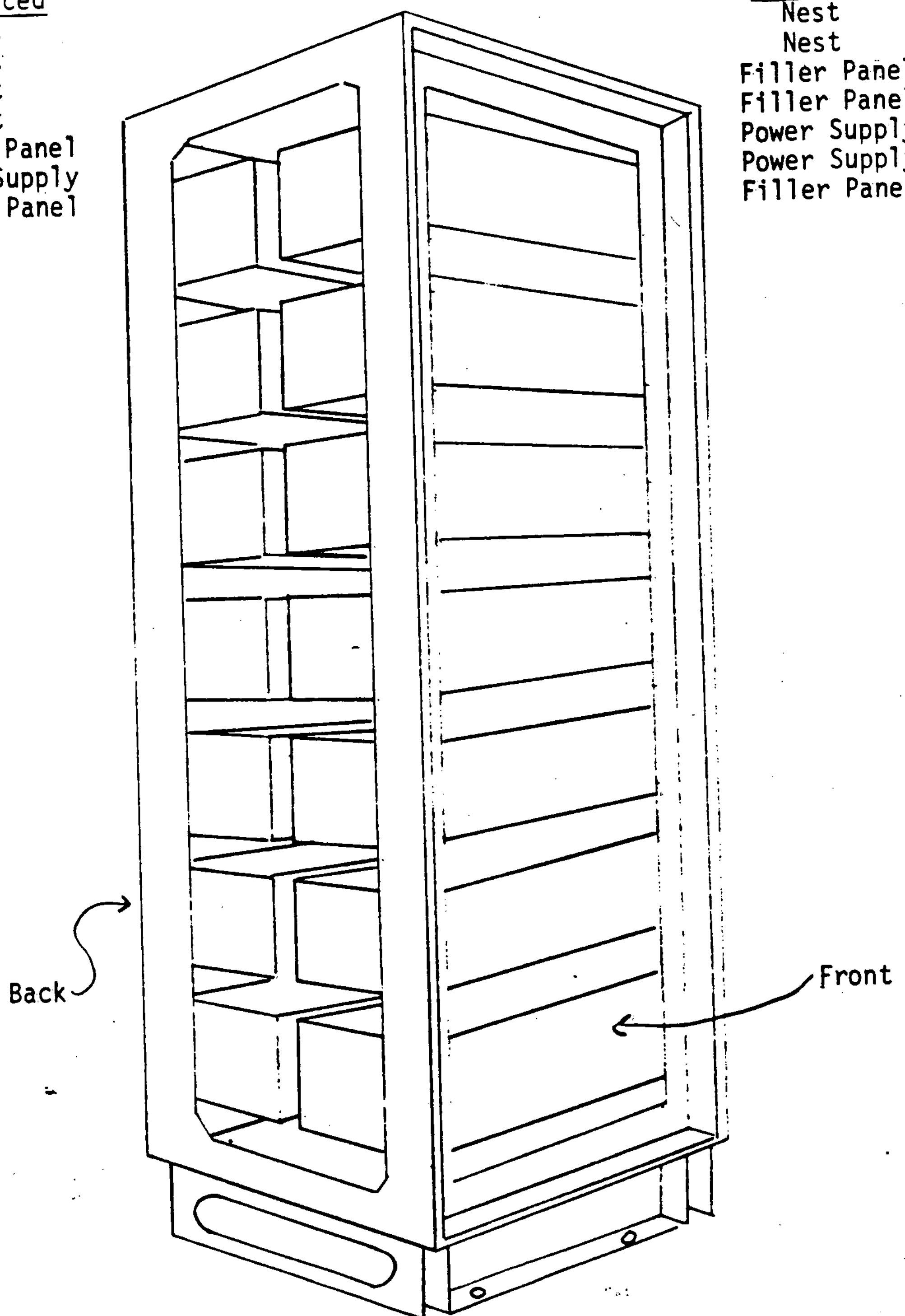
DIAGRAM NO. 1
RACK LOADING CONFIGURATIONS
TEST NO. T4-1025   SEPT. 24, 1974

Back Side Loading
Top-to-Bottom

Unbalanced	Balanced
Nest	Nest
Nest	Nest
Nest	Nest
Nest	Nest
Nest	Filler Panel
Nest	Power Supply
Nest	Filler Panel

Front Loading
Top-to-Bottom

Unbalanced	Balanced
Nest	Nest
Nest	Nest
Filler Panel	Nest
Filler Panel	Nest
Power Supply	Filler Panel
Power Supply	Power Supply
Filler Panel	Filler Panel



504-3-2-2

DIAGRAM NO. 2
SEISMIC TEST LEVELS
PEAK ACCELERATION VERSUS FREQUENCY
TEST NO. 74-1025   AUG., 1974

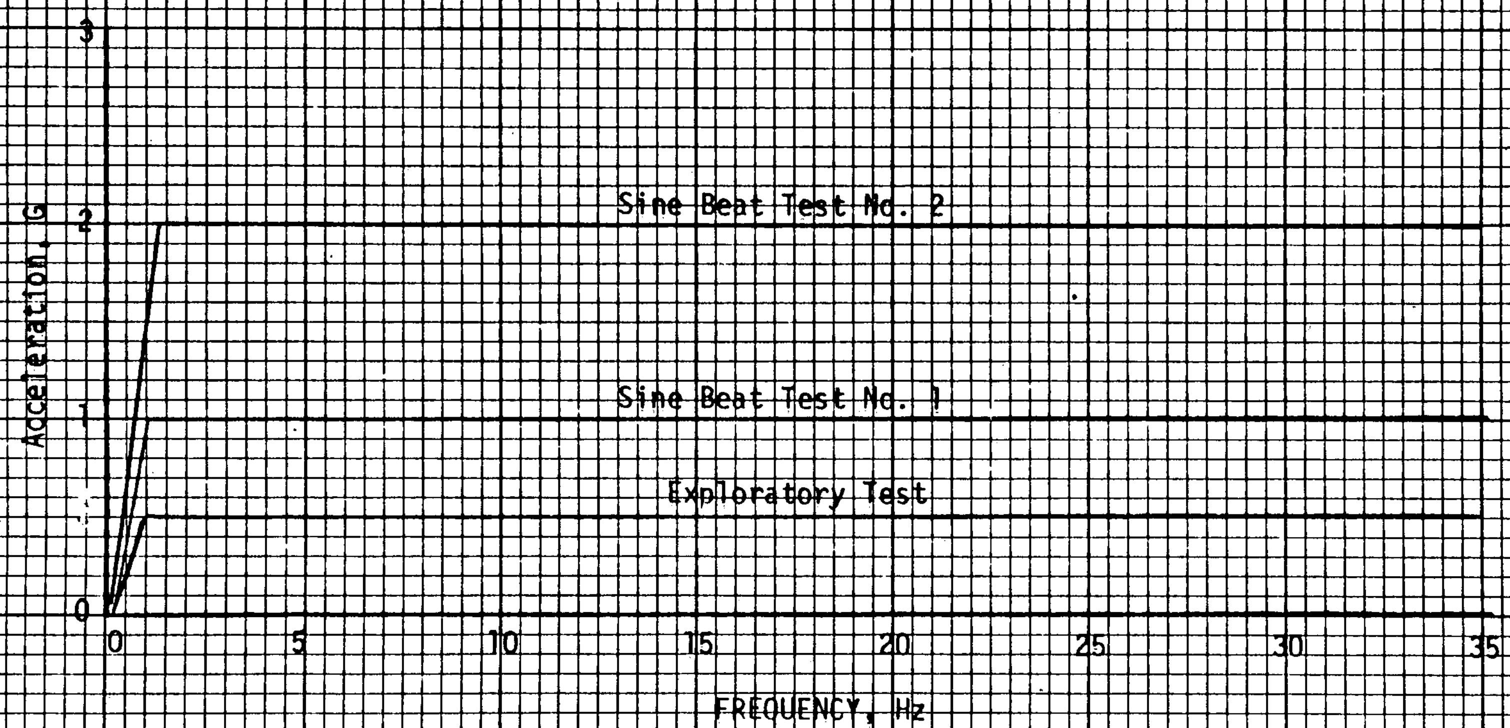
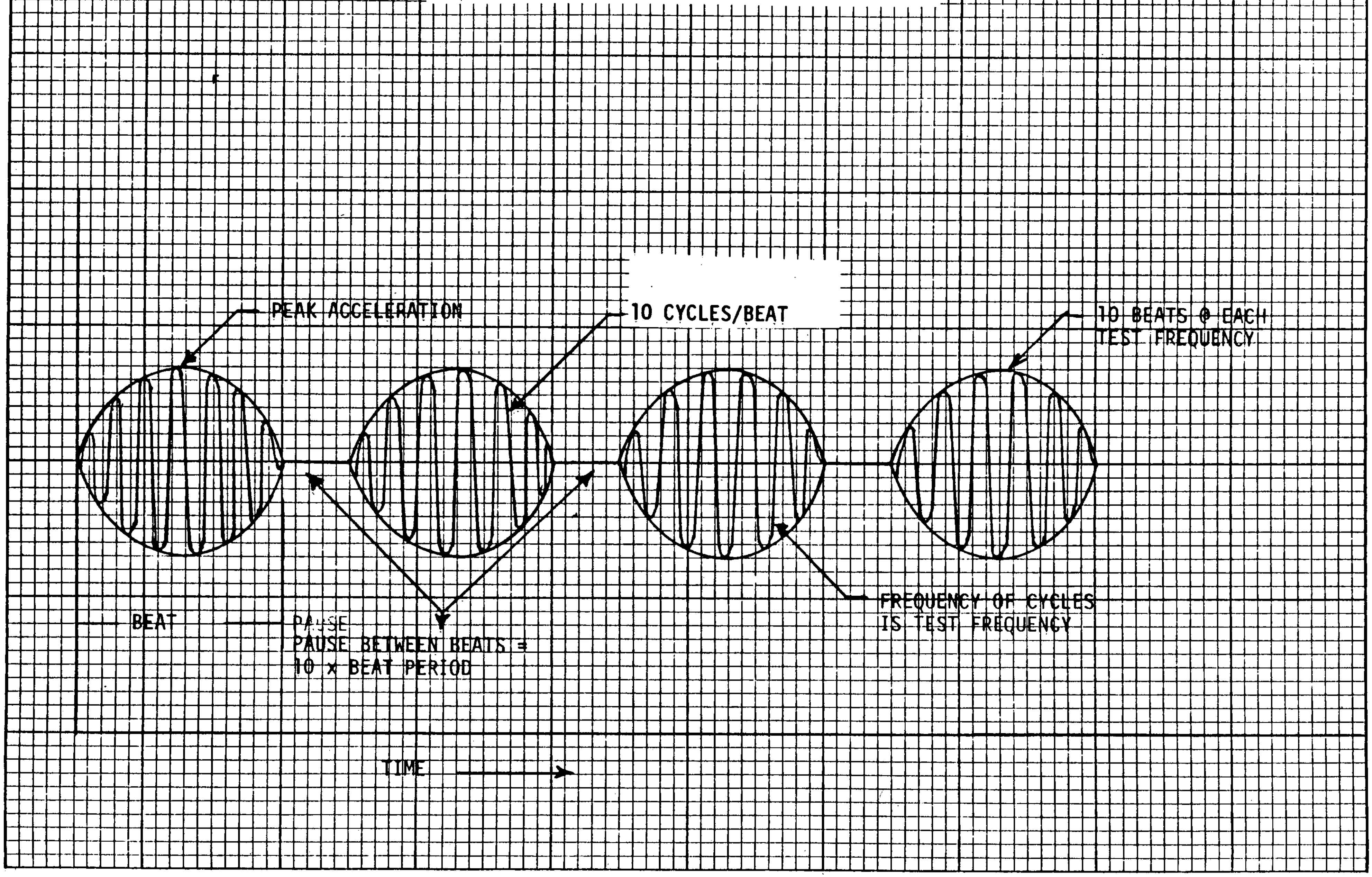
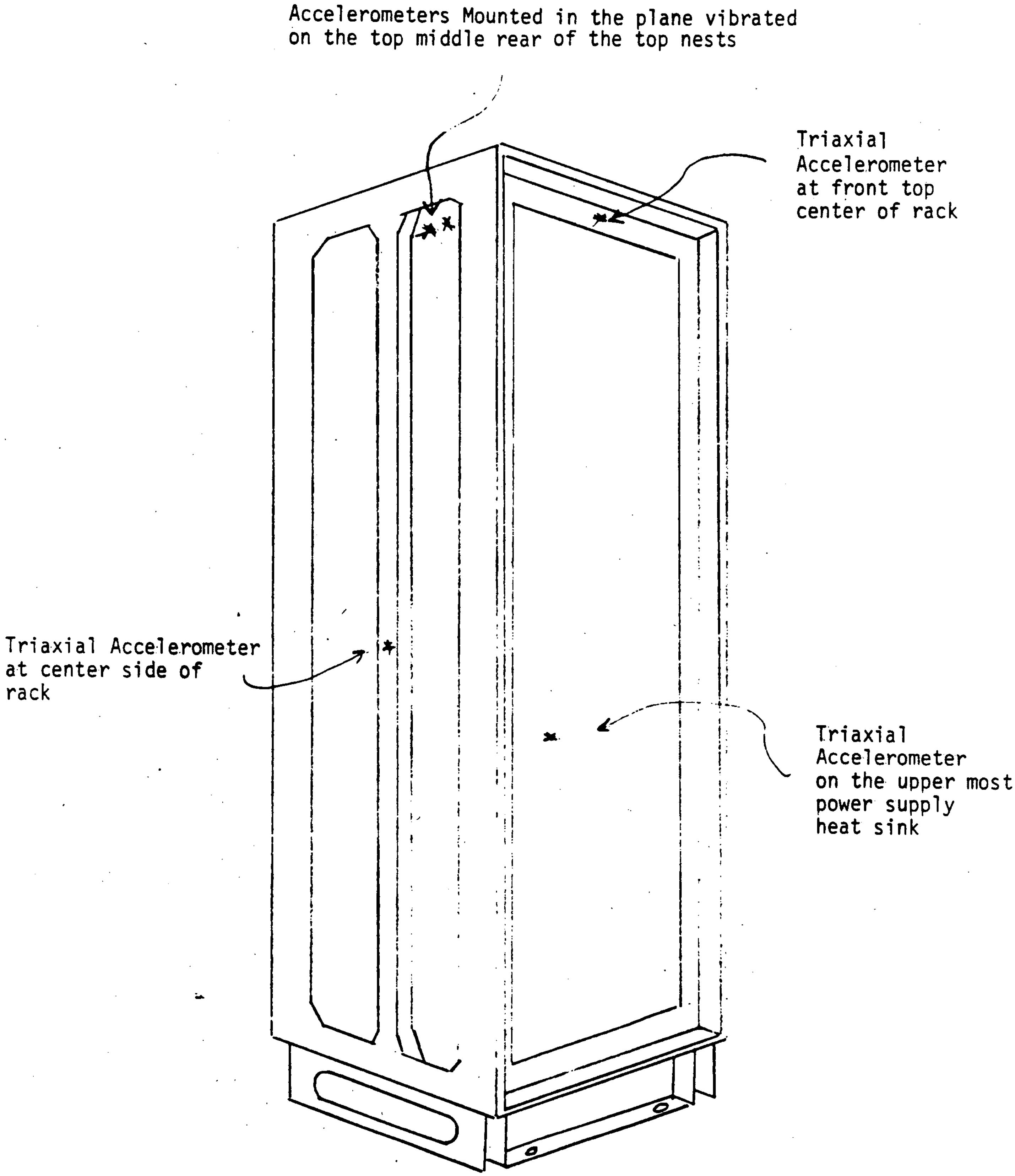


DIAGRAM NO. 3
SINE BEAT INPUT WAVEFORM
TEST NO. T4-1025   SEPT. 24, 1974



504-3-2-2

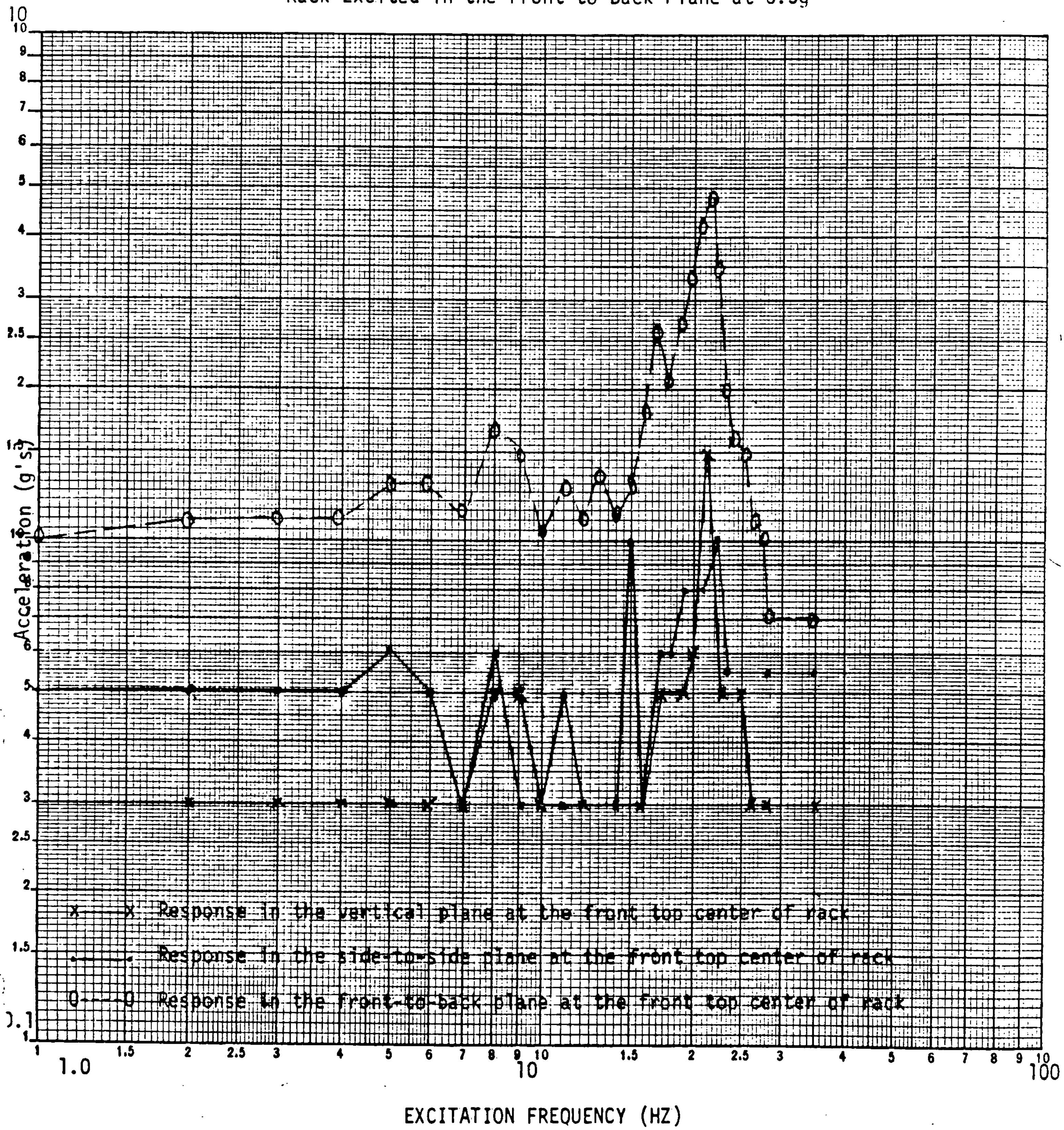
DIAGRAM NO. 4
PLACEMENT OF ACCELEROMETERS
TEST NO. T4-1025 SEPT. 24, 1974



504-3-2-2

GRAPH NO. 1

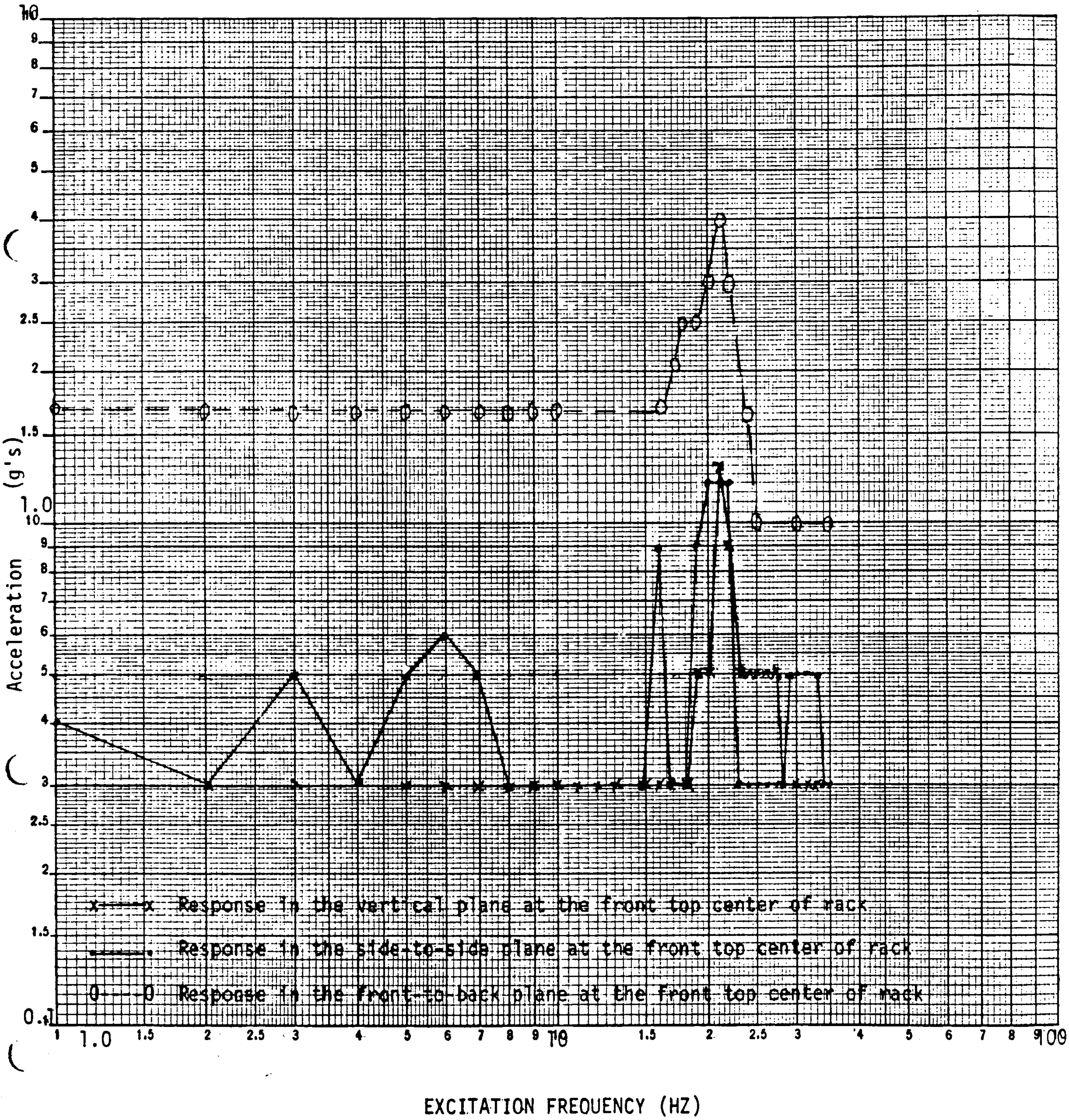
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 0.5g



504-3-2-2

GRAPH NO. 2

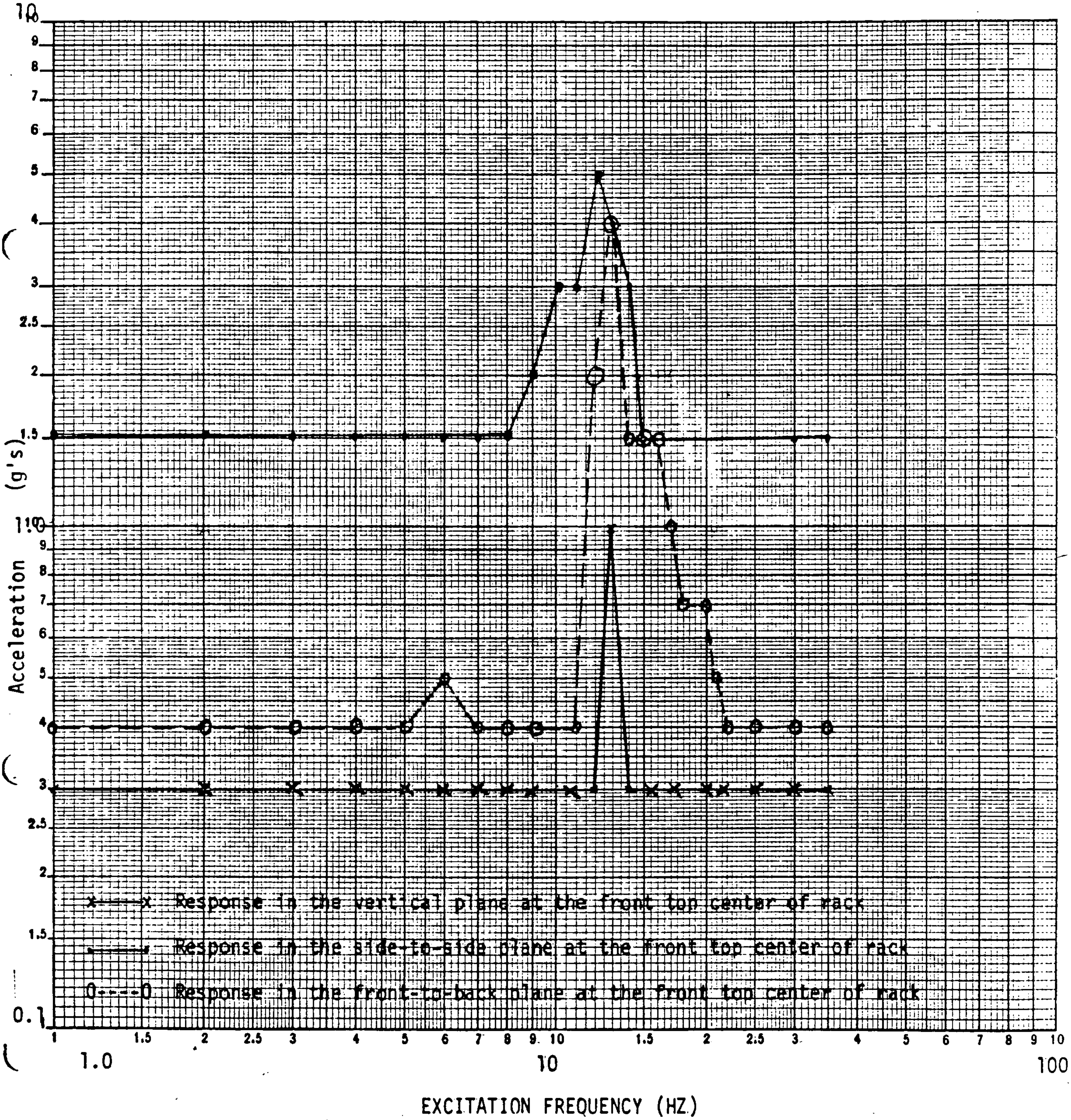
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 0.5g



504-3-2-2

GRAPH NO. 3

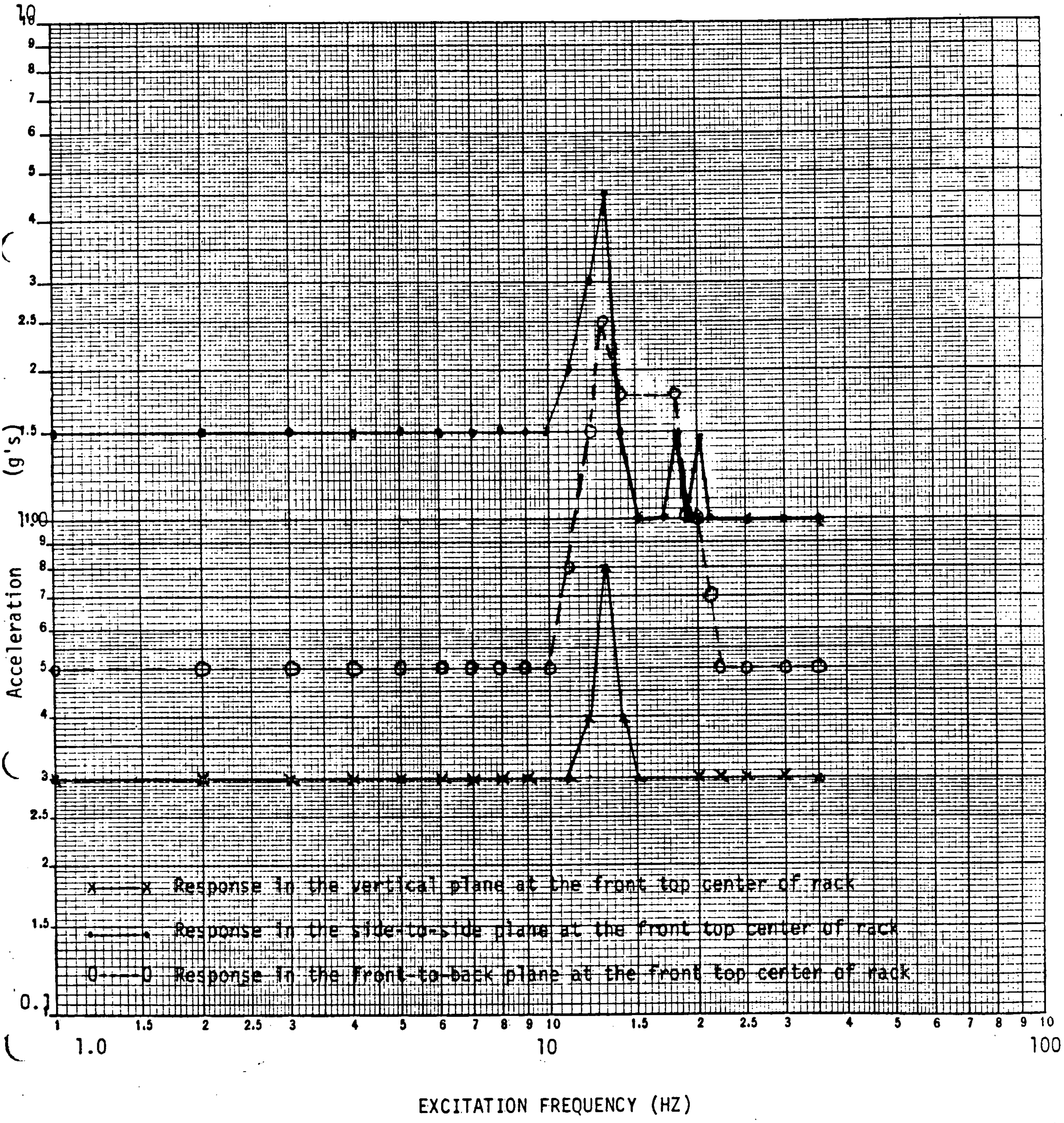
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025   August, 1974   L. Hewey
Rack Excited in the Side-to-Side Plane at 0.5g



504-3-2-2

GRAPH NO. 4

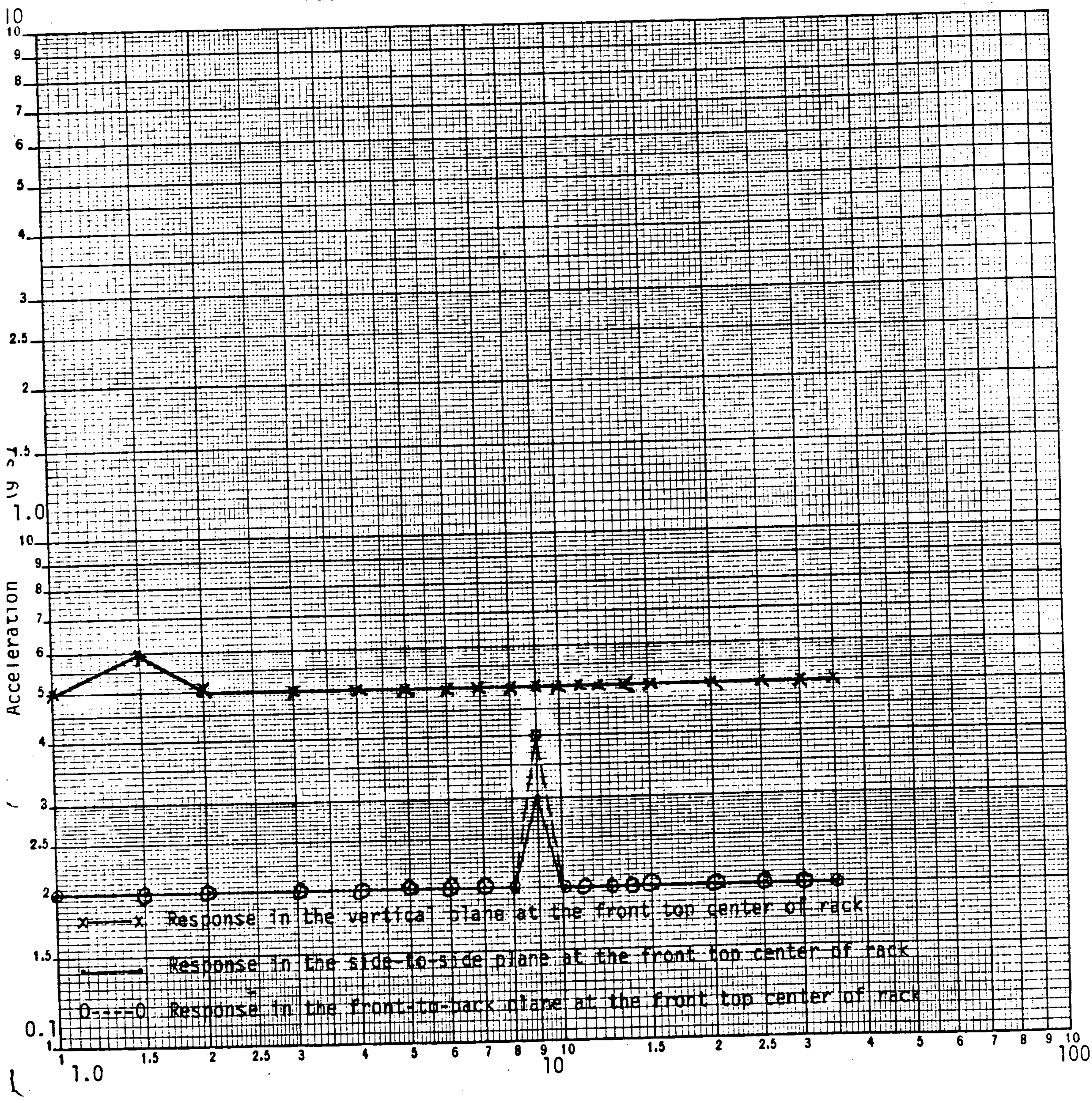
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 0.5g



504-3-2-2

GRAPH NO. 5

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 0.5g

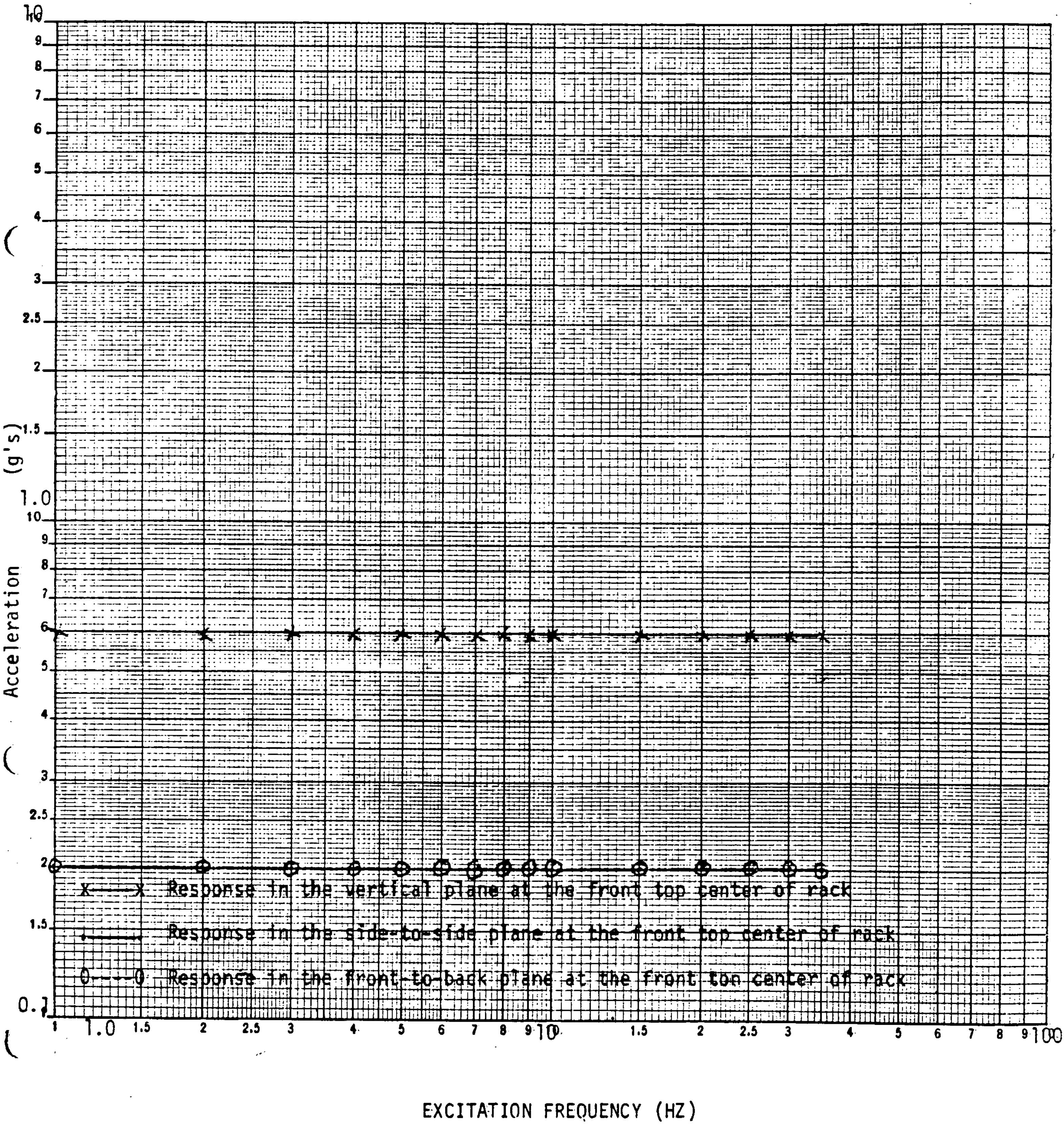


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 6

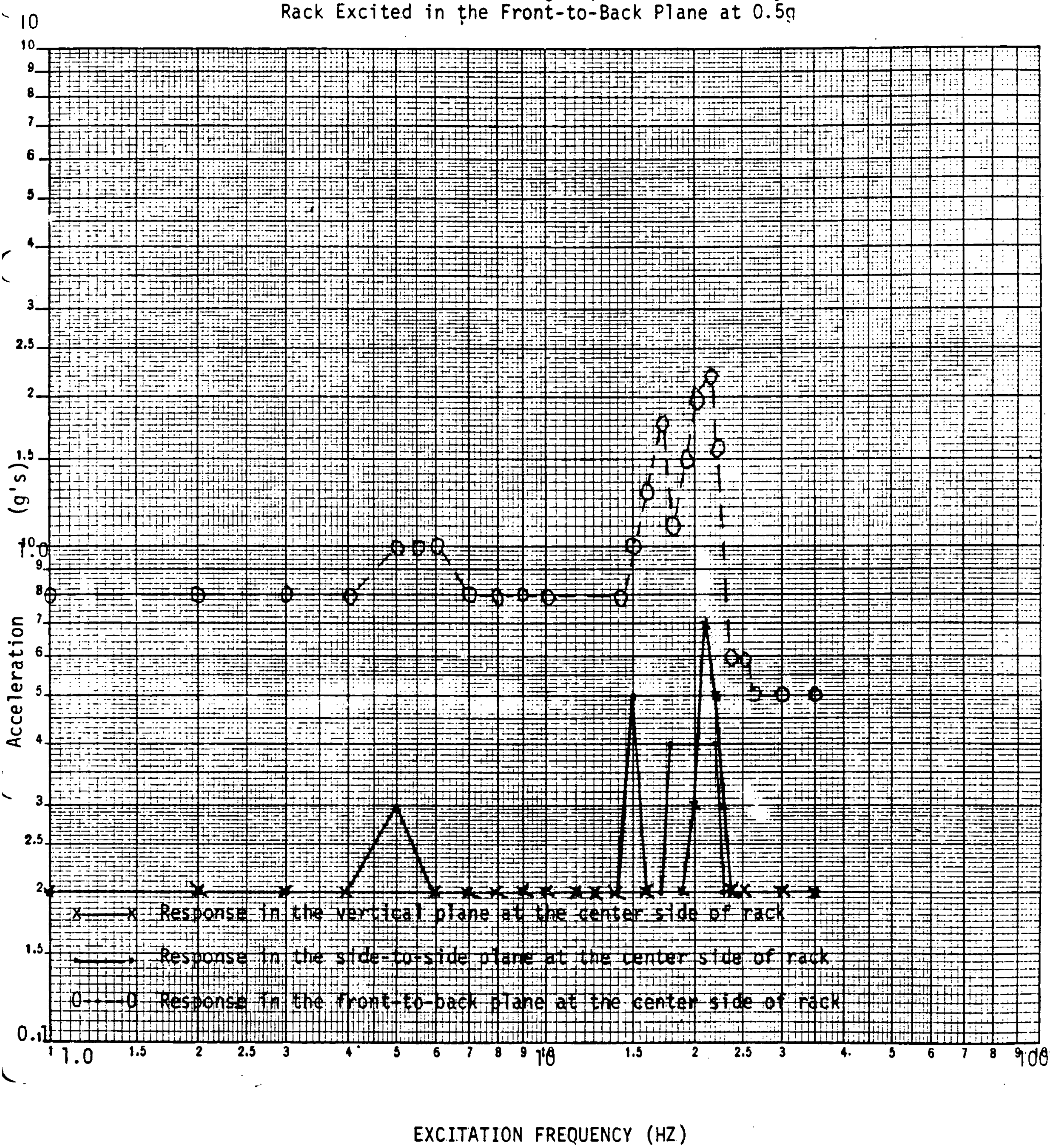
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 0.5g



504-3-2-2

GRAPH NO. 7

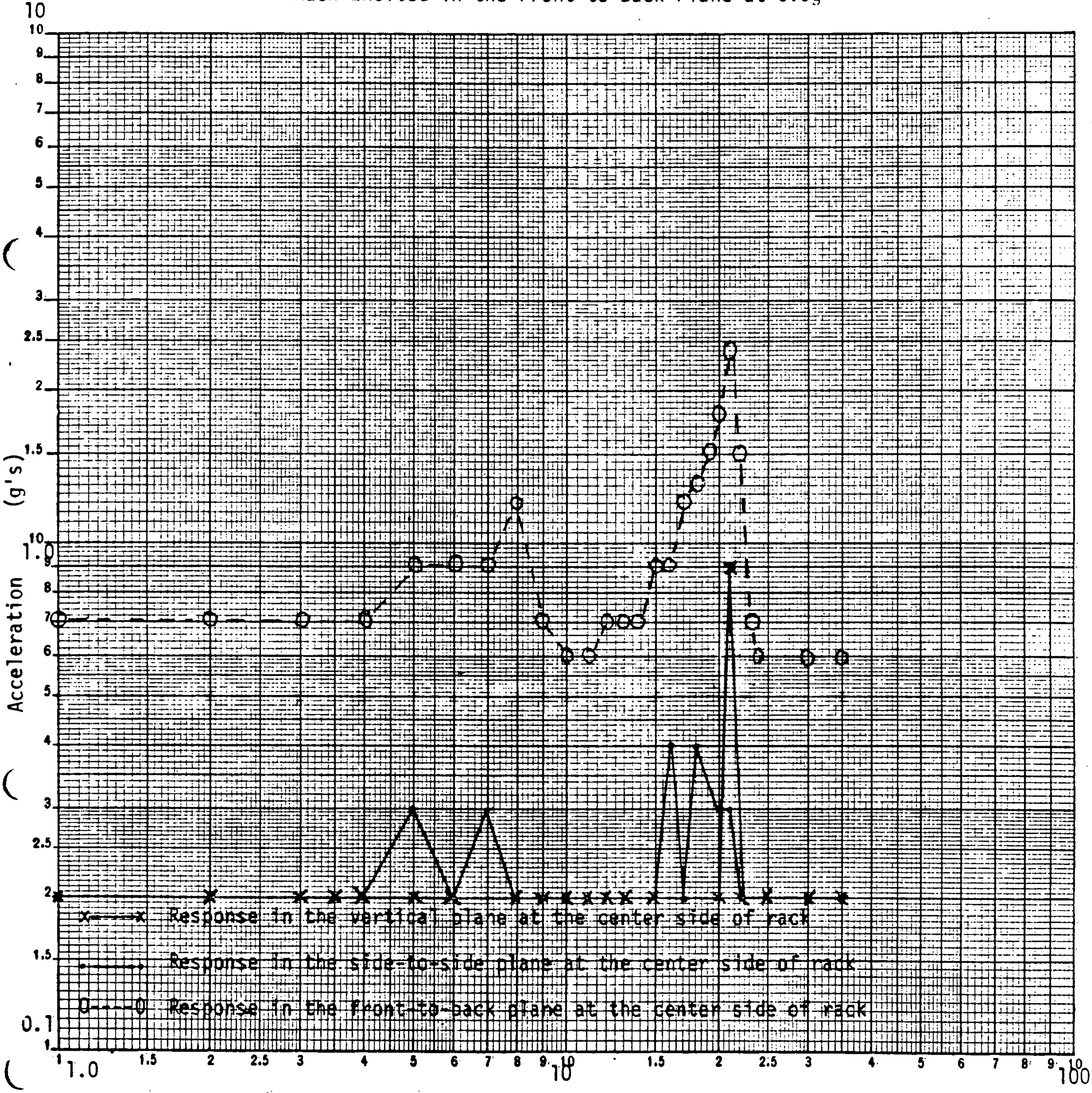
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 0.5g



504-3-2-2

GRAPH NO. 8

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 0.5g

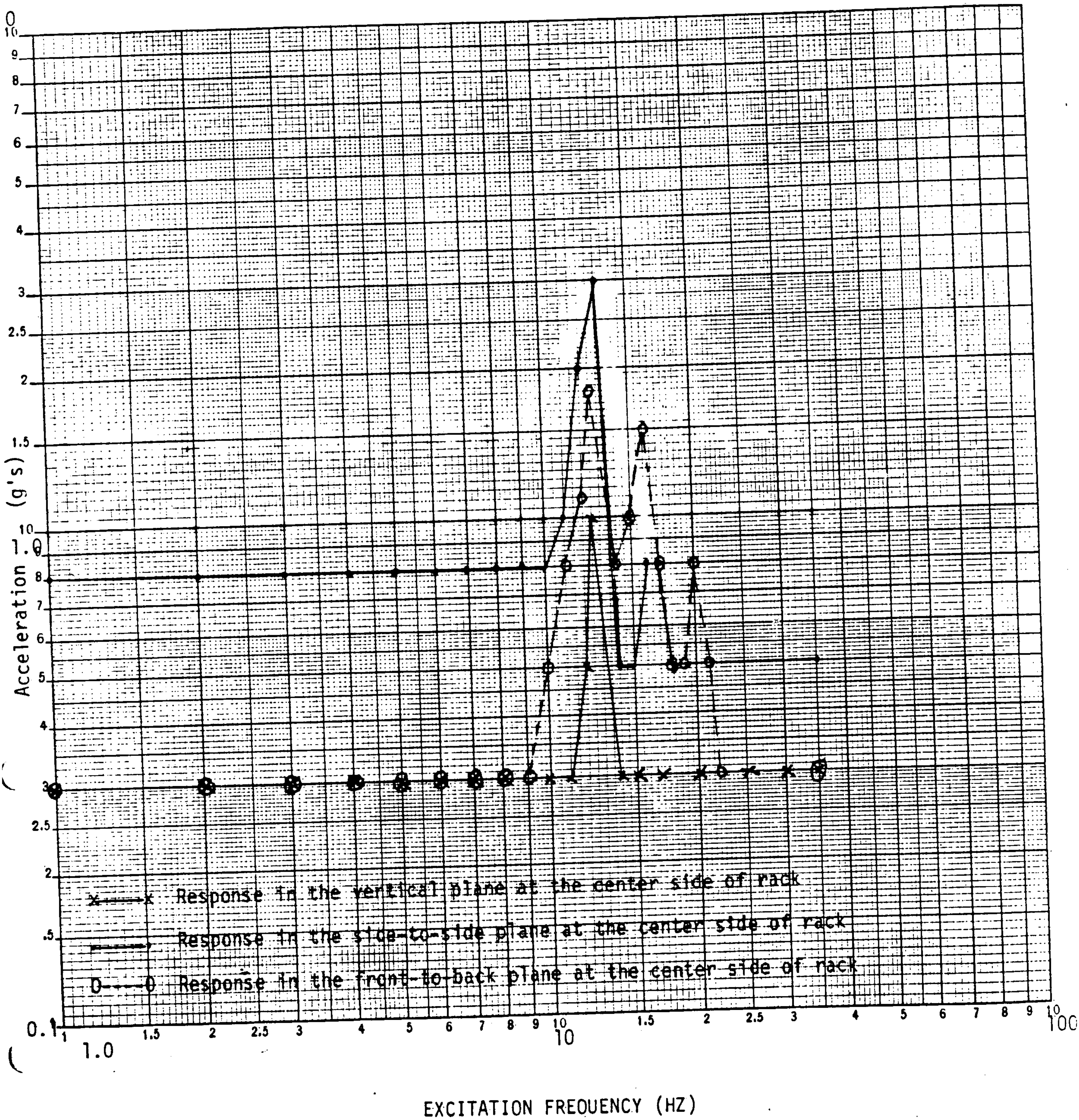


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 9

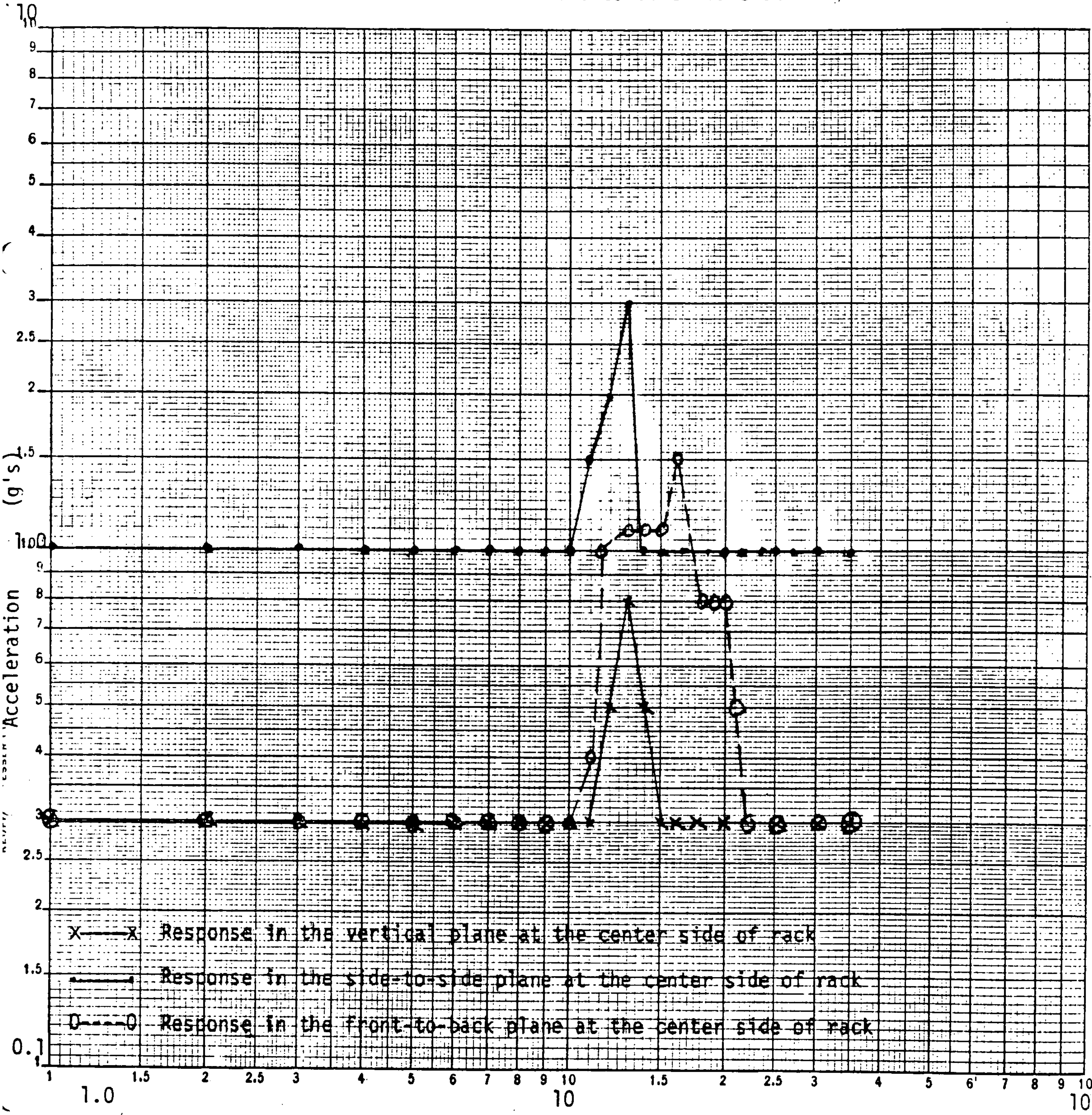
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 0.5g



504-3-2-2

GRAPH NO. 10

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 0.5g

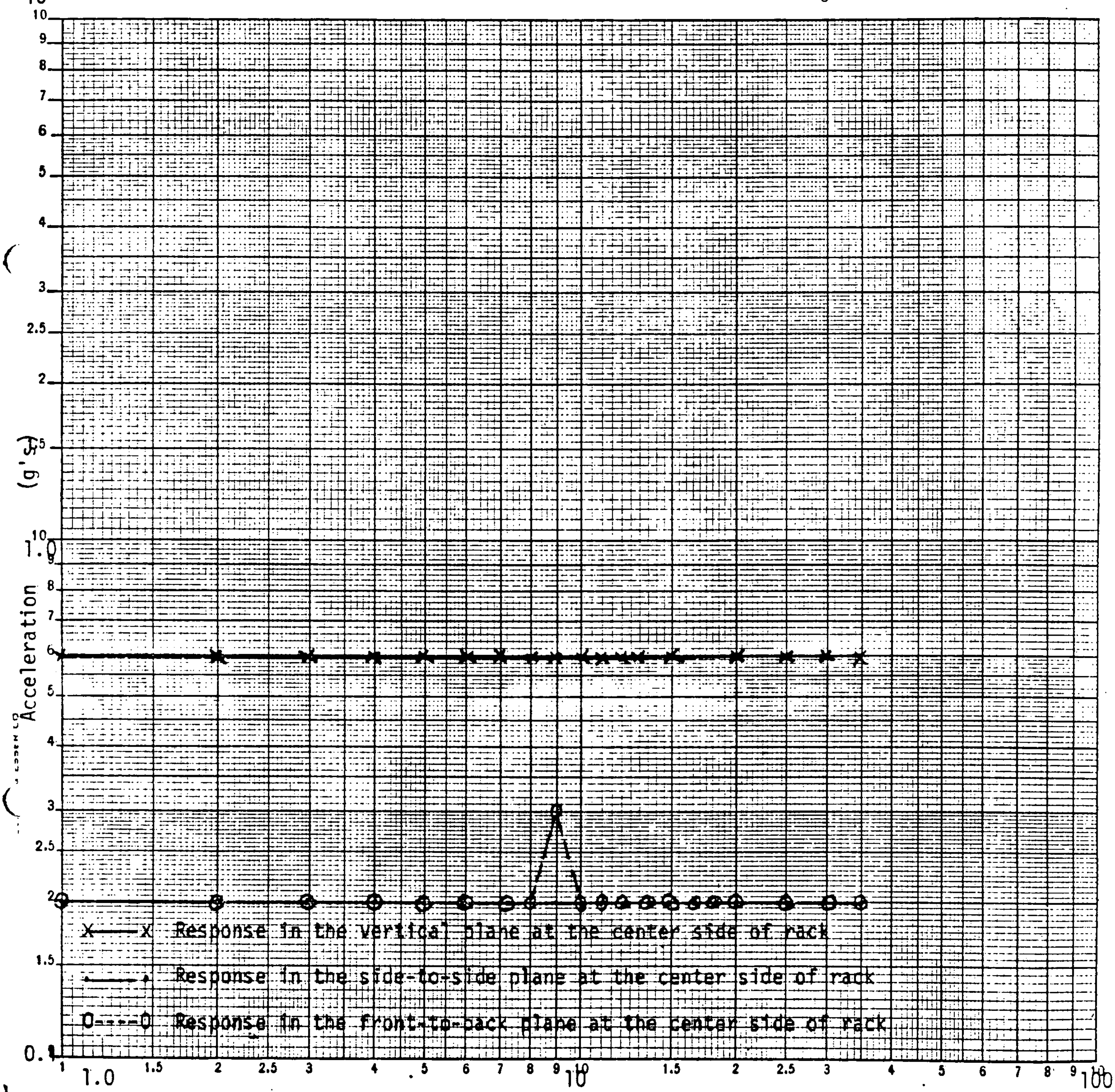


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 11

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 0.5g

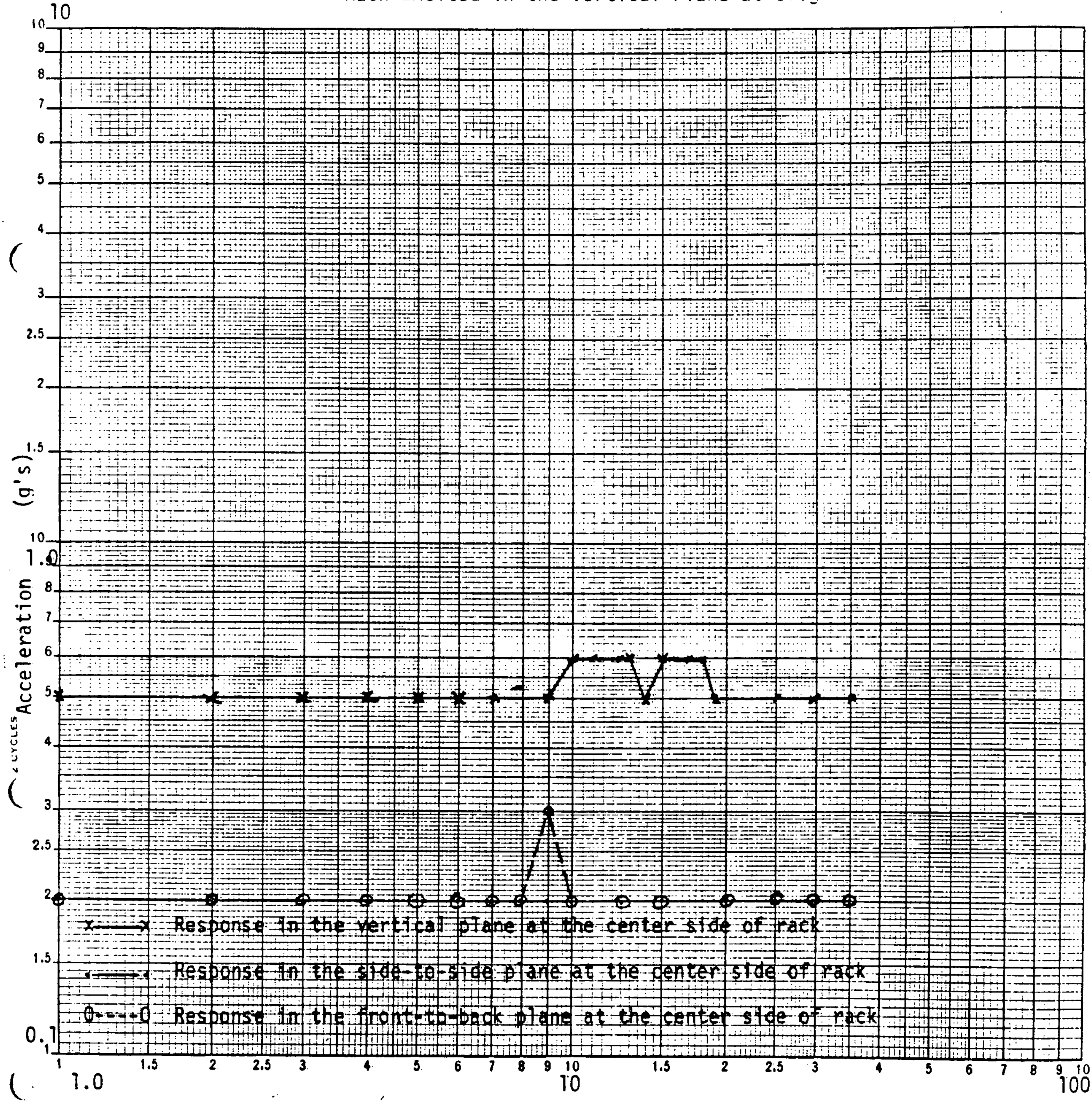


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 12

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 0.5g

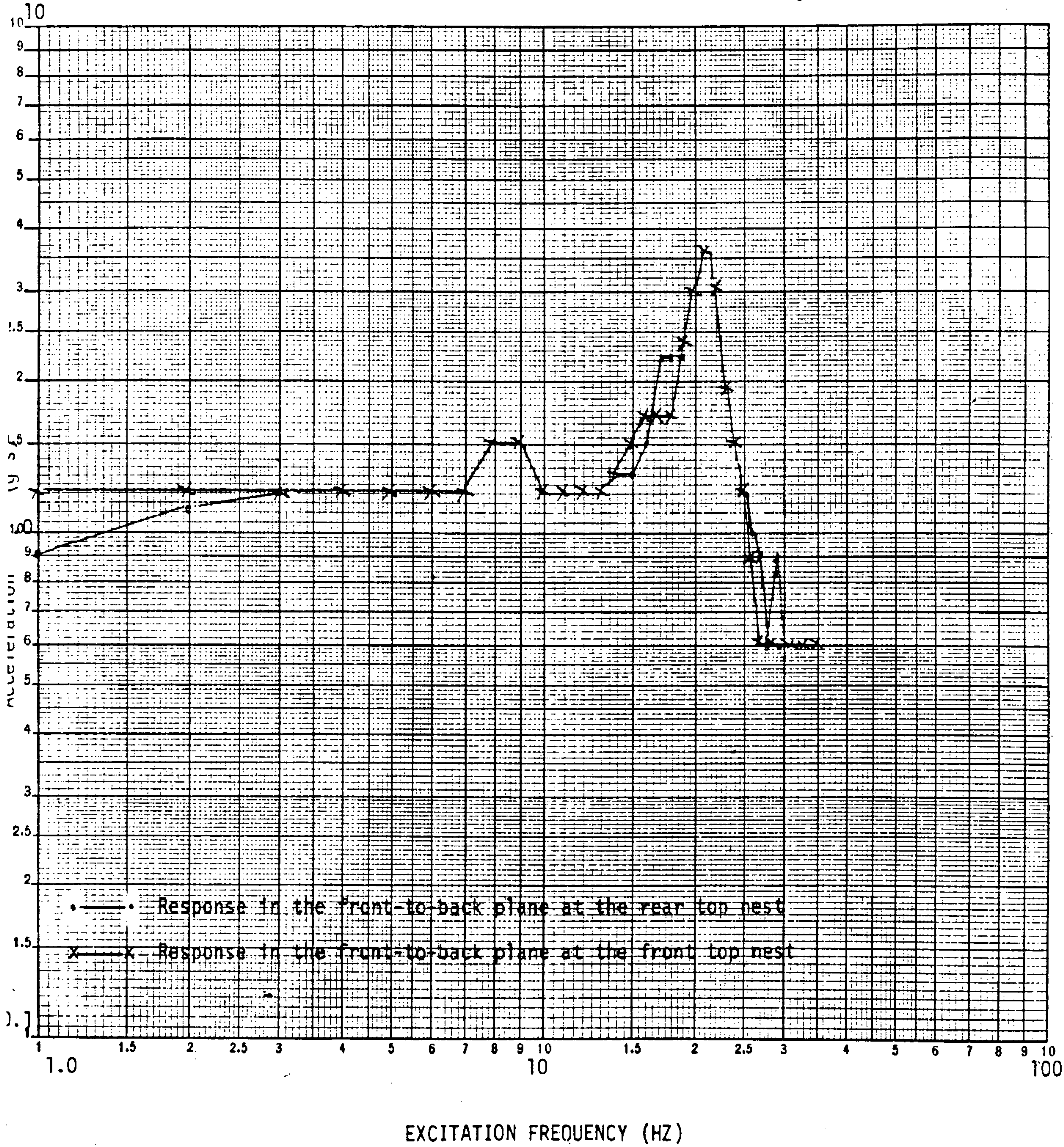


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 13

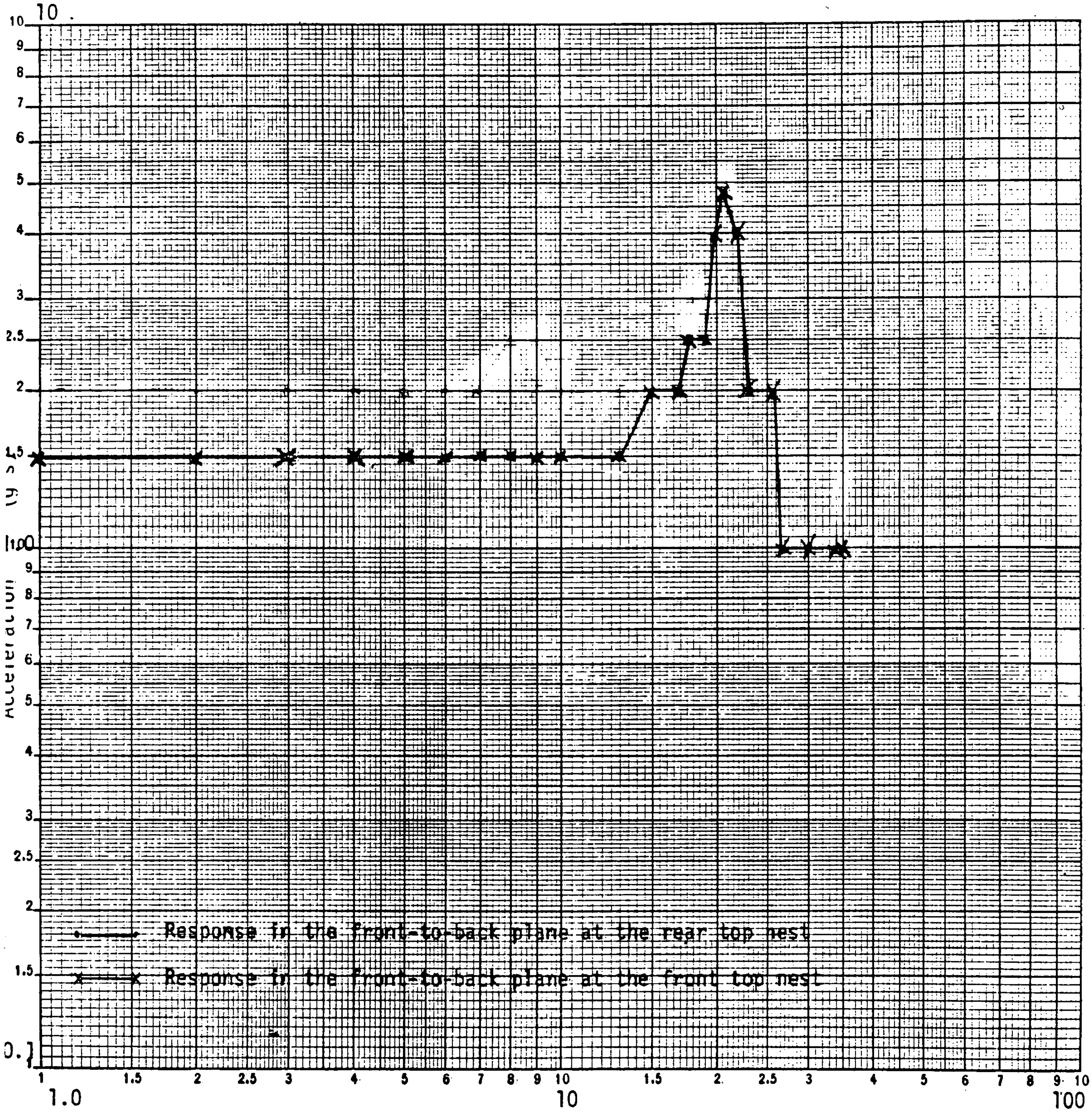
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 0.5g



504-3-2-2

GRAPH NO. 14

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 0.5g

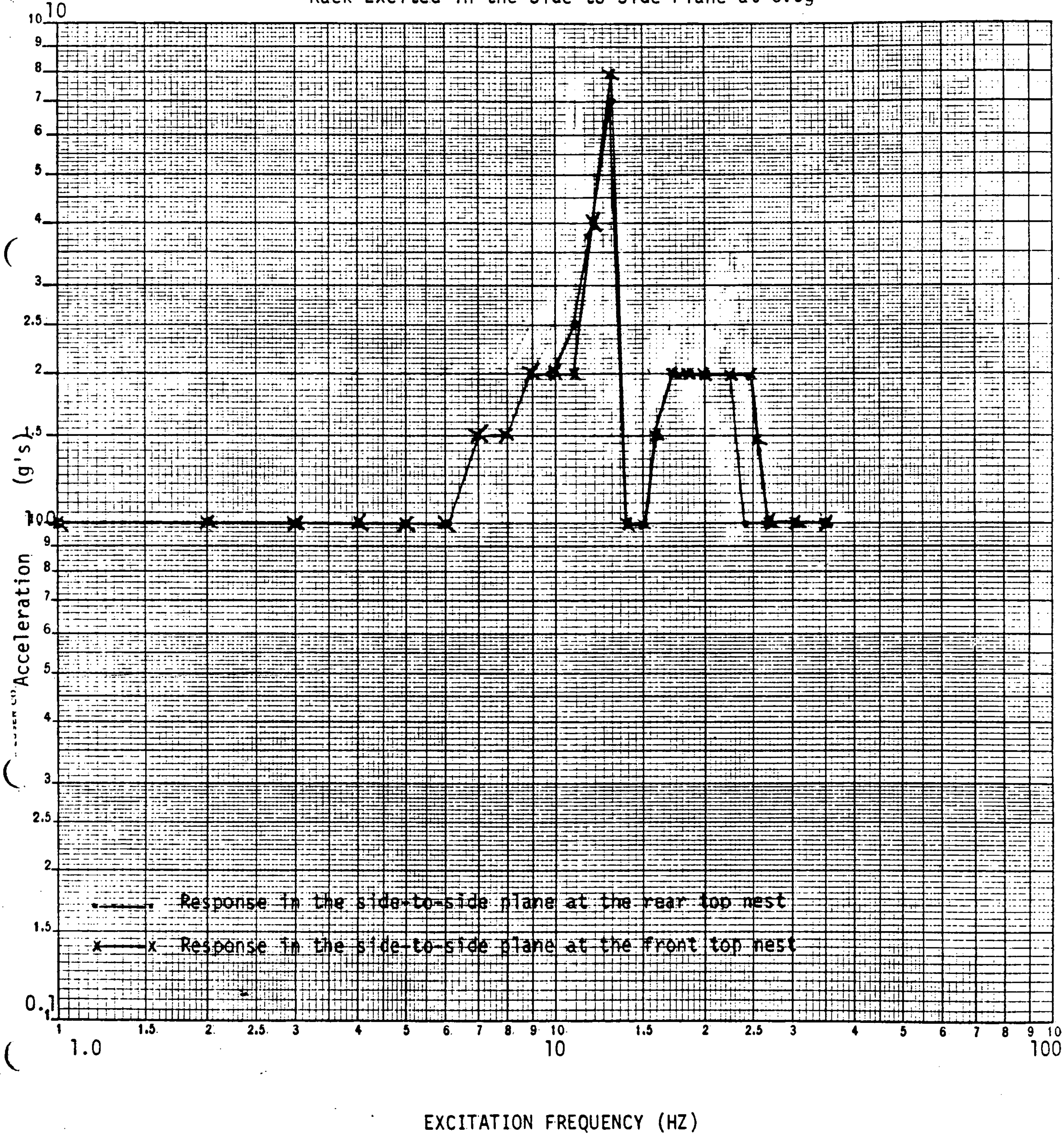


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 15

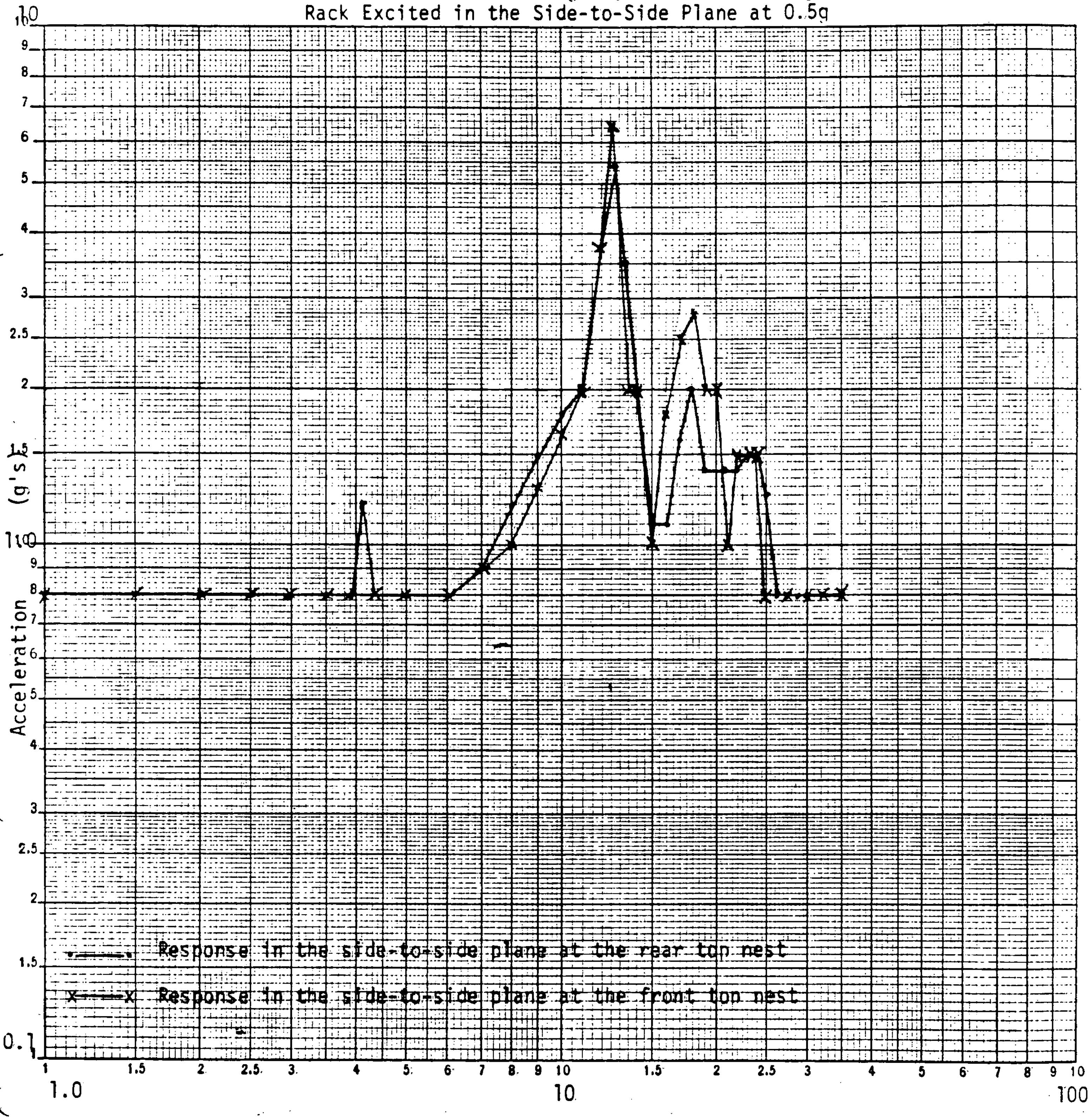
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 0.5g



504-3-2-2

GRAPH NO. 16

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 0.5g

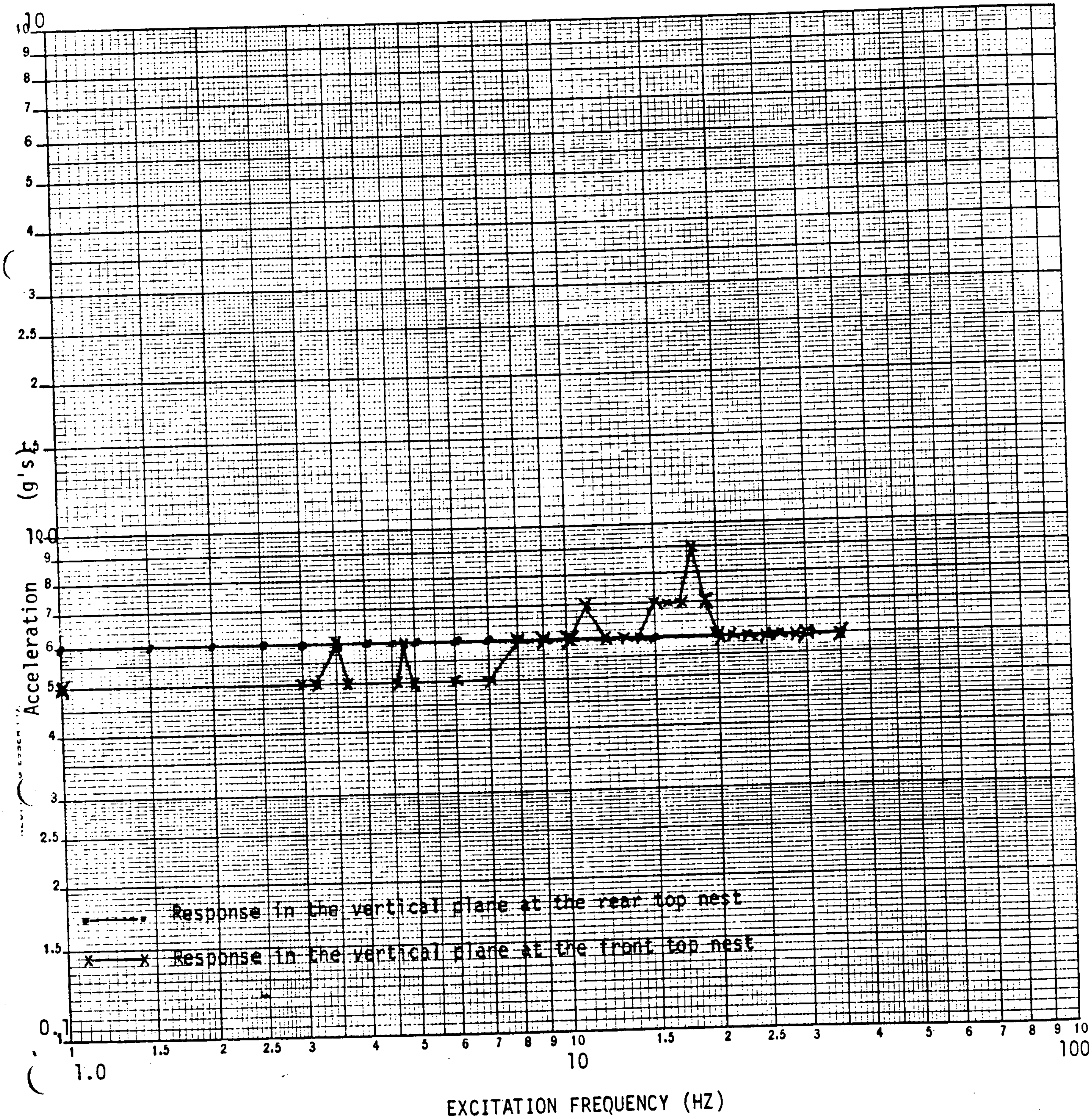


EXCITATION FREQUENCY (HZ)

5-04-3-2-2

GRAPH NO. 17

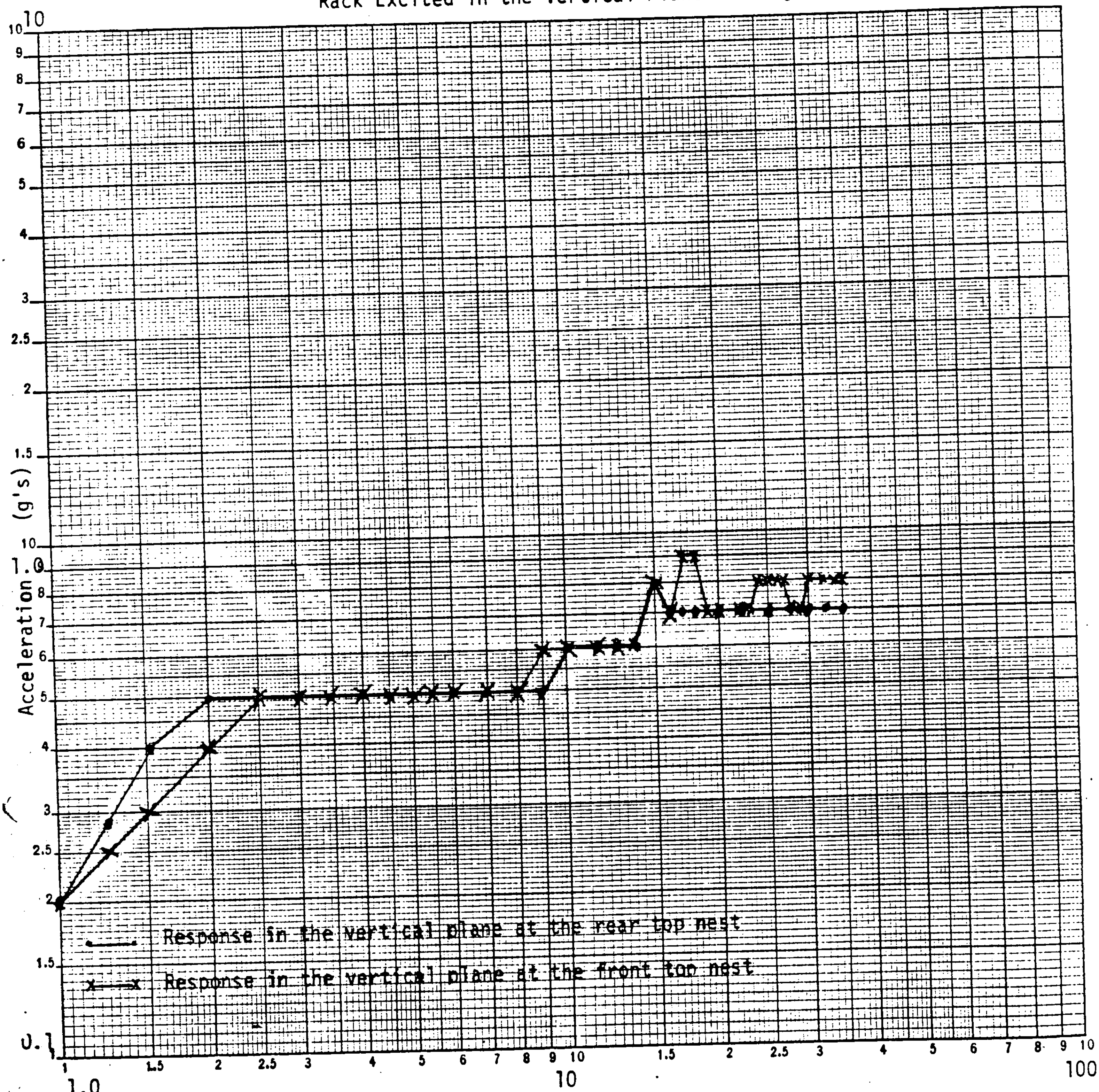
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 0.5g



5-04-3-2-2

GRAPH NO. 18

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 0.5g

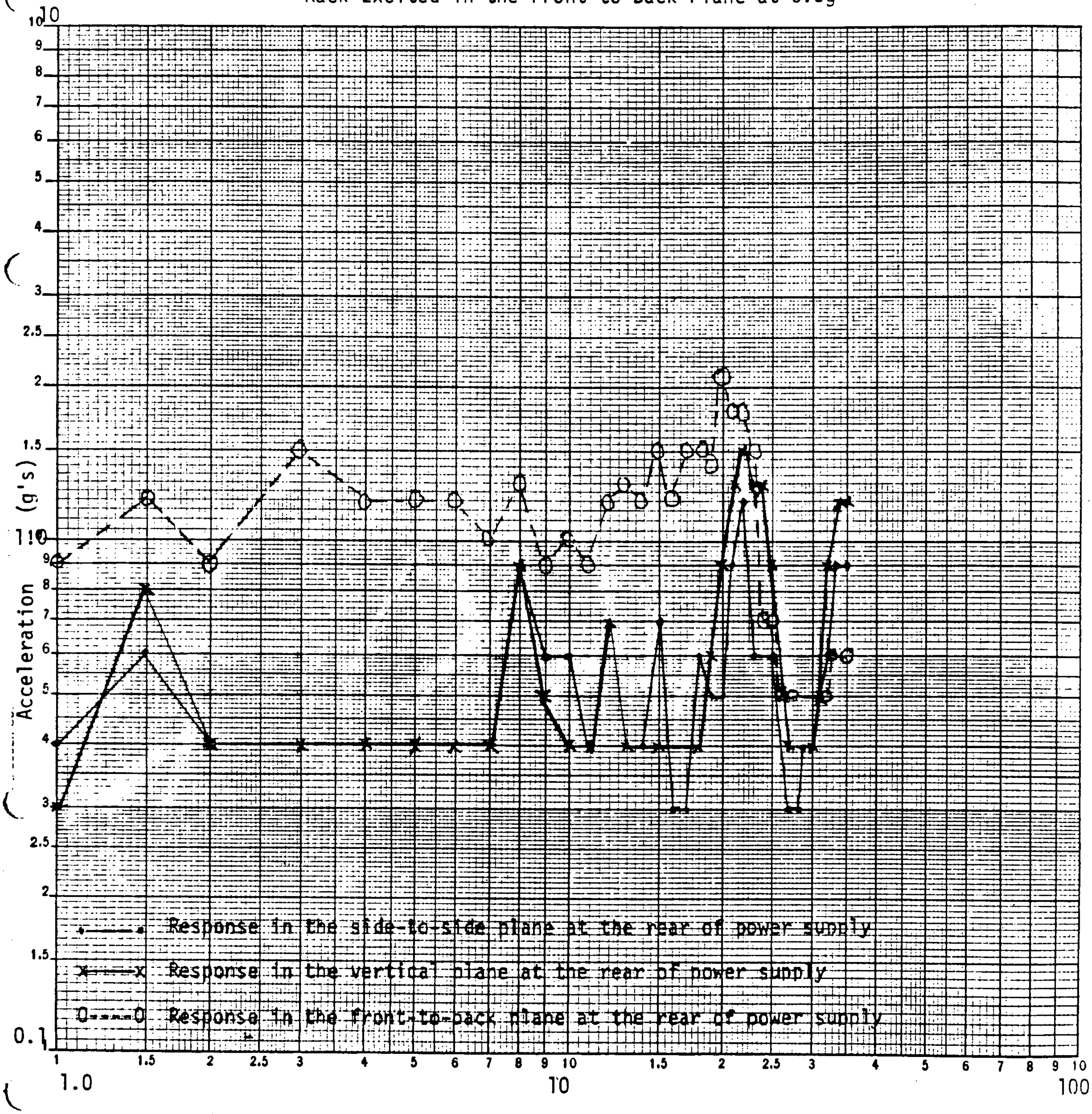


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 19

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 0.5g

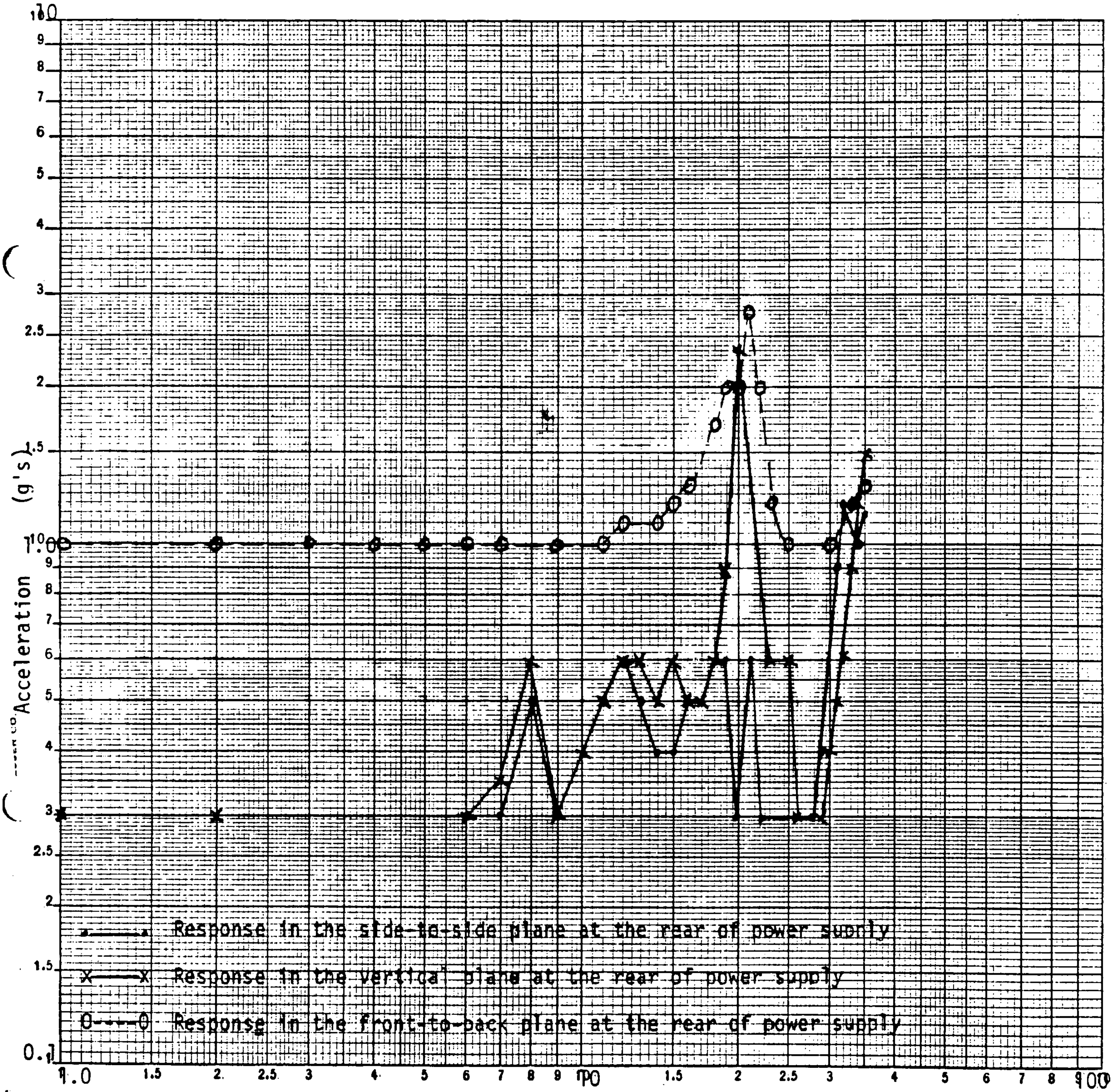


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 20

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 0.5g

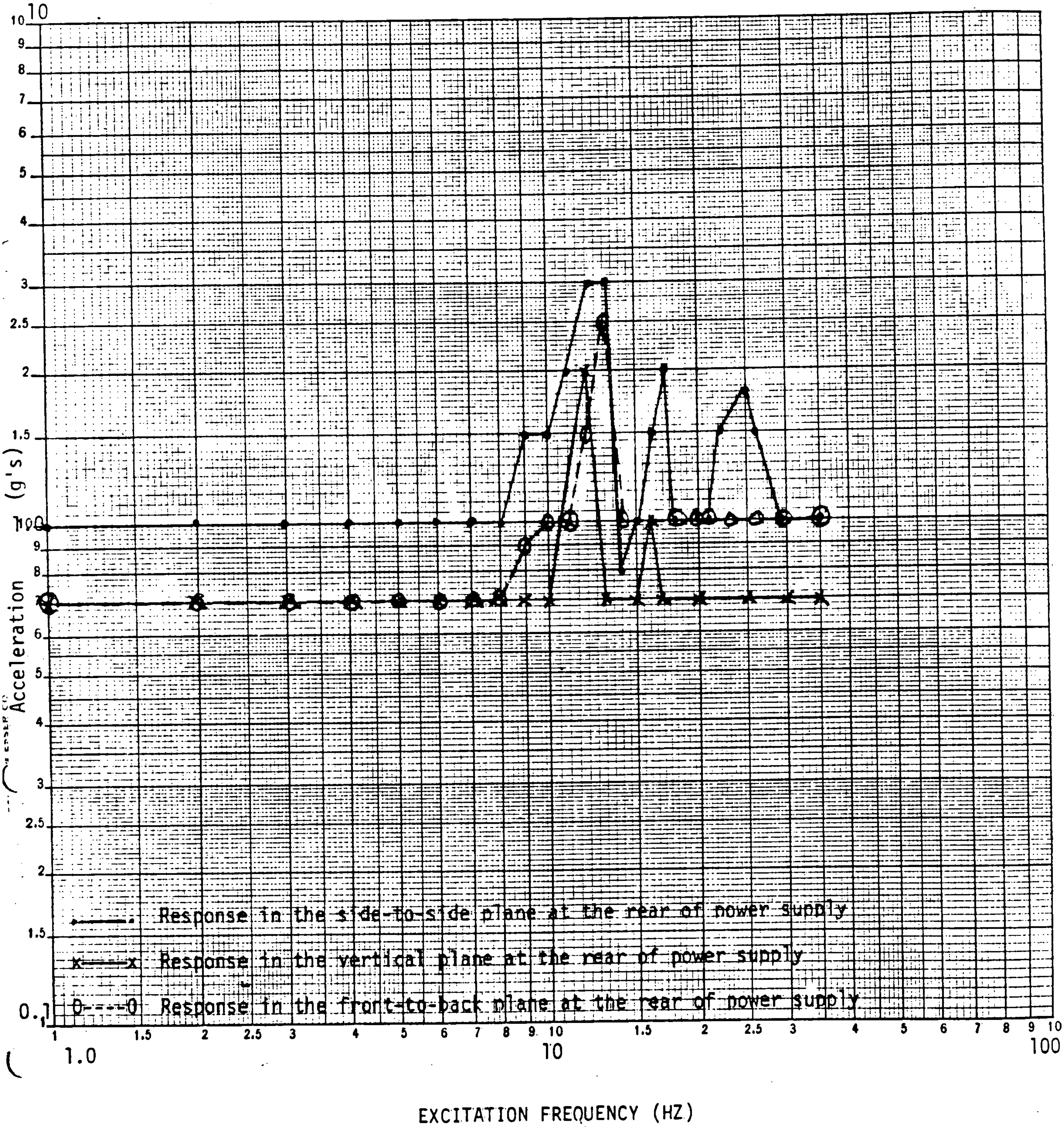


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 21

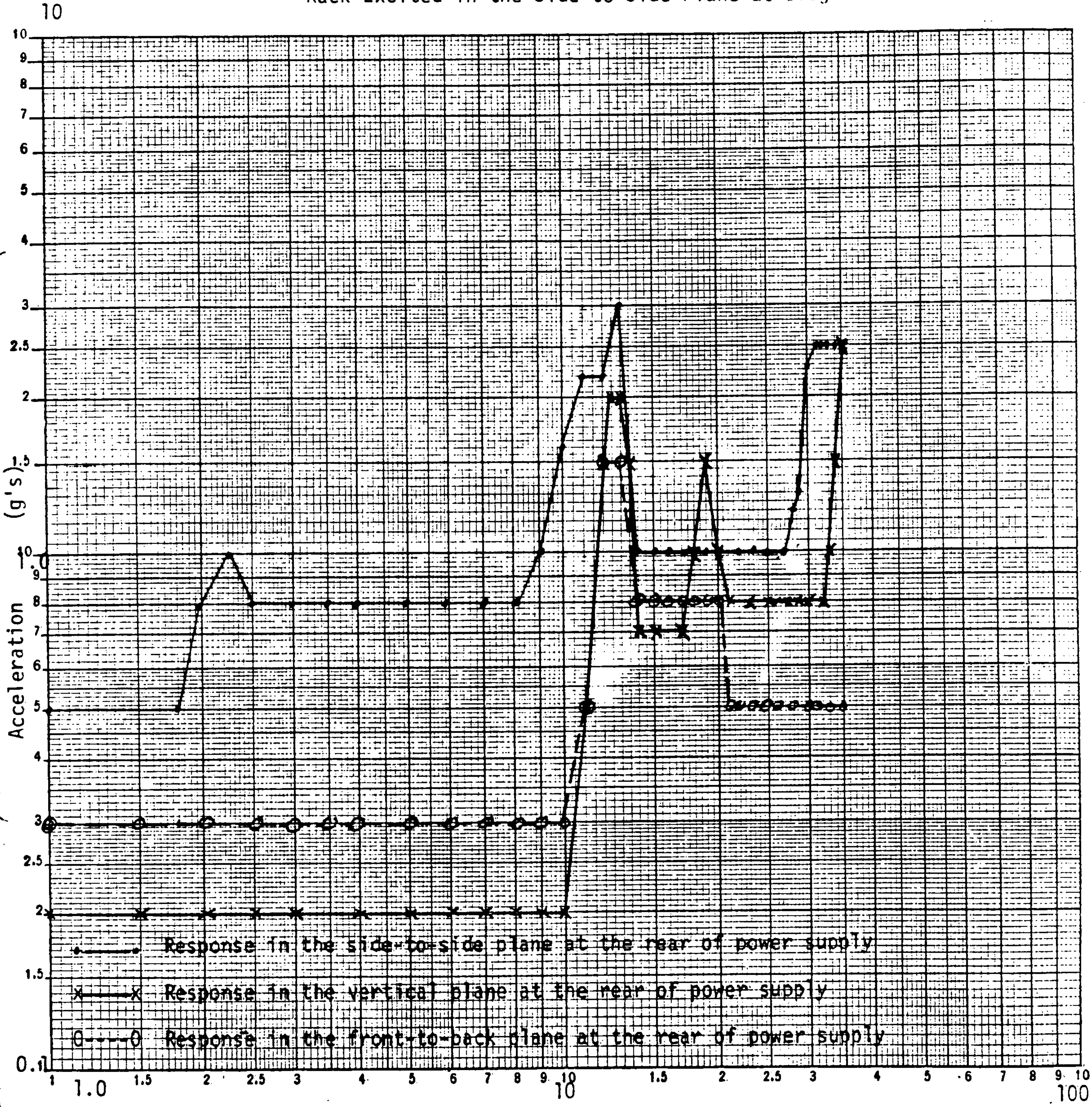
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 0.5g



504-3-2-2

GRAPH NO. 22

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 0.5g

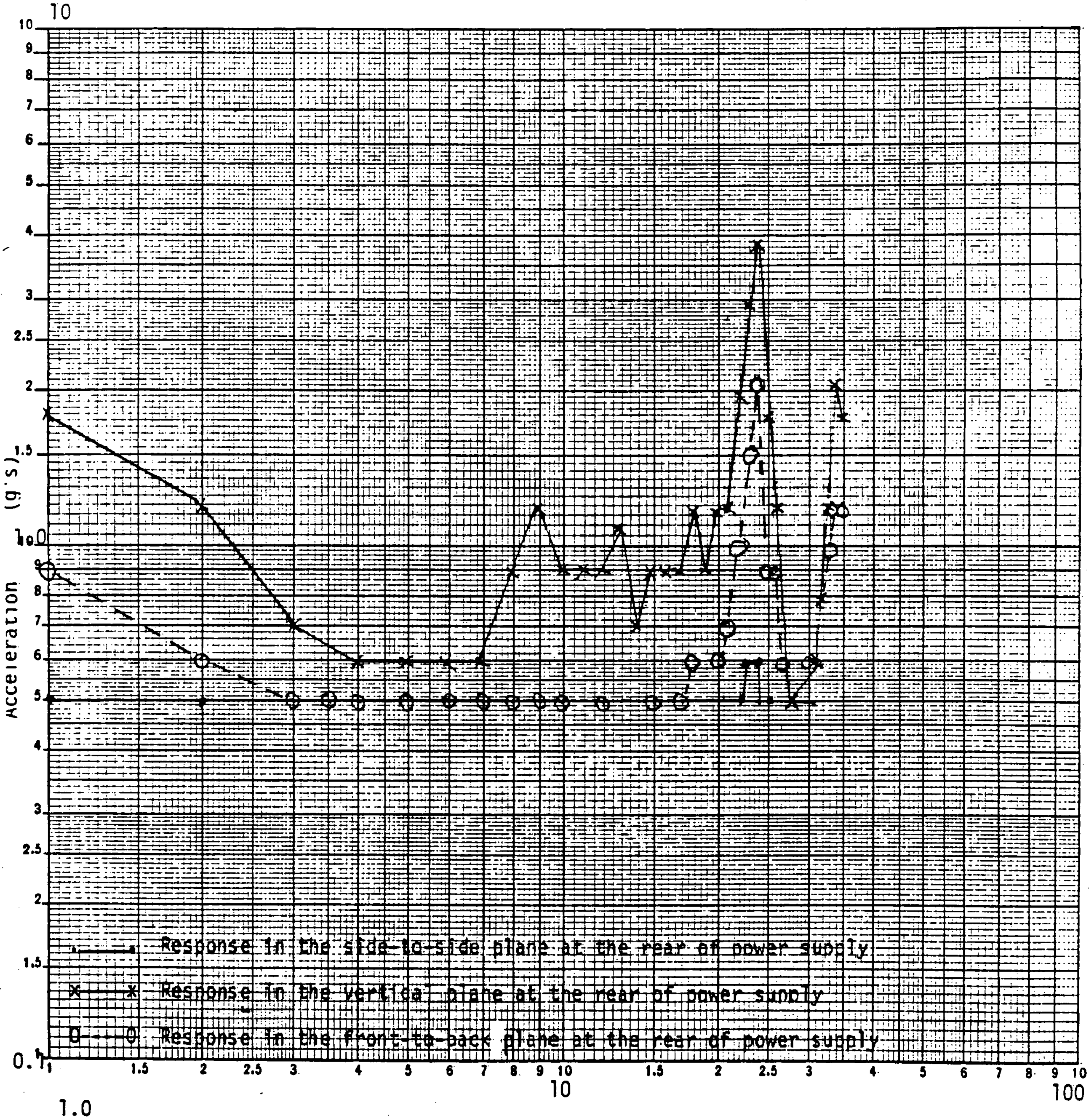


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 23

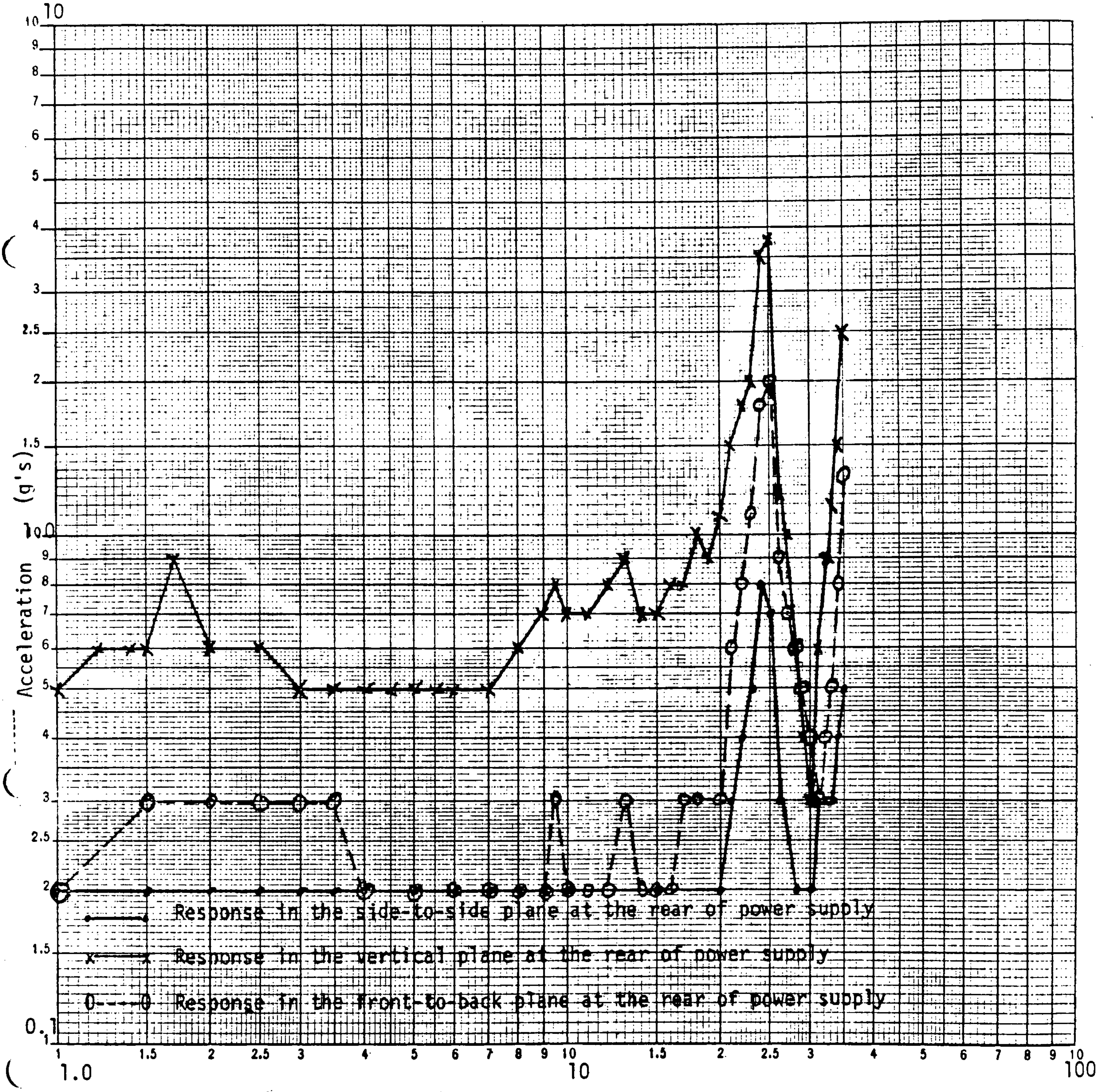
Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 0.5g



504-3-2-2

GRAPH NO. 24

Resonance Search
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Balanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 0.5g

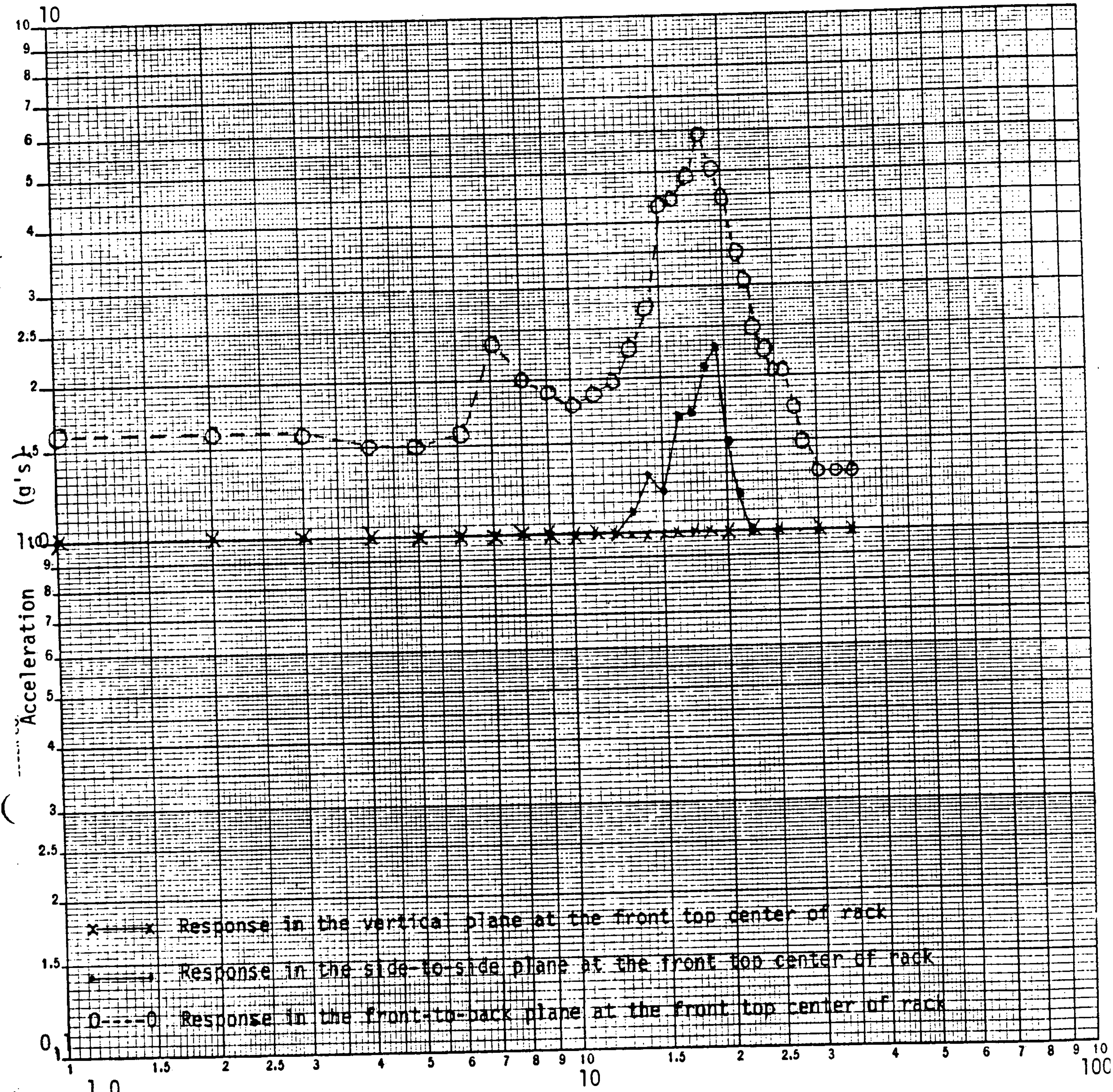


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 25

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025   August, 1974   L. Hewey
Rack Excited in the Front-to-Back Plane at 1.0g

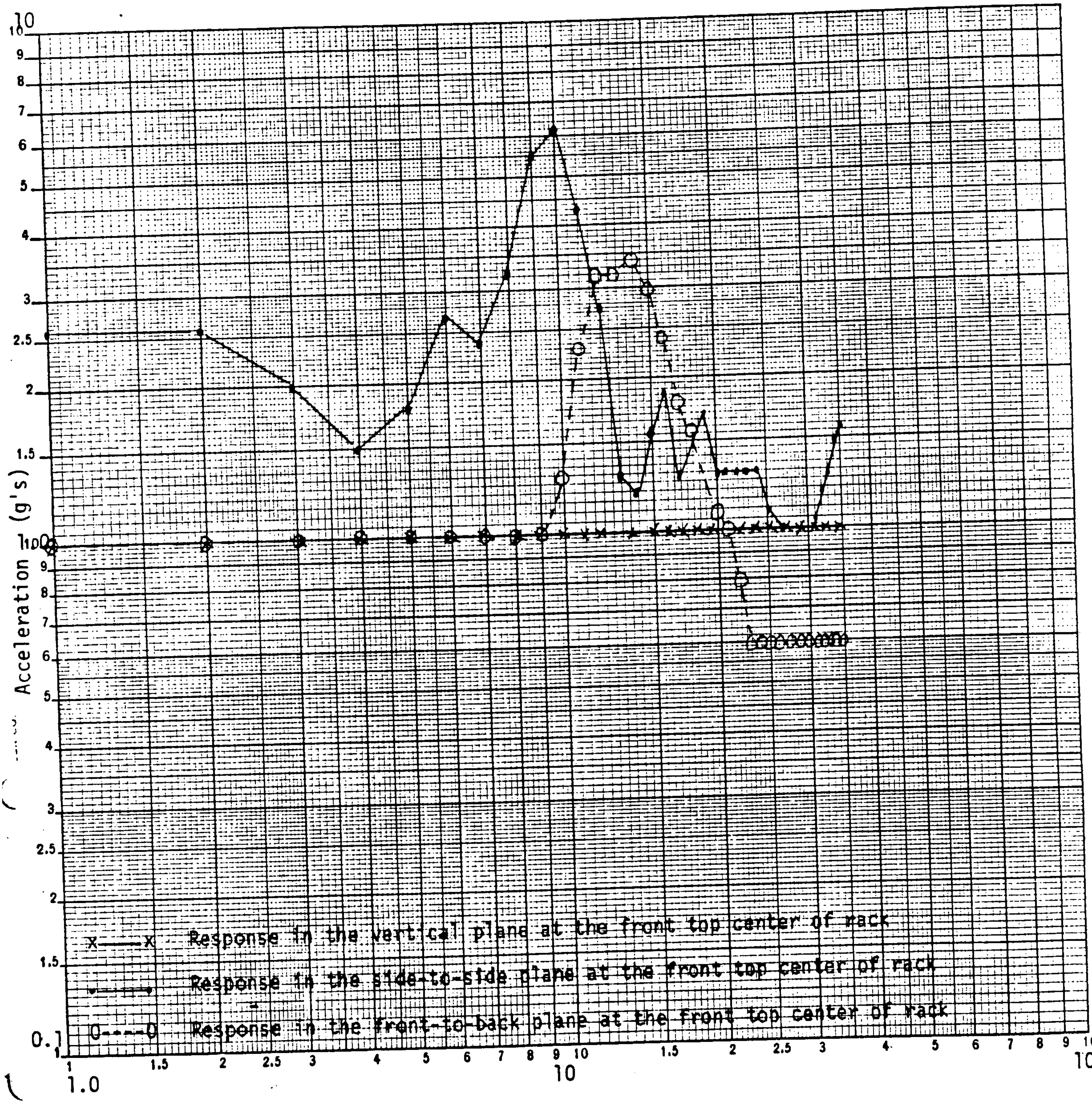


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 26

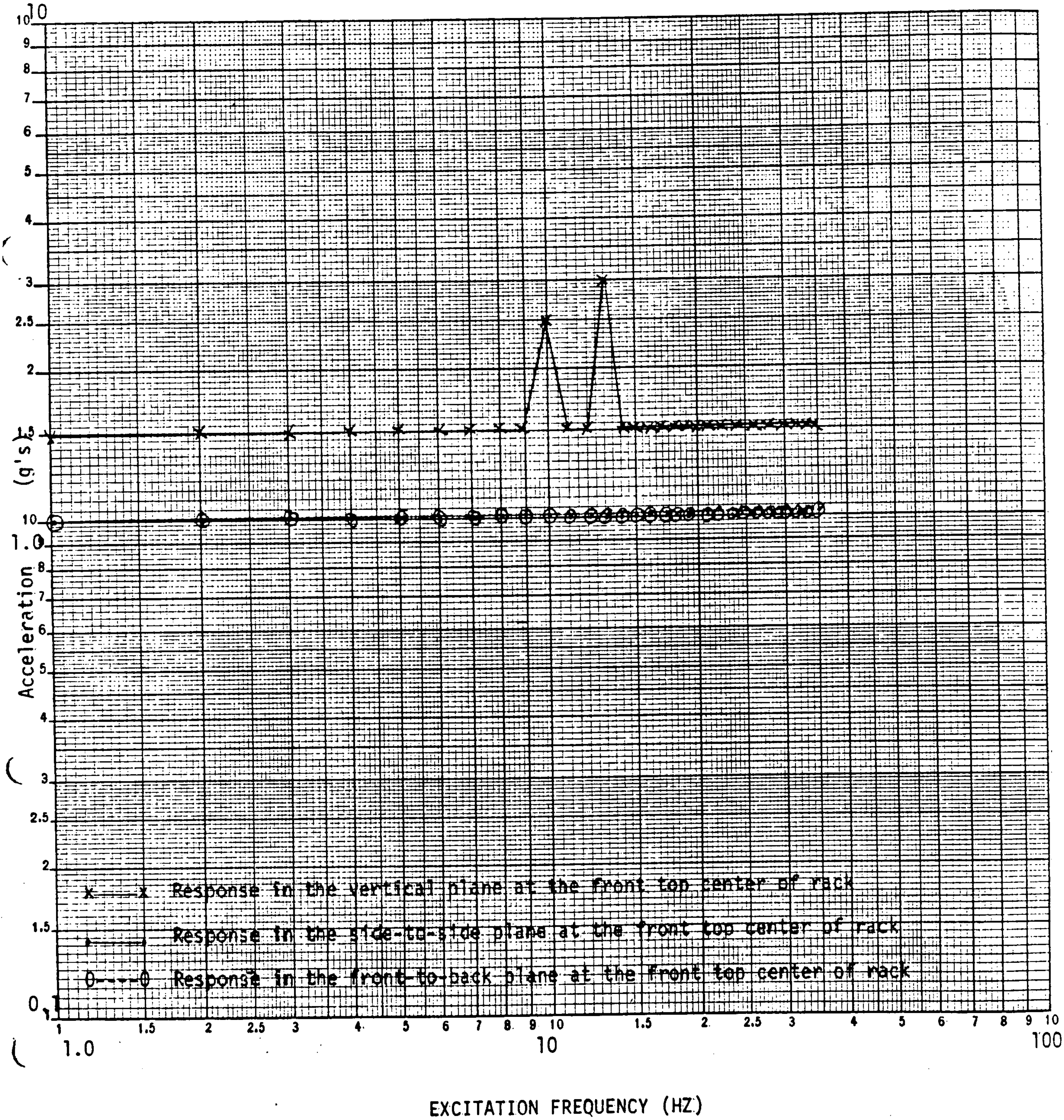
Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 1.0g



504-3-2-2

GRAPH NO. 27

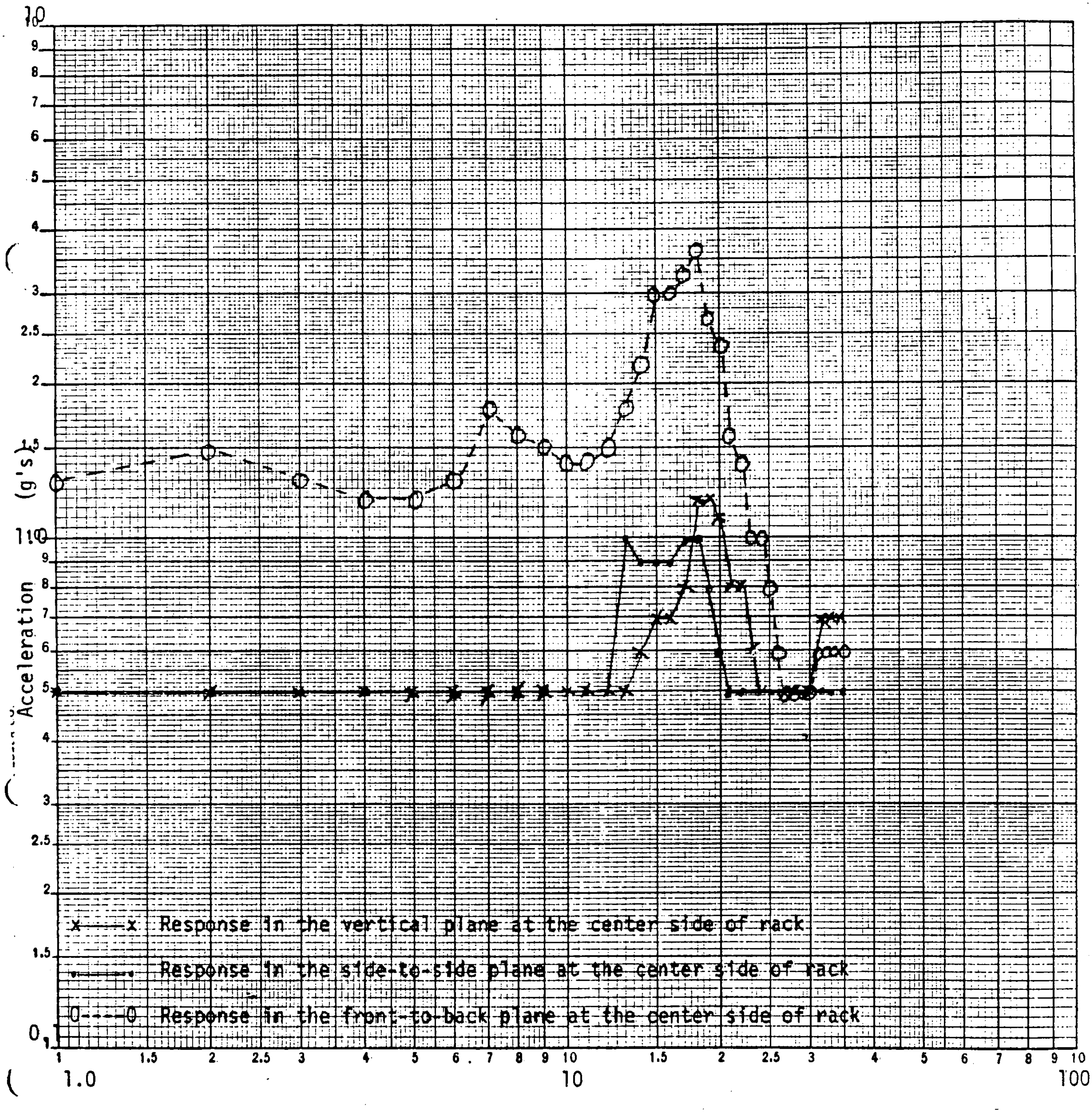
Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 1.0g



504-3-2-2

GRAPH NO. 28

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 1.0g

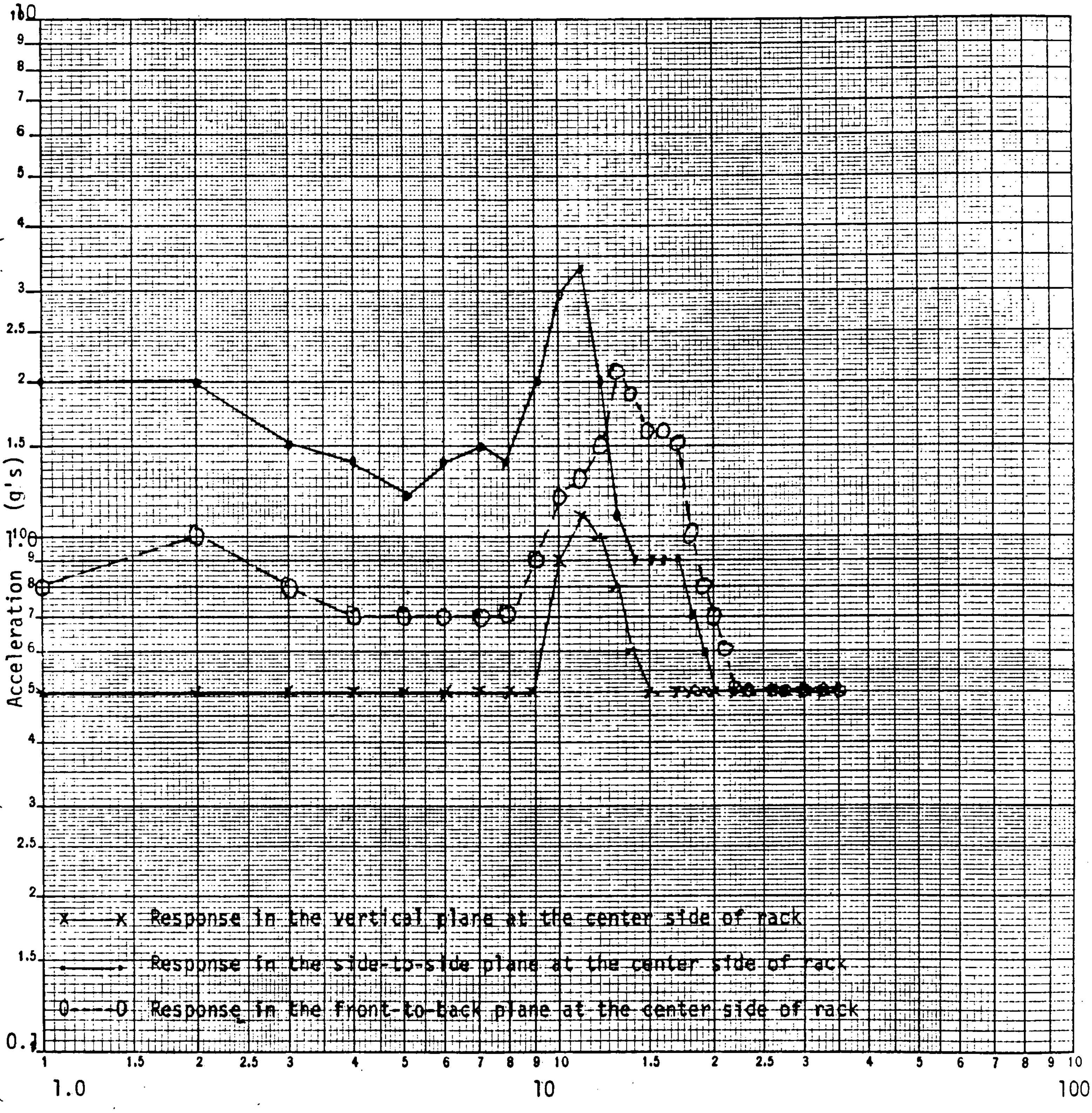


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 29

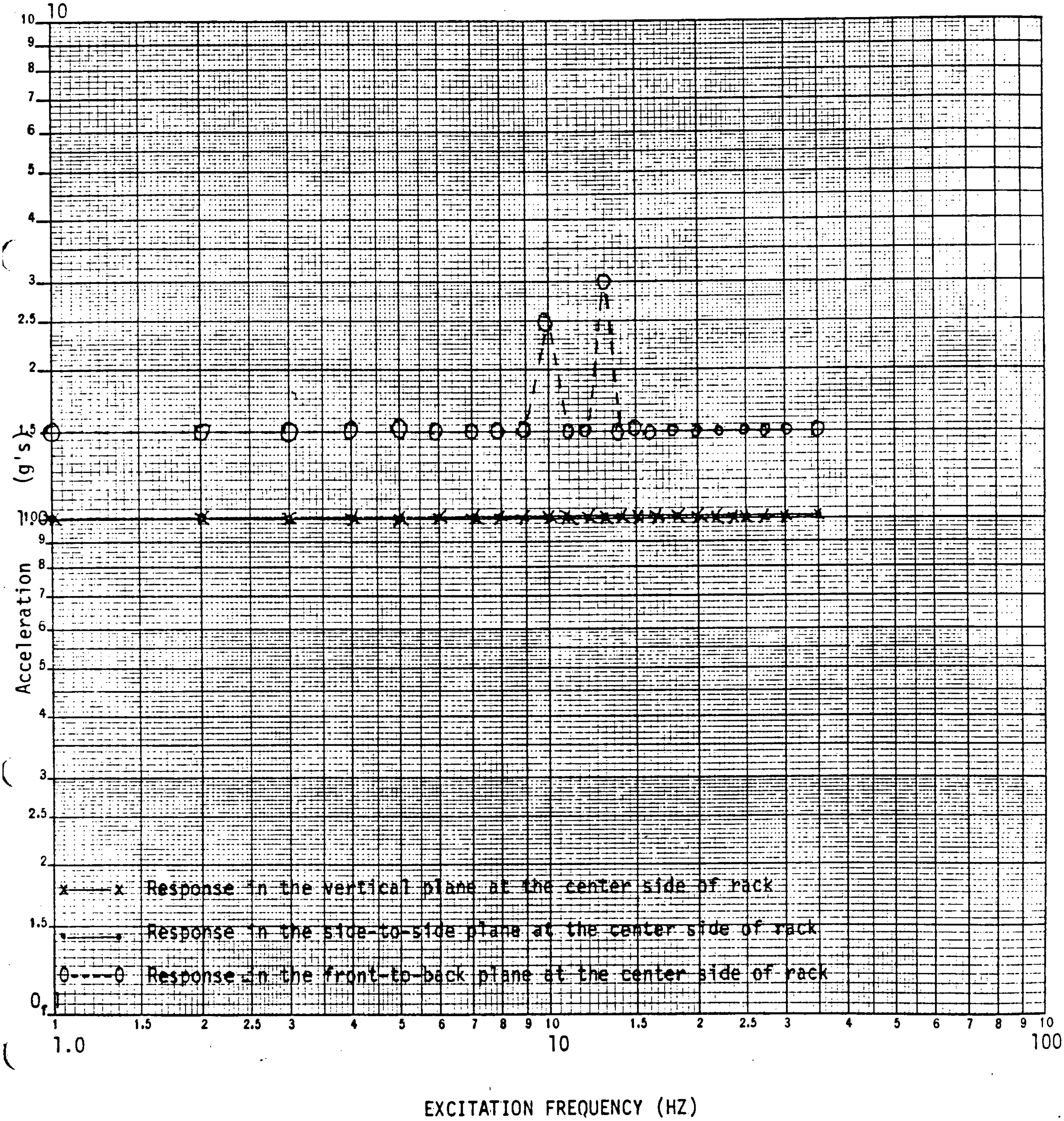
Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 1.0g



504-3-2-2

GRAPH NO. 30

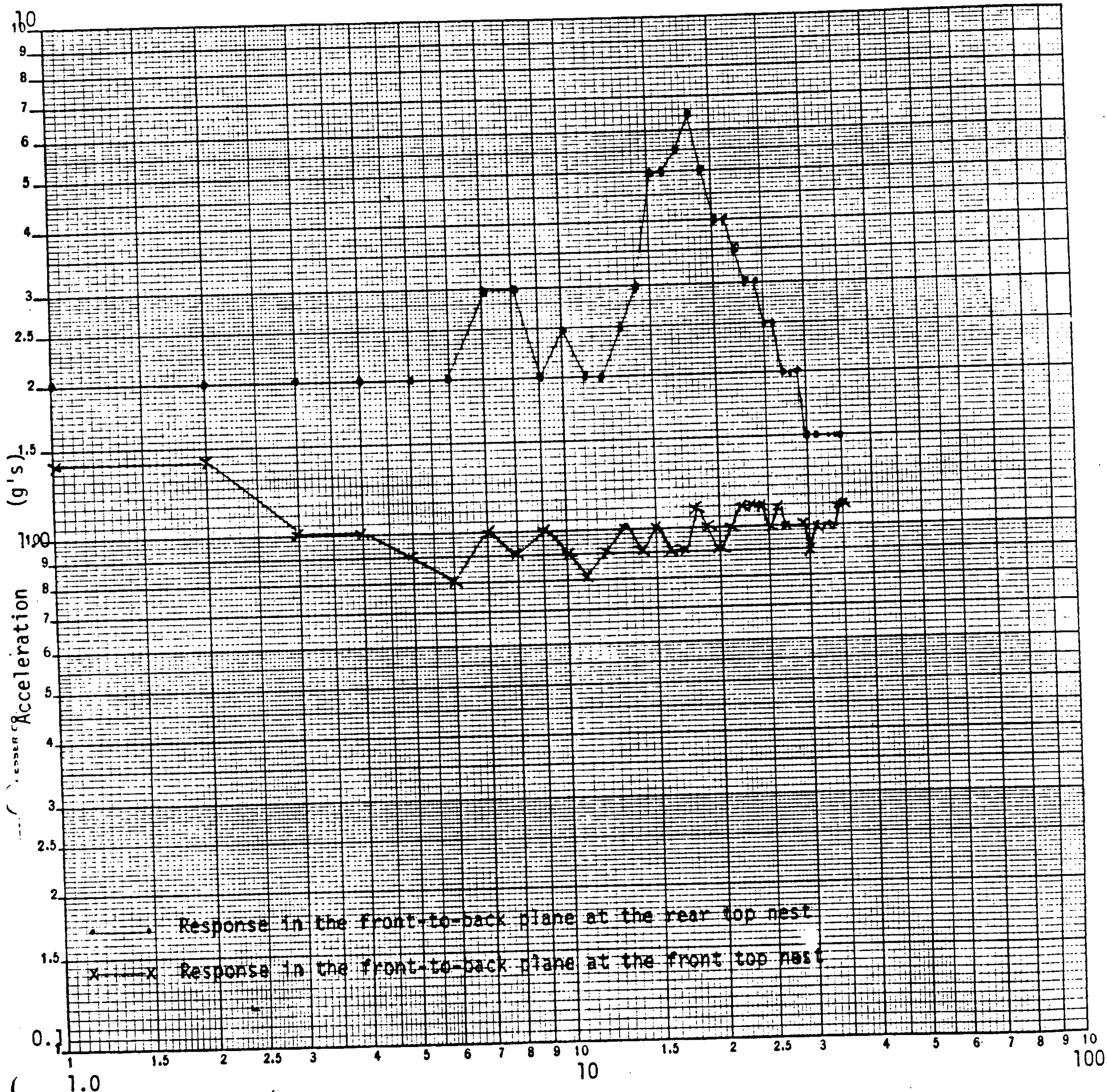
Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 1.0g



504-3-2-2

GRAPH NO. 31

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 1.0g

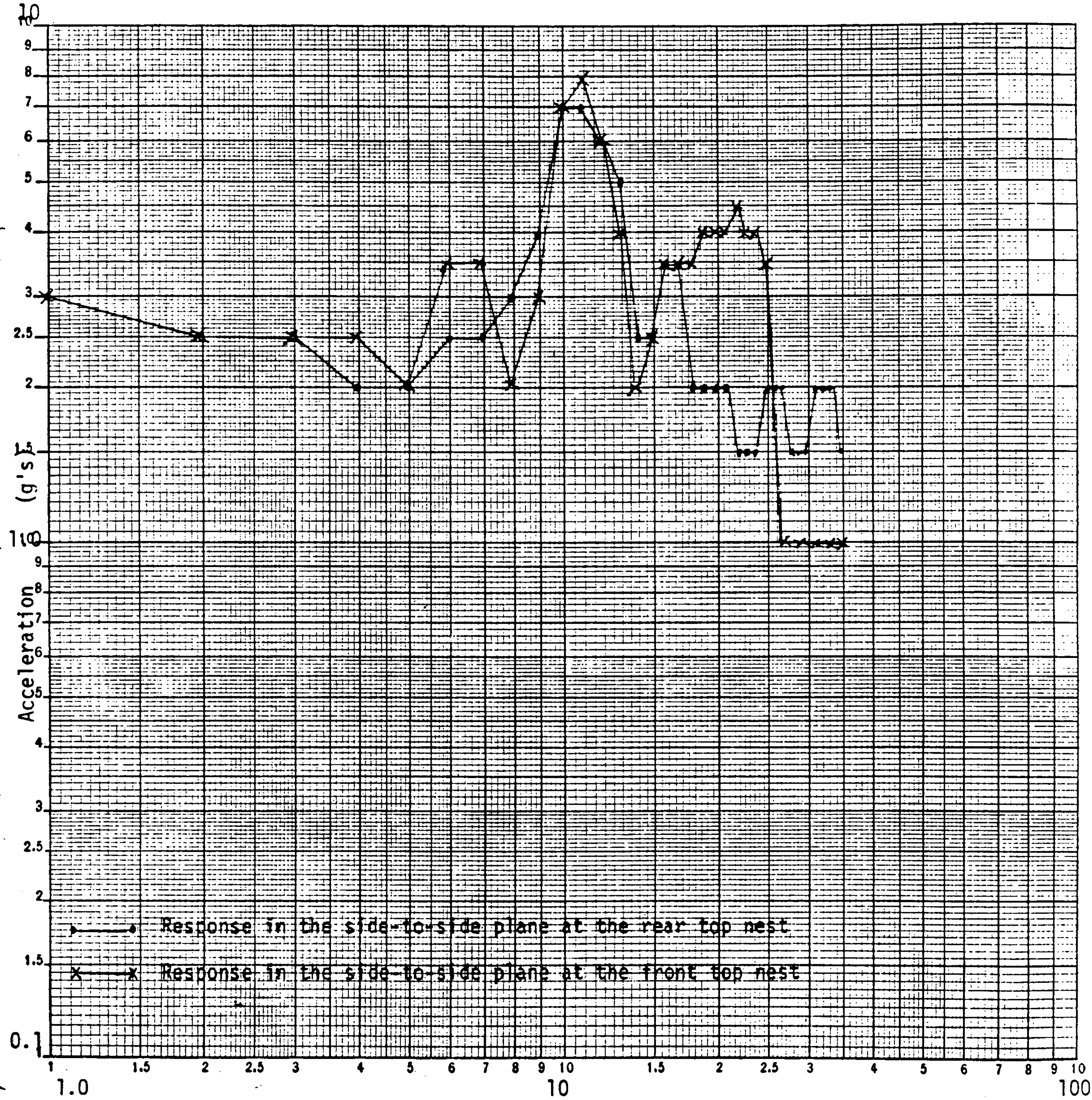


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 32

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 1.0g

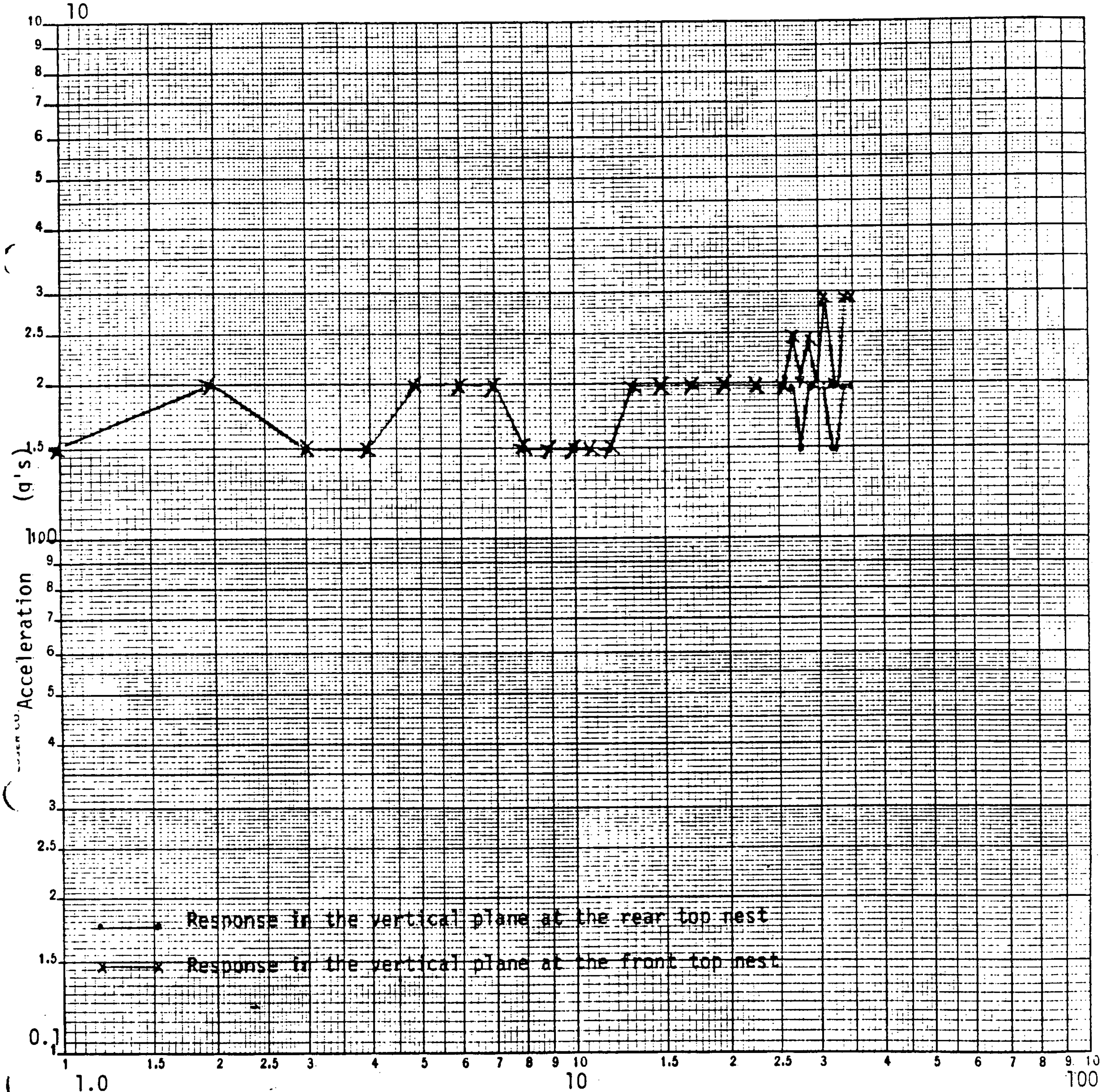


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 33

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025   August, 1974   L.Hewey
Rack Excited in the Vertical Plane at 1.0g

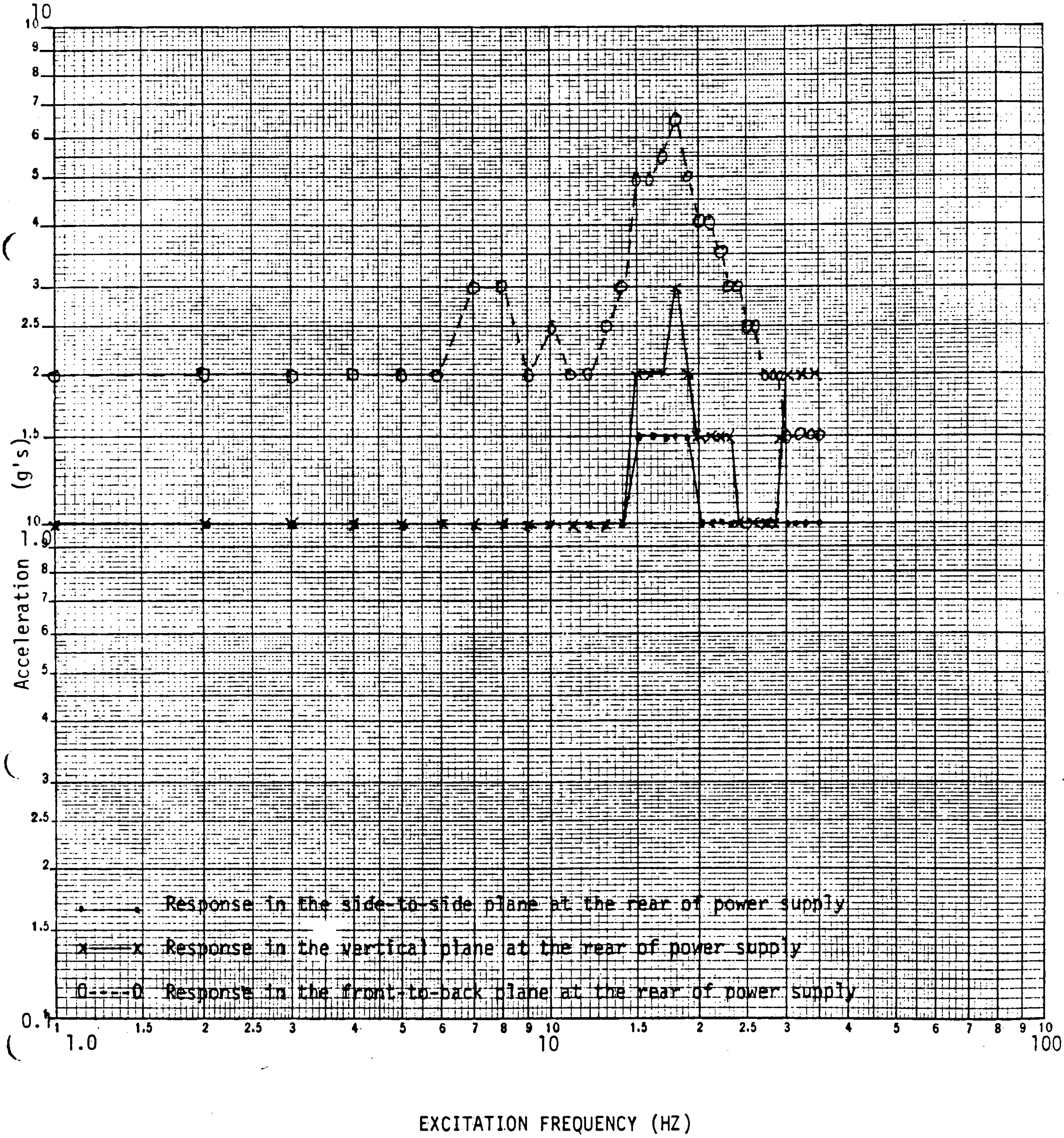


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 34

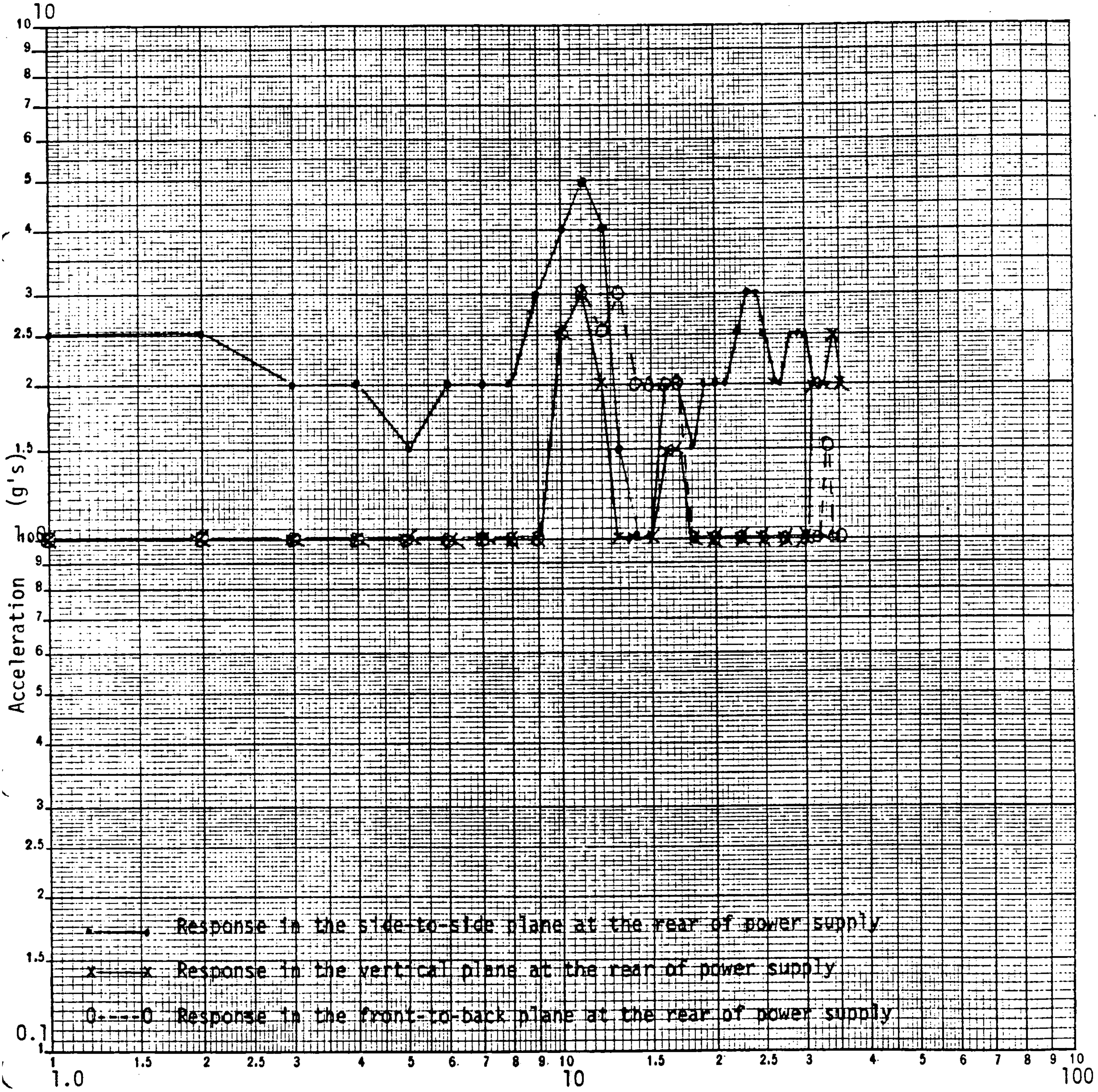
Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 1.0g



504-3-2-2

GRAPH NO. 35

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 1.0g

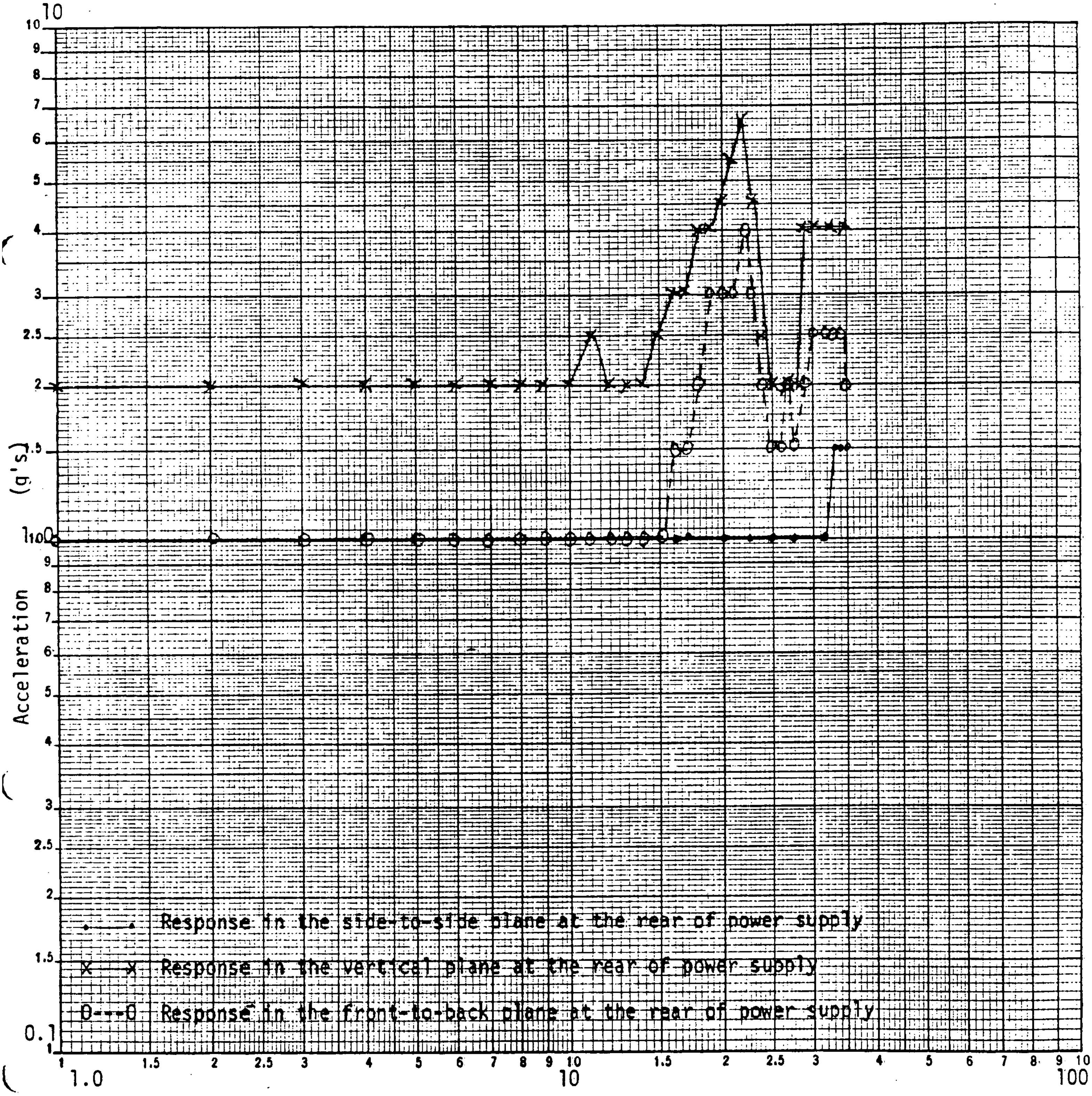


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 36

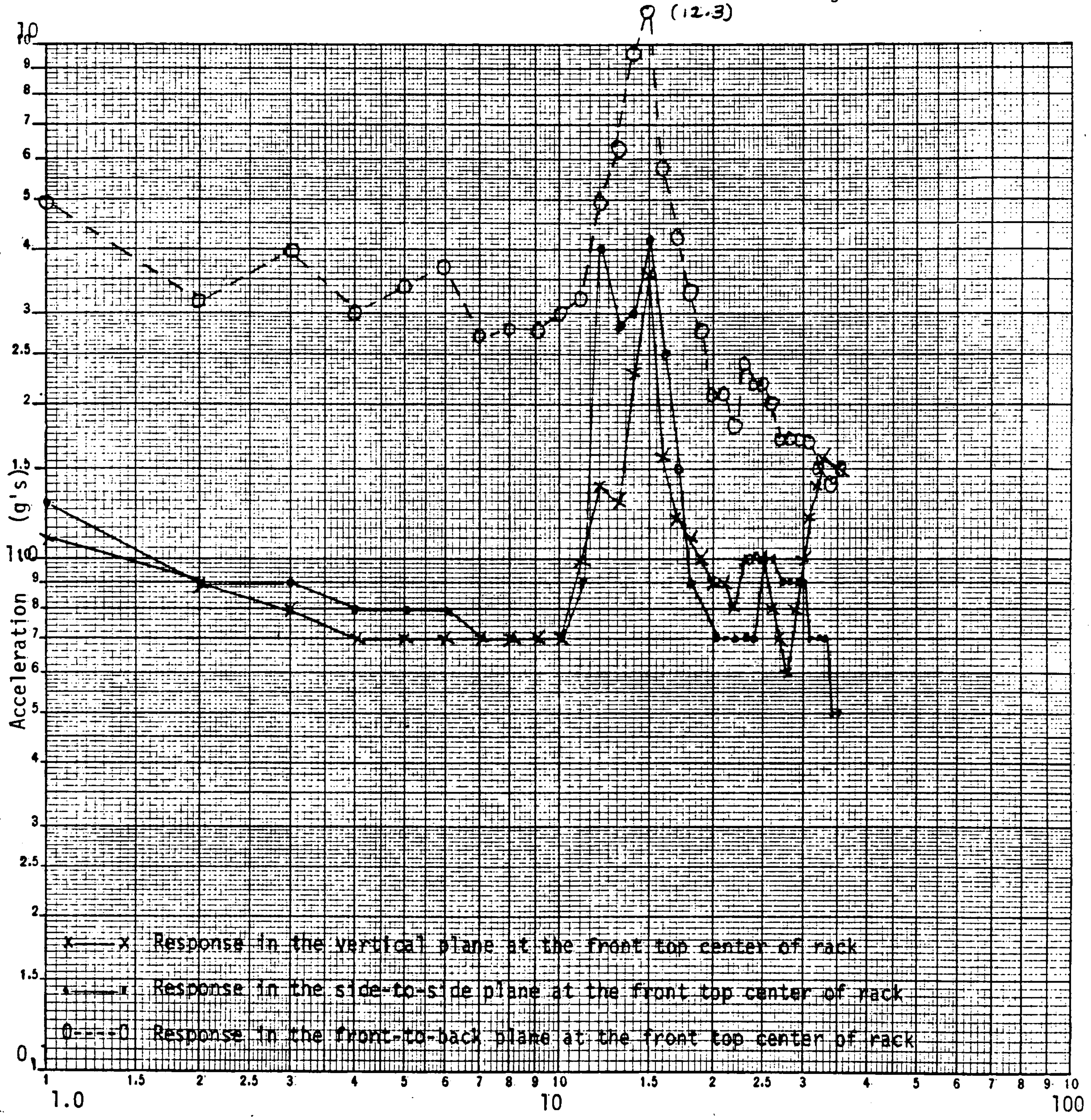
Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 1.0g



EXCITATION FREQUENCY (HZ)

504-3-2-2

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 2.0g's

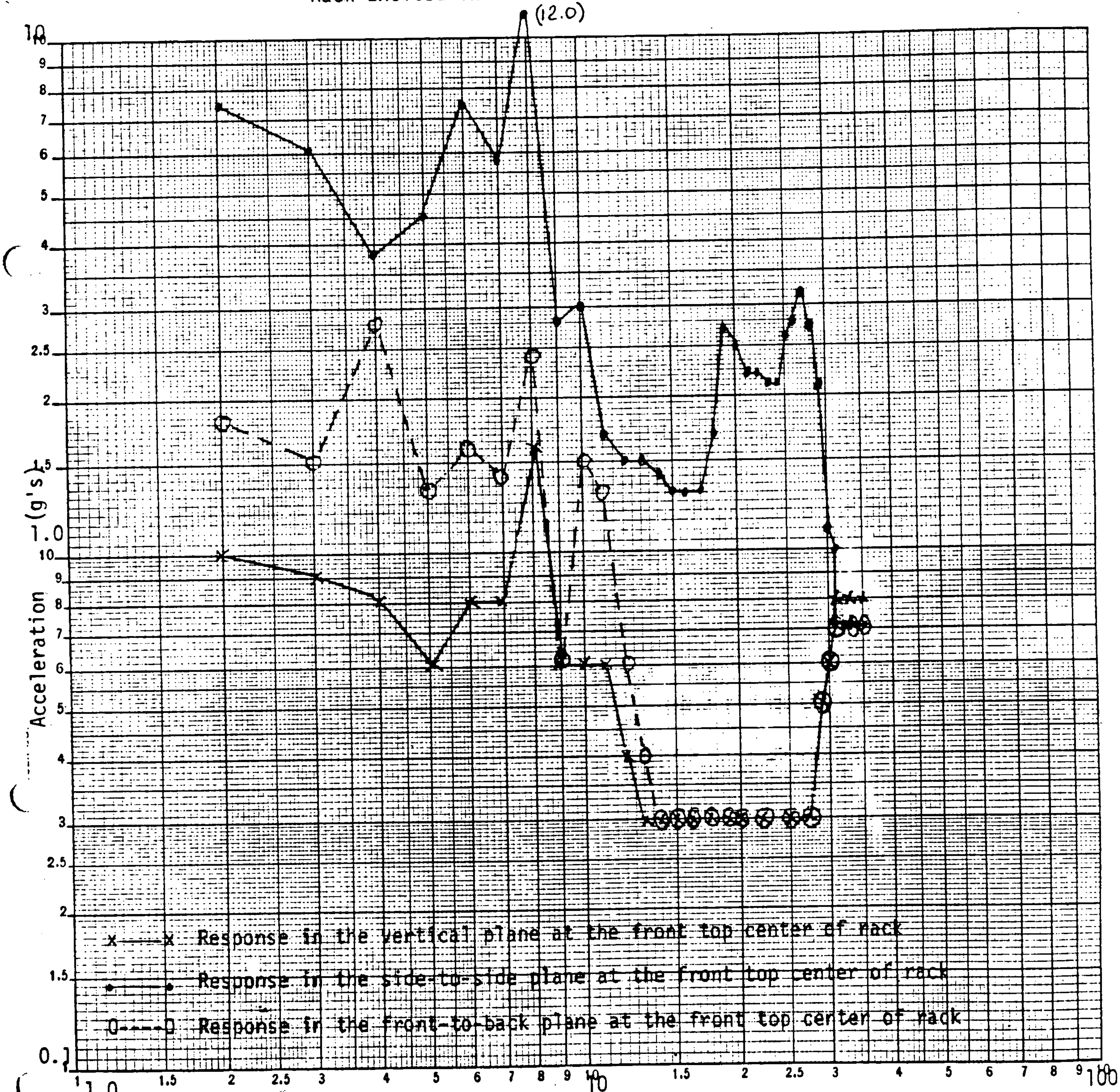


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 38

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 2.0g's

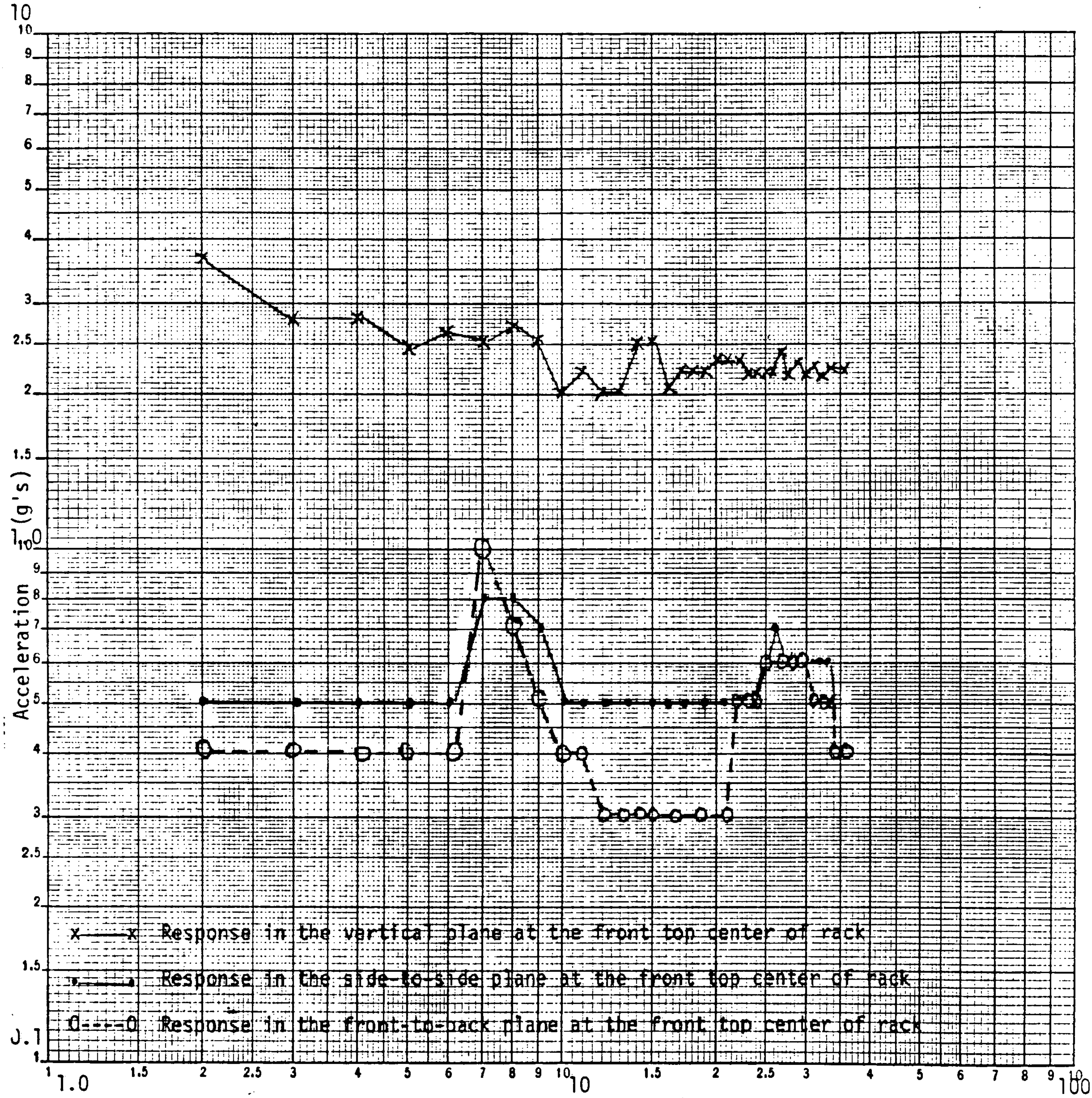


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 39

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 2.0g's

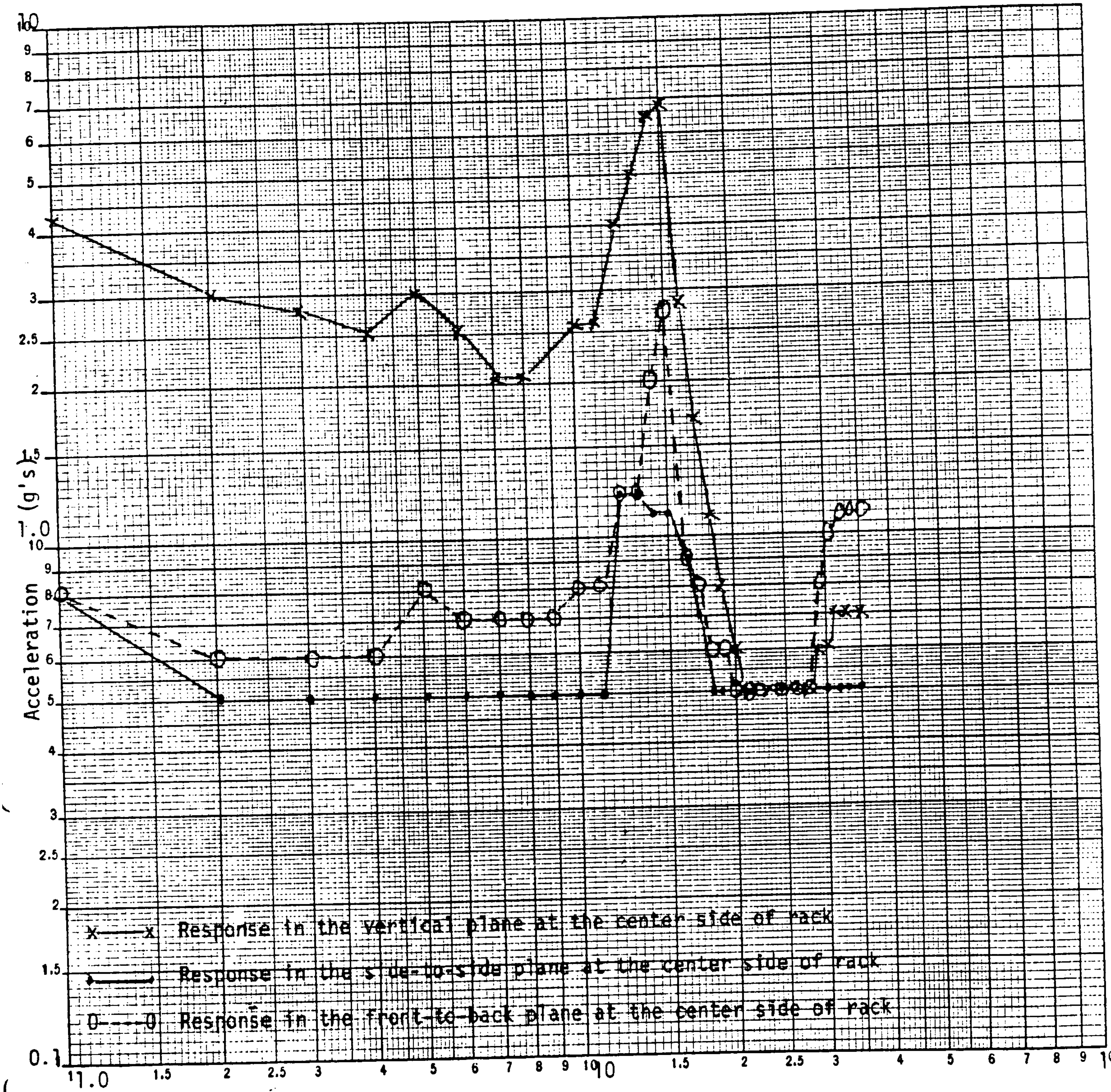


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 40

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-to-Back Plane at 2.0g's

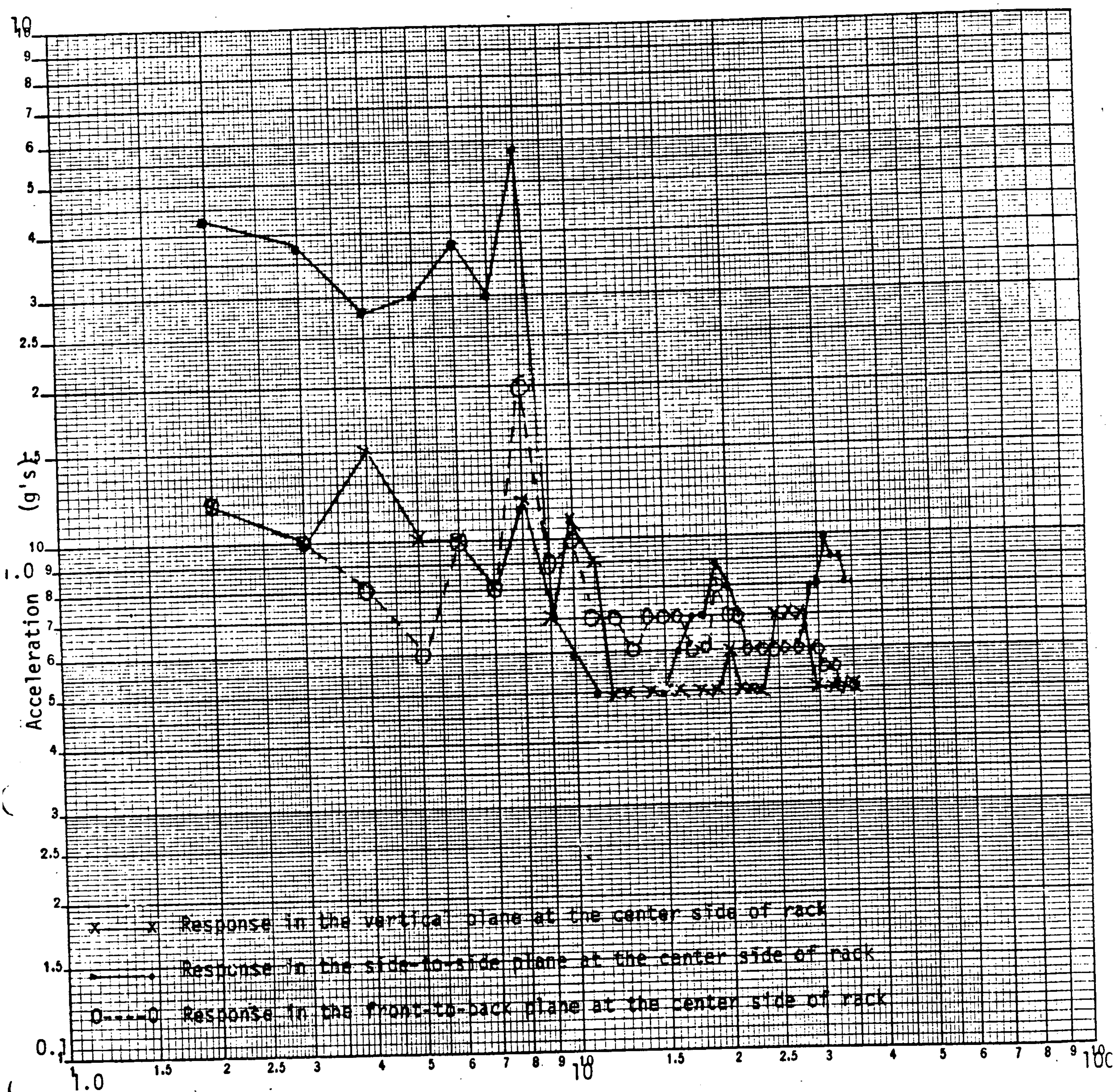


EXCITATION FREQUENCY (HZ)

504-3-2-2

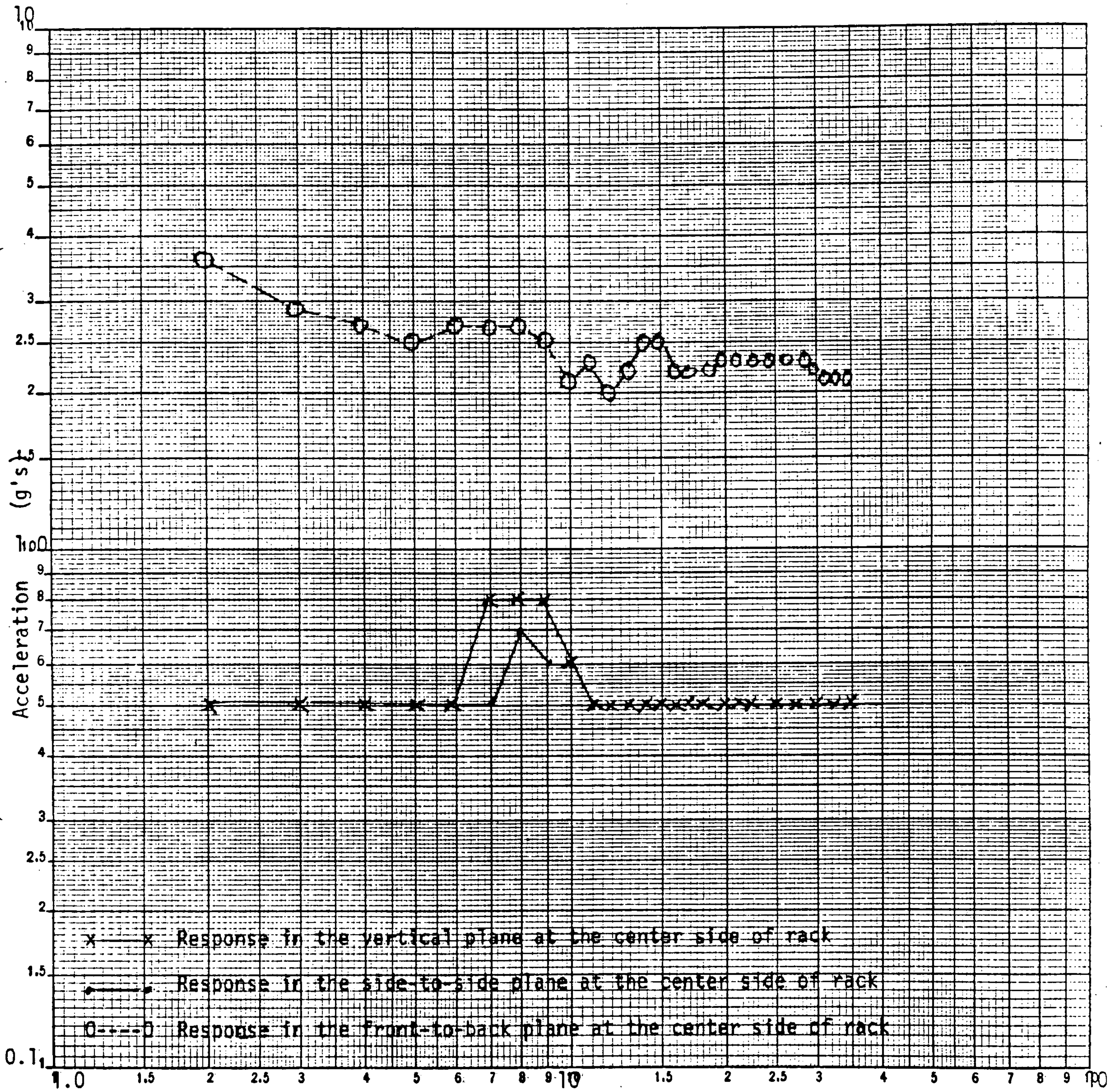
GRAPH NO. 41

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Side-to-Side Plane at 2.0g's



504-3-2-2

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 2.0g's

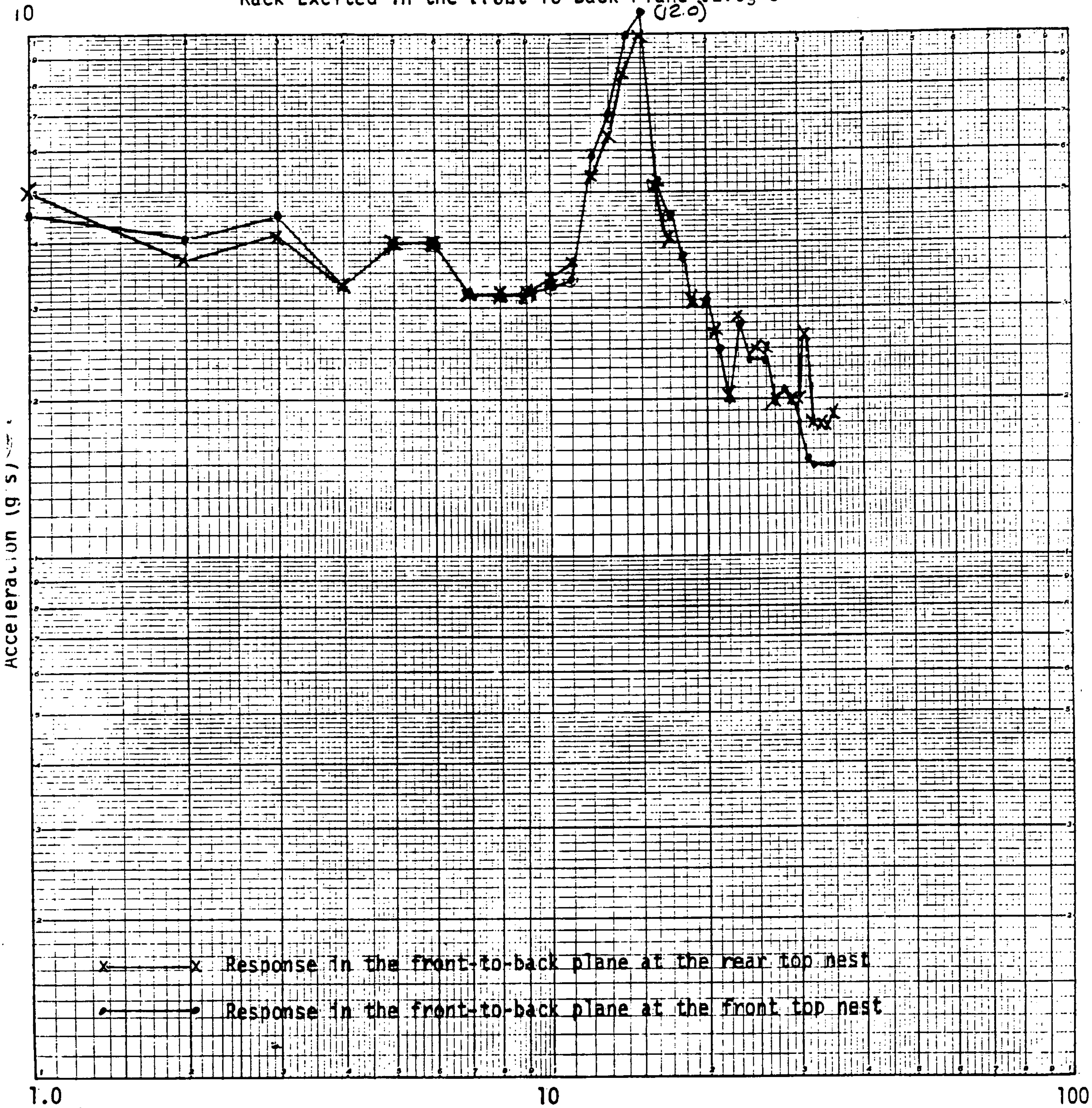


EXCITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 43

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to DWG. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Front-To-Back Plane @2.0g's

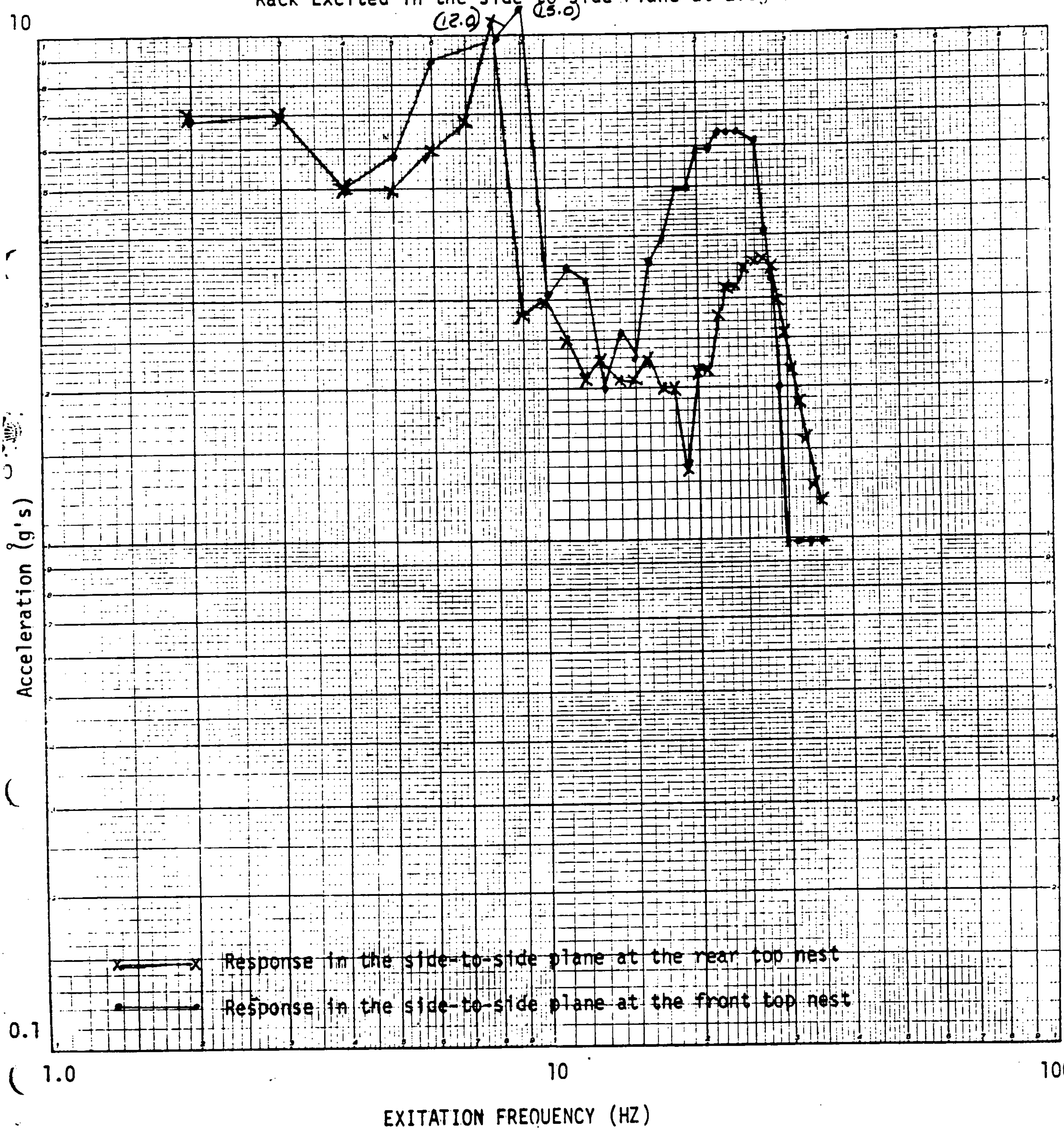


EXITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 44

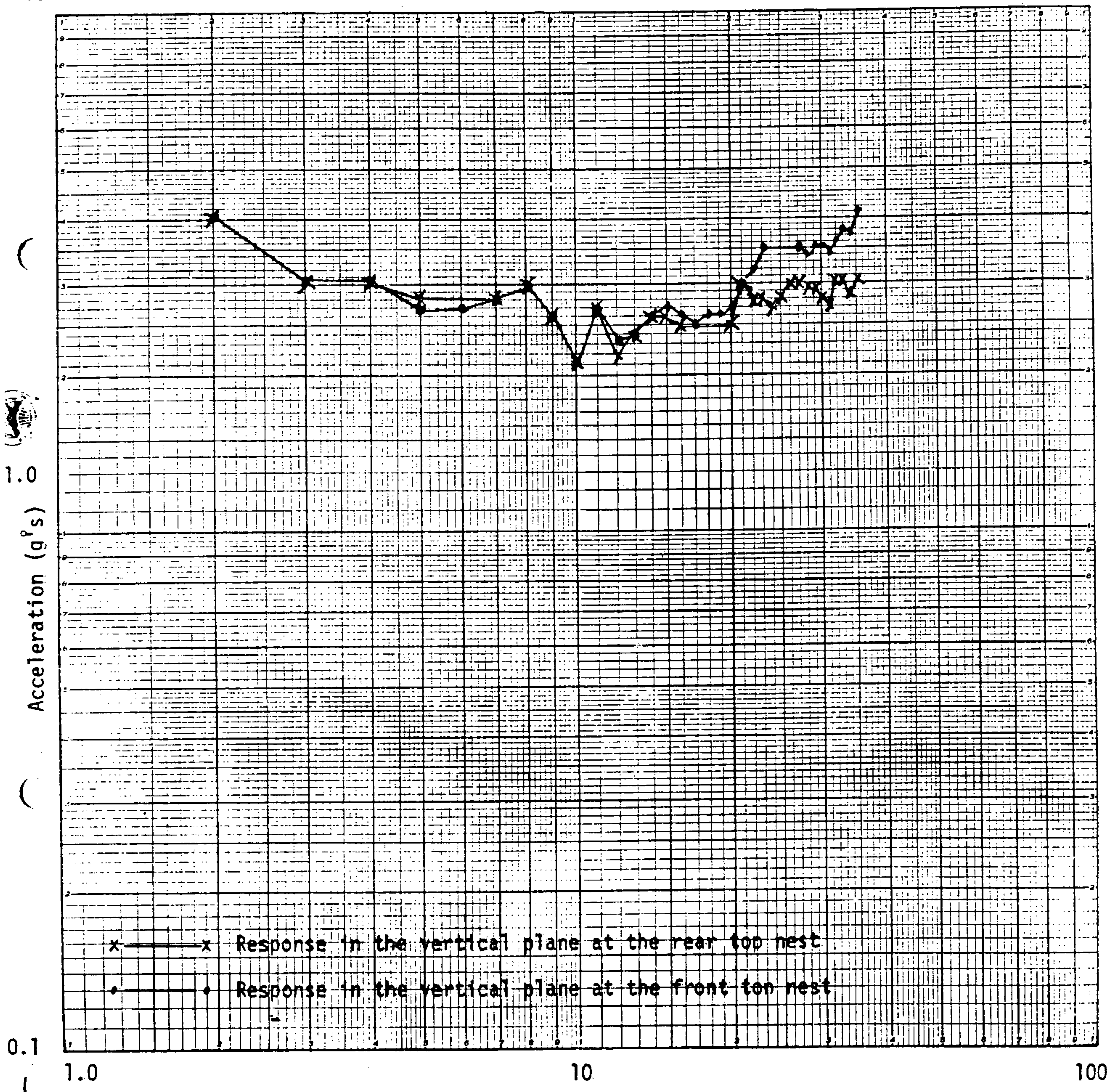
Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to DWG. No. 1)
Test No. T4-1025   August, 1974   L. Hewey
Rack Excited in the side-to-side Plane at 2.0g's



504-3-2-2

GRAPH NO. 45

Sine-Beat
Acceleration vs. Excitation Freauency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to DWG. No. 1)
Test No. T4-1025   August, 1974   L. Hewey
Rack Excited in the Vertical Plane at 2.0g's

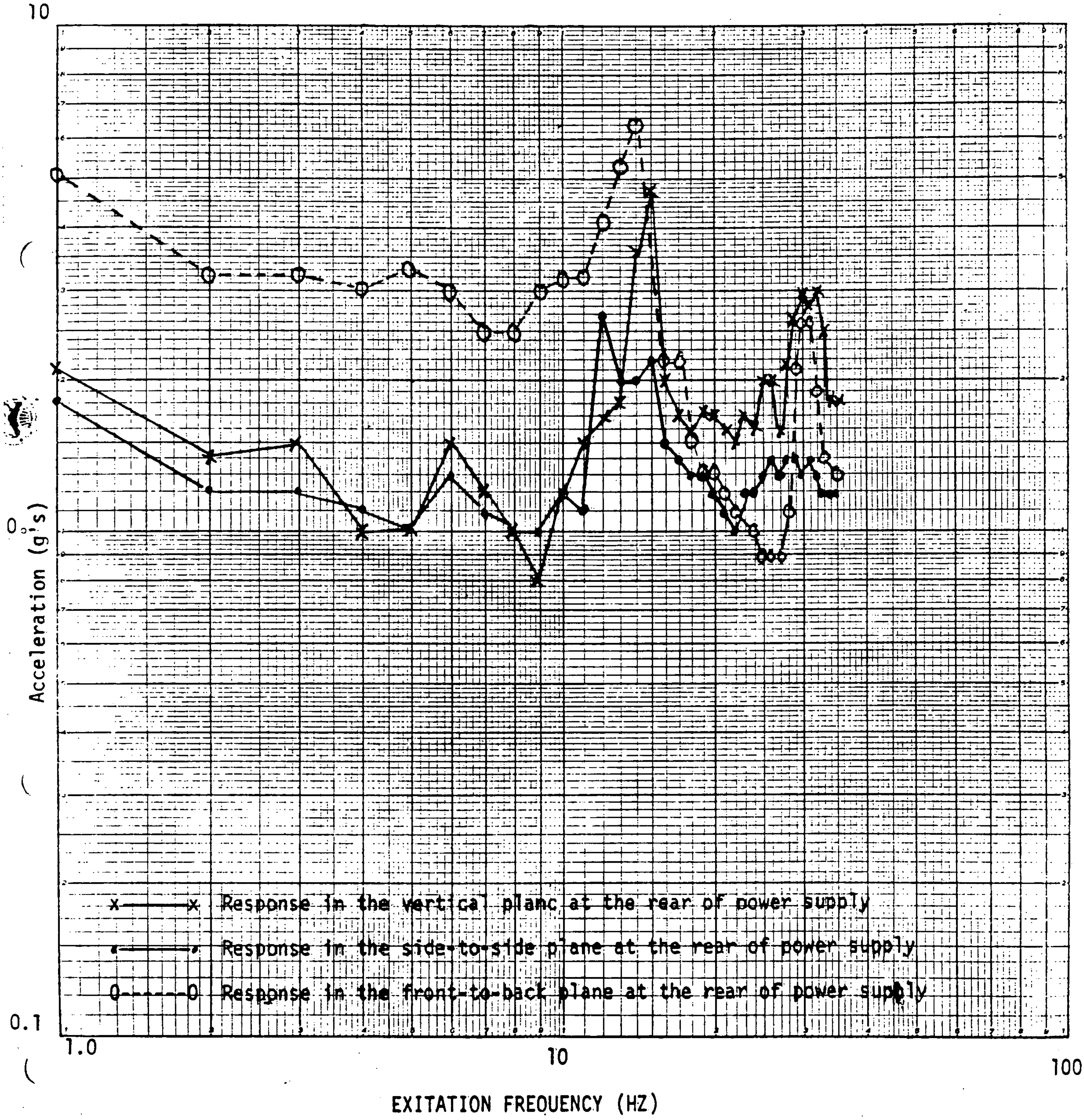


EXITATION FREQUENCY (HZ)

504-3-2-2

GRAPH NO. 46

Sine-Beat
Acceleration vs. Excitation Frequency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to DWG. No. 1)
Test No. T4-1025   August, 1974   L. Hewey
Rack Excited in the Front-To-Back Plane at 2.0g's



504-3-2-2

GRAPH NO. 47

~~Sine-Beat~~

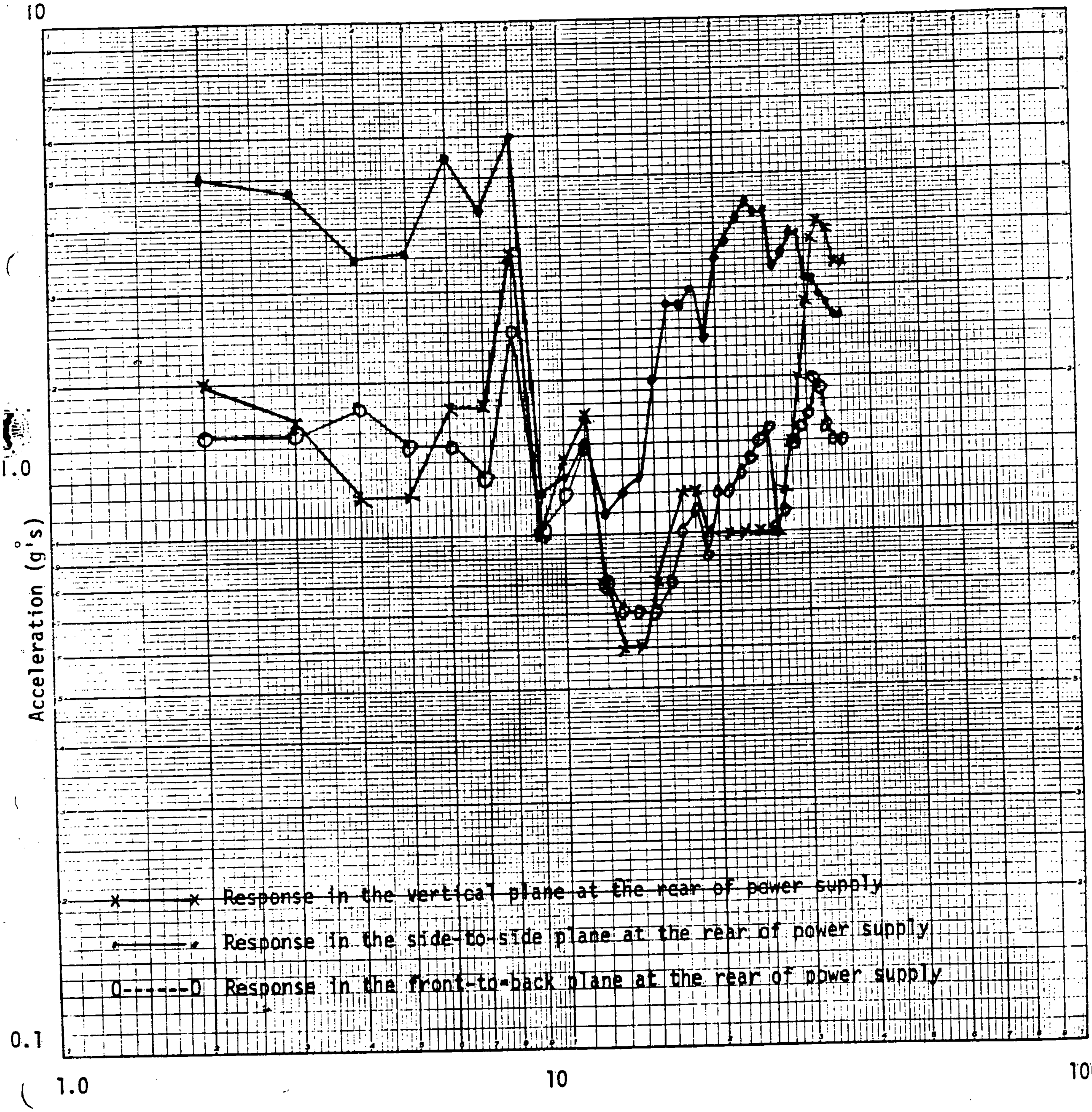
Acceleration vs. Excitation Frequency

Dummy-Loaded, Modified 2ES-N Spec 200 Rack

Rack "Unbalanced" (Refer to Dwg. No. 1)

Test No. T4-1025 August, 1974 L. Hewey

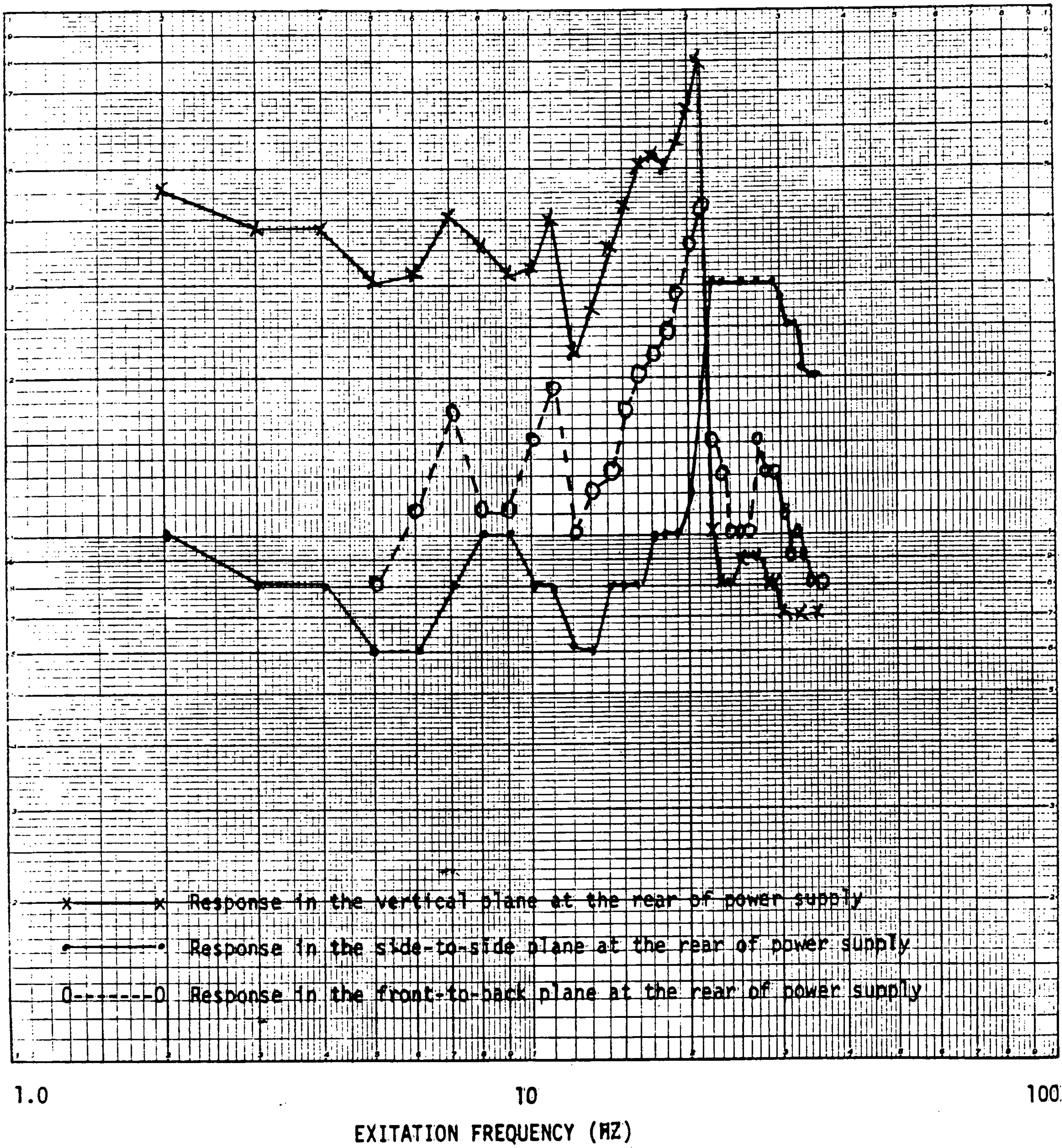
Rack Excited in the Side-To-Side Plane at 2.0g's



504-3-2-2

GRAPH NO. 48

Sine-Beat
Acceleration vs. Excitation Reeauency
Dummy-Loaded, Modified 2ES-N Spec 200 Rack
Rack "Unbalanced" (Refer to Dwg. No. 1)
Test No. T4-1025 August, 1974 L. Hewey
Rack Excited in the Vertical Plane at 2.0g's



504-3-2-2

AUG 28 1974

Test Report No. 11078 No. of Pages 5

Report of Test on

SEISMIC VIBRATION
of
2EZ-N INSTRUMENTATION CONTROL RACK
for
THE FOXBORO COMPANY
under
PURCHASE ORDER NO. E 11870

ACTON ENVIRONMENTAL TESTING CORPORATION

Date August 26, 1974

	Prepared	Checked	Approved
By	A.LeBourdais	M.Casaubon	M.L.Tolf
Signed	[illegible]	[illegible]	[illegible]
Date	8/27/74	8/27/74	8/27/74

MLT:AWL/hmf

504-3-2-2

Administrative Data

1.0 Purpose of Test: To subject the test item to seismic vibration (simulation).

2.0 Manufacturer:

The Foxboro Company
Foxboro, Mass.

3.0 Manufacturer's Type or Model No: 2EZ-N Instrumentation Control Rack

4.0 Drawing, Specification or Exhibit: The Foxboro Company Test Requirements, entitled "Qualification Testing, Seismic Vibration of Specification 200 Control Equipment".

5.0 Quantity of Items Tested:

One (1)

6.0 Security Classification of Items: None.

7.0 Date Test Completed:

August 14, 1974

8.0 Test Conducted By:

D.McLaughlin
J.O'Dowd

9.0 Disposition of Specimens: Returned to The Foxboro Company.

10.0 Abstract: No evidence of damage or deterioration to the test unit except during TEST NO. 11 and TEST NO. 12. (See RESULT section herein for details).

504-3-2-2

1.0 REQUIREMENTS

The 2EZ-N Instrumentation Control Rack is required to pass the seismic vibration qualification test specified in the Foxboro Company Document, entitled "Qualification Testing Seismic Vibration of Specification 200 Control Equipment".

2.0 PROCEDURES

The 2EZ-N Instrumentation Control Rack was mounted on the AETC Hydraulic Vibration System for vibration testing in each of three (3) mutually perpendicular axes. The accelerometers were located as follows:

Triaxial 1, 2 & 3 - on frame of top center - right side panel

Triaxial 4, 5 & 6 - on frame upper center - front of unit

Triaxial 7, 8 & 9 - top of power supply - second level in unit

Accelerometer #10 - power supply - top level within unit

Accelerometer #11 - power supply - top level within unit

NOTE: ACCELEROMETERS #10 and #11 were re-orientated to sense motion in the in-axis direction of test.

Accelerometer #12 - control accelerometer

The outputs of these accelerometers were monitored on oscillographic recorders. The test unit was non-operating throughout the test.

Following accelerometer instrumentation of the test item per Foxboro Company representative's instructions, the following tests were performed:

TEST NO. 1 - Balance Load - Vertical Axis

A resonance survey sine vibration test was performed at a test level of .4g's peak between the frequencies of 1 and 35 Hz at a sweep rate of 1 octave/minute.

TEST NO. 2 - Unbalanced Load - Vertical Axis

Same as TEST NO. 1.

TEST NO. 3 - Front-to-Back Direction - Unbalanced

Same as TEST NO. 1.

TEST NO. 4 - Front-to-Back Direction - Balance Load

Same as TEST NO. 1.

Following TEST NO. 4, all channels of visicorders were changed to a sensitivity of 10g's/inch except Channel 12 which was changed to 1g/inch.

TEST NO. 5 - Side-to-Side Direction - Balance Load

Same as TEST NO. 1.

TEST NO. 6 - Side-to-Side Direction - Unbalanced Load

Same as TEST NO. 1.

TEST NO. 7 - Side-to-Side Direction -

A sine beat test was performed. The sine beat test consisted of 10 beats, 10 cycles/beat, from 1 to 35 Hz at 1g peak.

TEST NO. 8 - Front-to-Back Direction

Beat frequency test same as TEST NO. 7.

Report No. 11078

TEST NO. 9 - Vertical Direction -

Beat frequency test same as TEST NO. 7.

TEST NO. 10 - Vertical Direction

Beat frequency test 2g's peak, 2 Hz - 35 Hz, 10 cycles/beat, 10 beats at each frequency.

TEST NO. 11 - Front-to-back Direction

Beat frequency test same as TEST NO. 10, except test was stopped at 10 Hz to check rack. (Rack o.k.) Stopped at 13 Hz at beat #5 to close front door as it opened during test. Stopped at completion of 13 Hz beat test to repair doors. Stopped at end of 14 Hz beat test. At this point the doors were removed as spot welds had fractured. Went on from this point to complete the sine beat test in the front-to-back axis.

TEST NO. 12 - Side-to-Side Axis

Beat frequency test same as TEST NO. 10, except as follows: Stopped test at 5 Hz after the 5th beat to tighten mounting bolts. Went on after this to complete test in the side-to-side axis.

3.0 RESULTS

There was no visible or apparent evidence of damage or deterioration to the system during test except as follows:

TEST NO. 11- After 5th beat at 13 Hz, test was stopped to close door as it opened during test. Stopped test at end of beat at 13 Hz position to repair doors. Stopped at end of 14 Hz beat test to remove doors as spot welds fractured.

TEST NO. 12 - Stopped at end of 5th beat during 5 Hz sine beat test to tighten mounting bolts as they had become loose.

Visicorder recordings generated during test were retained by Foxboro representatives.

Report No. 11078

5-04-3-2-2

TEST EQUIPMENT LIST

NAME	MFGR.	MODEL	SER.NO.	RANGE	ACCURACY	INV.#	CAL.FREQ.
Accelerometer	BK1	4335	135298	2 Hz - 6 KHz	±2%	AC331	3 months
Accelerometer	PCB	302A	666	1 Hz - 5 KHz	±5%	AC375	3 months
Accelerometer	PCB	302A	696	1 Hz - 5 KHz	±5%	AC386	3 months
Hydraulic Actuator	MTS	204.63S		DC-300 Hz,25K force lbs. 25" DA max.	±2% F ±5% A	PE367	
Controller	MTS	443.115		DC - 2000 Hz	±1%	PE367	
Visicorder	Honeywell	906	9-5235	DC-2 KHz 12 channel	±1 DB	RE332	3 months
Visicorder	Honeywell	906B	8687	DC-2 KHz 12 channel	±1 DB	RE301	3 months
Sweep Oscillator	SDY	SD-104-5	21A	0.005 Hz-50 KHz	±1%	SG315	6 months
Low Freq.Gen.	HP	202B	397	0.01 Hz - 1 KHz	±5%	SG319	6 months
Tone Burst Gen.	GRC	1396	1052	DC - 2 MHz	N/A	SG326	6 months
AC Voltmeter	HP	403A		10 Hz-1 MHz,0-300V	±3%	MV322	3 months
Scope,Storage	Tektronix	564-	11582	DC - 10 MHz	±3%	OS309	3 months

5-04-3-2-2

— NOTICE —

THE ATTACHED FILES ARE OFFICIAL RECORDS OF THE DIVISION OF DOCUMENT CONTROL. THEY HAVE BEEN CHARGED TO YOU FOR A LIMITED TIME PERIOD AND MUST BE RETURNED TO THE RECORDS FACILITY BRANCH 016. PLEASE DO NOT SEND DOCUMENTS CHARGED OUT THROUGH THE MAIL. REMOVAL OF ANY PAGE(S) FROM DOCUMENT FOR REPRODUCTION MUST BE REFERRED TO FILE PERSONNEL.

DEADLINE RETURN DATE 50-361

CONTROL# 8103060541

DATE- 2/13/81

REGULATORY DOCKET FILE COPY

RECORDS FACILITY BRANCH