Bendix
Aerospace Systems Division

ALSEP Array D Subpackages 1 & 2
Vibration Test Results

NO.	REV. NO.
ATM-993	

DATE 12-15-71

This technical memorandum represents the design limit level vibration test report for ALSEP Array D (EDM Subpackage No. 1 and Qual D Subpackage No. 2).

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1.0 SUBPACKAGE NO. 1 - EDM

1.1 INTRODUCTION

Since the Array D Subpack 1 experiments, and components in general, had all been qualified as part of previous ALSEP arrays, the qualification model and qualification testing were deleted due to previous array similarity. However, for the Array D engineering model (EDM) vibration tests it was necessary to verify that the experiment dynamic environments would not exceed previous qualification levels for each experiment (LSM, PSE, ASE).[1]

1.2 TEST ARTICLE

Table 1.1 lists the major EDM components along with drawing numbers, serial numbers, and previous usage. Since the EDM vibration test must serve to demonstrate qualification of the experiments, it was necessary to fabricate the EDM per flight design, as nearly as possible. This was best accomplished by utilizing existing hardware from Qual SA and Qual C. Only the sunshield assembly was new.

Figure 1.1 shows a photograph of the EDM.

1.3 TEST DESCRIPTION

1.3.1 Purpose

The purpose of the EDM vibration test is to (1) verify structural integrity of the system and (2) demonstrate that dynamic environments are not excessive relative to the qualification environments of each experiment.

1.3.2 Input Levels

Figures 1.2 through 1.7 show the specified Array D (Subpacks 1 and 2) design limit vibration test levels.[2] These levels are based upon mechanical vibration data recorded at the LM/ALSEP interface during the LTA-3DR acoustic tests.

Test level tolerances[3] are:

(1) random vibration: ±3 db, power spectral density (PSD) (except that a maximum of three channels may exceed +3 db to as high as +6 db).

±10%, root-mean-square acceleration (g_{RMS})

(2) Sinusoidal vibration: ±10%, acceleration (g-peak)

1.3.3 Instrumentation

Eighteen single axis accelerometers were mounted on the EDM as shown in Figures 1.8 and 1.9. The primary objective of this accelerometer location plan was to allow determination of vibration environments for each of the the experiments. Each experiment was instrumented as it had been for Qual SA and/or Qual C, allowing a direct comparison of EDM and Qual data[4].

1.4 RESULTS

Table 1.2 lists the root-mean-square acceleration (g_{RMS}) values recorded during each random vibration test at locations A, B, E, G, and J.

Figures 1.10, 1.11, and 1.12 are data response envelopes at the ASE interface (locations E, G, and J) which were constructed using data obtained during the sinusoidal vibration tests. These envelopes represent the maximum response level at a given frequency as determined by in-axis and cross-axis data. For example, Figure 1.10 is an envelope of three in-axis (x_{out}/x_{in}) plots from locations E, J, and G; and two cross-axis plots at location E (x_{out}/y_{in}, x_{out}/z_{in}).

Similarly, Figures 1.13. 1.14, and 1.15 are data response envelopes at the ASE interface for the L&B random vibration tests; and Figures 1.16, 1.17, and 1.18 are ASE response envelopes for the Lunar Descent random vibration tests.

Corresponding response envelopes for the LMS (location B) and PSE (location A) are shown in Figures 1.19 through 1.36.

Each of the above figures show two response envelopes for purposes of comparison. The envelopes labeled "D" correspond to EDM data and those labeled "A" or "C" correspond to qualification test data. The ASE was qualified during the Qual C tests while the LMS and PSE were qualified during the Qual SA tests.

Accelerometer data at locations C, D, F, H, and K were recorded and is available. This data was obtained as "back-up" information and, therefore, is not presented in this report. However, it should be noted that the difference between the location A and location K data was insignificant.

1.5 CONCLUSIONS

The experiment environments were not equal to or less than qualification levels at all frequencies, but excedents were not significant.[5] Generally, EDM dynamic responses were mild compared to previous ALSEP arrays, in spite of the fact that a dummy central station/thermal plate assembly was incorporated as part of the EDM. Previous ALSEP tests indicated that the use of mass/c.g. dummy components tended to increase response levels.

It is recommended that the ASE, LMS, and PSE be considered qualified for Array D via qualification tests for Arrays A and C. Hence, no design changes and/or further testing of Array D Subpack 1 is required.[6]

Table 1-1 - Array D Subpackage 1 (EDM)

Configuration Description (major components)

component	dwg. no.	serial no.	previous usage
primary structure	2339001	SN-8	D2-Qual.
thermal plate/CSE	2345183	SN-1	Qual. C
sunshield	2339010	SN-14	---
antenna	230307	SN-4	Qual. C
ASE	2330750	SN-4	Qual. C
PSE	2341604	SN-2	Qual. SA
LSM	2330657	SN-2	Qual. SA

Table 1.2

Random Vibration Root-Mean-Square Response Acceleration Levels

Exp.	Loc.	Resp. Axis	X-input		Y-input		Z-input	
			L&B	L. D.	L&B	L. D.	L&B	L. D.
ASE	E	X	3.0	2.6	---	---	---	---
		Y	---	---	3.0	2.5	---	---
		Z	---	---	---	---	2.3	1.8
	J	X	2.9	3.0	---	---	---	---
		Y	---	---	2.0	1.9	---	---
		Z	---	---	---	---	0.7	0.8
	G	X	4.2	3.1	2.6	2.5	1.9	1.6
		Y	2.4	1.6	2.7	2.3	1.8	1.0
		Z	2.4	1.7	2.6	2.0	0.4	0.3
LSM	B	X	6.0	4.0	2.8	2.9	2.3	1.7
		Y	2.2	1.6	3.4	2.8	1.3	1.0
		Z	3.5	2.3	1.7	1.4	2.0	1.5
PSE	A	X	3.3	3.1	2.6	2.2	1.9	1.4
		Y	2.7	1.9	3.0	2.7	1.6	1.2
		Z	2.6	1.8	2.2	1.8	1.6	1.6

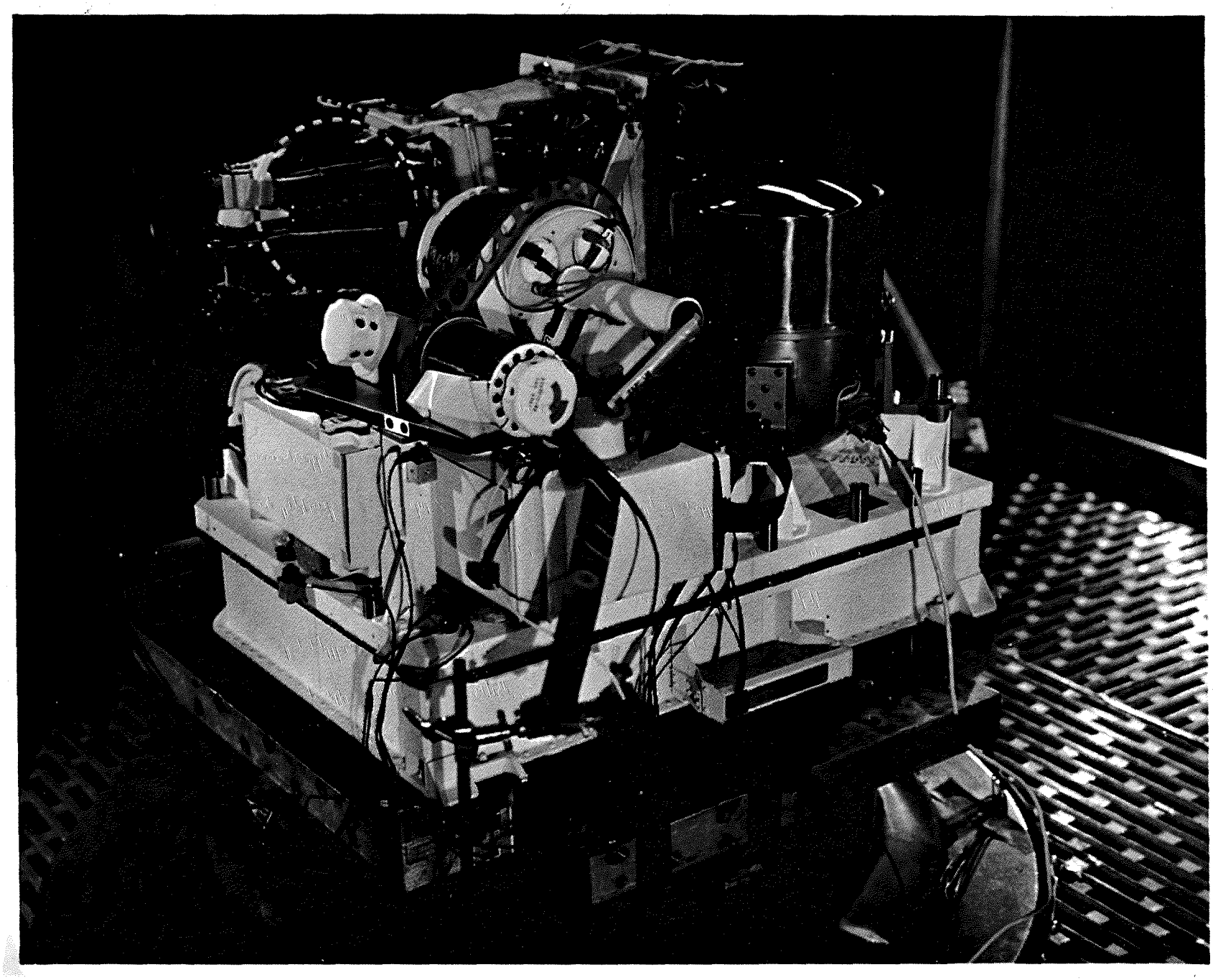

Figure 1.1 - EDM Subpack 1

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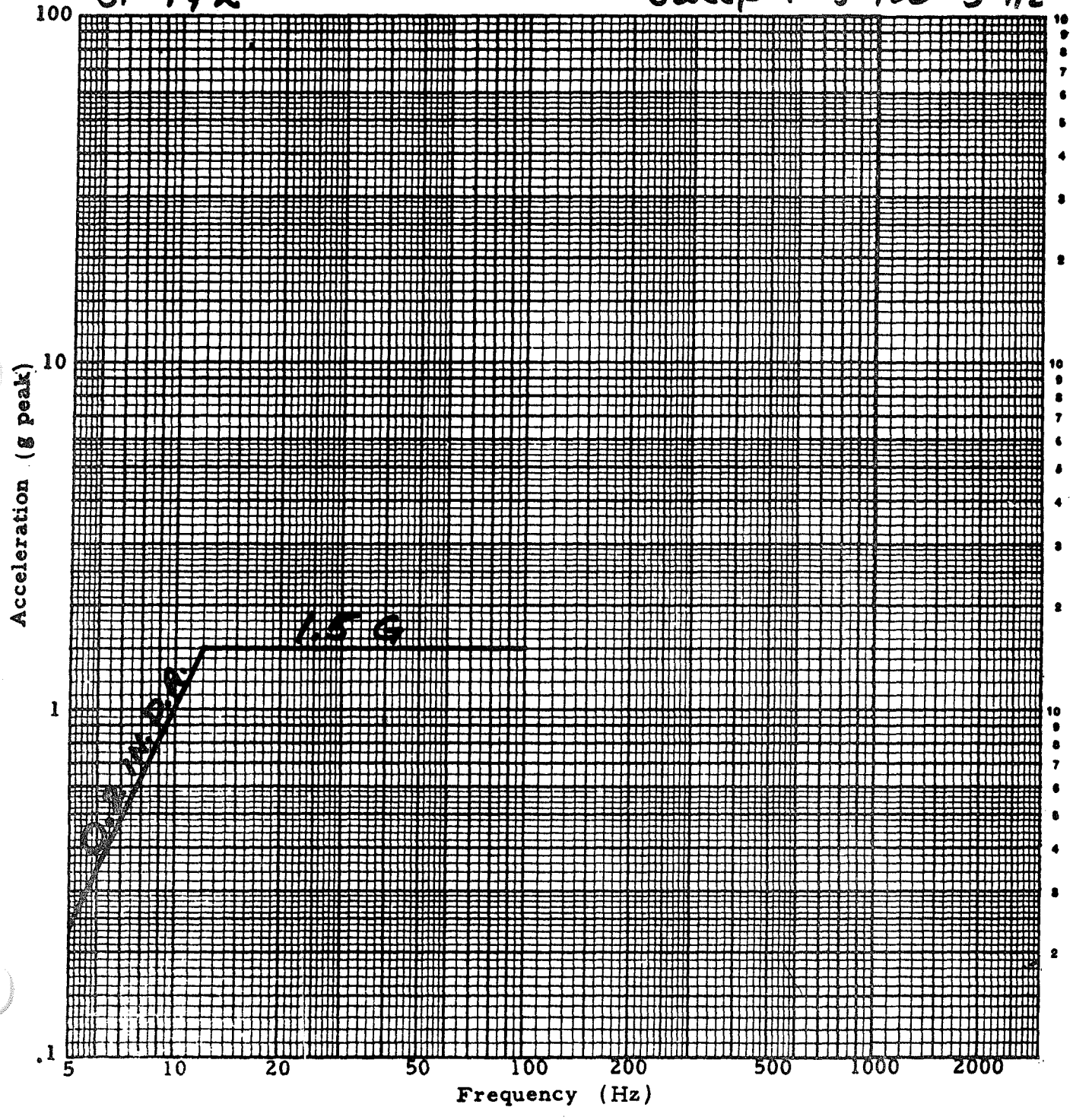
LTA-3DR
DESIGN LIMIT
SINUSOIDAL VIBRATION

Axis: X, Y, Z

Sweep Rate: 3/4 oct/min

SP-1&2

Sweep : 5-100-5 Hz



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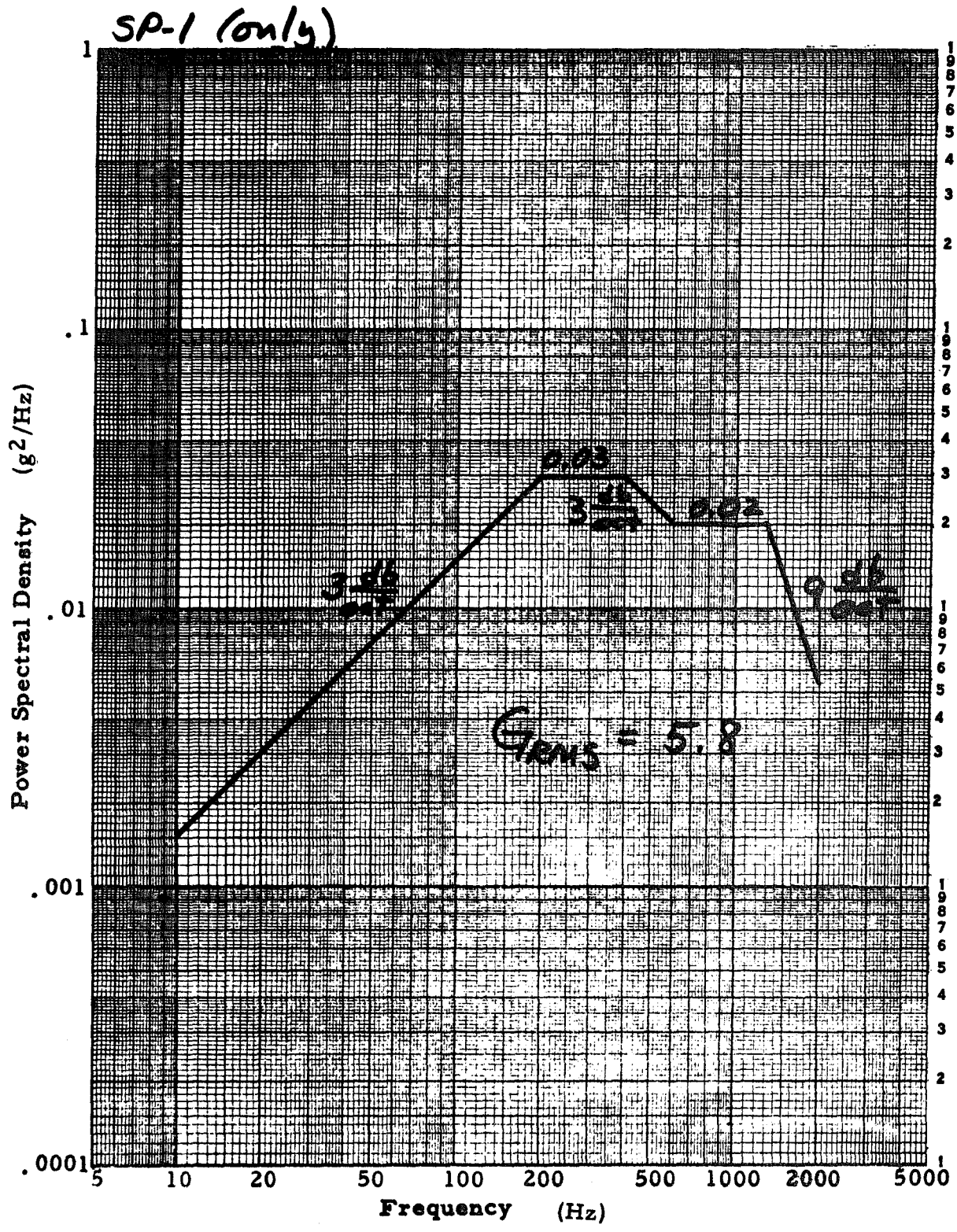
LTA-3DR
DESIGN LIMIT L&B
RANDOM VIBRATION SPECTRUM

Axis: X

Duration: 2.5 min



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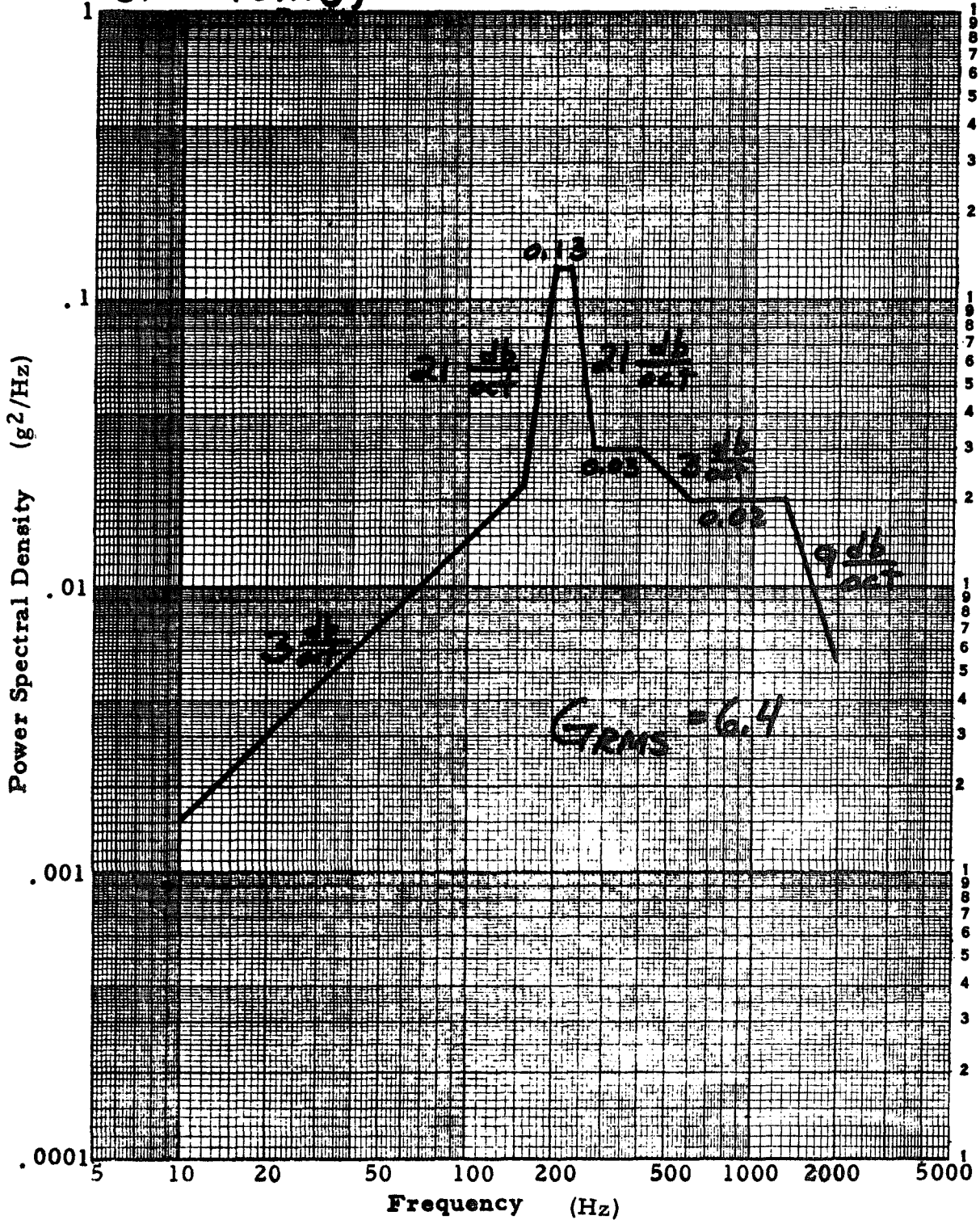
LTA-3DR
DESIGN LIMIT L+B
RANDOM VIBRATION SPECTRUM

Axis: X

Duration: 2.5 min

SP-2 (only)



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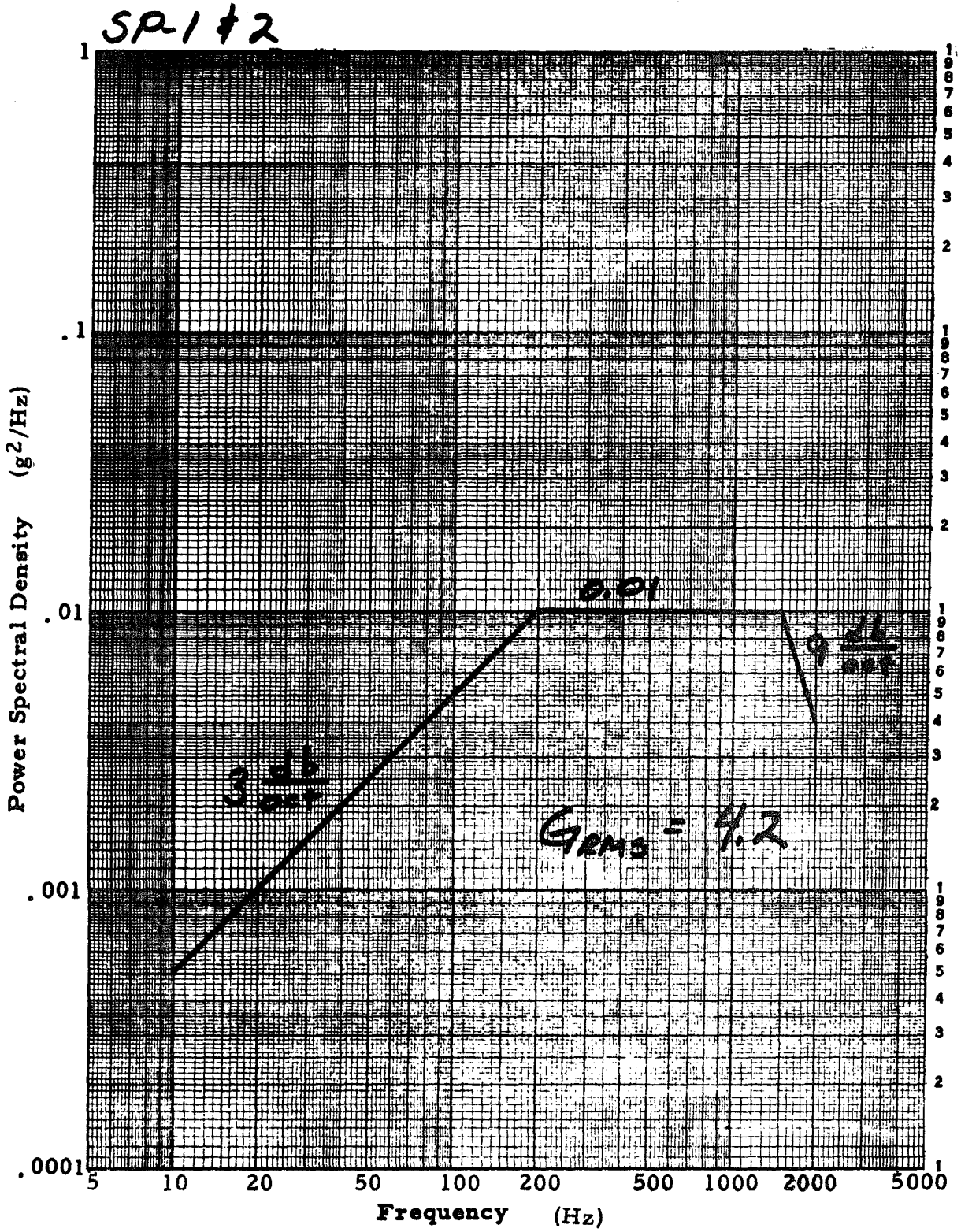
LTA-3DR
DESIGN LIMIT L+B
RANDOM VIBRATION SPECTRUM

Axis: Y

Duration: 2.5 min



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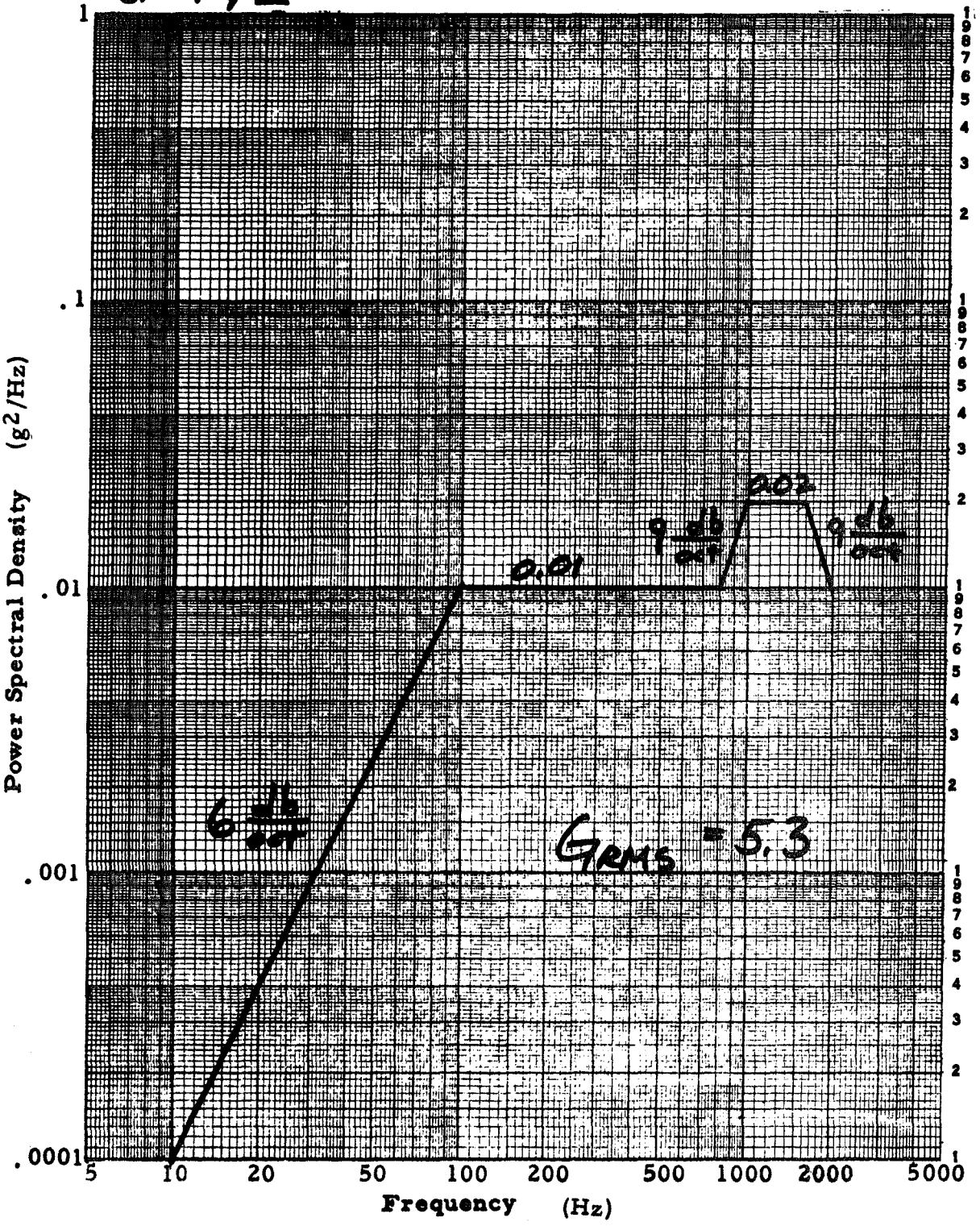
LTA-3DR
DESIGN LIMIT L+B
RANDOM VIBRATION SPECTRUM

Axis: Z

Duration: 2.5 min

SP-1 & 2



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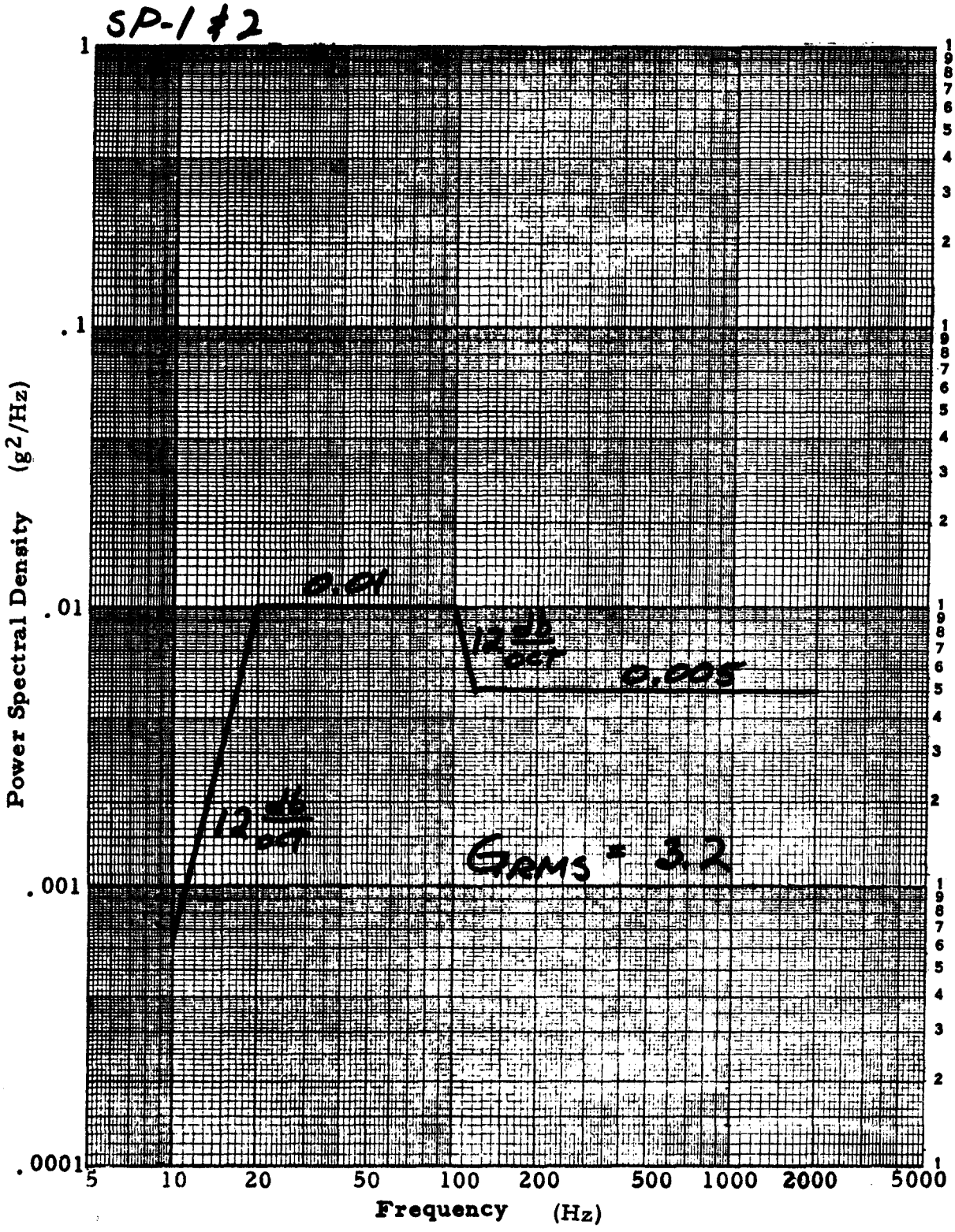
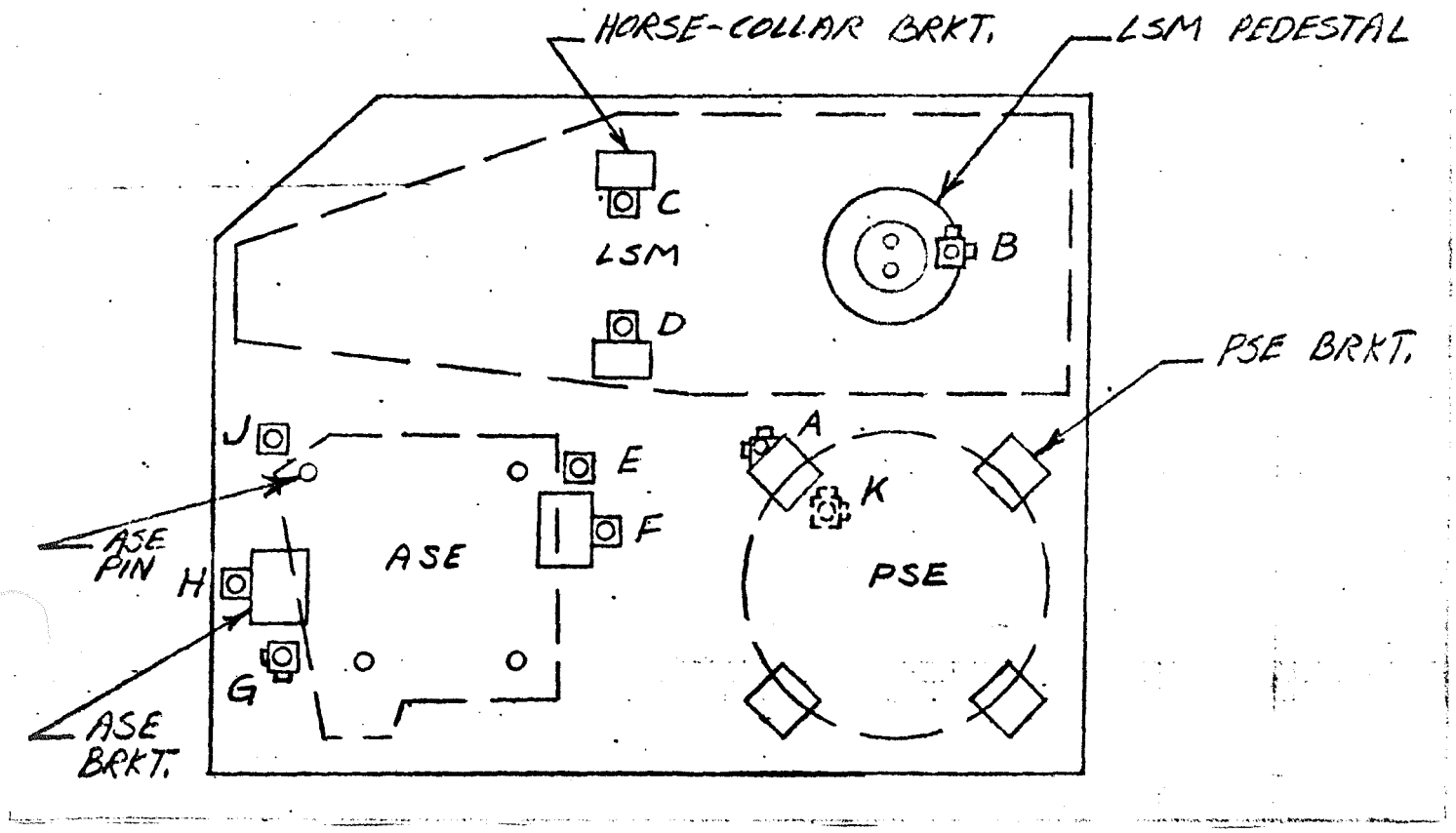
LTA-3 DR
DESIGN LIMIT LUN. DES.
RANDOM VIBRATION SPECTRUM

Axis: X, Y, Z

Duration: 12.5 min/axis

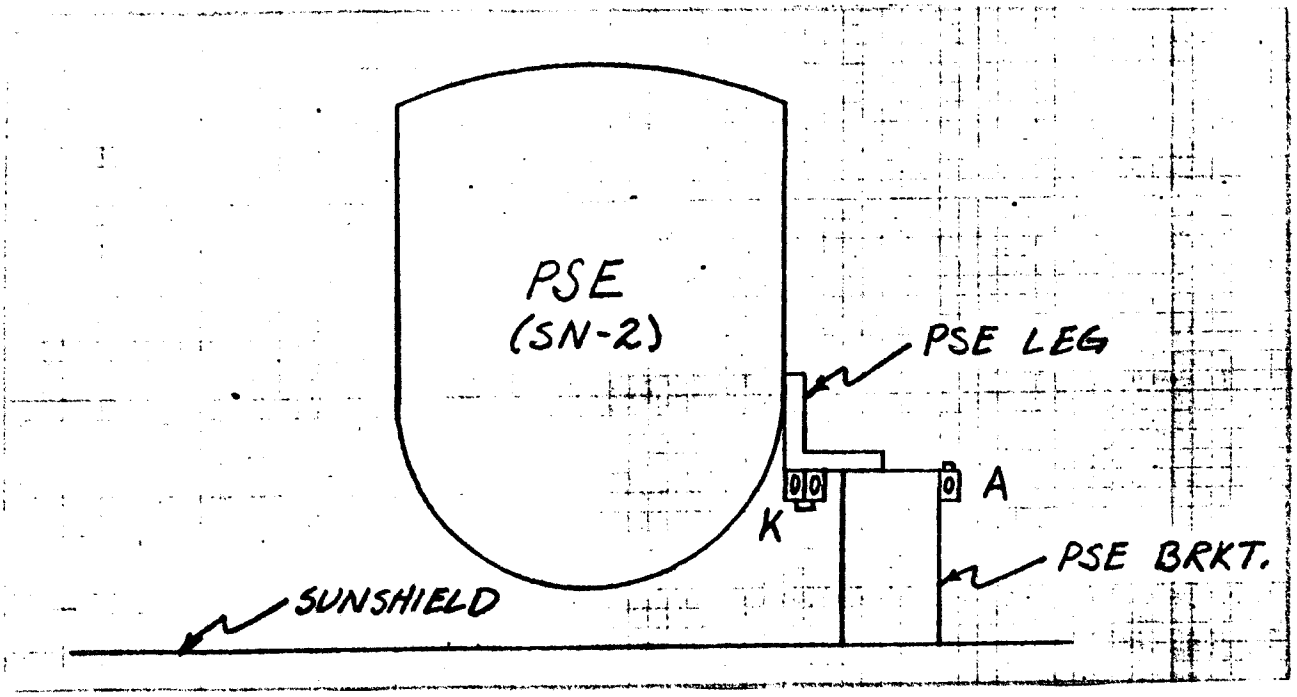




Loc. No.	Accelerometer	Location
A	Tri-Axis	PSE Mtg. Brkt., Top
B	Tri-Axis	LSM Pedestal, Top
C	Single Axis	Horse-collar Brkt., Top
D	Single Axis	Horse-collar Brkt., Top
E	Single Axis	Sunshield, Near ASE Brkt.
F	Single Axis	ASE Brkt., Top
G	Tri-Axis	Sunshield, near ASE Brkt.
H	Single Axis	ASE Brkt., Top
J	Single Axis	Sunshield, near ASE Pin

NOTE: Accelerometer locations (A-J) are to be as near as possible to the experiment interfaces on the BxA side of such interfaces.

Figure 1.8 - EDM Instrumentation (pallet)



Loc. K: Tri-Axis Accelerometer, under side of PSE leg which is fastened to Loc. A Brkt.

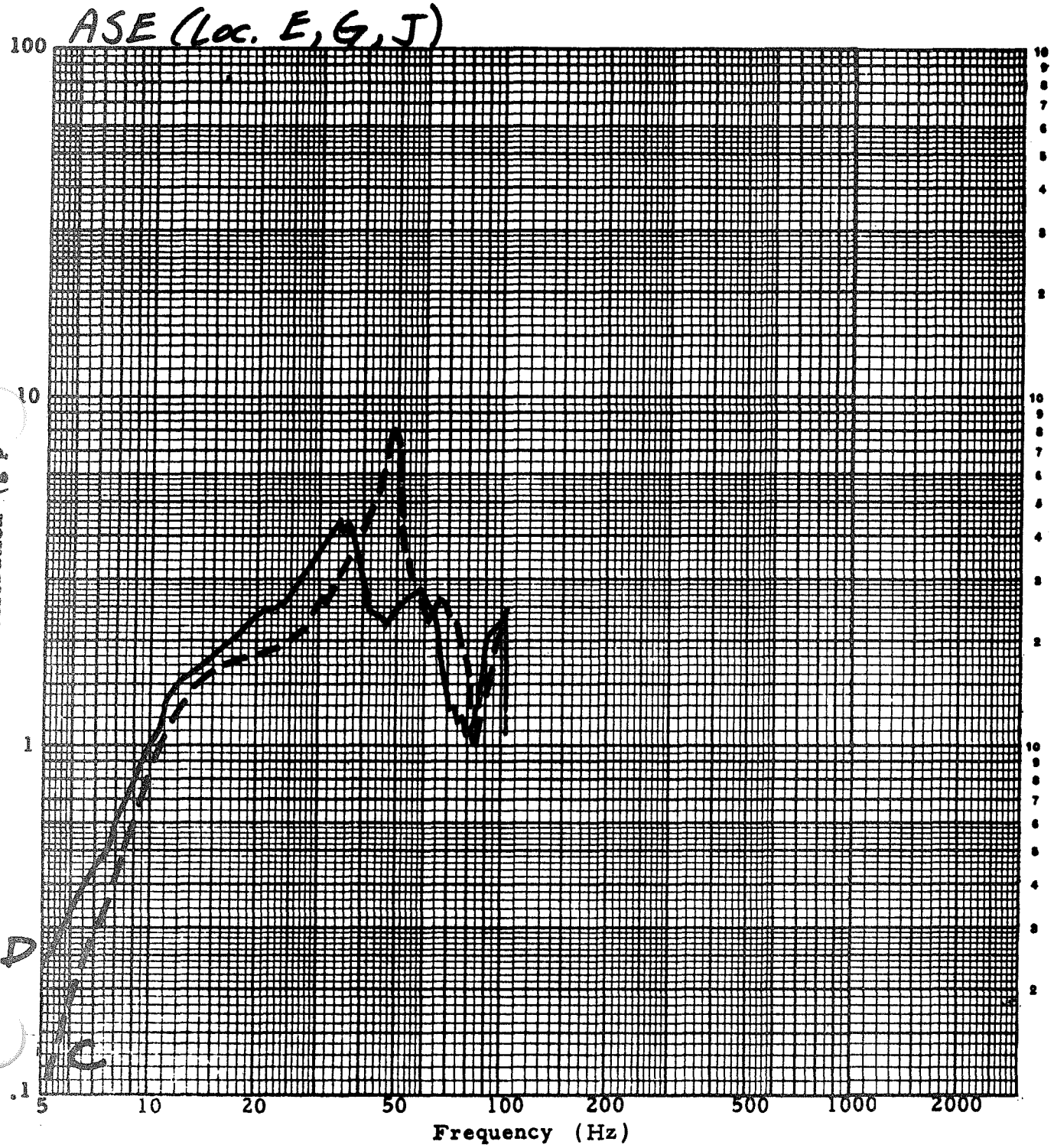
NOTE: All accelerometers (A-K) must be aligned with ALSEP axes (x_A, y_A, z_A) as required.

Figure 1.9 - EDM Instrumentation (PSE)

SINUSOIDAL VIBRATION

Axis: X

Sweep Rate:



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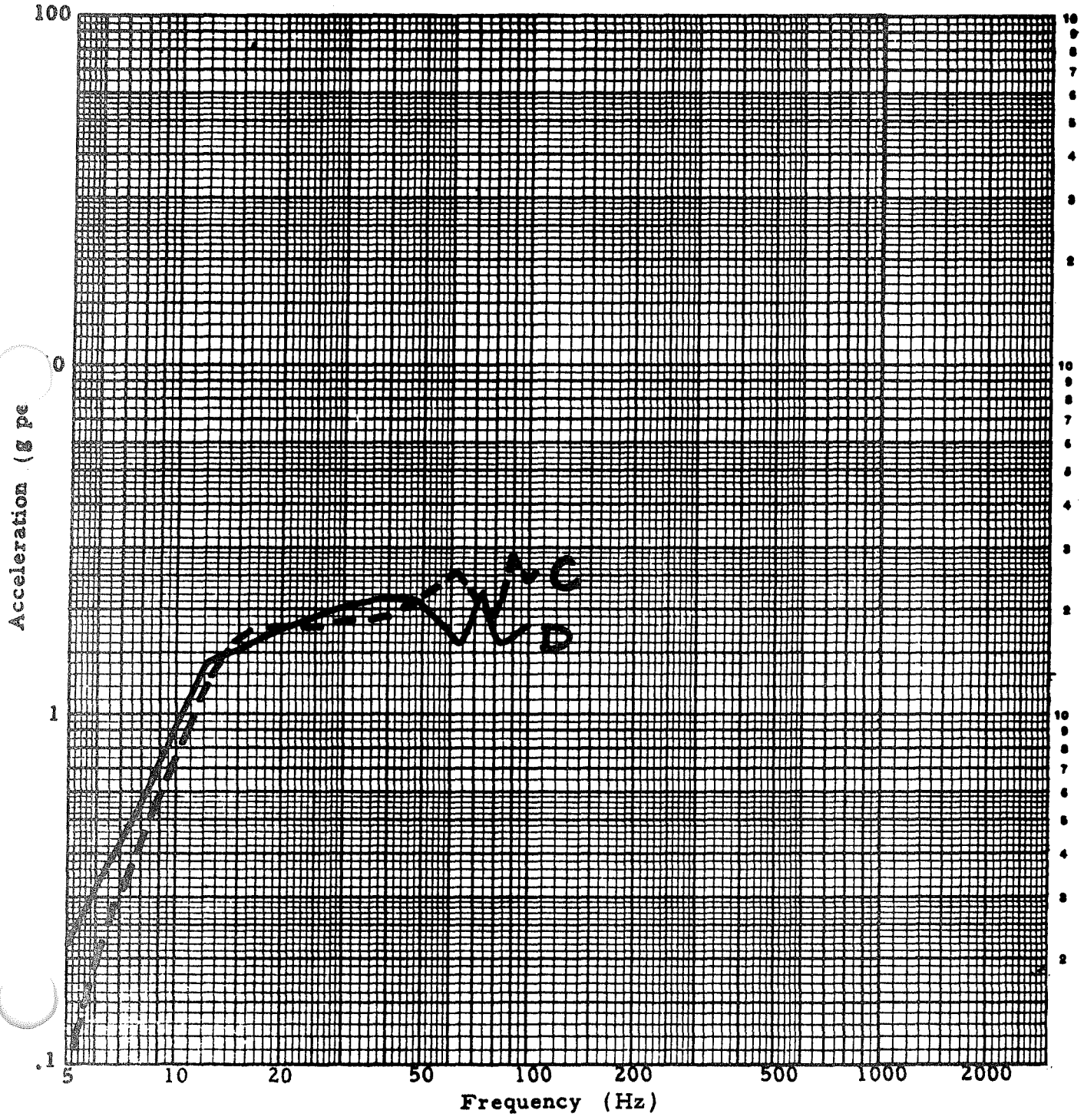
ASE (Loc. E, G, J)

SINUSOIDAL VIBRATION

Axis: Y

Sweep Rate:

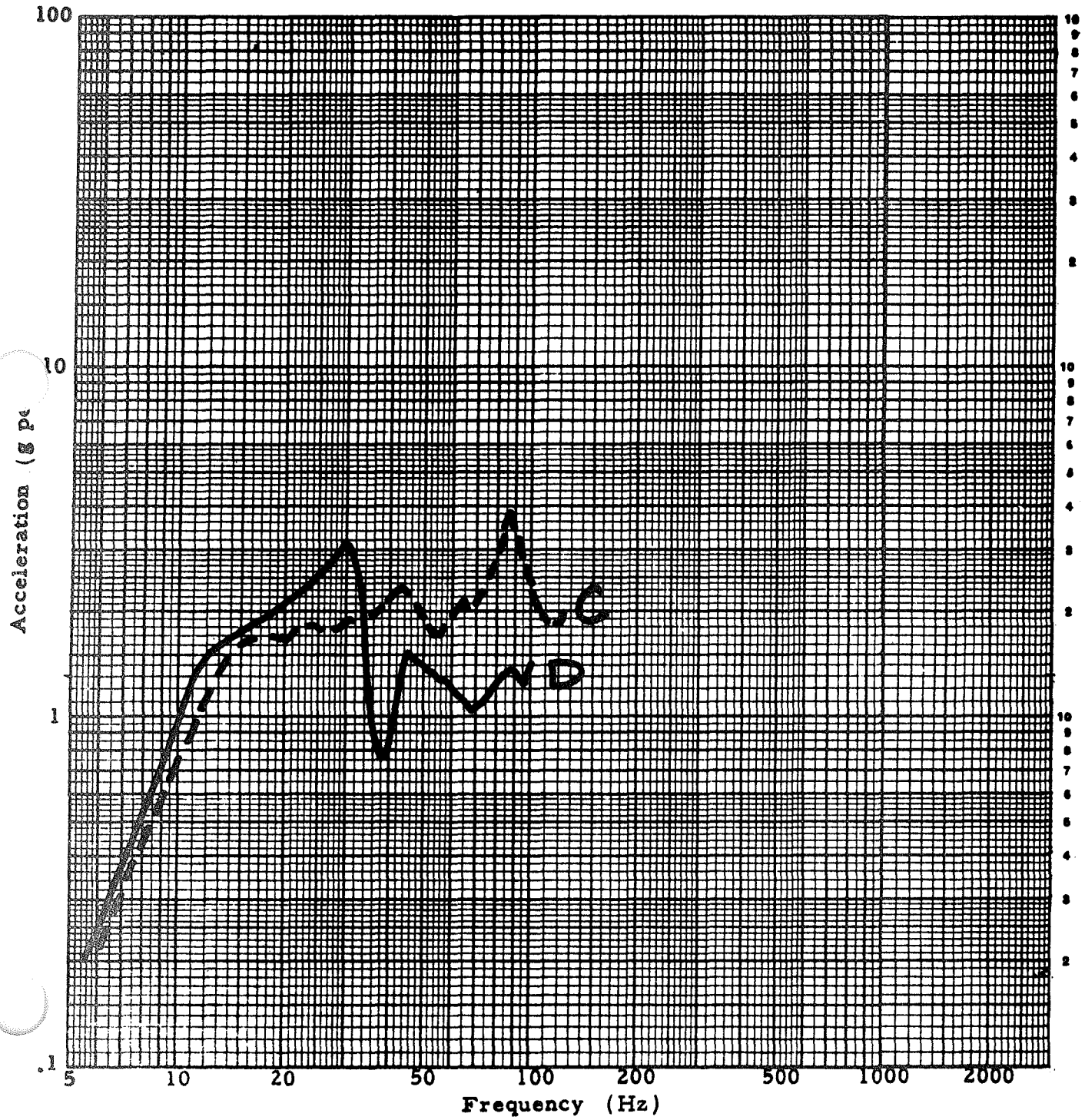


ASE (Loc. E, G, J)

SINUSOIDAL VIBRATION

Axis: Z

Sweep Rate:



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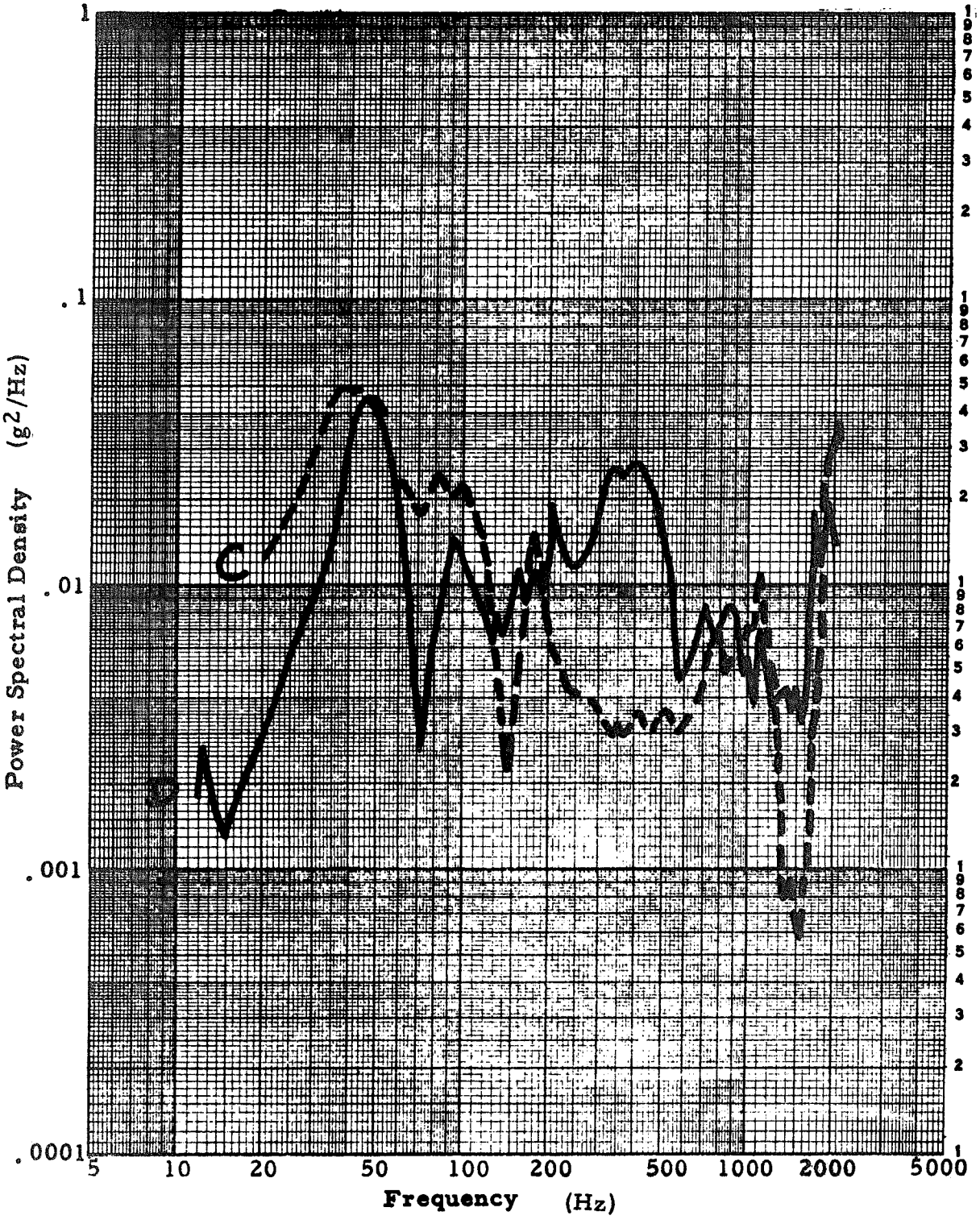
ASE (Loc. E, G, J) LHB
RANDOM VIBRATION SPECTRUM

Axis: X

Duration:



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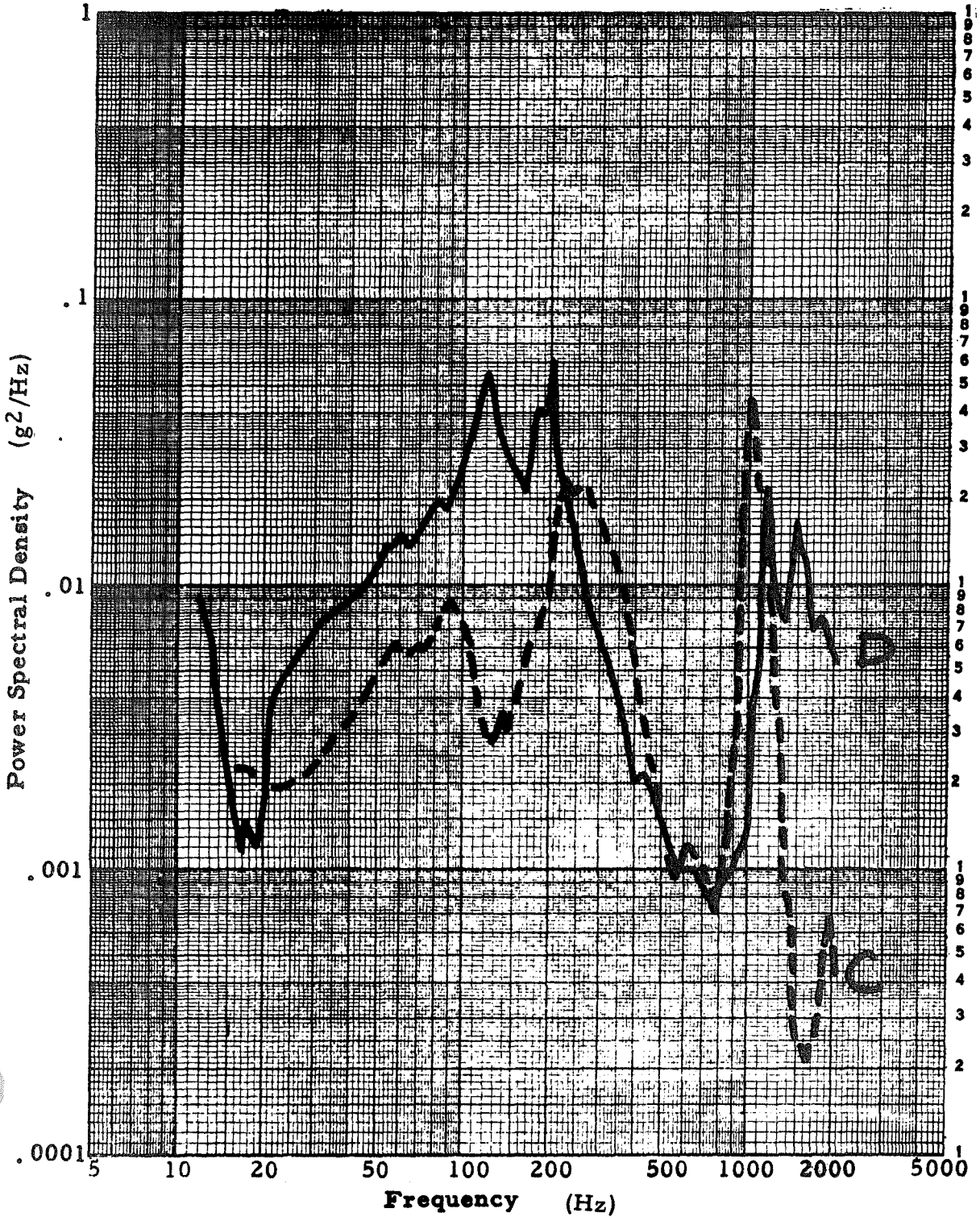
ASE (Loc. E, G, J)
RANDOM VIBRATION SPECTRUM 4 & B

Axis: Y

Duration:



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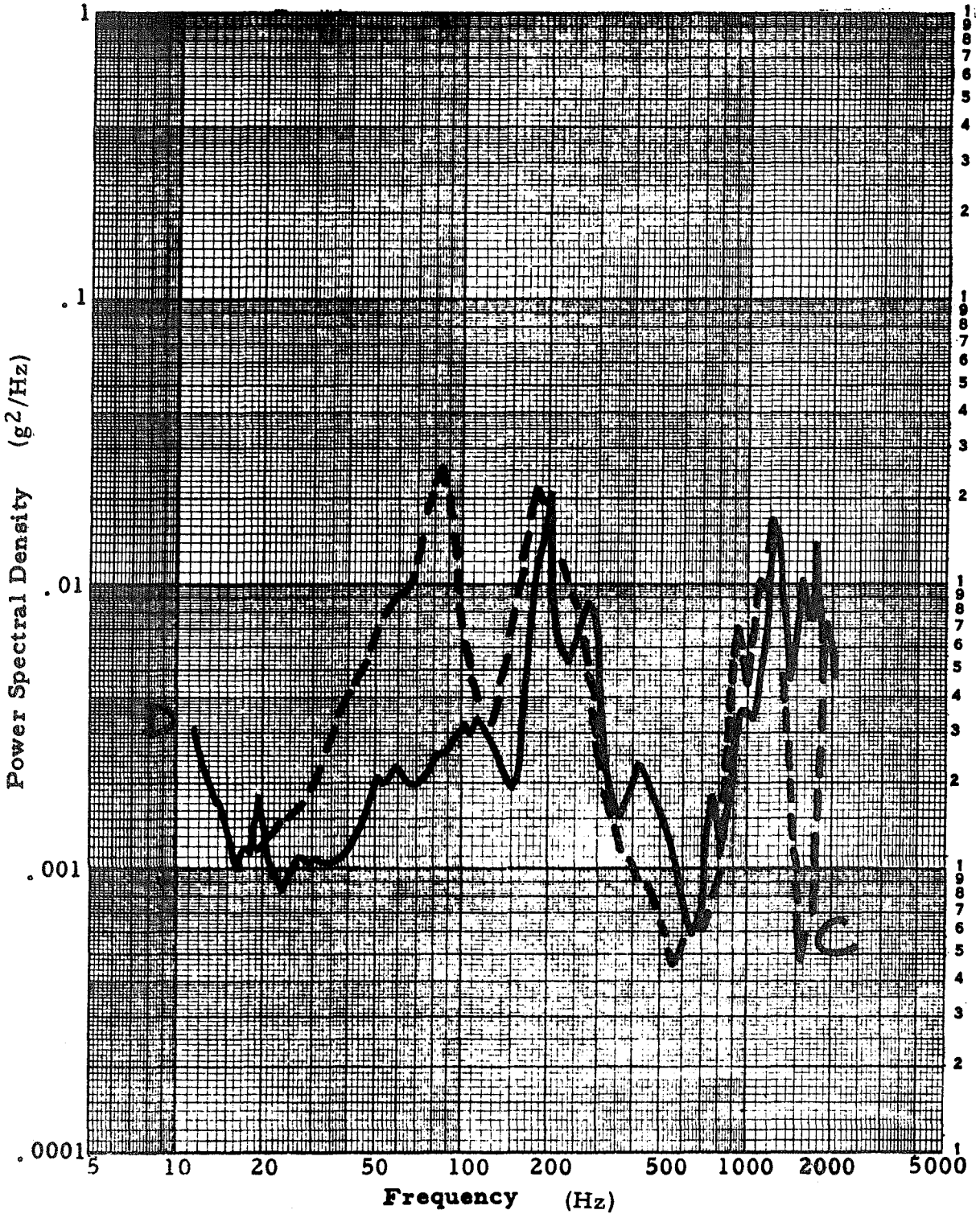
ASE (Loc. E, G, J)

RANDOM VIBRATION SPECTRUM L & B

Axis: Z

Duration:



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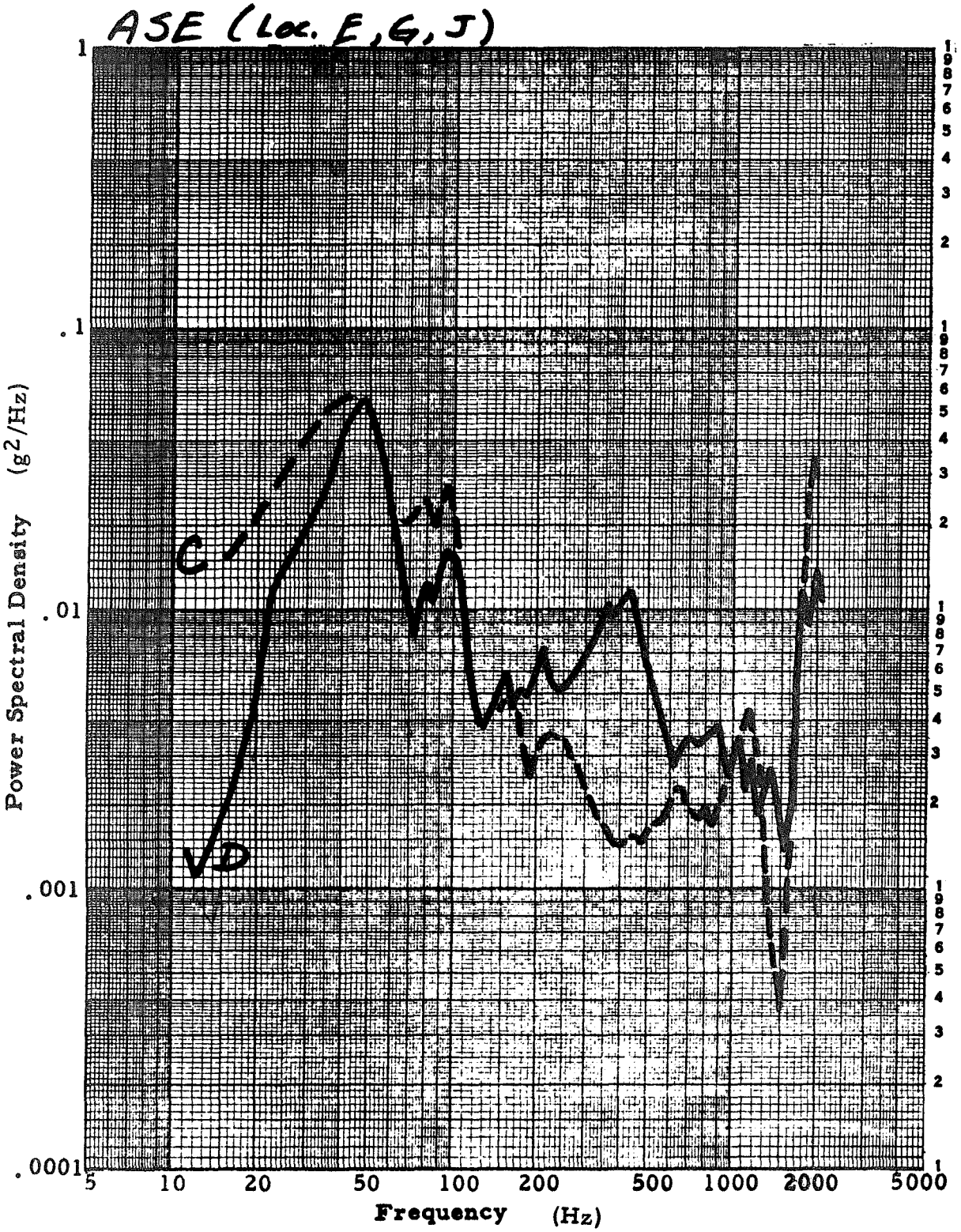
Lun. Des.

Axis: X

RANDOM VIBRATION SPECTRUM

Duration:



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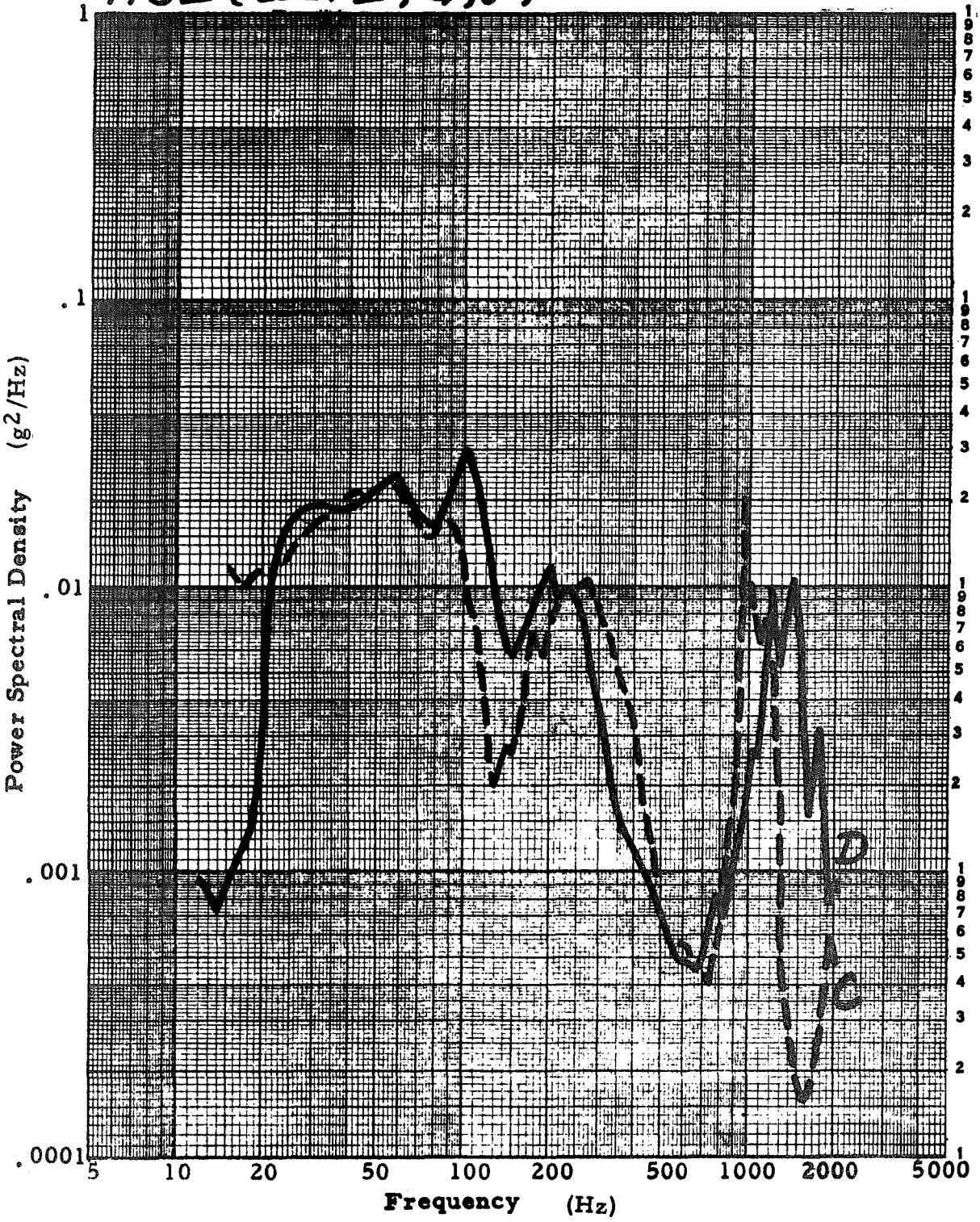
Lun. Des,

RANDOM VIBRATION SPECTRUM

Axis: Y

Duration:

ASE (Loc. E, G, J)



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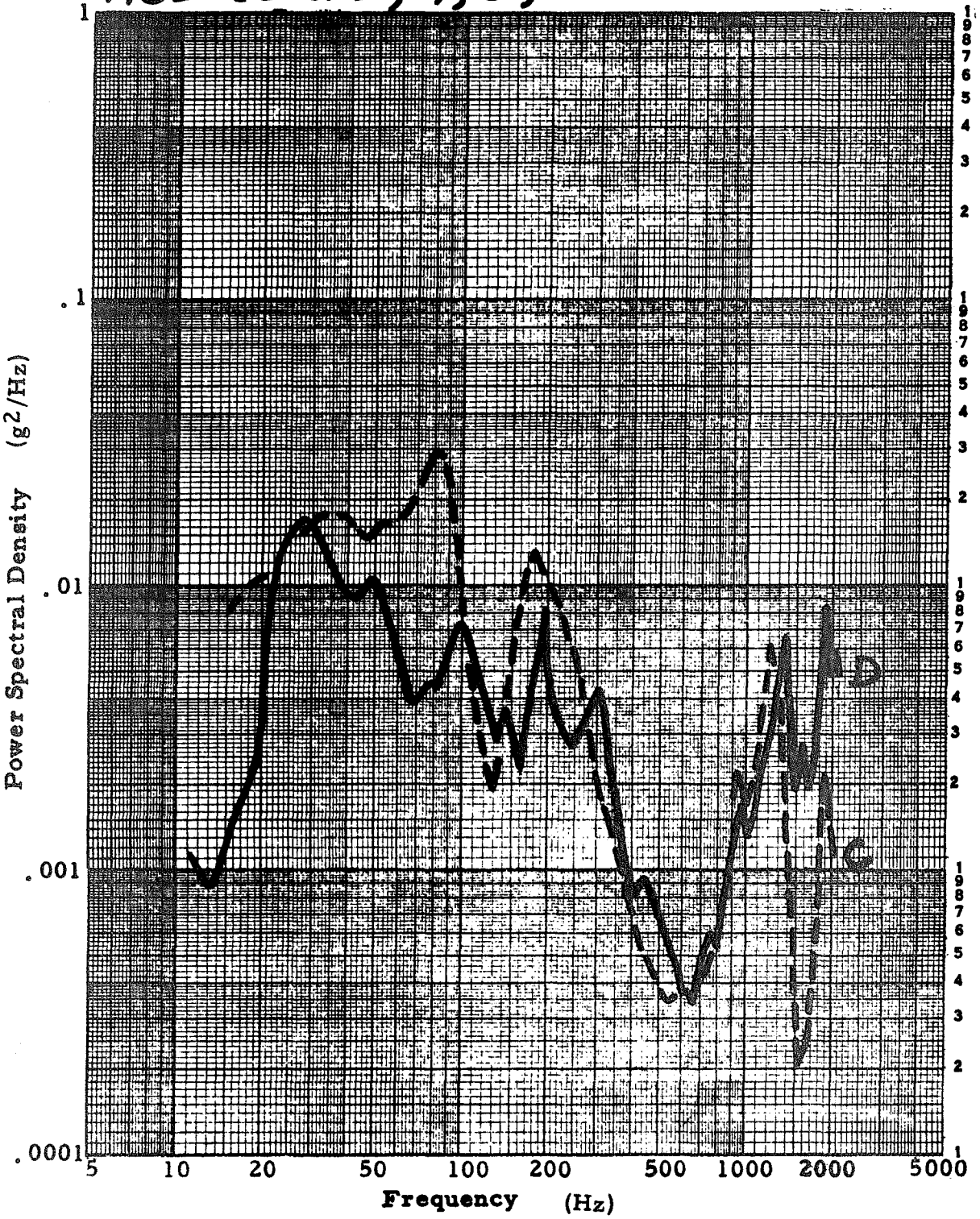
Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration:

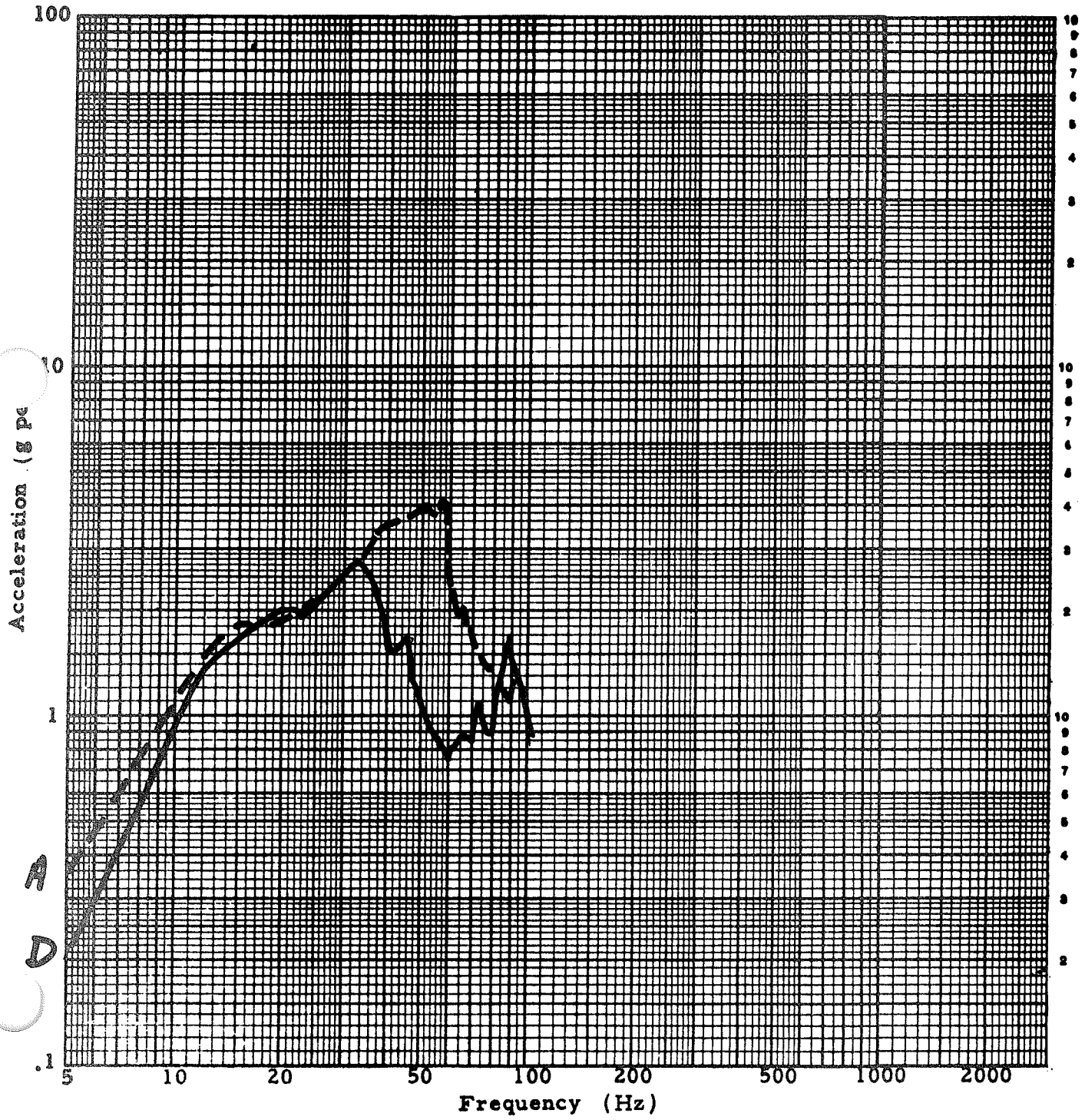
ASE (Loc. E, G, J)



SINUSOIDAL VIBRATION
LSM (Loc. B)

Axis: X

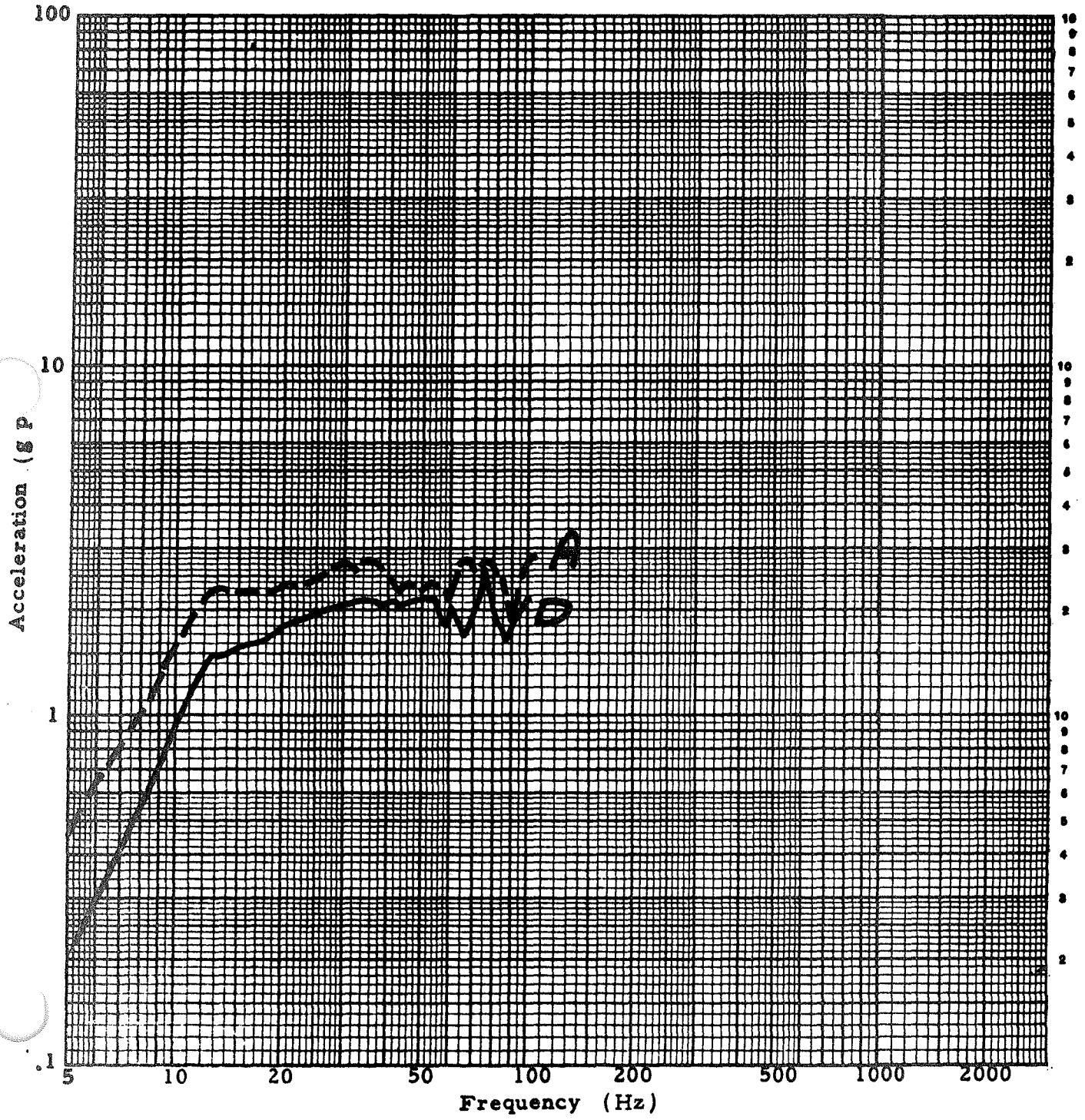
Sweep Rate:



LSM
SINUSOIDAL VIBRATION
(loc. B)

Axis: Y

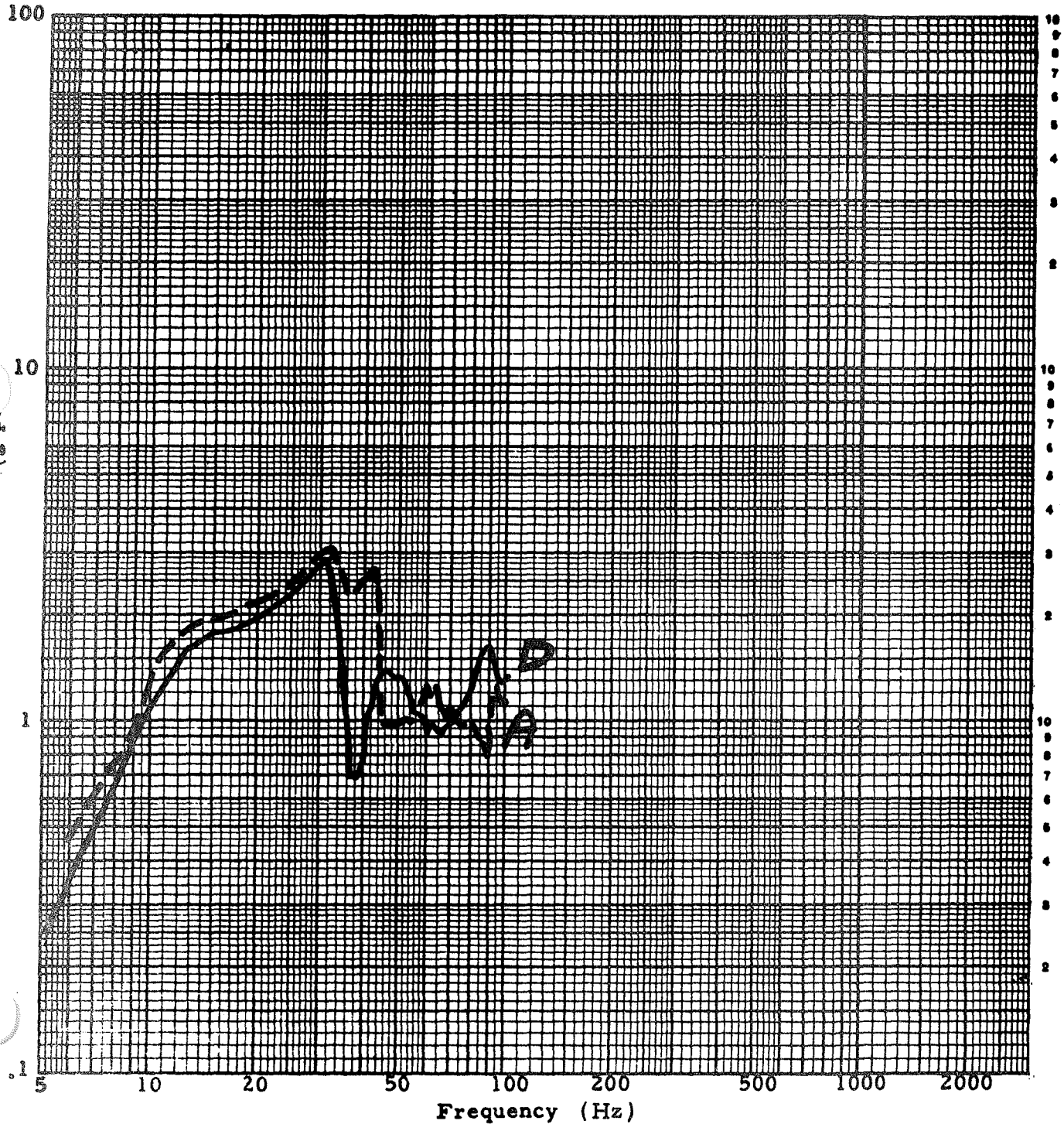
Sweep Rate:



SINUSOIDAL VIBRATION
LSM (Loc. B)

Axis: Z

Sweep Rate:



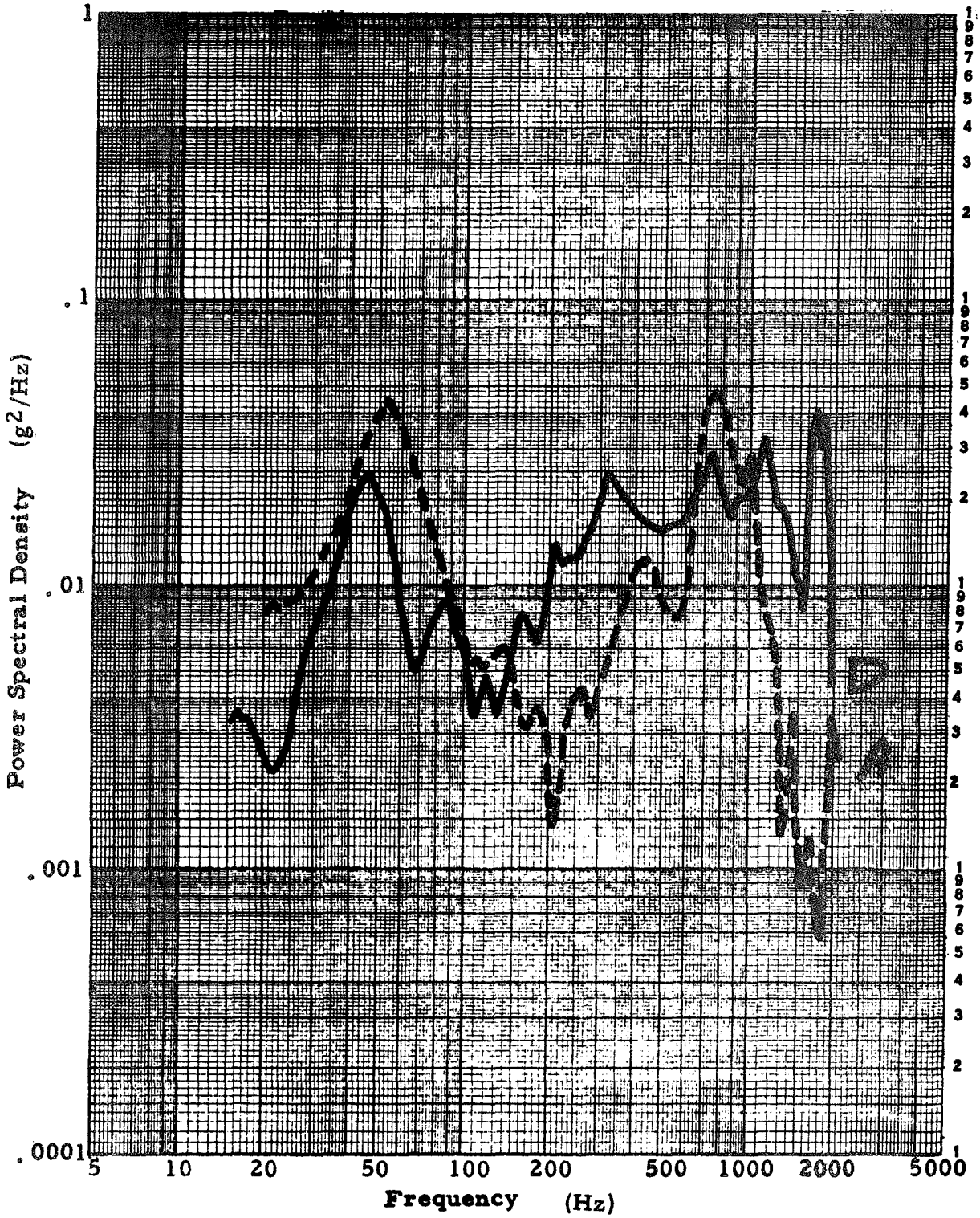
L&B

RANDOM VIBRATION SPECTRUM

LSM (Loc. B)

Axis: X

Duration:



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Note: Qual. SA data determined by applying a factor of 1.69 to accept. level data

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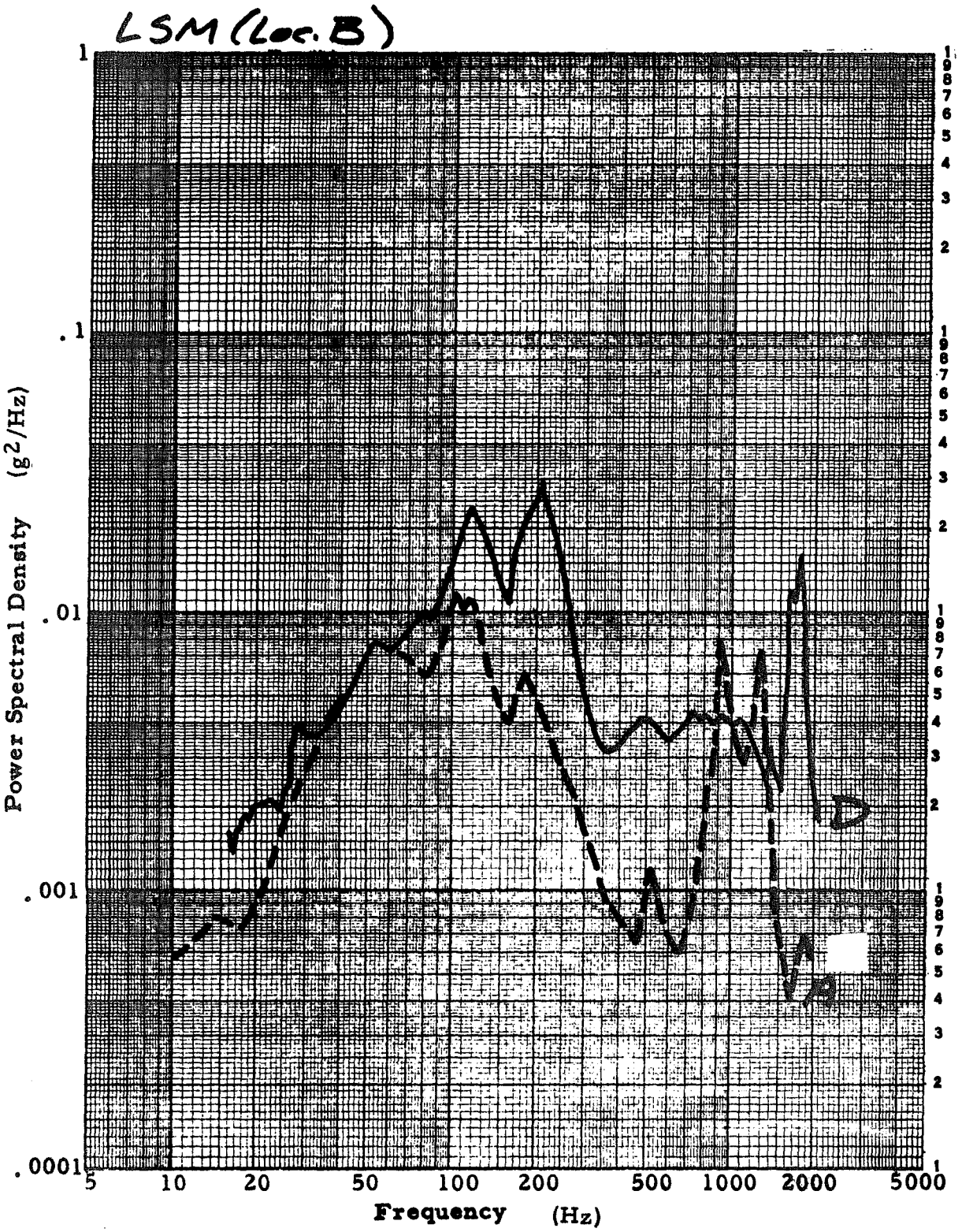
L&B

Axis: Y

RANDOM VIBRATION SPECTRUM

Duration:



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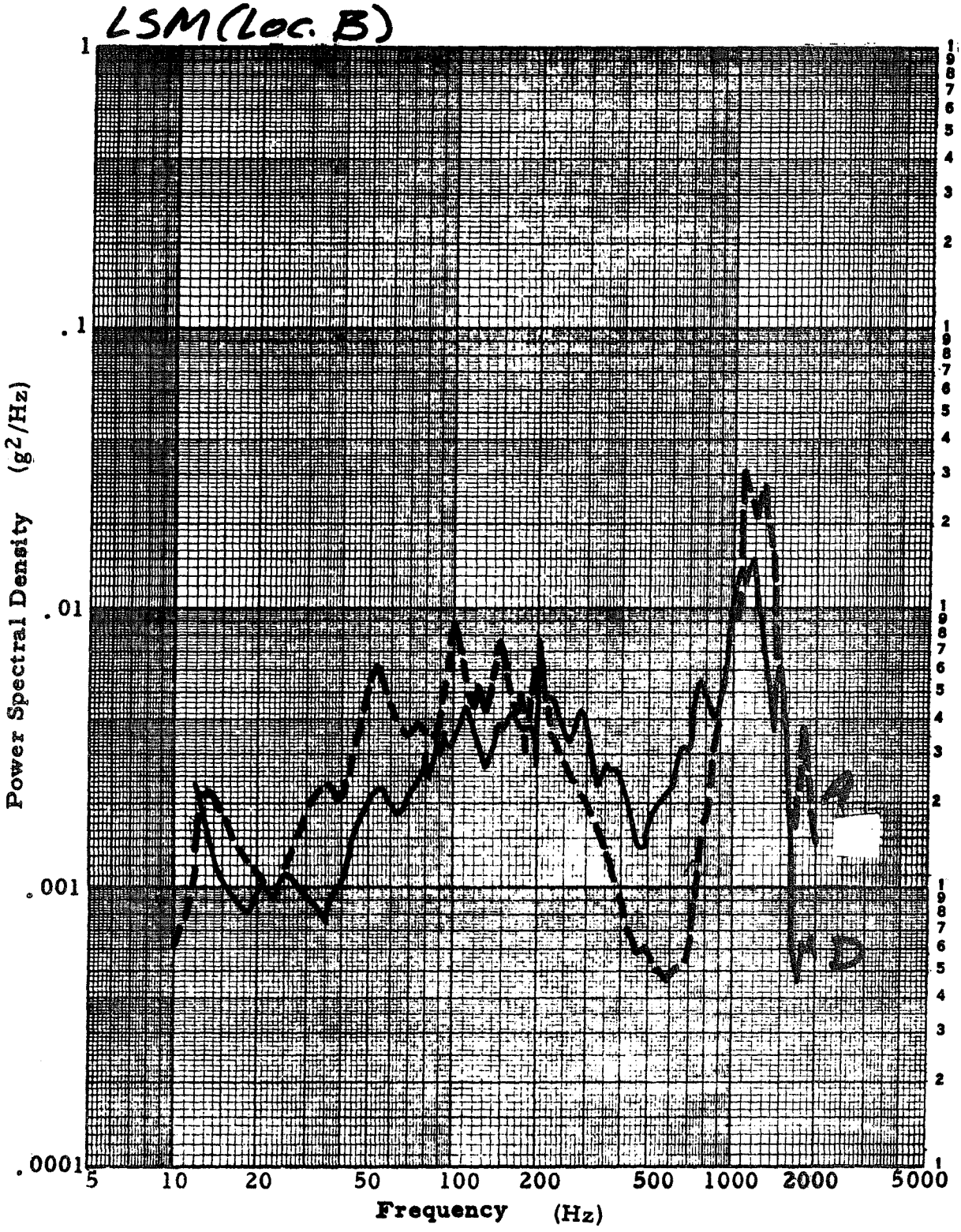
L&B

RANDOM VIBRATION SPECTRUM

Axis:

Duration:



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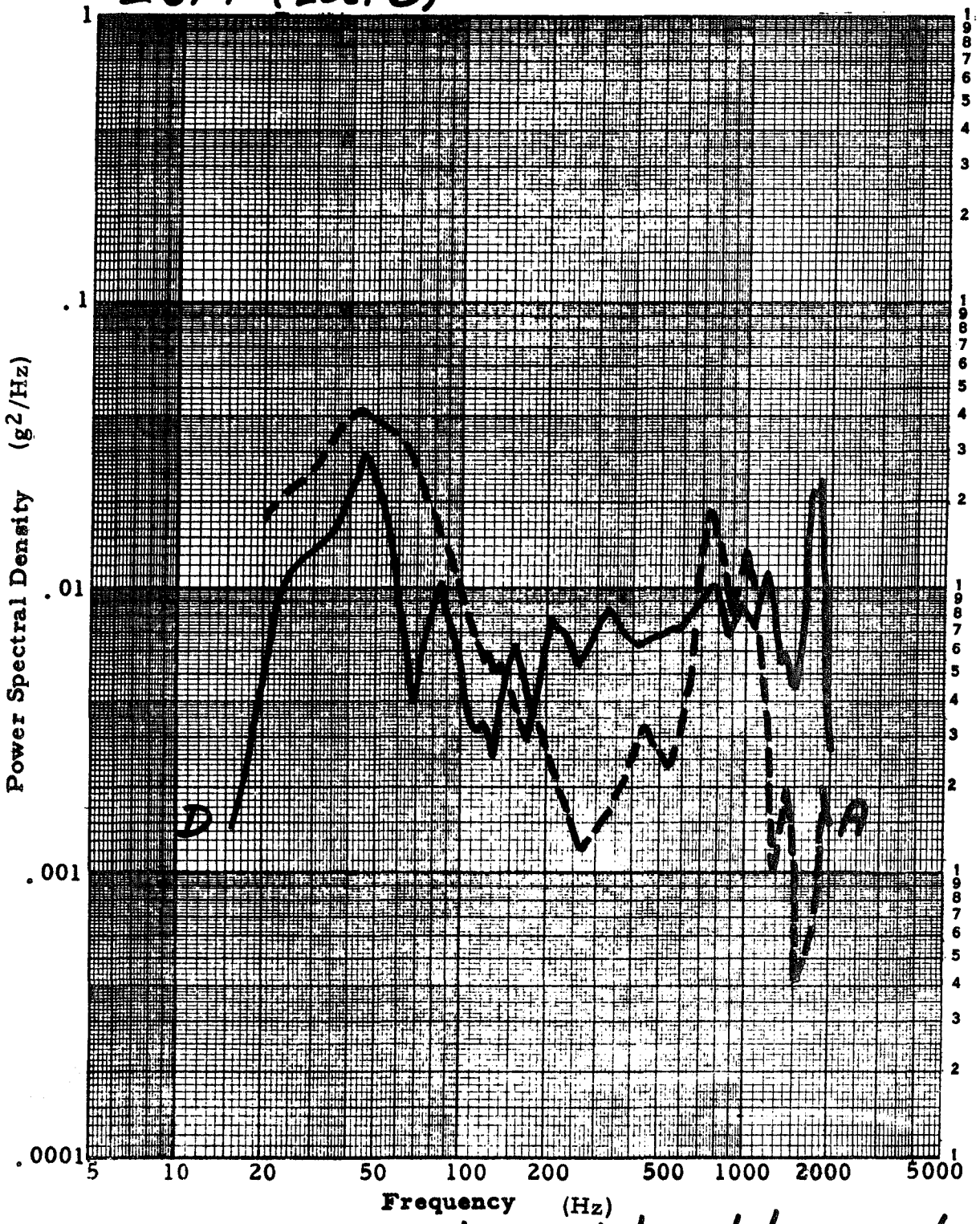
Lun. Des.

Axis: X

RANDOM VIBRATION SPECTRUM

Duration:

LSM (Loc. B)



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Note: Qual. SA data determined by applying a factor of 1.69 to accept. level data

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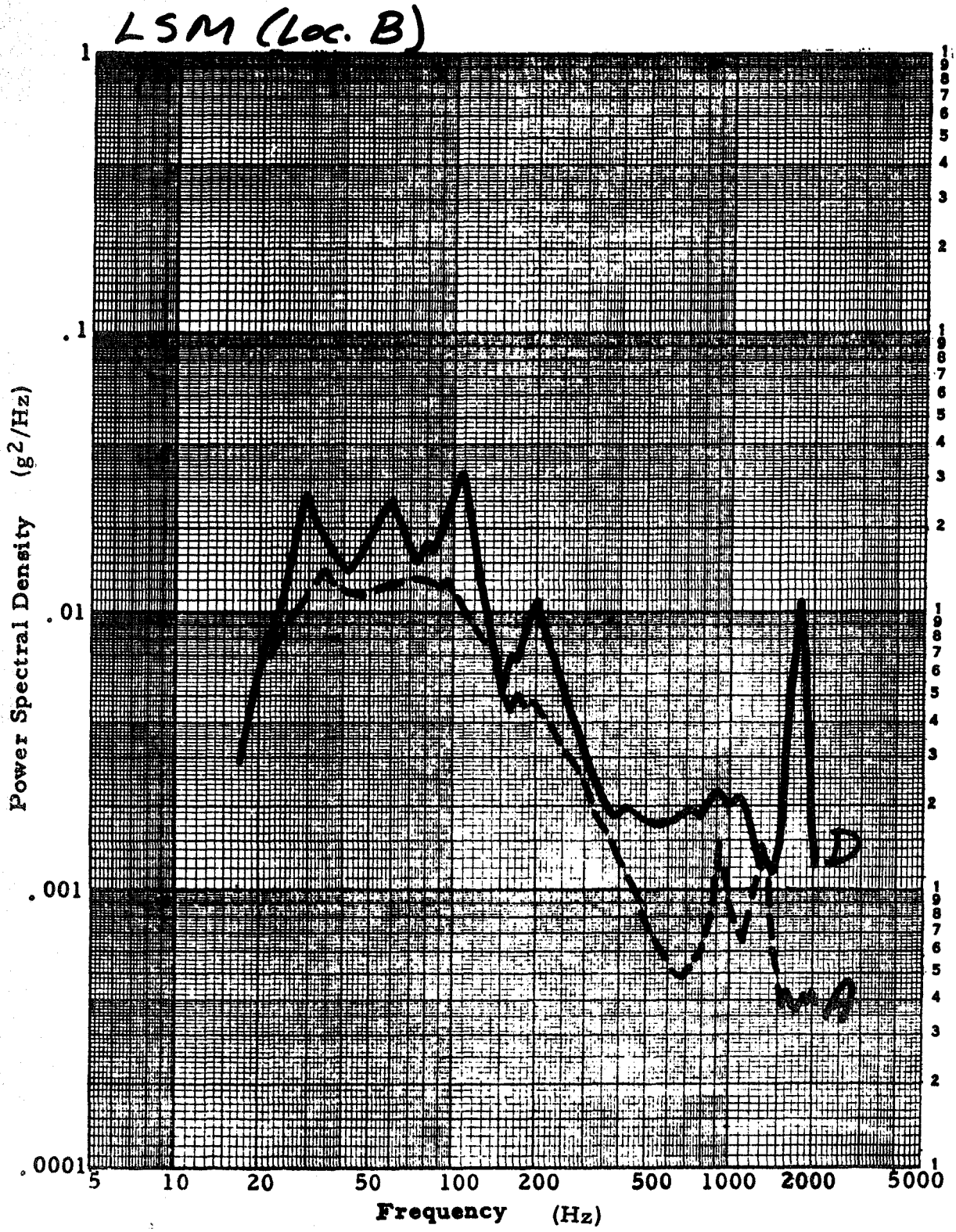
Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: Y

Duration:



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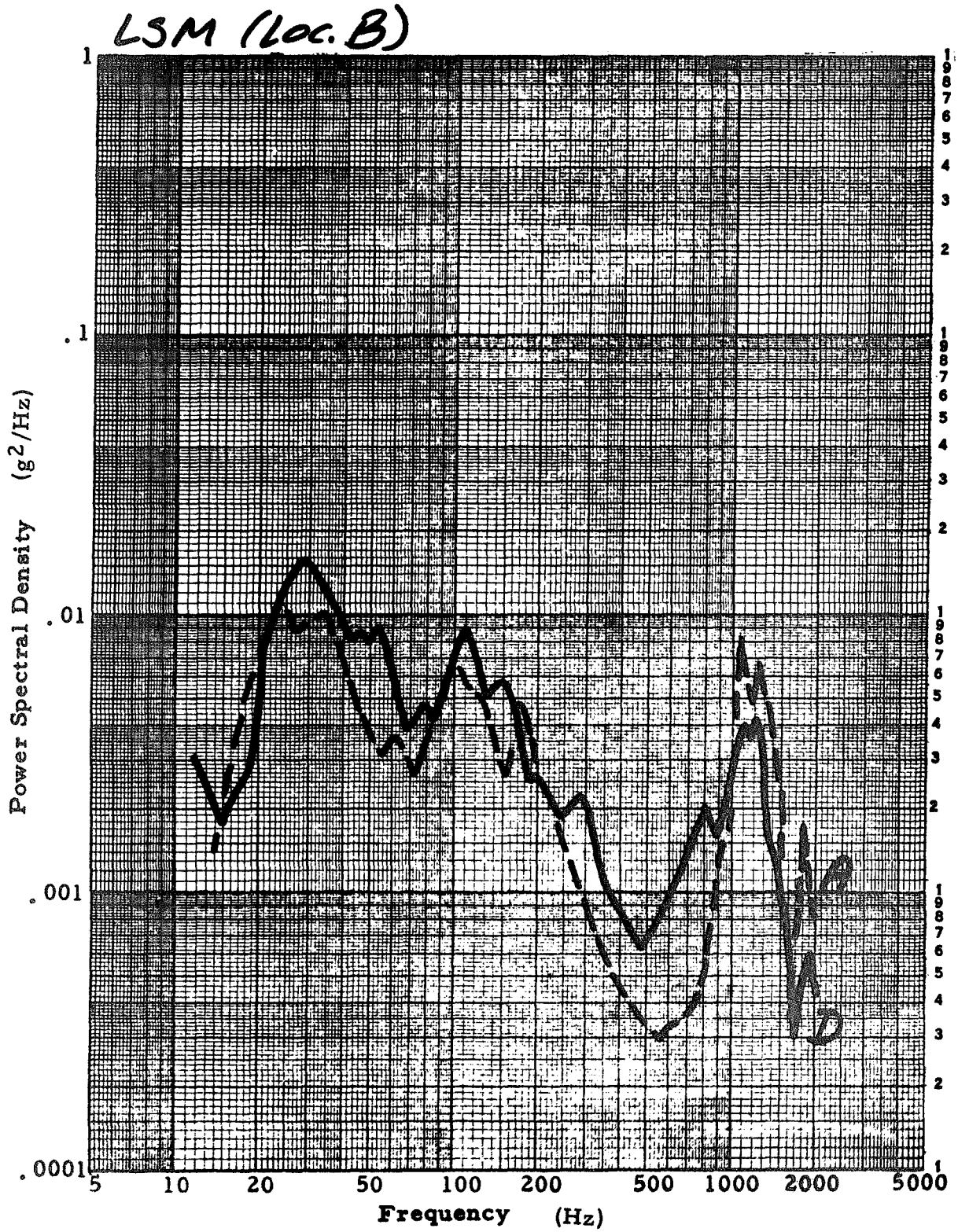
Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration:



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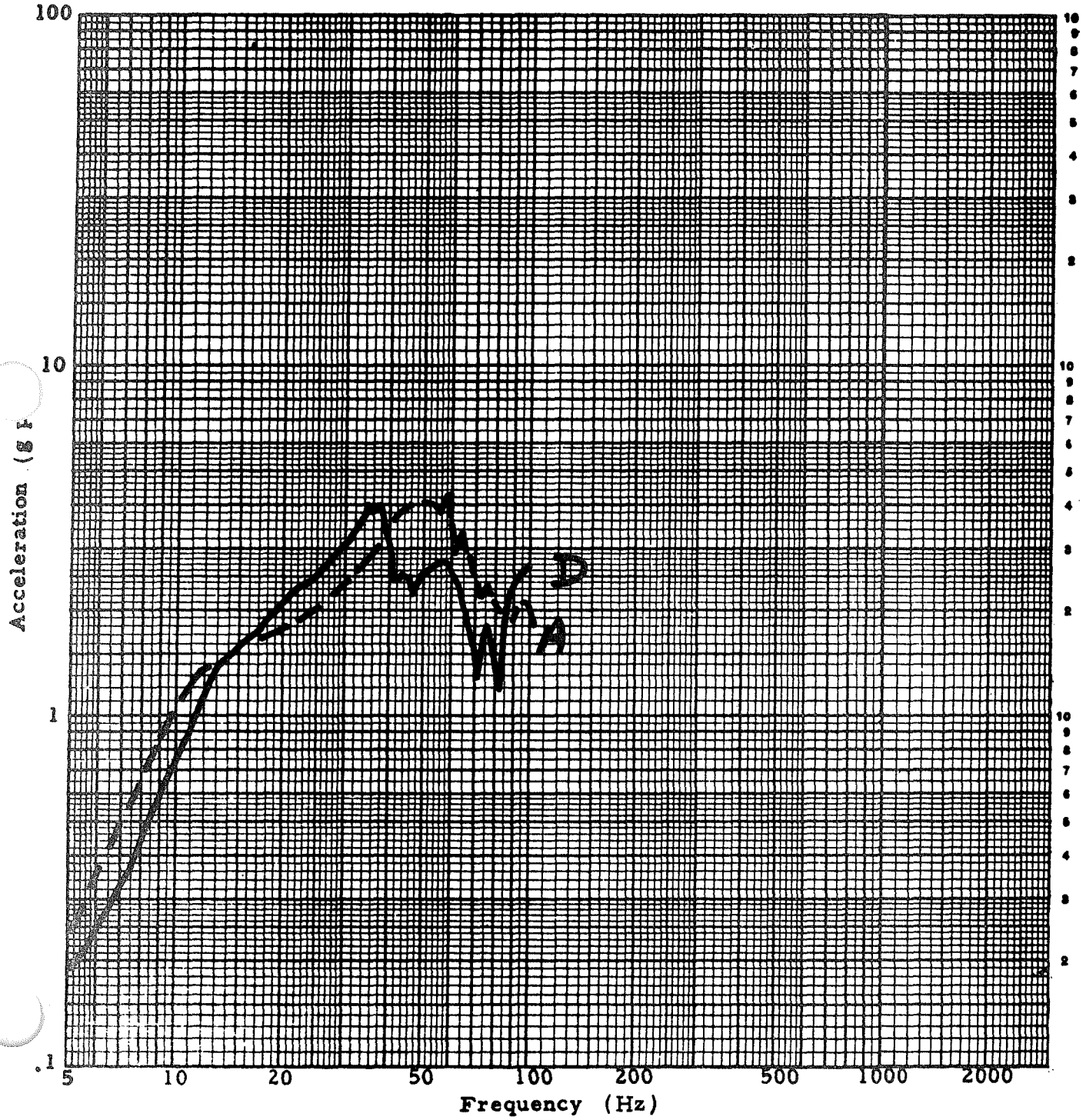
PSE (Loc. A)

SINUSOIDAL VIBRATION

Axis: X

Sweep Rate:



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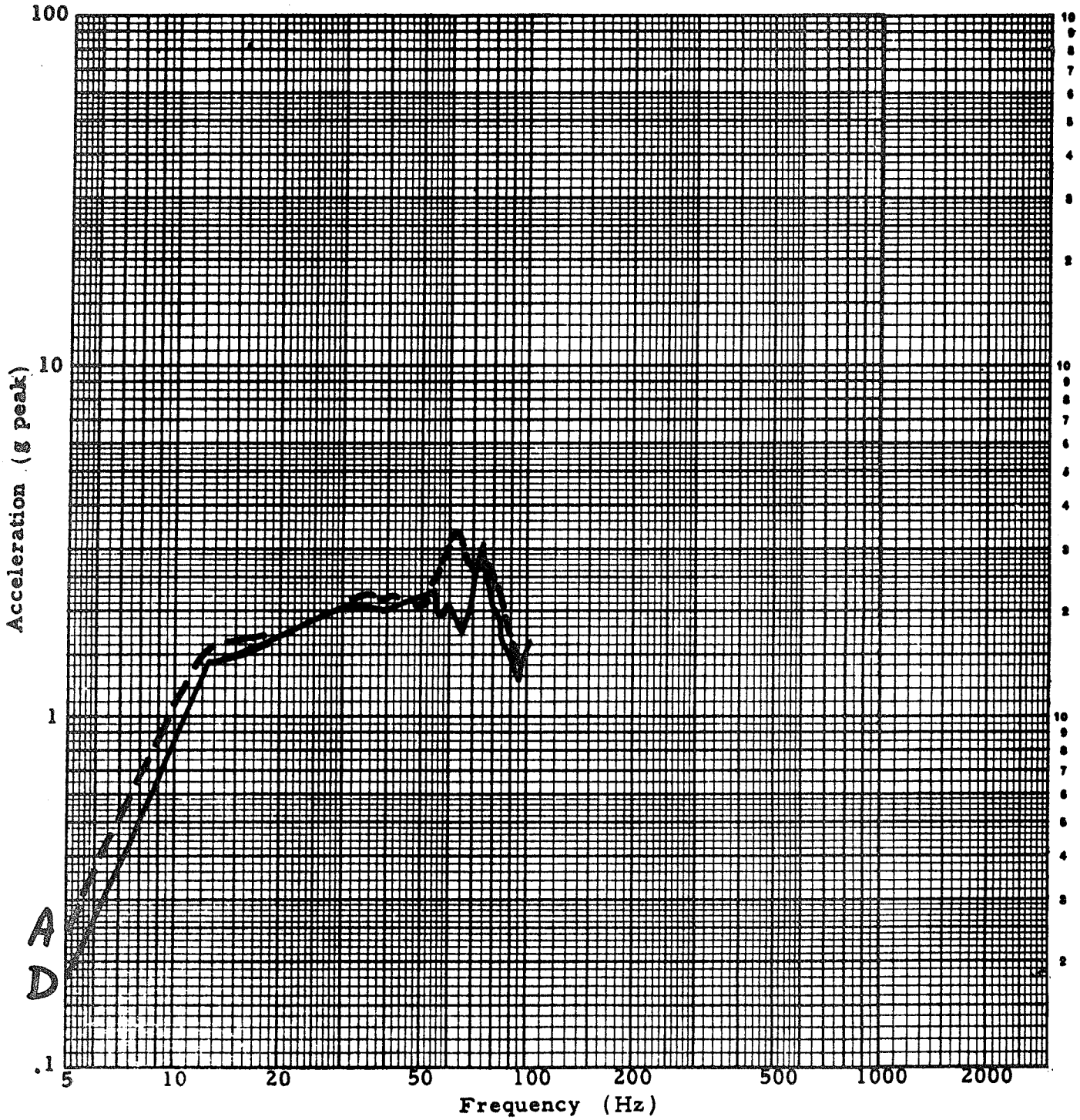
PSE (Loc. A)

SINUSOIDAL VIBRATION

Axis: Y

Sweep Rate:



A
D

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PSE

SINUSOIDAL VIBRATION

(Loc. A)

Axis: Z

Sweep Rate:

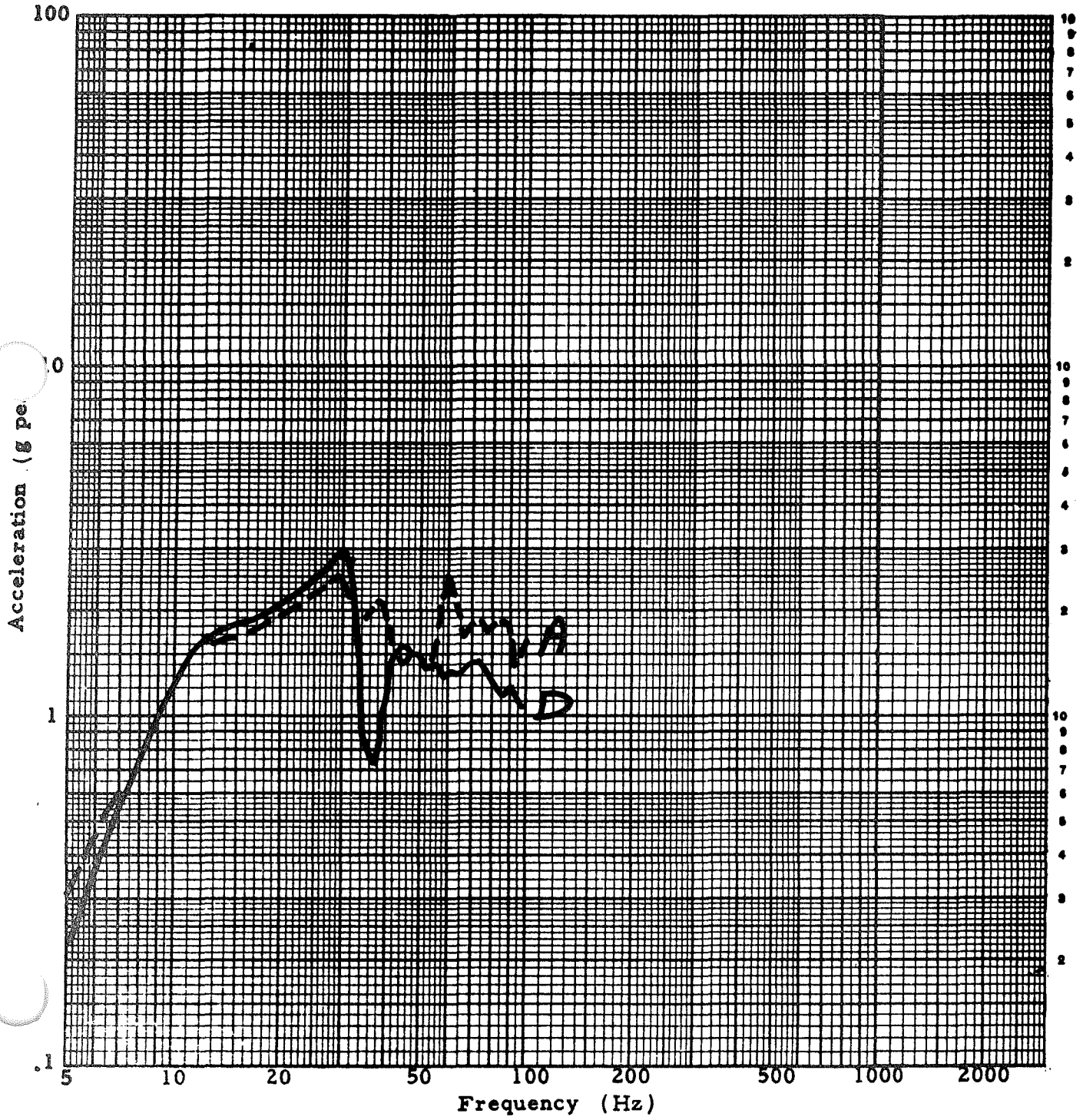

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Figure 1.31

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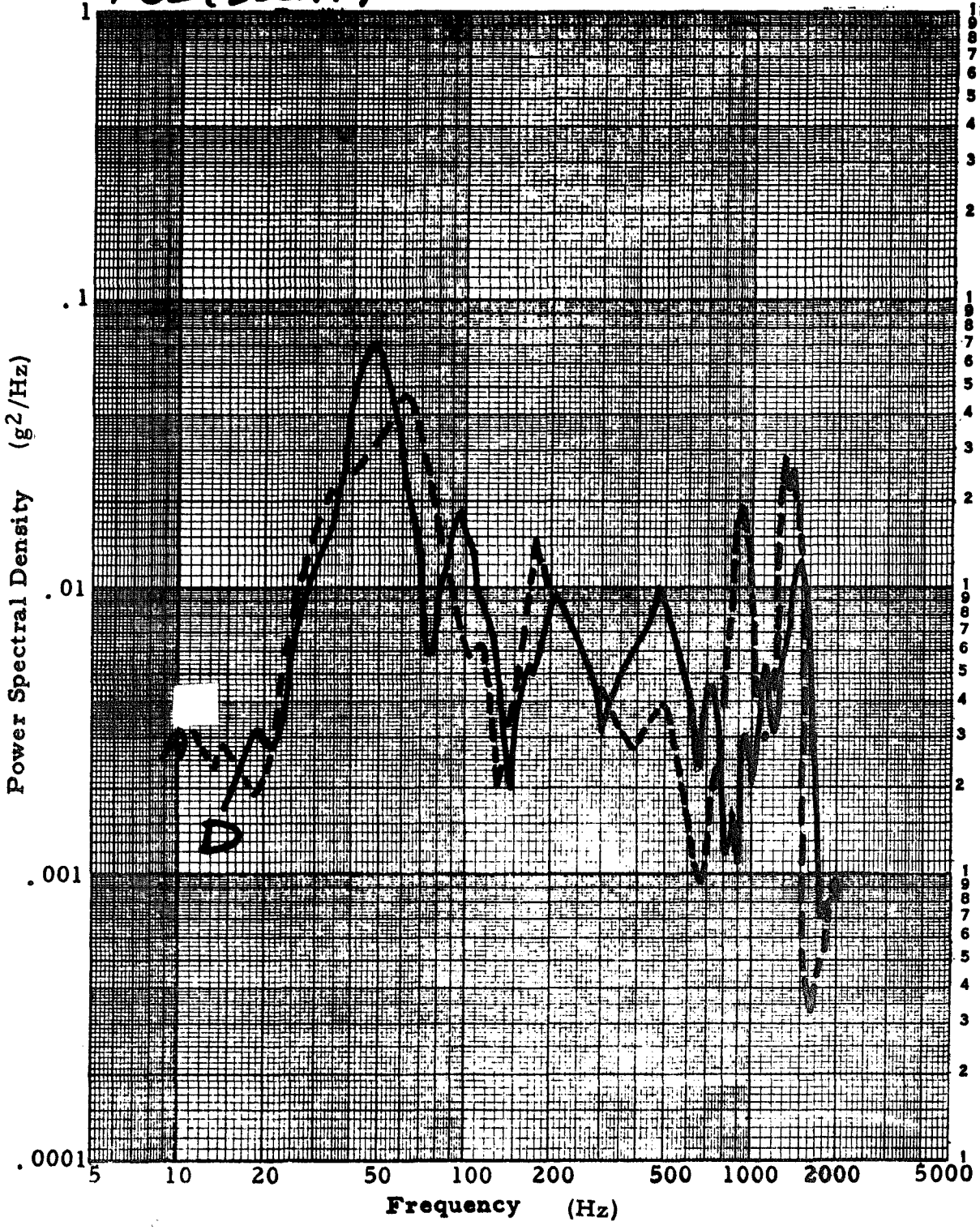
L&B

Axis:

RANDOM VIBRATION SPECTRUM

Duration: X

PSE (Loc. A)



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L&B

Axis:

RANDOM VIBRATION SPECTRUM

Duration: Y

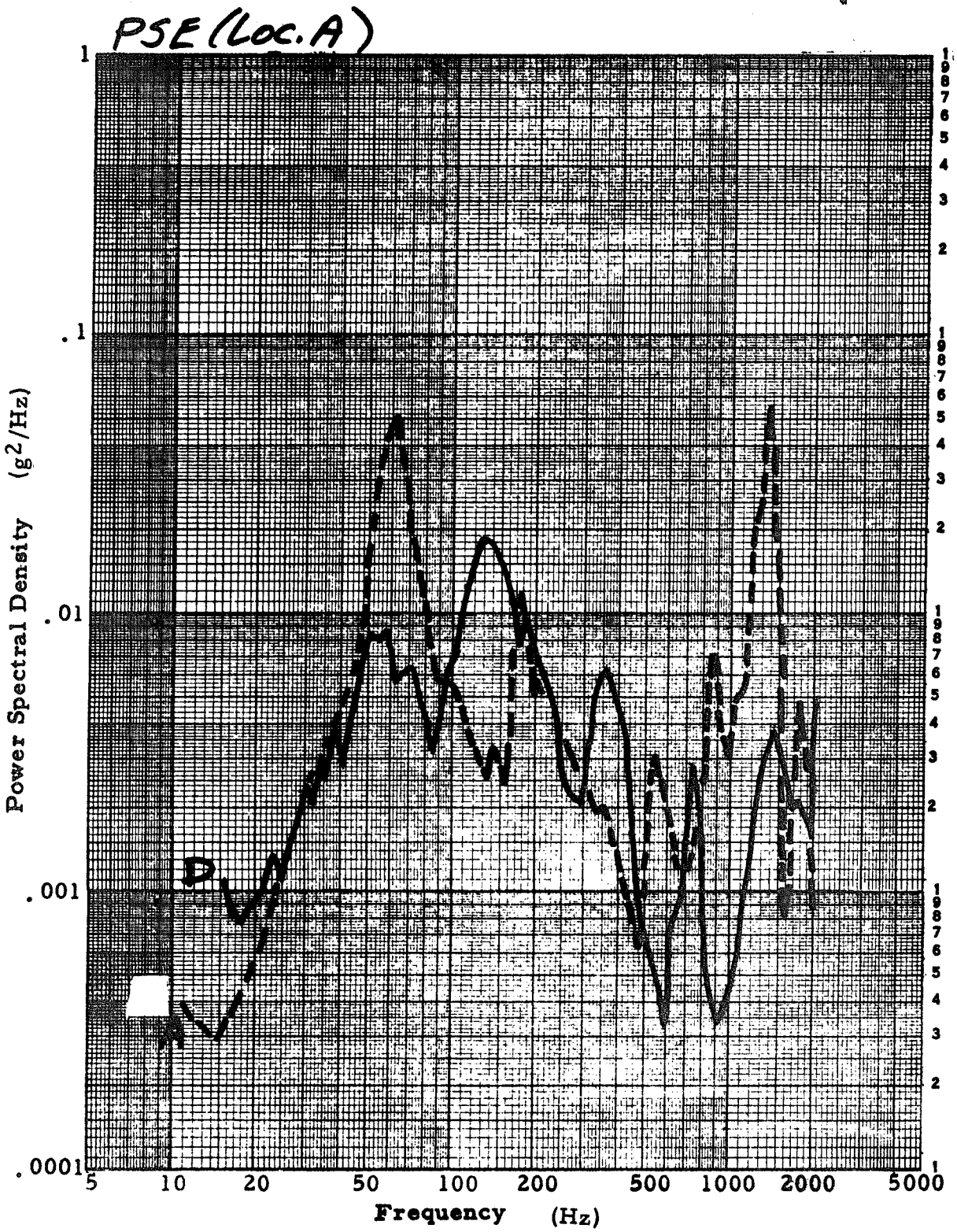

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Figure 1.33

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L&B

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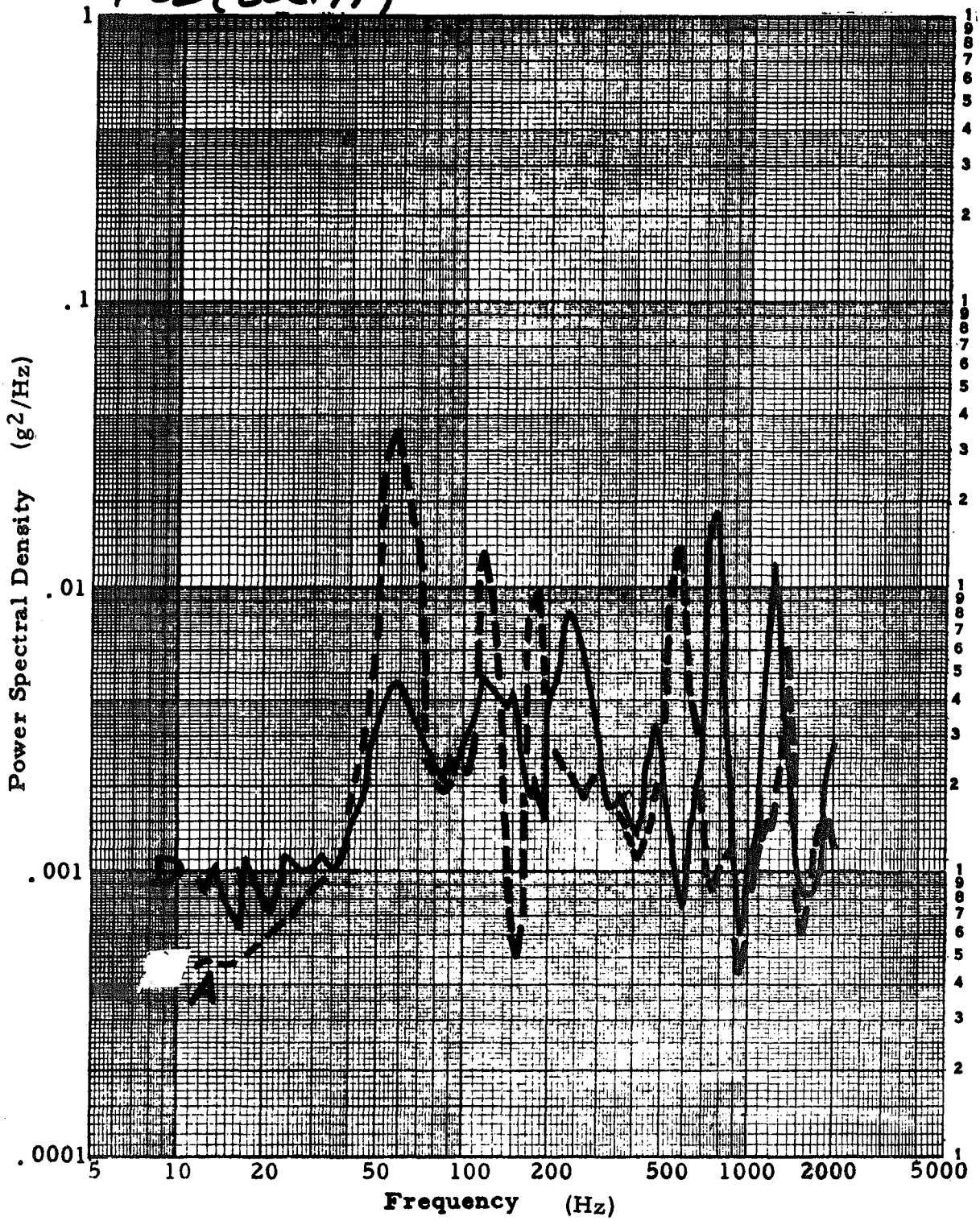
Axis:

RANDOM VIBRATION SPECTRUM

Z

Duration:

PSE (Loc. A)



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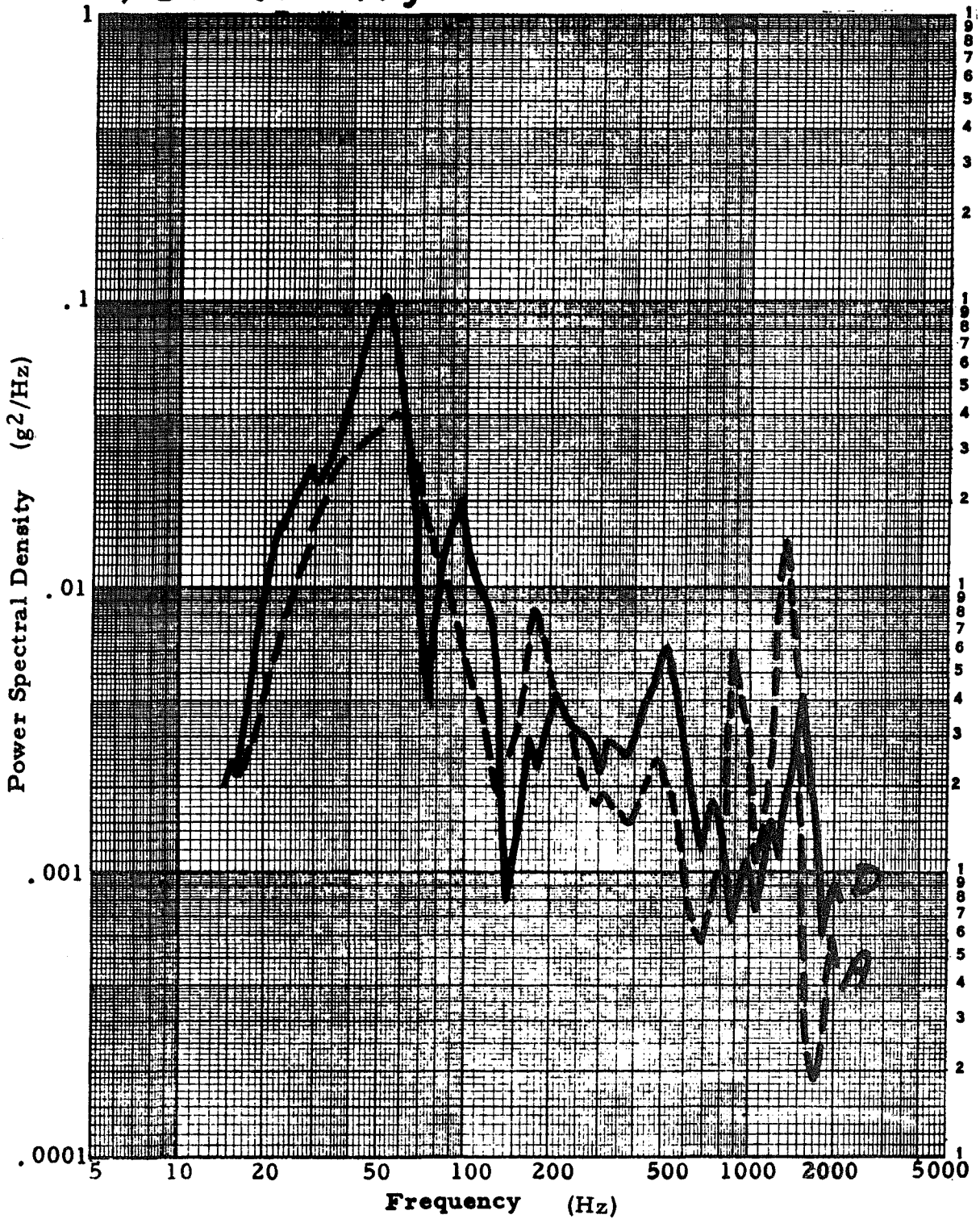
Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: X

Duration:

PSE (Loc. A)



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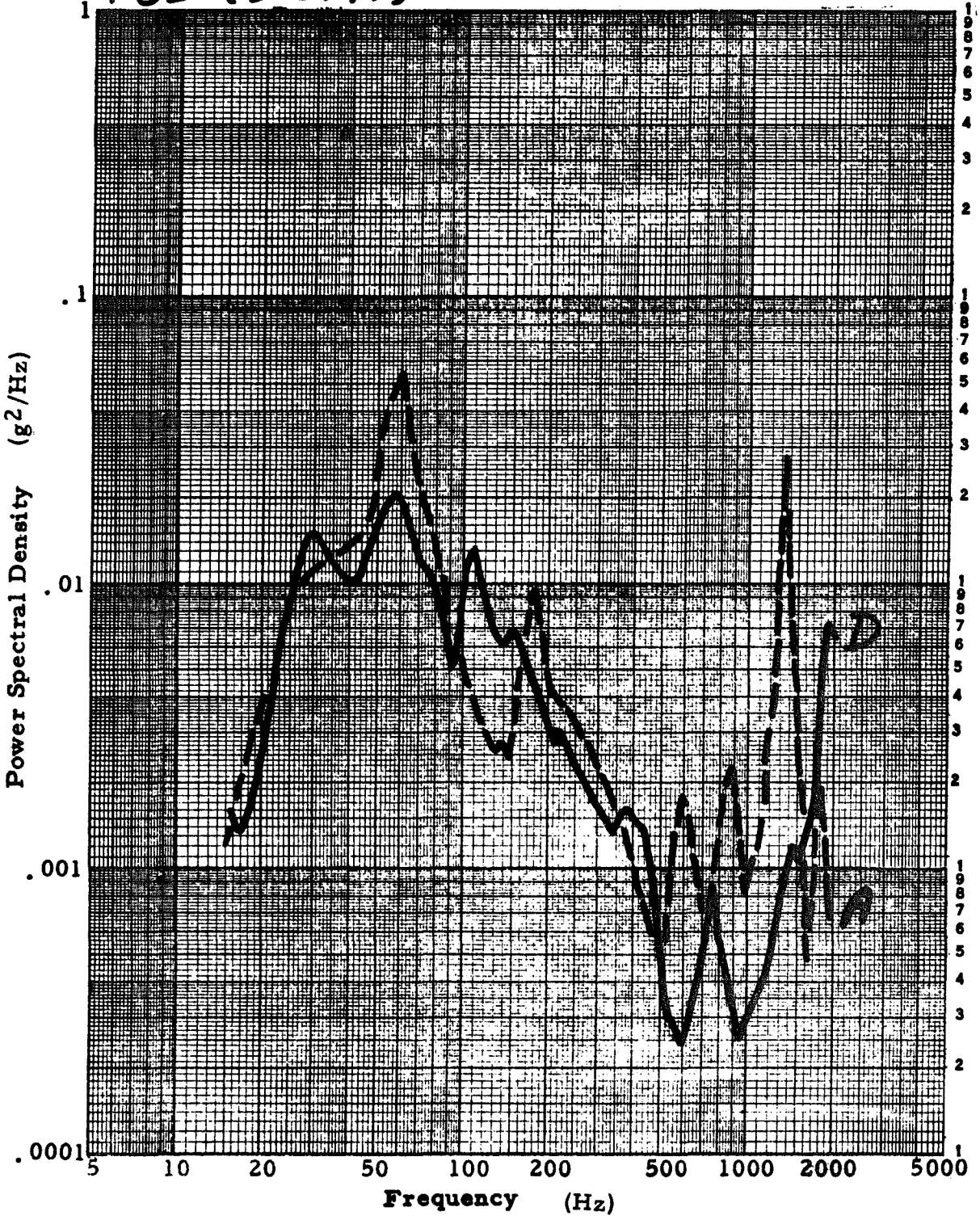
Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: y

Duration:

PSE (Loc. A)



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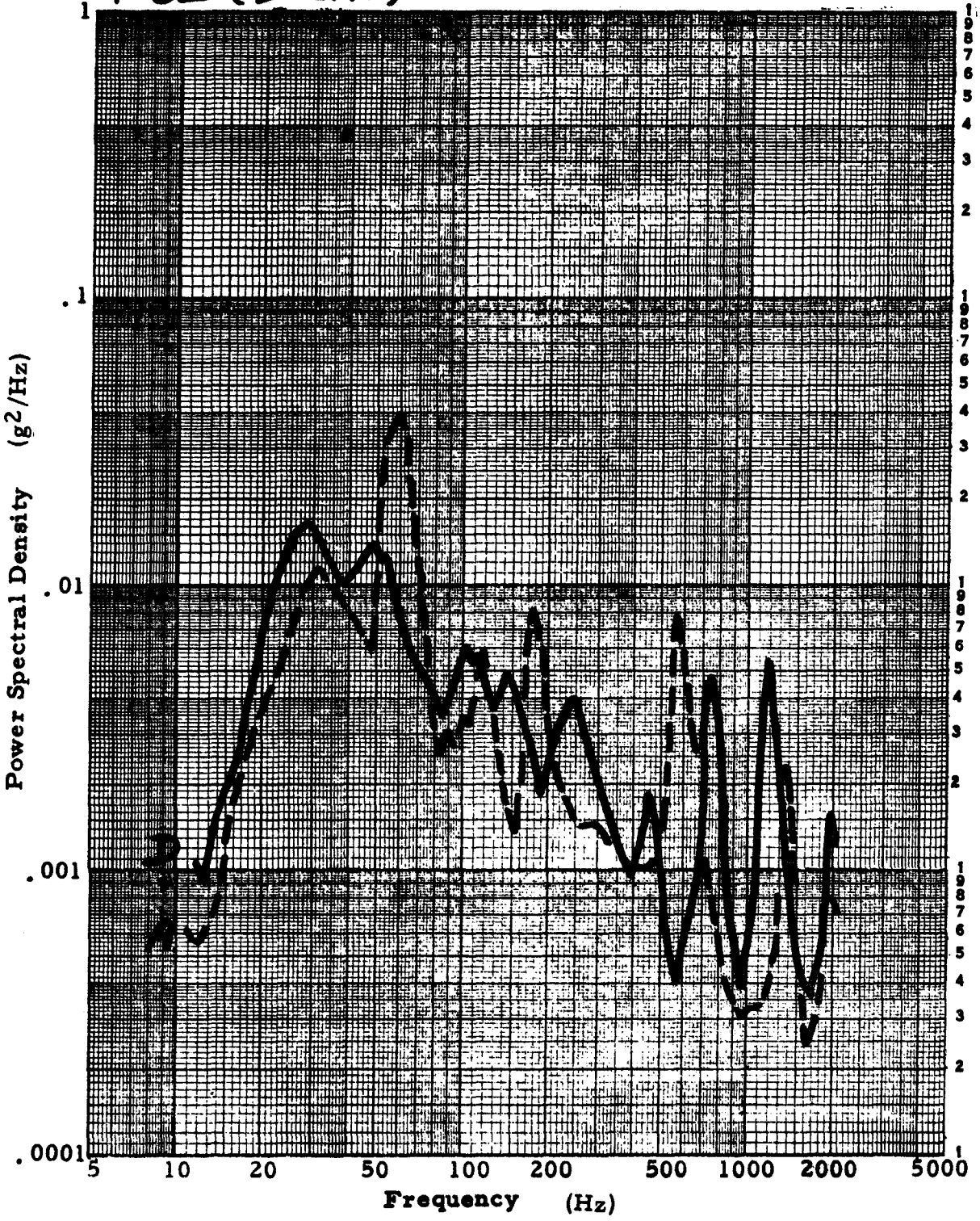
Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration:

PSE (Loc. A)



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2.0 SUBPACKAGE NO. 2 - QUAL D

2.1 INTRODUCTION

The initial attempt to qualify the Array D modifications to Subpack 2 resulted in an HFE (SN-3) discrepancy probably caused by excessive vibration response of the HFE subpallet. It was inherent in the subpallet design that the HFE environment would be more severe than it had been on Array B. The intent of the Qual D test was to qualify the HFE for the new environment. Unfortunately the resulting vibration environment was more severe than had been anticipated.[7]

In order to increase damping silicone rubber grommets were added to the design at (1) the HFE subpallet clevis brackets, (2) the top of the HFE subpallet struts, and (3) at the top of the HFE electronics package support brackets.

While the above design changes were being incorporated, it had been decided by NASA/MSC to remove the ALSD from subpack-2 for stowage elsewhere in the LM. In addition, the ALSEP vibration specifications were up-dated per the results of the LTA-11 acoustic tests at NASA/MSC.

In order to verify the effectiveness of the design change without jeopardizing the HFE, it was decided to perform a "pre-qual" test on subpack-2 with the DVT model HFE (i.e., SN-1). The test consisted of an acceptance level sinusoidal and a design limit level L&B random vibration per axis. Evaluation of accelerometer data from the pre-qual test verified that the HFE environment had been substantially reduced.[8]

At this point the DVT HFE was replaced by the refurbished SN-2 and a complete qualification test was conducted. During this test the pallet suffered a structural failure probably due to fatigue. This failure was not unexpected since the pallet had been subjected to almost three hours of vibration testing which certainly far exceeds any fatigue life design goals (see Table 2.1). The pallet was repaired and the test completed without incident. This report presents the results of this requalification test of Qual D subpack-2.

2.2 TEST ARTICLE

Table 2.2 lists the major Qual D Subpack 2 components along with drawing numbers, serial numbers, and previous usage. Figure 2.1 shows a photograph of the test article.

2.3 TEST DESCRIPTION

2.3.1 Purpose

The purpose of the Qual D test is to qualify the new subpack 2 components (i.e., items peculiar to Array D). In addition the HFE had to be requalified since its dynamic environment on Array D is significantly different from that on Array B (for which the HFE has been previously qualified).

2.3.2 Input Levels

Figures 2.2 through 2.8 show the specified Array D (subpacks 1 and 2) design limit vibration test levels. These levels are based upon mechanical vibration data recorded at the LM/ALSEP interface during the LTA-11 acoustic tests conducted at NASA/MSC during October, 1970.

Test level tolerances are defined in Section 1.3.2 of this report.

2.3.3 Instrumentation

Eighteen single axis accelerometers were mounted on Qual D Subpack 2 as shown in Figures 2.9 and 2.10. The objective of the instrumentation plan was to record the environment at the component interfaces (i.e., HFE electronics package, HFE probe package, and RTG) and at other pertinent points. [9,10]

2.4 RESULTS

Table 2.3 lists the root-mean-square acceleration (g_{RMS}) values recorded during each random vibration test at locations α, A, D, F, and G.

Vibration response envelopes for the HFE electronics package (locations A and D) are shown in Figures 2.11 to 2.19. The Array D envelopes are labeled "D". For comparison the corresponding envelopes from the Qual B vibration tests are also shown and labeled "B". The construction of a response envelope from vibration data is explained in Section 1.4 of this report.

The orientation of the HFE (both electronics and probe packages) relative to the ALSEP coordinate system is not consistent between Arrays B and D. Hence in order to properly compare the HFE response envelopes one should compare the Array D x-axis with Array B y-axis, Array D y-axis with Array B z-axis, and Array D z-axis with Array B x-axis. This has been done in Figures 2.11 to 2.19.and also 2.20 to 2.28 for HFE probe package data. The designated axis on each figure refers to the Array D HFE orientation. The Array B data on each figure is not for the axis designated on that figure, but for the appropriate axis as defined above.

Figures 2.20 to 2.28 show the vibration response envelopes for the HFE probe package (locations F and G) for both Arrays B and D.

Figures 2.29 to 2.37 show the vibration response envelopes for the RTG (location α). For comparison each figure shows a second envelope which was constructed from the Qual SA and Qual B data obtained at location α. These curves are labeled A/B on Figures 2.29 to 2.37.

Figures 2.38 to 2.46 also show RTG (location α) response envelopes. In this case however, the Array D requalification data is labeled D-2 and is compared with the first Array D qualification test data labeled D-1.

Accelerometer data at locations β, γ, and δ were recorded and is available. This data was obtained as "back-up" information and is not presented in this report.

2.5 CONCLUSIONS

Although greatly improved relative to the first Qual D test, the HFE data was more severe at certain frequencies than the Qual B data, particularly during the sinusoidal tests. Such differences are of no concern since the HFE passed post test functionals and is, therefore, qualified for Array D regardless of environmental comparisons.

The addition of silicone rubber grommets to the design was effective in reducing response levels especially during random vibration tests. Some indication of this can be seen in Figures 2.38 to 2.46. Further comparisons can be obtained from references 7 and 8.

Since the RTG used on Qual D was not a qualification unit but a dynamic model, it was not requalified as was the HFE. Hence, the Array D RTG environment must be compared with the environment to which the RTG was qualified (i.e., Qual SA and Qual B). Figures 2.29 to 2.37 make such a comparison. The Array D RTG response envelopes rarely exceed the Array A/B envelopes. At those frequencies, where Array D RTG response data exceeds the Array A/B RTG response data, the differences are not significant.

In order to determine the effect of off-loading the ALSD upon the Array D Subpack 2 dynamic response, one must compare the first Qual D test data with the second Qual D test data. Figures 2.38 to 2.46 make such a comparison at location α, which show results similar to other locations on the subpack. The data shows that the subpack 2 dynamic response is not generally higher for the second Qual D test than for the first. Hence, it can be concluded that off-loading the ALSD may or may not have an adverse effect upon Subpack 2 dynamic characteristics, but in combination with adding silicone rubber grommets and revising ALSEP vibration specifications per LTA-11, no difficulties are predicted.

Table 2.1

Qual D Subpack #2 Dynamic Test History

	TEST	DATE	ALSD	HFE	DURATION
1.	Acceptance (x, y, z) LTA-3DR	9/70	Qual.	SN-3	
	a. Sine (3/4 oct/min, 5-100 Hz)				17.28 min
	b. L&B random (2.5 min)				7.50
	c. Lunar descent random (12.5 min)				37.50
2.	Design Limit (x, y, z) LTA-3DR	9/70	Qual.	SN-3	
	a. Sine (3/4 oct/min, 5-100-5 Hz)				34.56
	b. L&B random (2.5 min)				7.50
	c. Lunar descent random (12.5 min)				37.50
	d. Shock (15)				0.05
3.	Pre-Qual (x, y, z) LTA-11	12/70	None	SN-1 (DVT)	
	a. sine (3 oct/min, 5-100 Hz)				4.29
	b. L&B random (1.0 min)				3.00
4.	Acceptance (x, y, z) LTA-11				
	a. Sine (3 oct/min, 5-100 Hz)	1/71	None	SN-2	4.29
5.	Design Limit (x, y, z) LTA-11	1/71	None	SN-2	
	a. Sine (3 oct/min, 5-100-5 Hz)				8.58
	b. L&B random (1.0 min)				3.00
	c. Lunar descent random (12.5 min)				37.50
	d. Shock (15)				0.05

Total Test Time = 202.60 min

Pallet failure was noted after the second sine sweep of test (5). At that point the pallet had undergone 172.74 min. of dynamic testing. Compare this with 141.84 min. for Qual SA/SP-2, 53.37 min. for Qual E/SP-2, and 17.79 min. for Flight Models.

Table 2.2

Array D Subpackage 2 (Qual. D)

Configuration Description (major components)

component	dwg.no.	serial no.	previous usage
pallet assy	2339101	SN-11	---
HFE subpallet	2339130	SN-2	---
Carrier assy structure, tools, & PSE stool	2339115	(simulator)	---
RTG	GE/47R 300839G1	(simulator)	Qual. SB
gimbal container assy	2339140	SN-7	---
aiming mechanism	2339175	SN-4	---
HFE	2345430	SN-2	---

Table 2.3 - Qual. D Subpack - 2

Random Vibration Root-Mean-Square Acceleration Levels

Subsystem	loc.	Resp. Axis	X-input L&B	X-input L. D.	Y-input L&B	Y-input L. D.	Z-input L&B	Z-input L. D.
RTG	α	X	7.1	4.2	3.3	2.5	3.0	1.8
		Y	6.2	3.8	4.2	3.2	3.2	1.2
		Z	3.8	2.4	3.4	2.5	2.2	1.7
HFE elect.	A	X	*	*	1.0	0.5	1.5	1.2
		Y	1.5	1.0	0.9	1.0	0.7	0.5
		Z	1.9	1.3	1.8	0.8	0.9	0.7
	D	X	2.6	2.1	---	---	---	---
		Y	---	---	1.3	1.2	---	---
		Z	---	---	---	---	0.9	0.7
HFE-probe	F	X	2.0	1.6	1.5	1.5	0.7	0.6
		Y	2.3	1.4	1.3	1.2	1.0	0.9
		Z	1.7	1.5	1.0	1.2	0.9	0.8
	G	X	2.2	0.5	---	---	---	---
		Y	---	---	1.8	0.7	---	---
		Z	---	---	---	---	1.8	1.6

*no data available

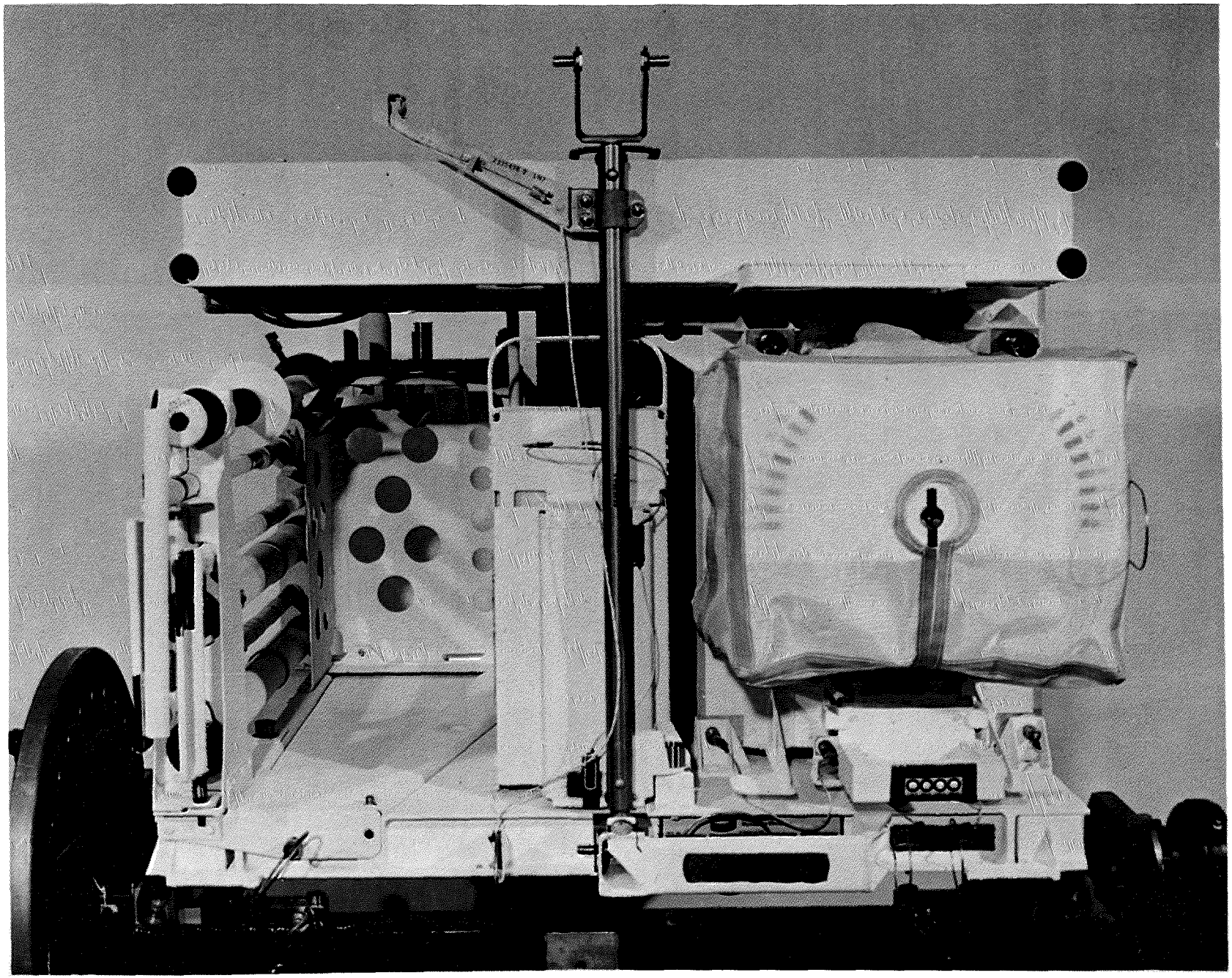

Figure 2.1 - Qual D Subpack 2

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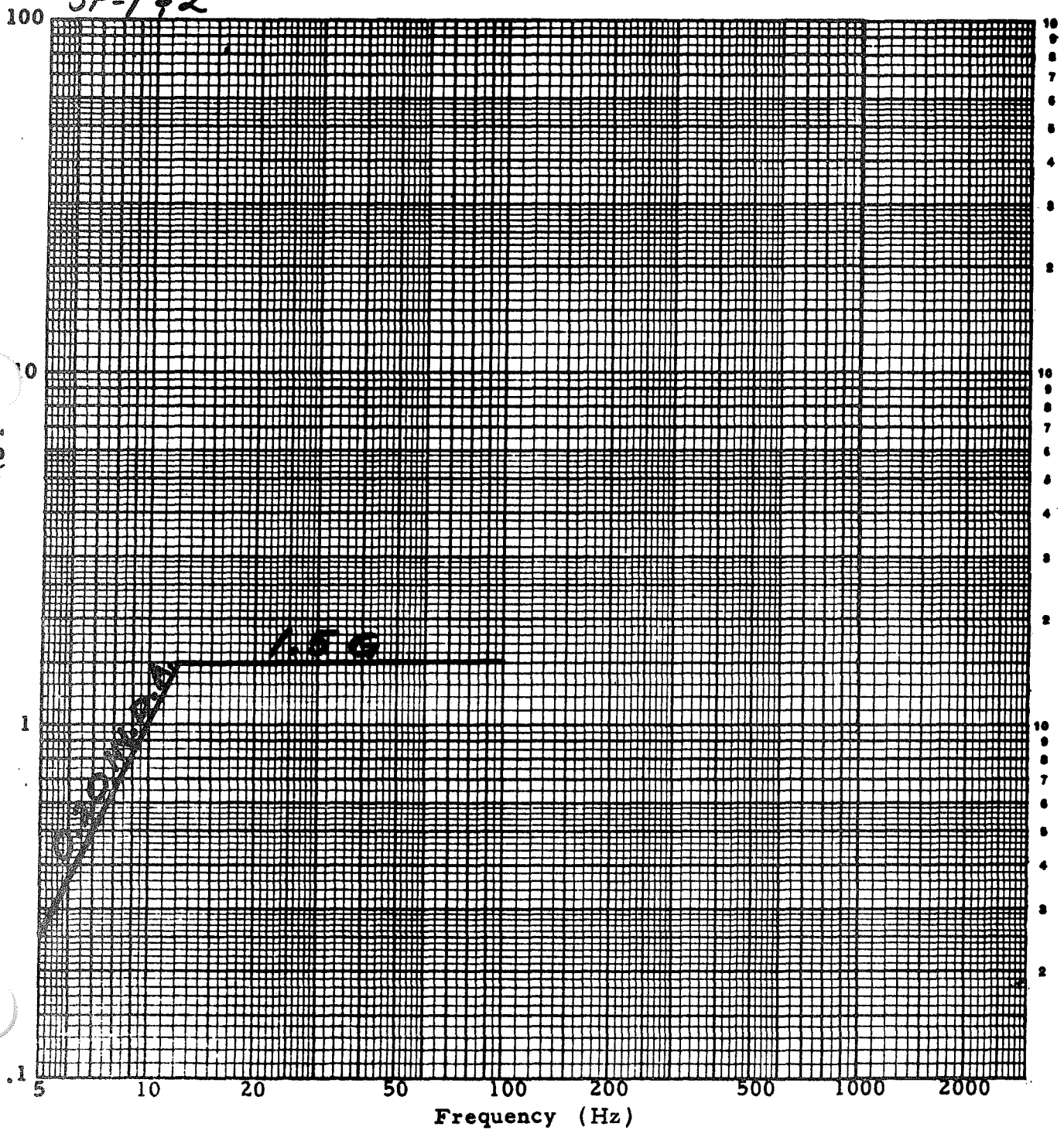
DESIGN LIMIT LEVEL

SINUSOIDAL VIBRATION

Axis: X, Y, Z

Sweep Rate: 3 oct/min

SWEEP: 5-100-5 Hz



Date: 12-15-71

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Figure 2.3

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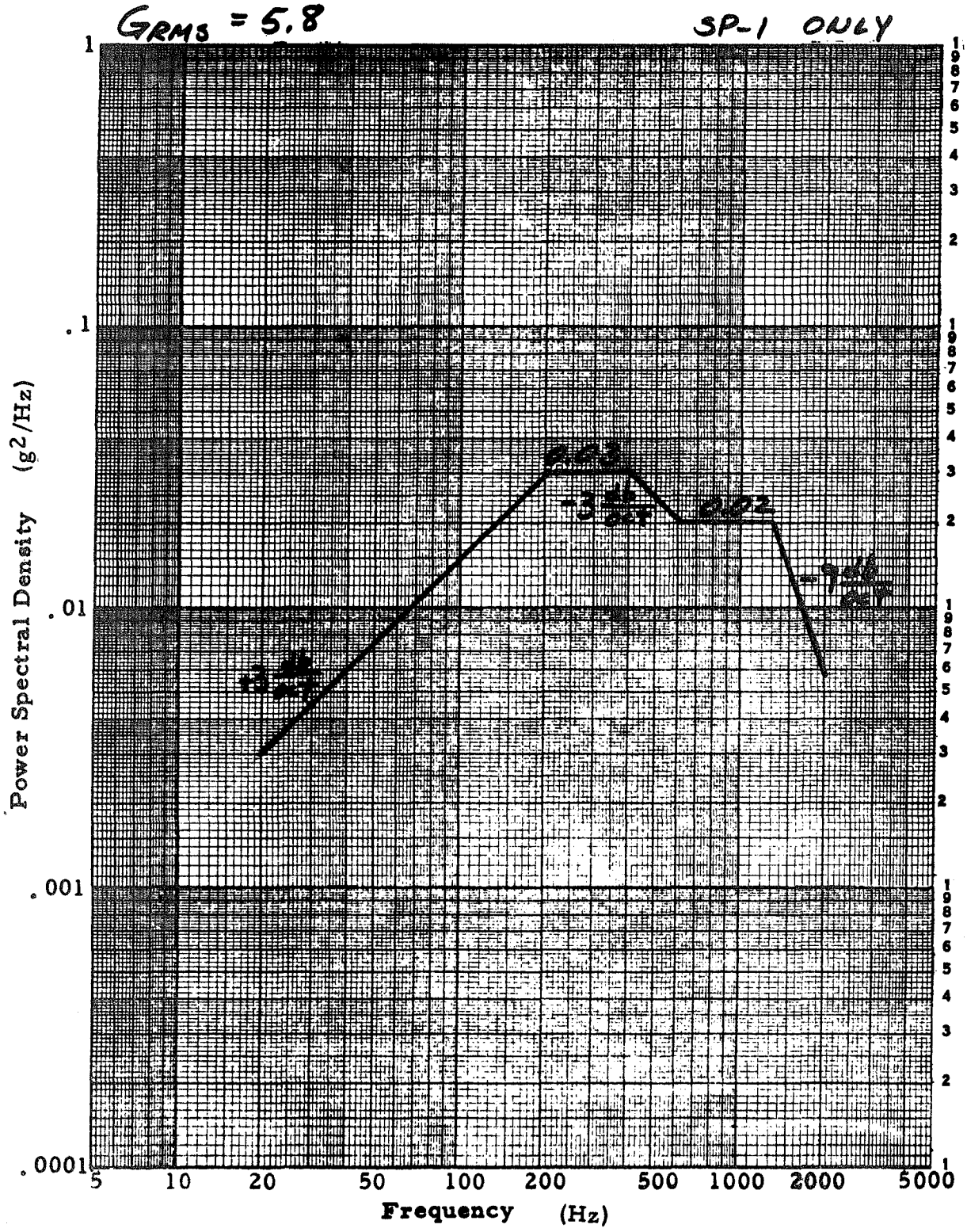
DESIGN LIMIT LEVEL L+B

RANDOM VIBRATION SPECTRUM

Axis: X

Duration: 1.0 min



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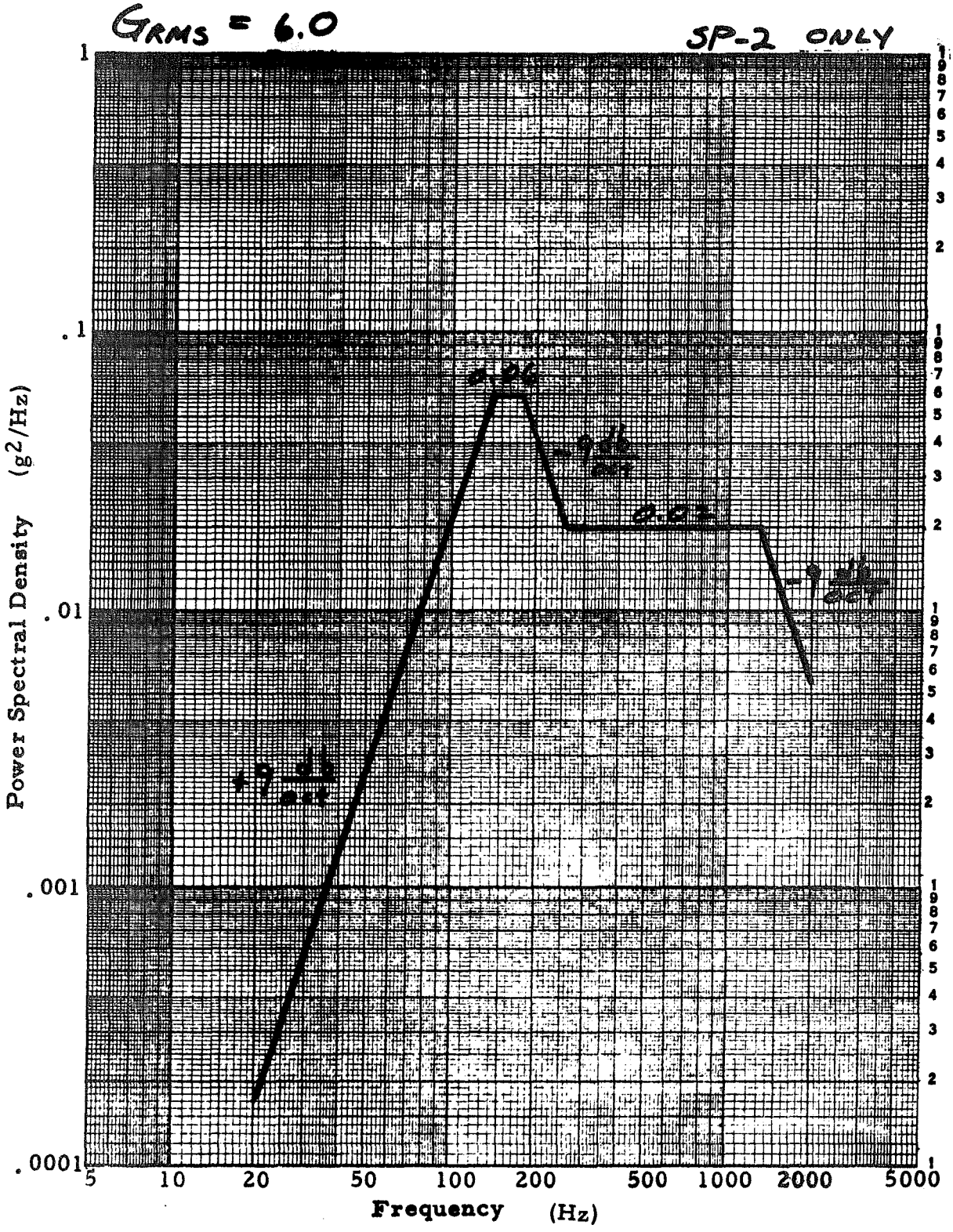
LTA-11

DESIGN LIMIT LEVEL L&B

RANDOM VIBRATION SPECTRUM

Axis: X

Duration: 1.0 min



Date: 12-15-71

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Figure 2.5
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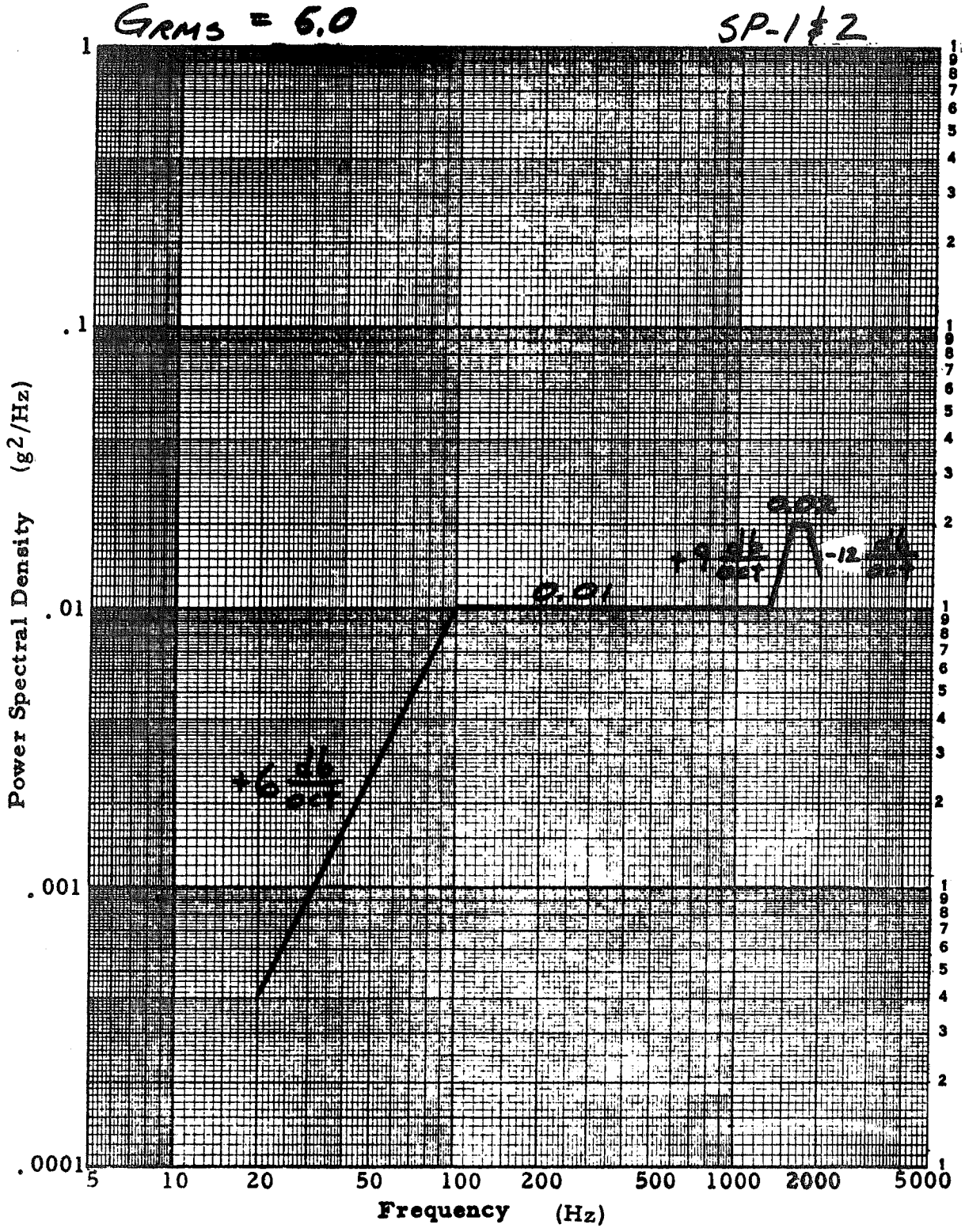
LTA-11

DESIGN LIMIT LEVEL L#B

RANDOM VIBRATION SPECTRUM

Axis: Y

Duration: 1.0 min



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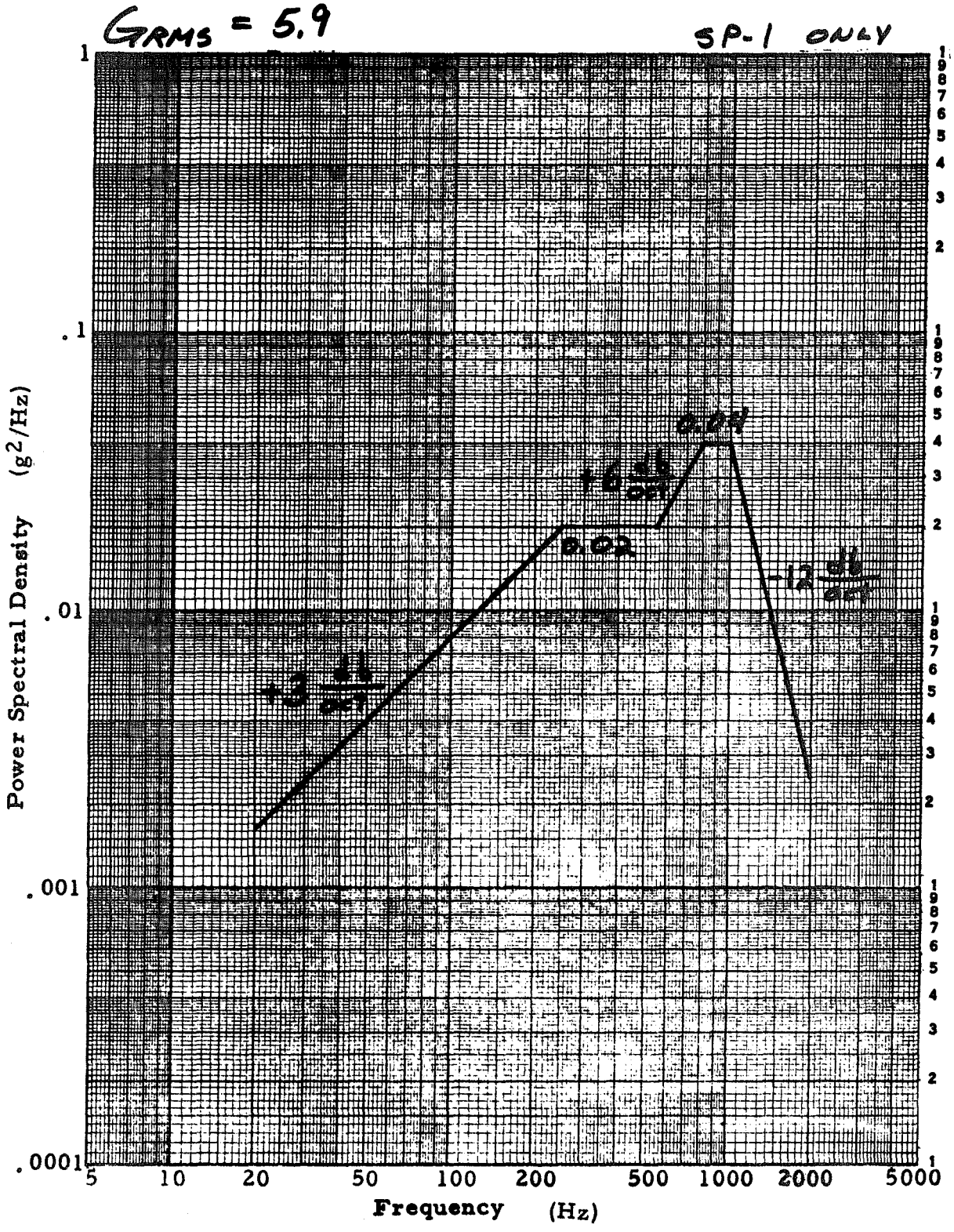
LTA-11

DESIGN LIMIT LEVEL L+B

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration: 1.0 min



Date: 12-15-71

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Figure 2.7
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DESIGN LIMIT LEVEL L#B

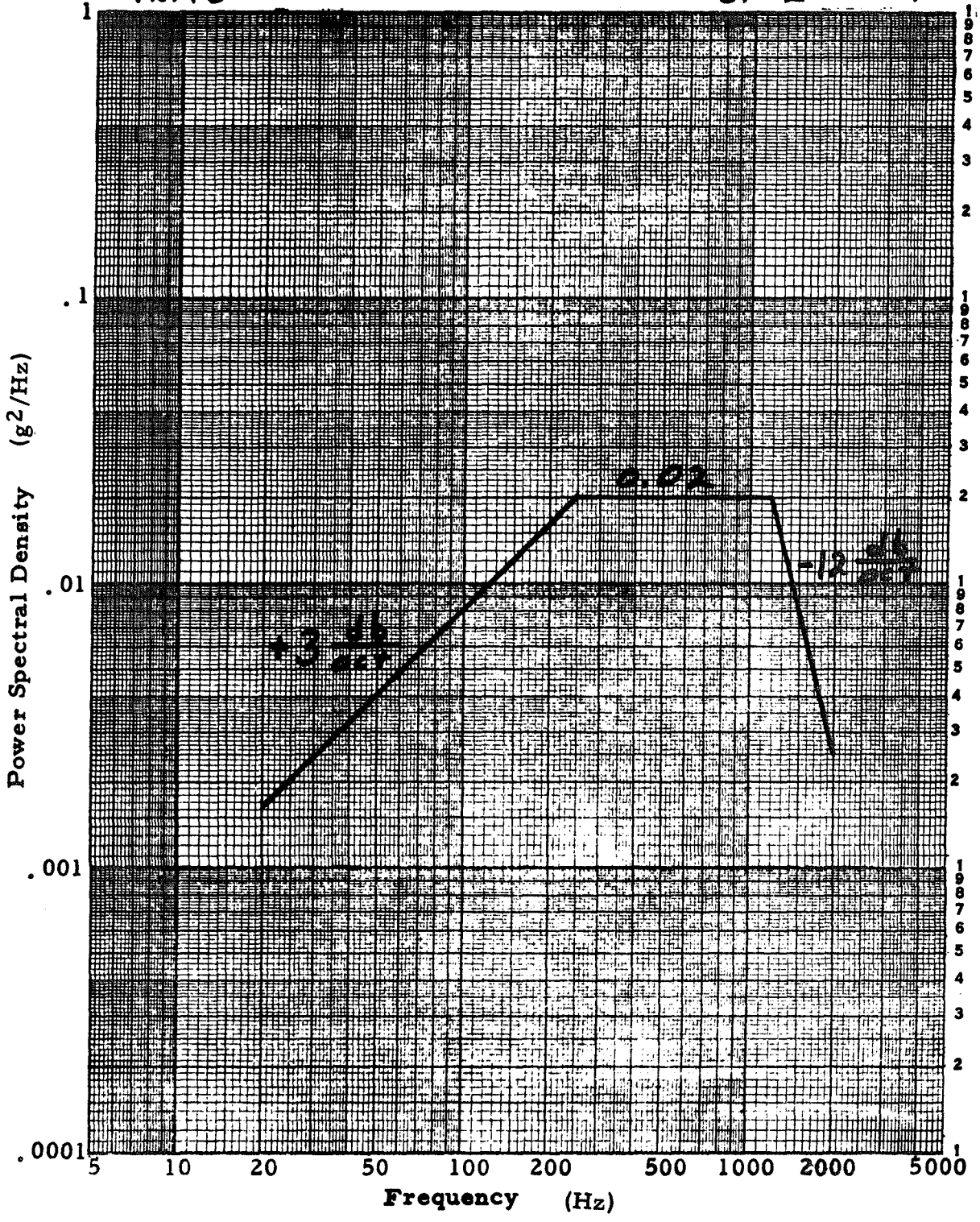
RANDOM VIBRATION SPECTRUM

Axis: Z

Duration: 1.0 min

GRMS = 5.3

SP-2 ONLY



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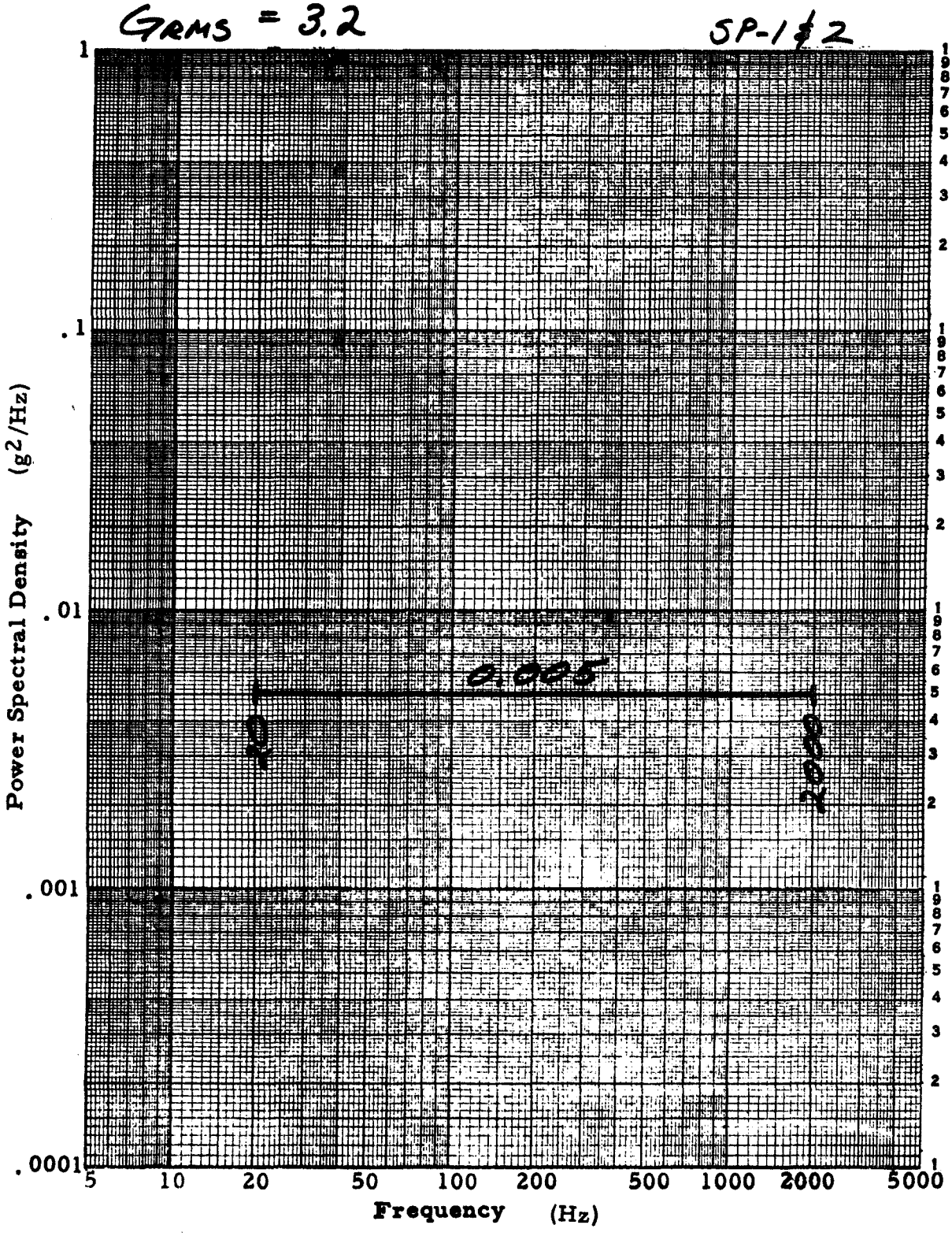
LTA-11

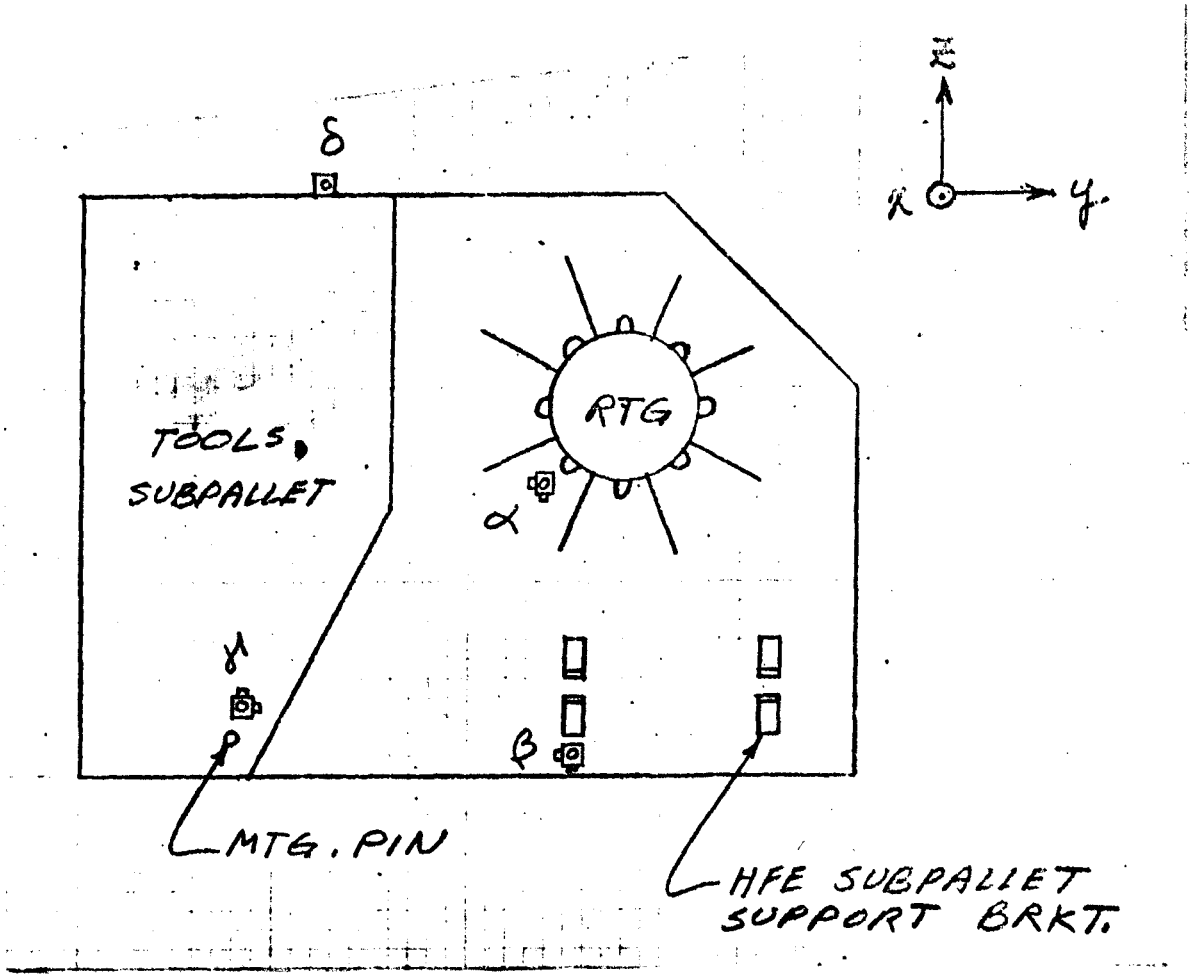
DESIGN LIMIT LUNAR DESCENT

RANDOM VIBRATION SPECTRUM

Axis: X, Y, Z

Duration: 12.5 min/axis

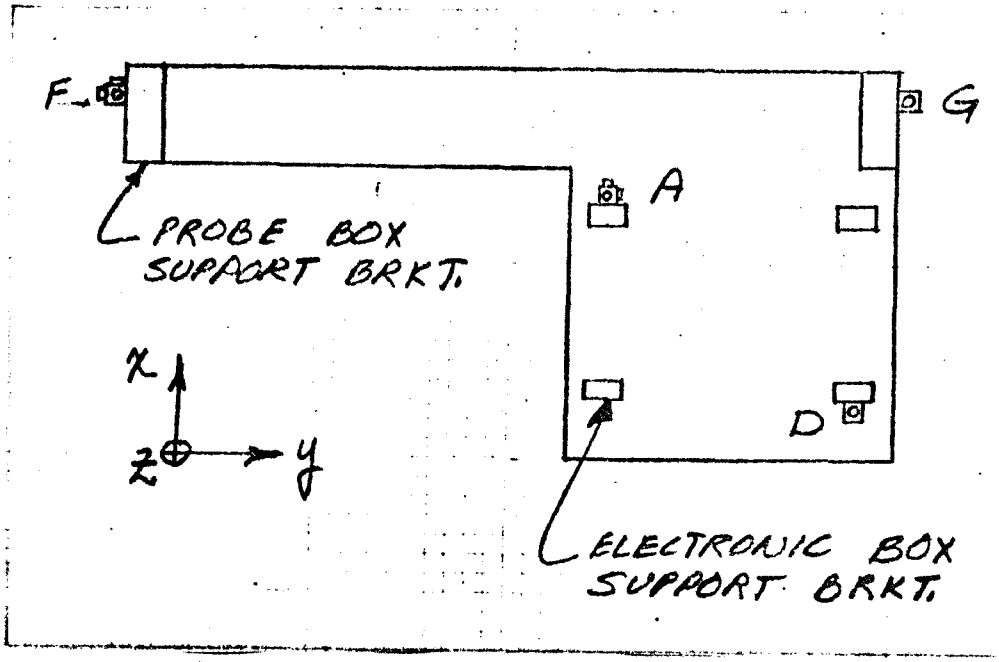




Loc.	Accelerometer	Location Description
α	Tri-Axial	on pallet near RTG
β	Tri-Axial	on pallet near HFE Subpallet Mtg. Brkt.
γ	Tri-Axial	on ALSD Subpallet near Mtg. Pin
δ	Single Axis	on Subpallet behind right ALSD Support Pin

NOTE: Single axis accelerometers must be oriented to the direction of input for all tests.

Figure 2.9 - Qual D Instrumentation (pallet)



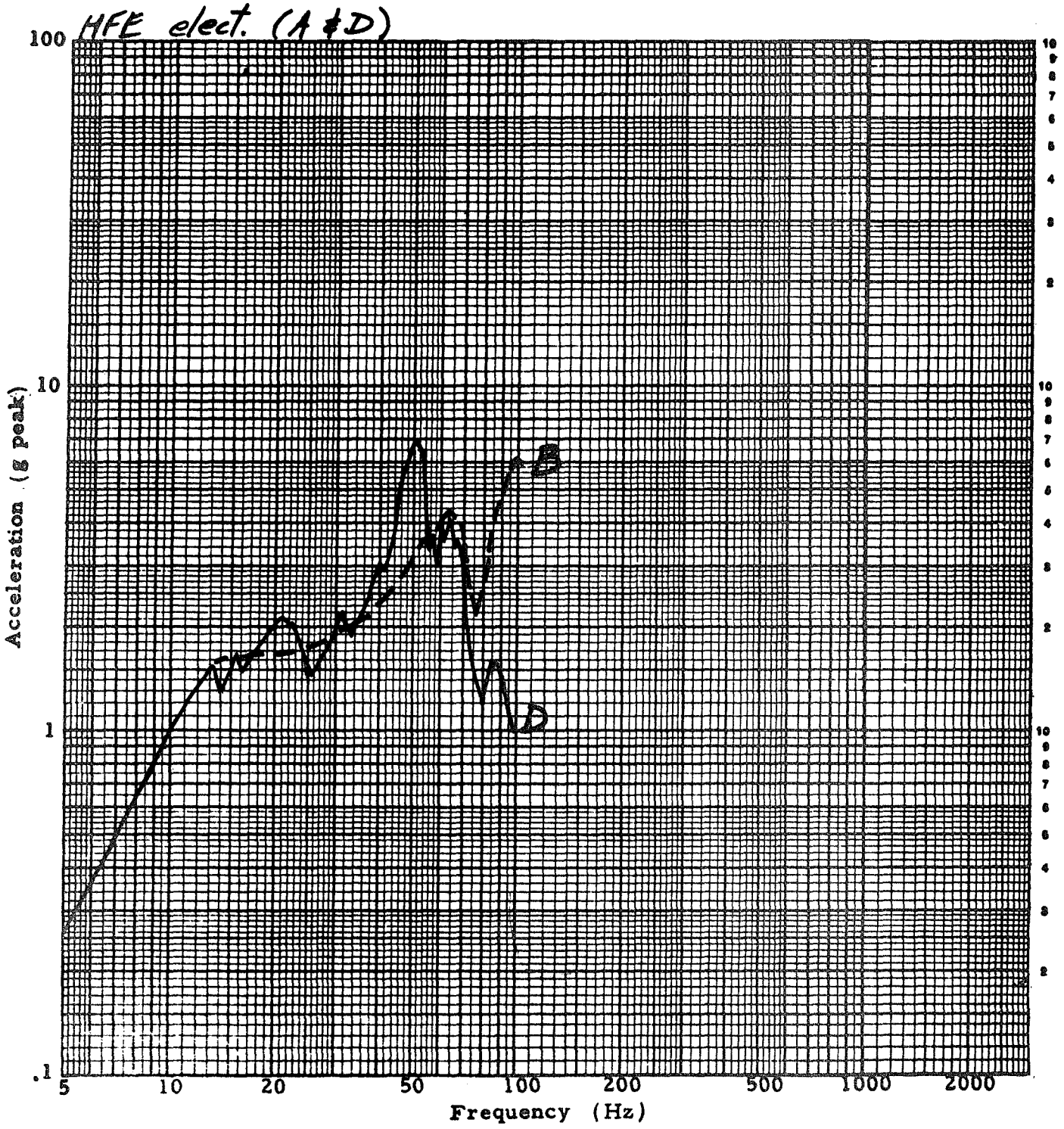
Loc.	Accelerometer	Location Description
A	Tri-Axial	Top of upper left HFE Elect. Support Brkt.
D	Single Axis	Top of lower right HFE Elect. Support Brkt.
F	Tri-Axial	on left HFE Probe Support Brkt.
G	Single Axis	on right HFE Probe Support Brkt.

Figure 2.10 - Qual D Instrumentation (HFE Subpallet)

SINUSOIDAL VIBRATION

Axis: X

Sweep Rate:



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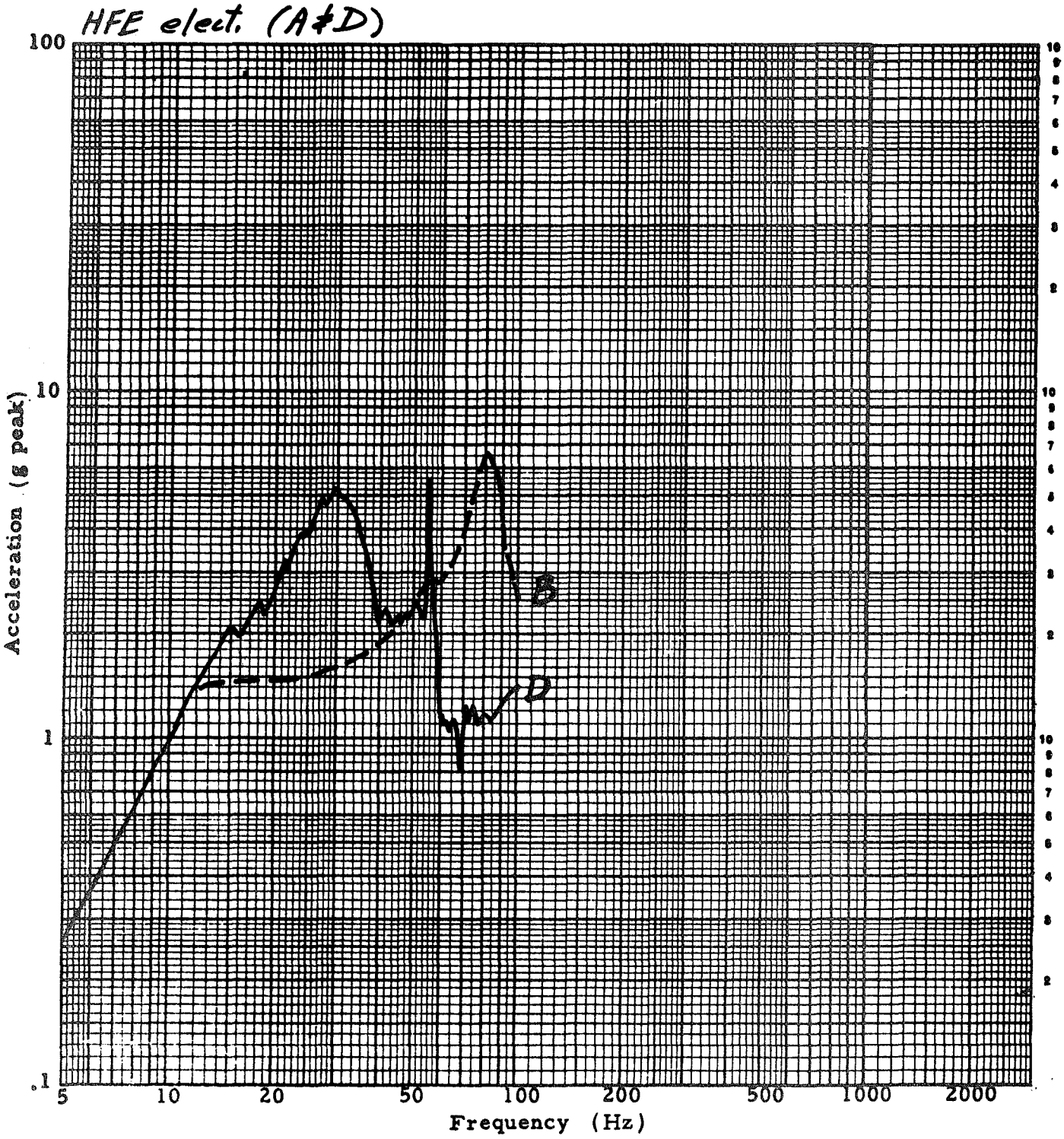
SINUSOIDAL VIBRATION

Axis: 4

Sweep Rate:



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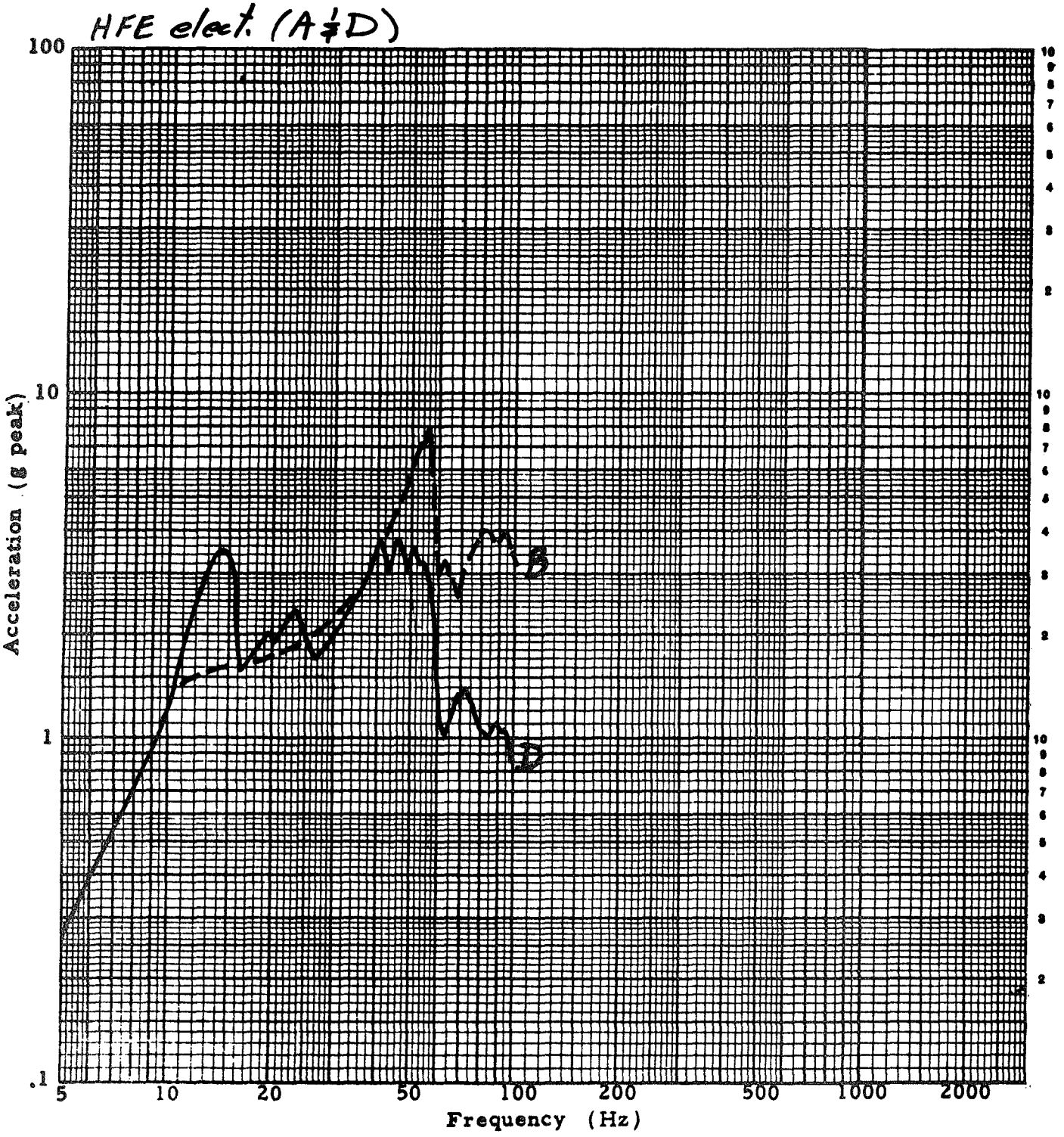
SINUSOIDAL VIBRATION

Axis: Z

Sweep Rate:



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L&B

RANDOM VIBRATION SPECTRUM

Axis: X

Duration:

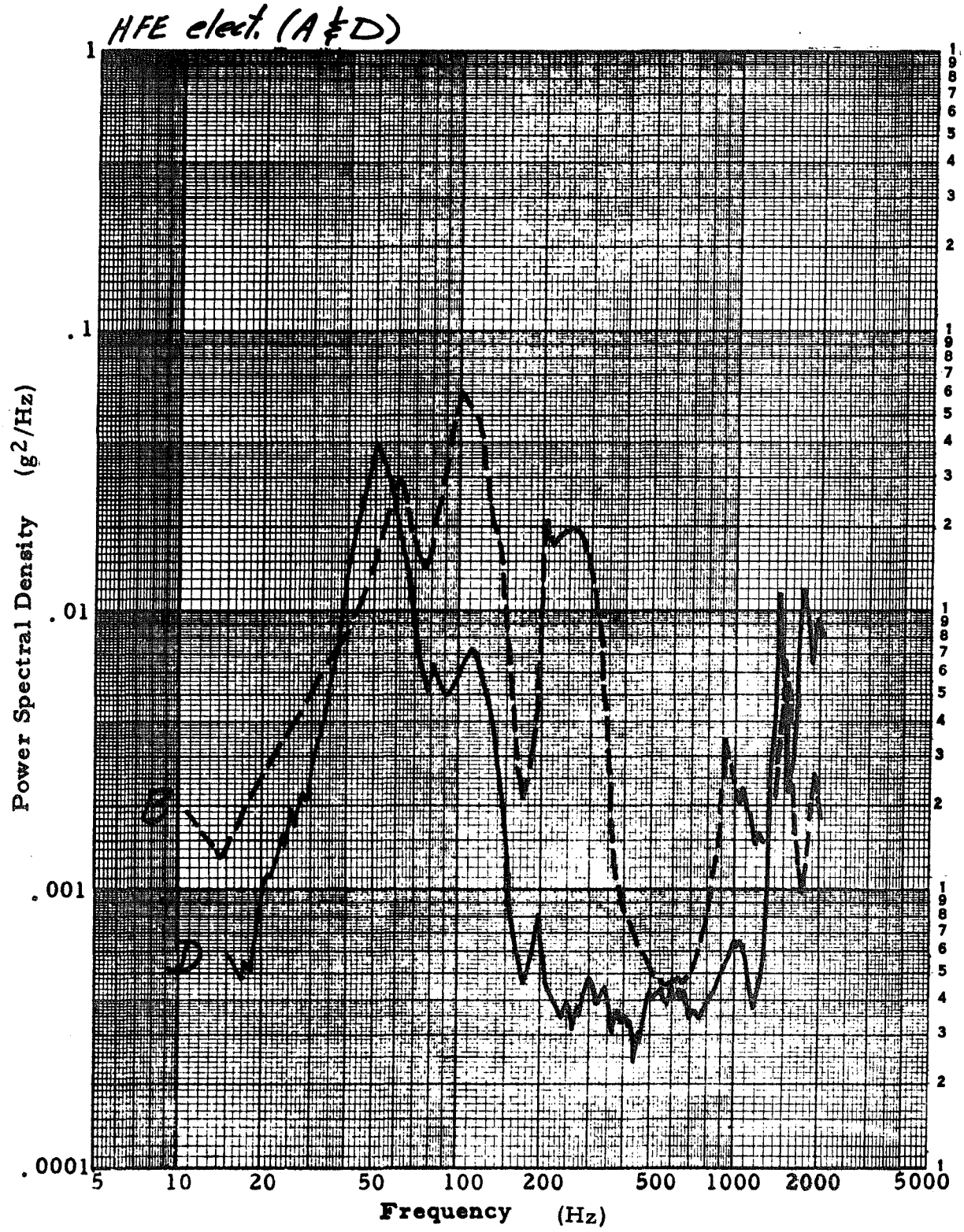

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Figure 2.15

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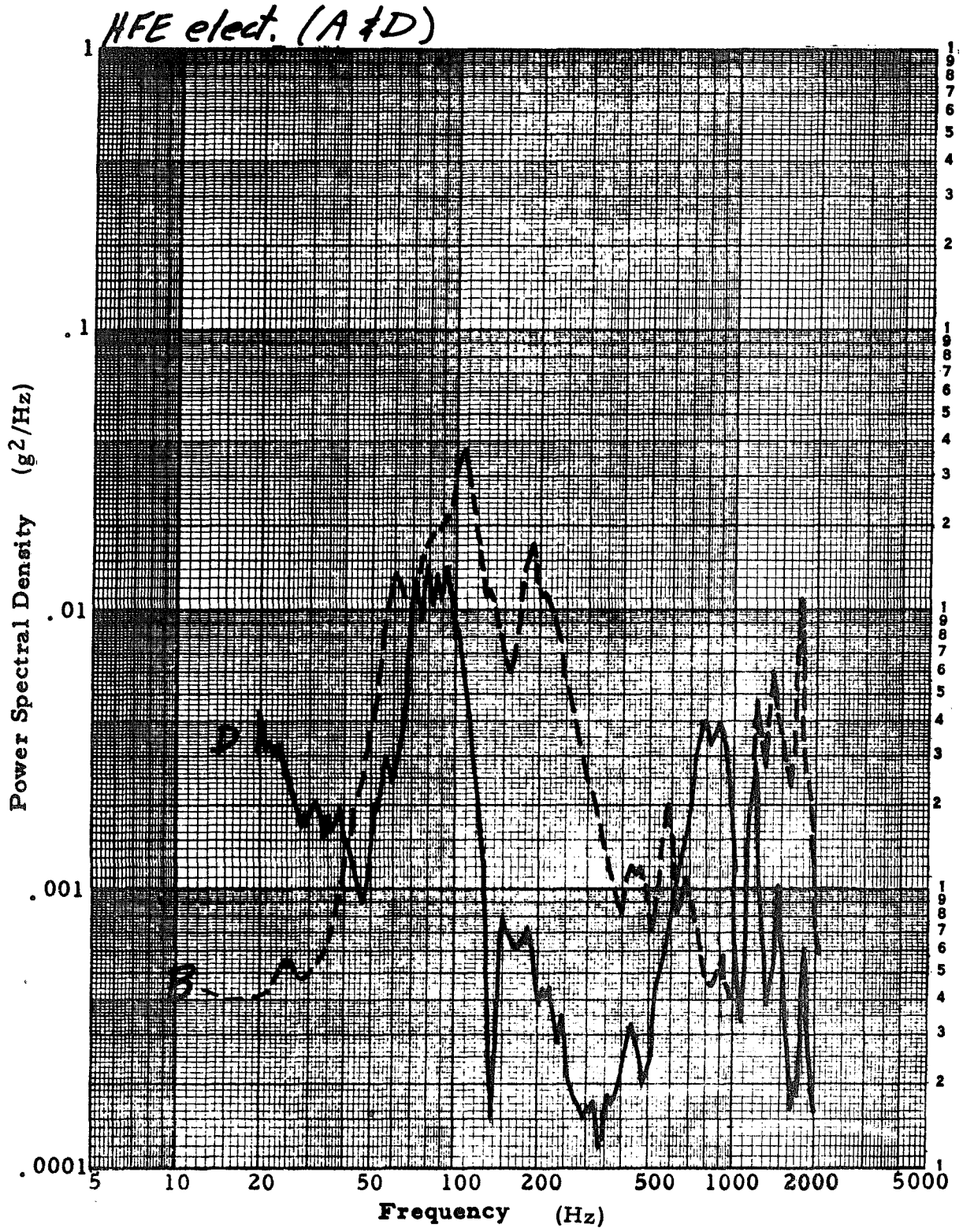
L & B

RANDOM VIBRATION SPECTRUM

Axis: y

Duration:



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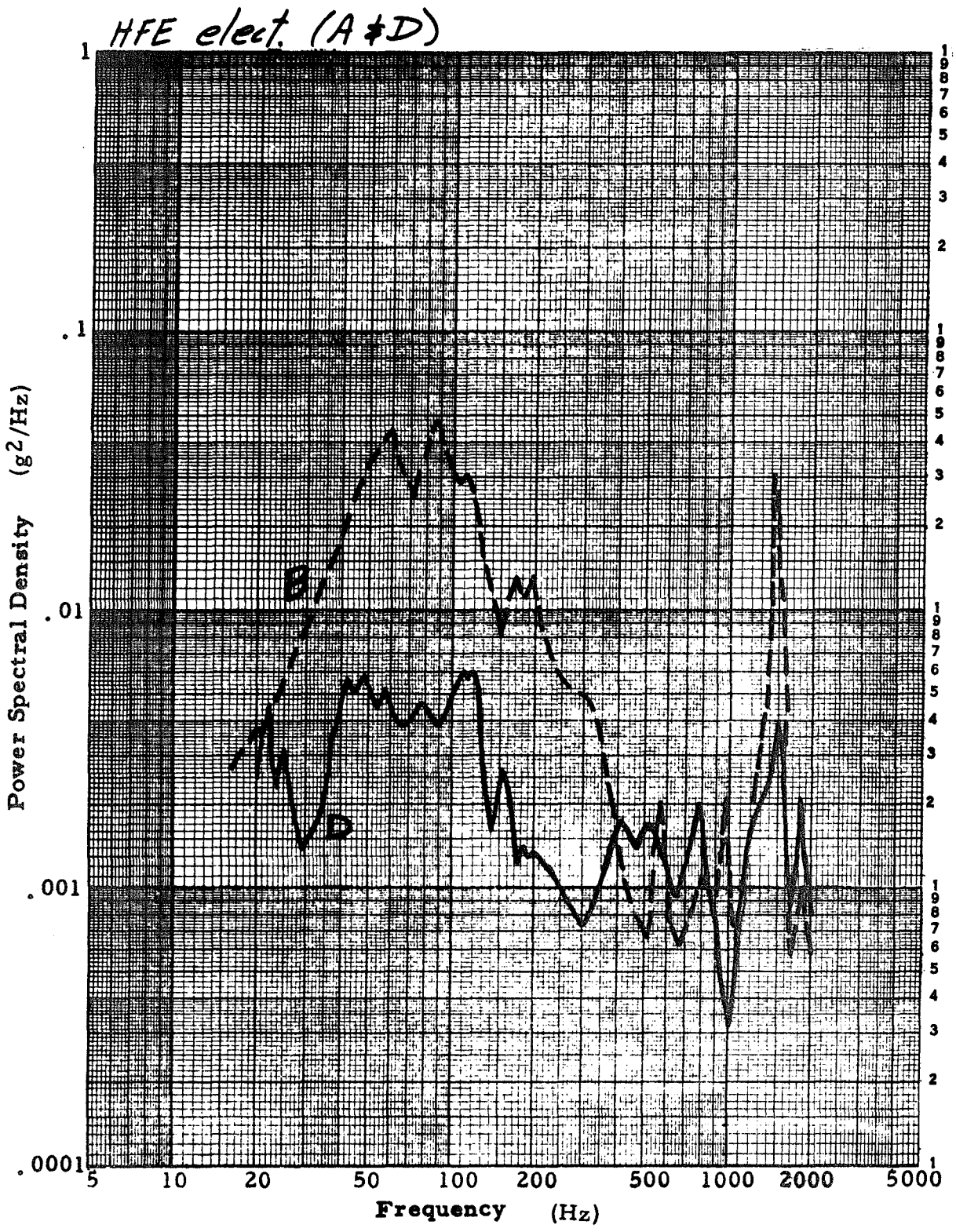
L & B

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration:



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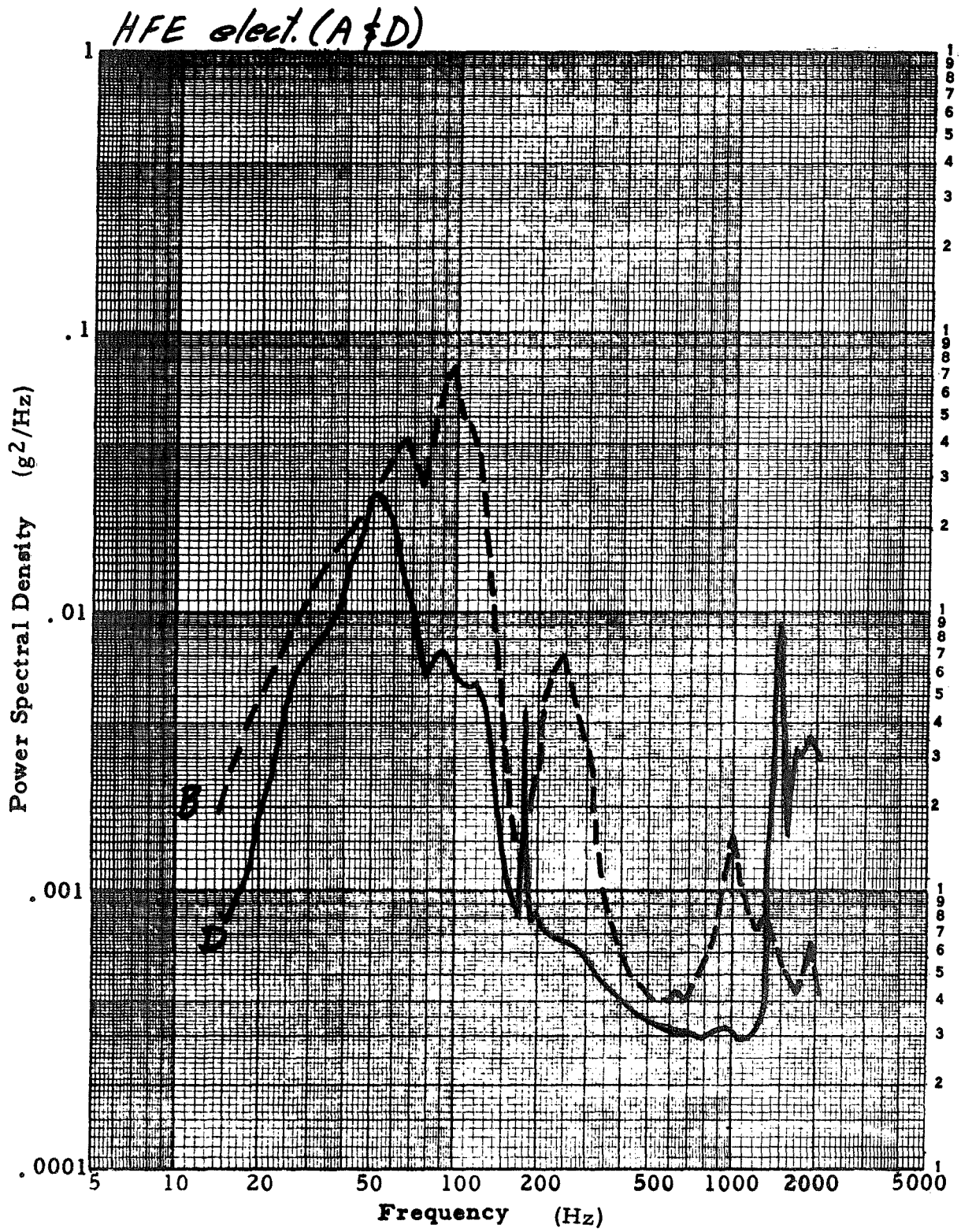
Lun. Des.

Axis: X

RANDOM VIBRATION SPECTRUM

Duration:



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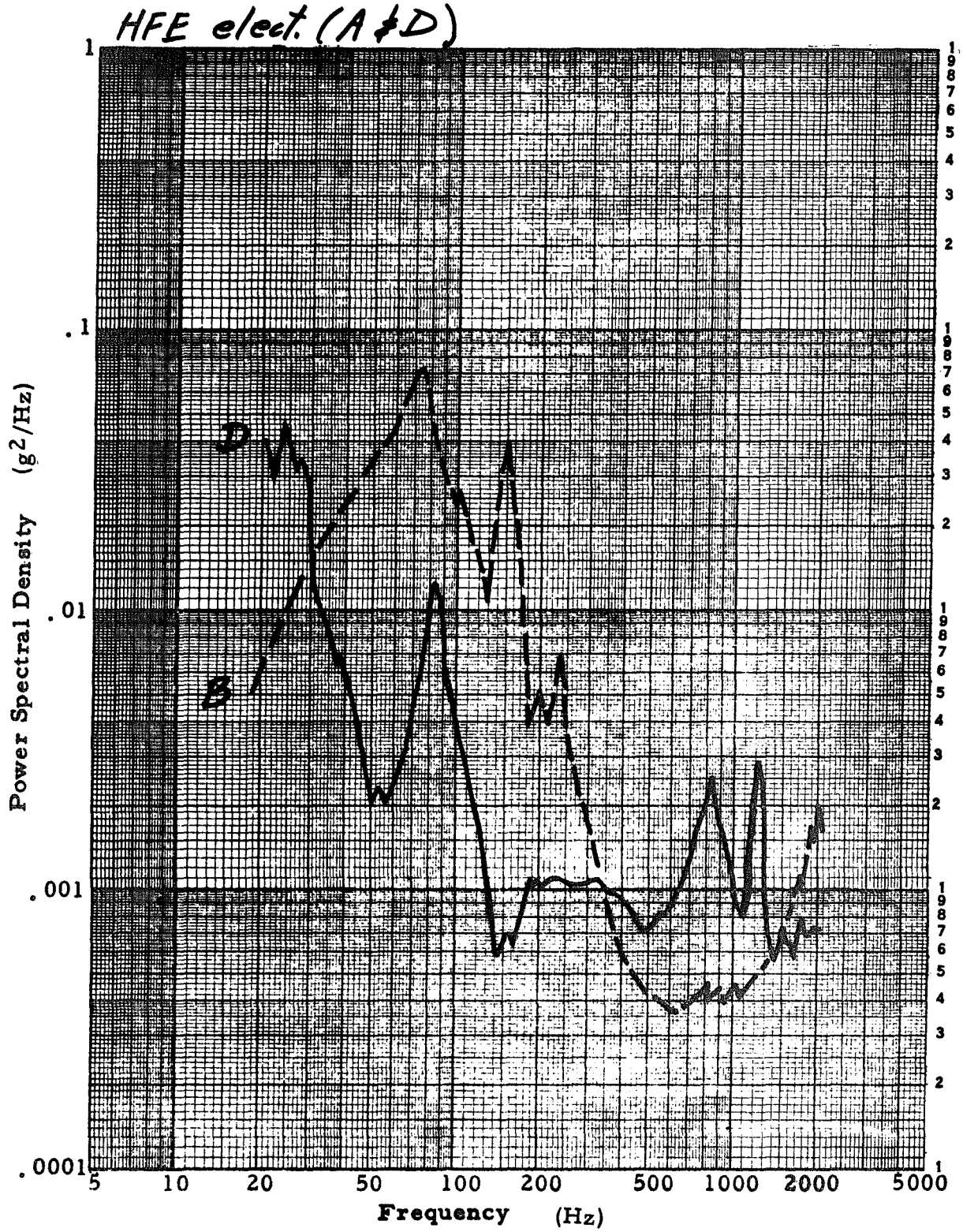
RANDOM VIBRATION SPECTRUM

Axis: y

Duration:



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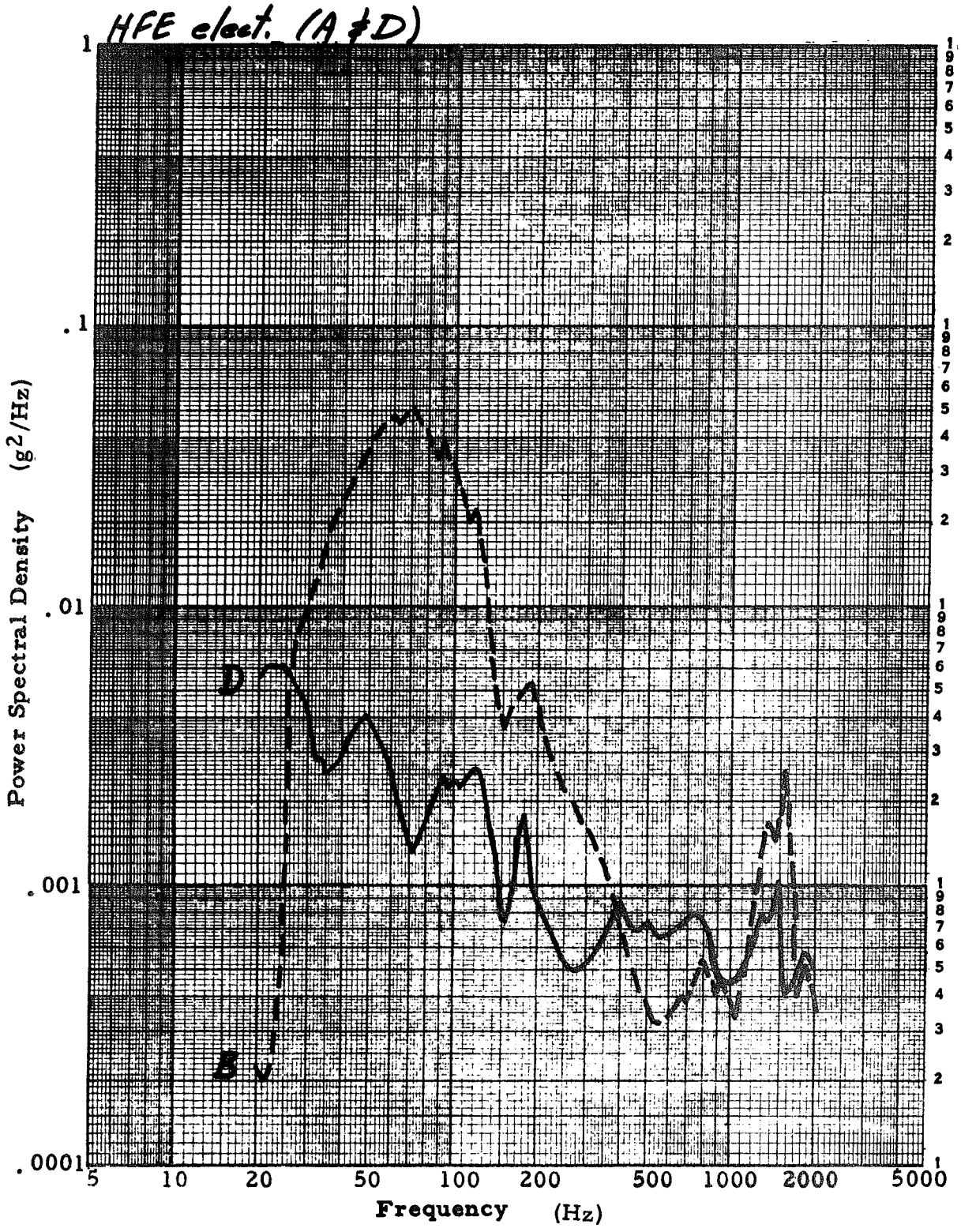
Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration:



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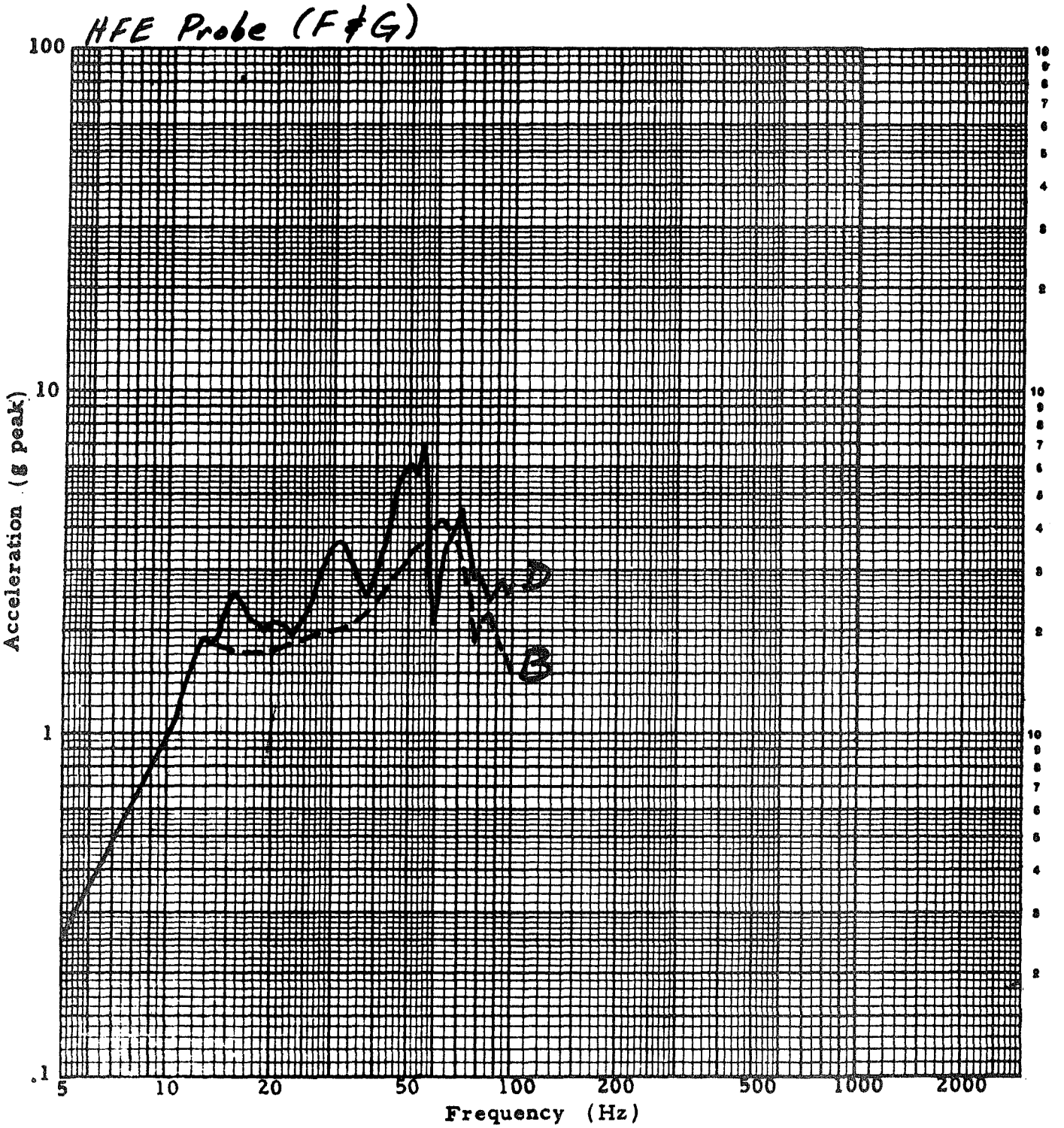
SINUSOIDAL VIBRATION

Axis: X

Sweep Rate:



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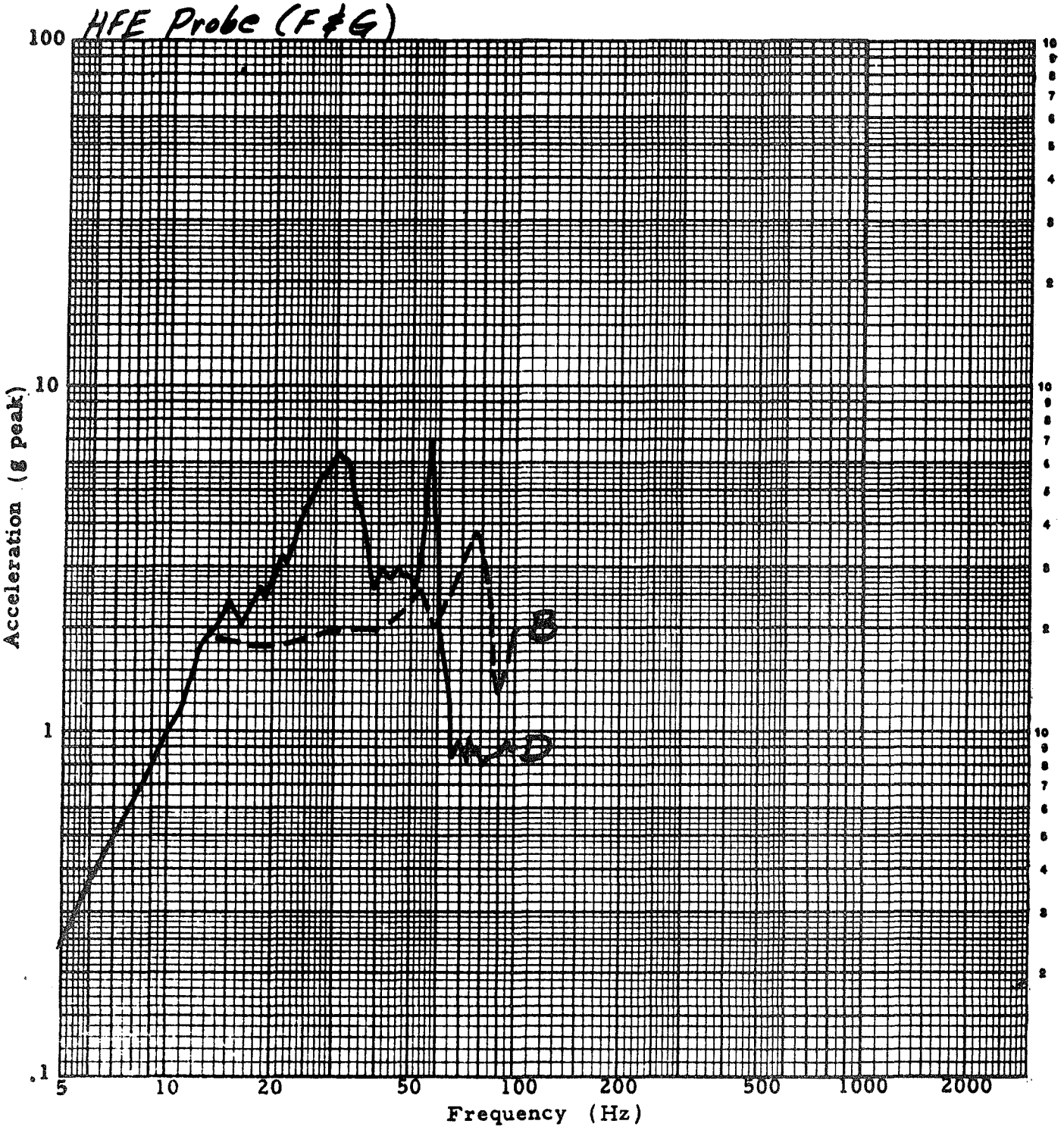
SINUSOIDAL VIBRATION

Axis: Y

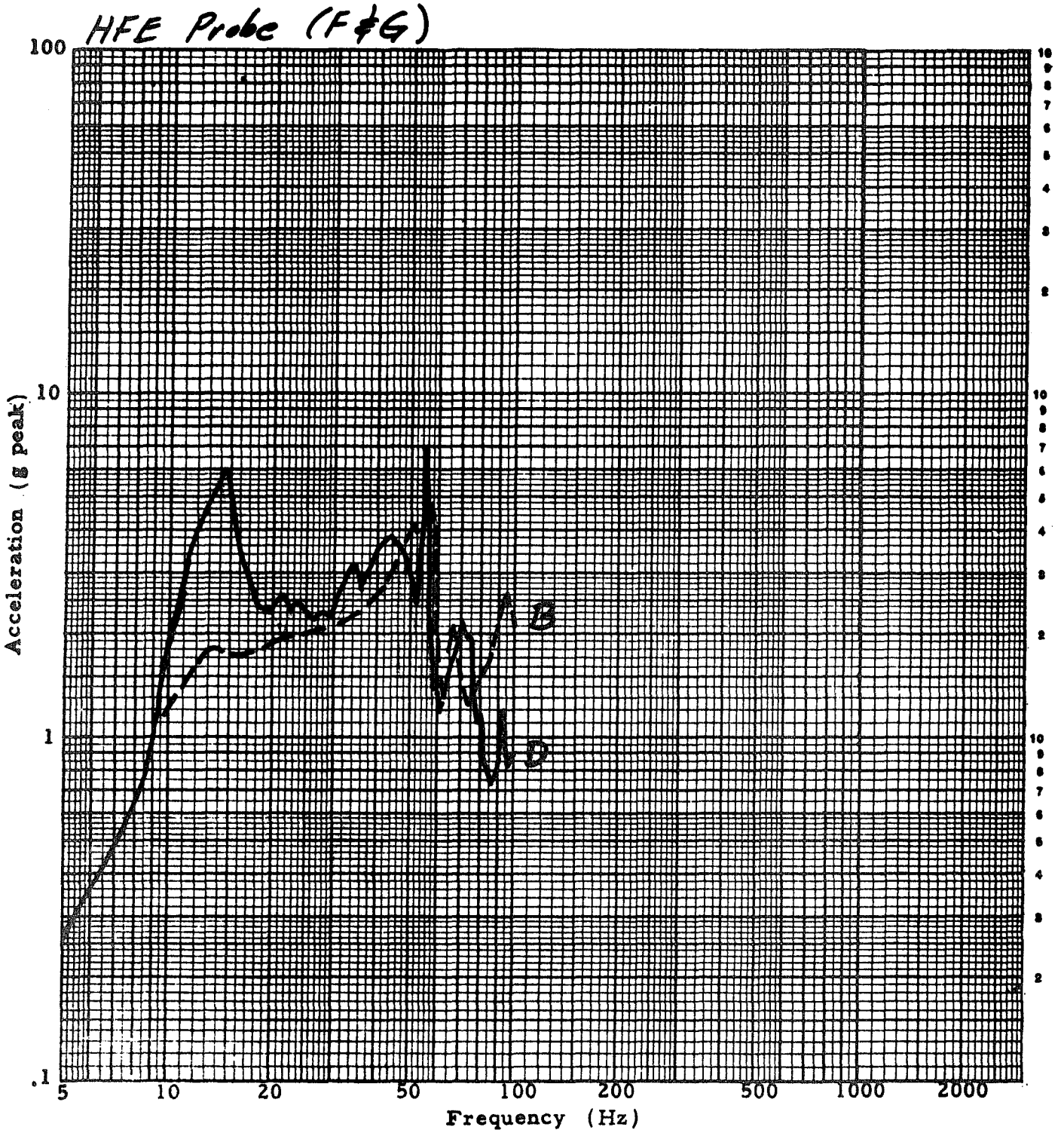
Sweep Rate:



SINUSOIDAL VIBRATION

Axis: Z

Sweep Rate:



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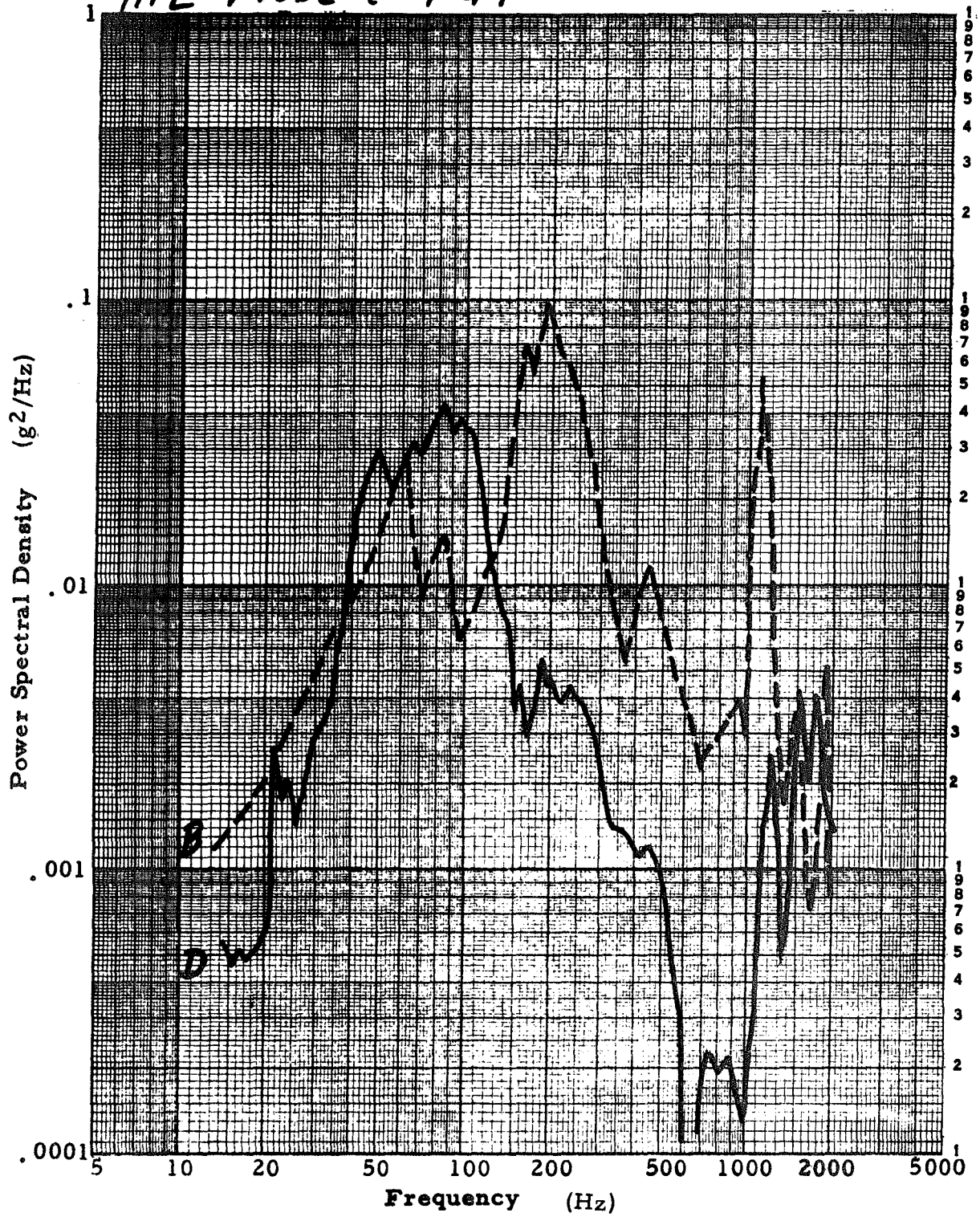
L&B

Axis: X

RANDOM VIBRATION SPECTRUM

Duration:

HFE Probe (F&G)



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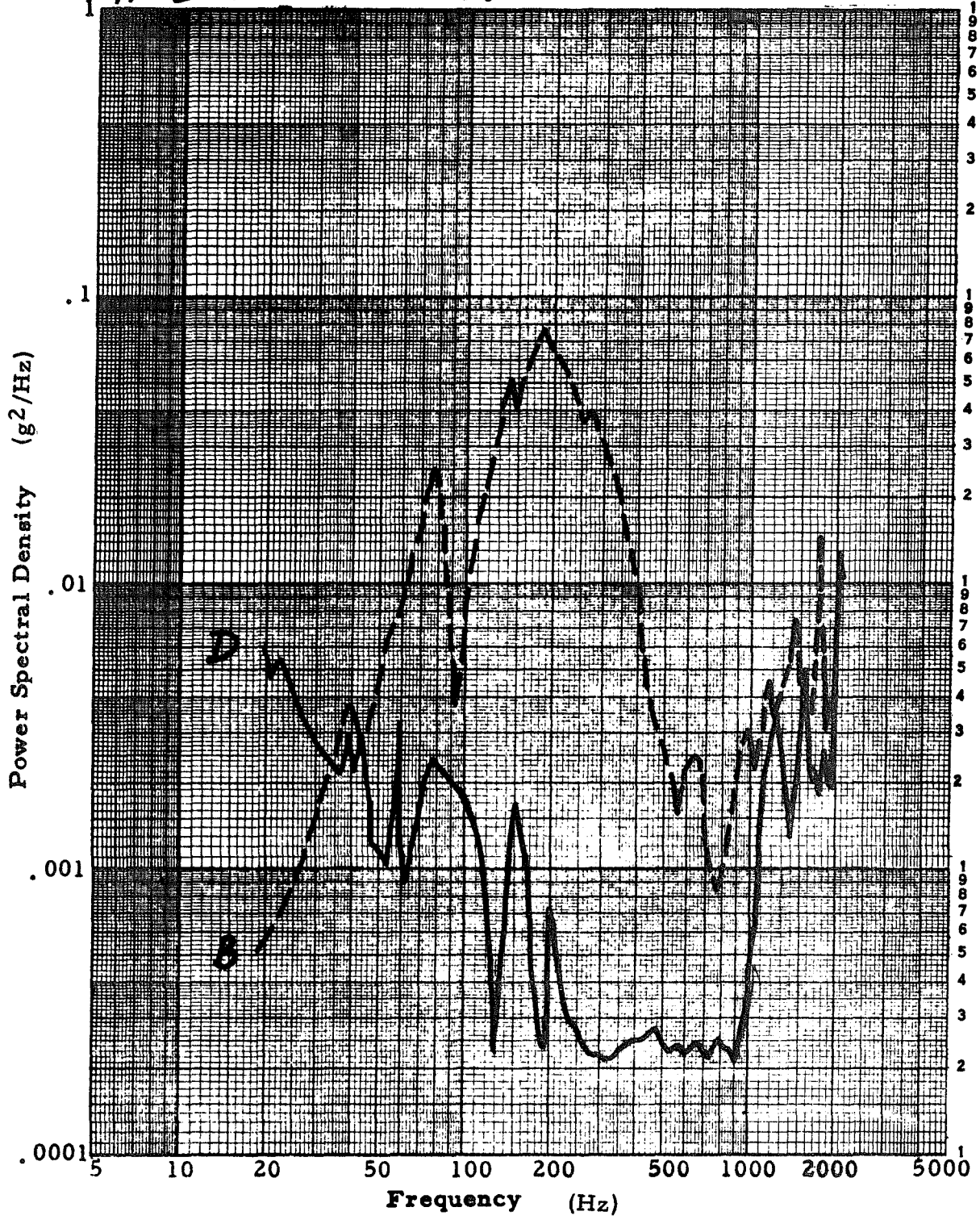
L & B

RANDOM VIBRATION SPECTRUM

Axis: y

Duration:

HFE Probe (F & G)



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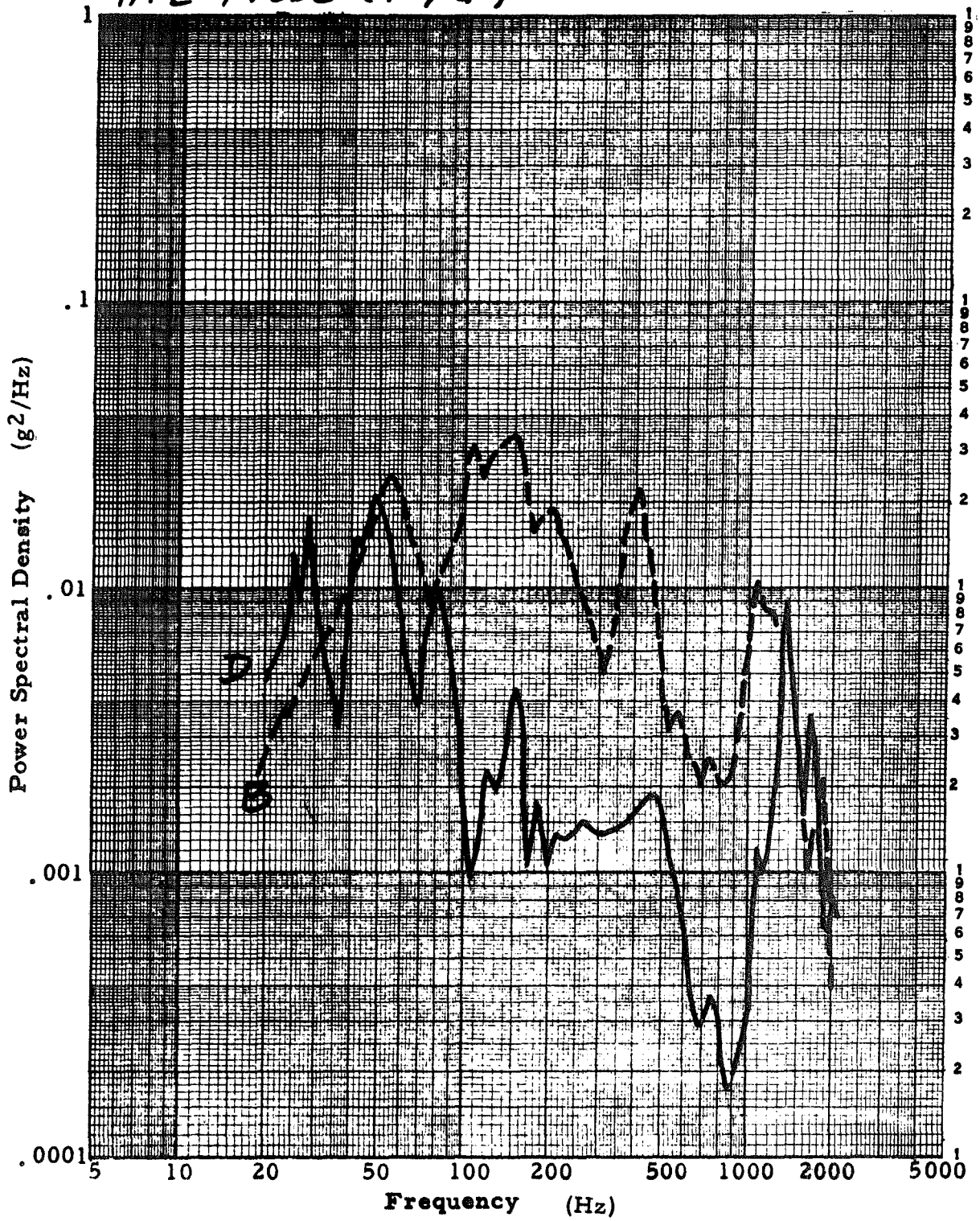
L & B

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration:



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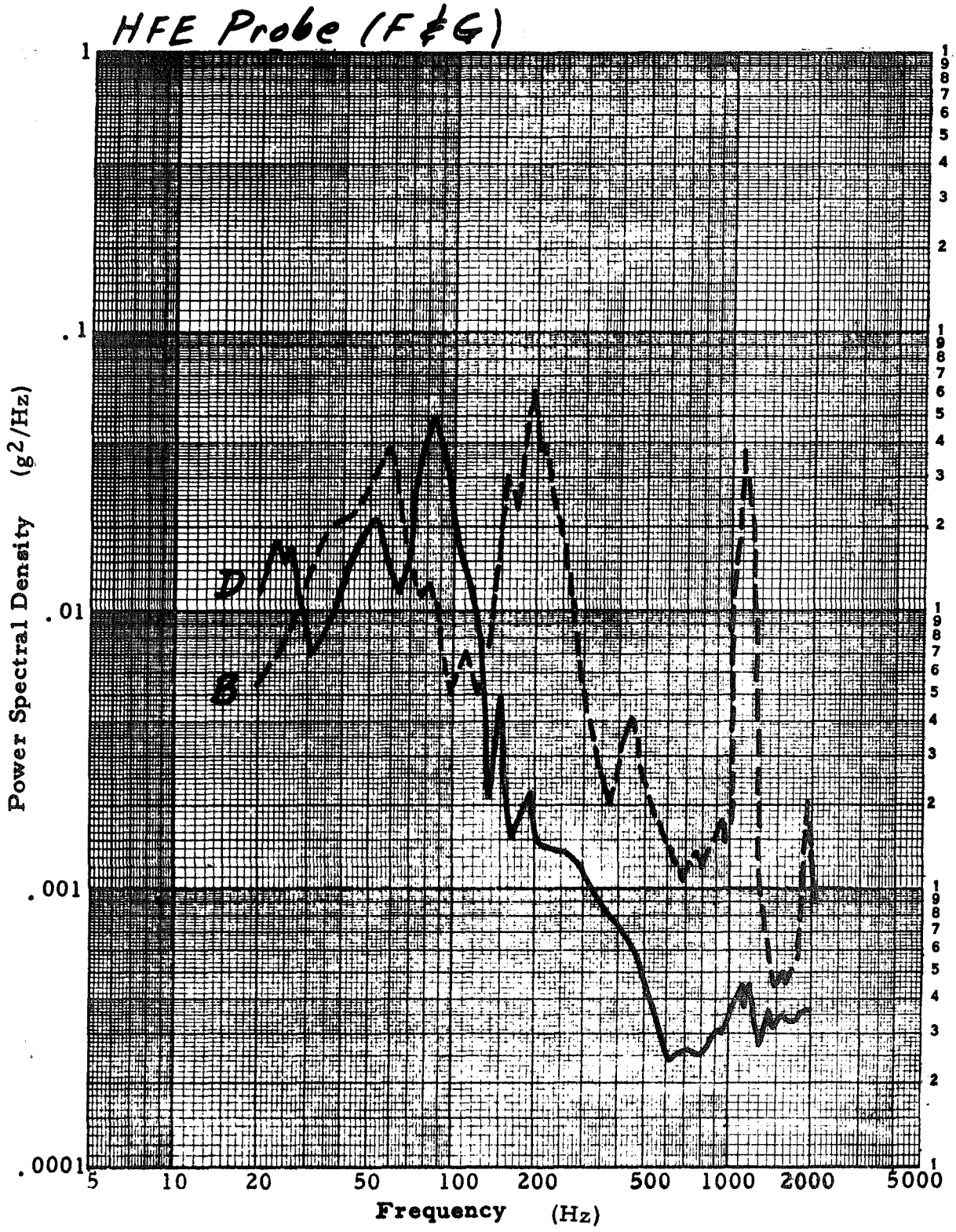
Lun. Des.

Axis: X

RANDOM VIBRATION SPECTRUM

Duration:



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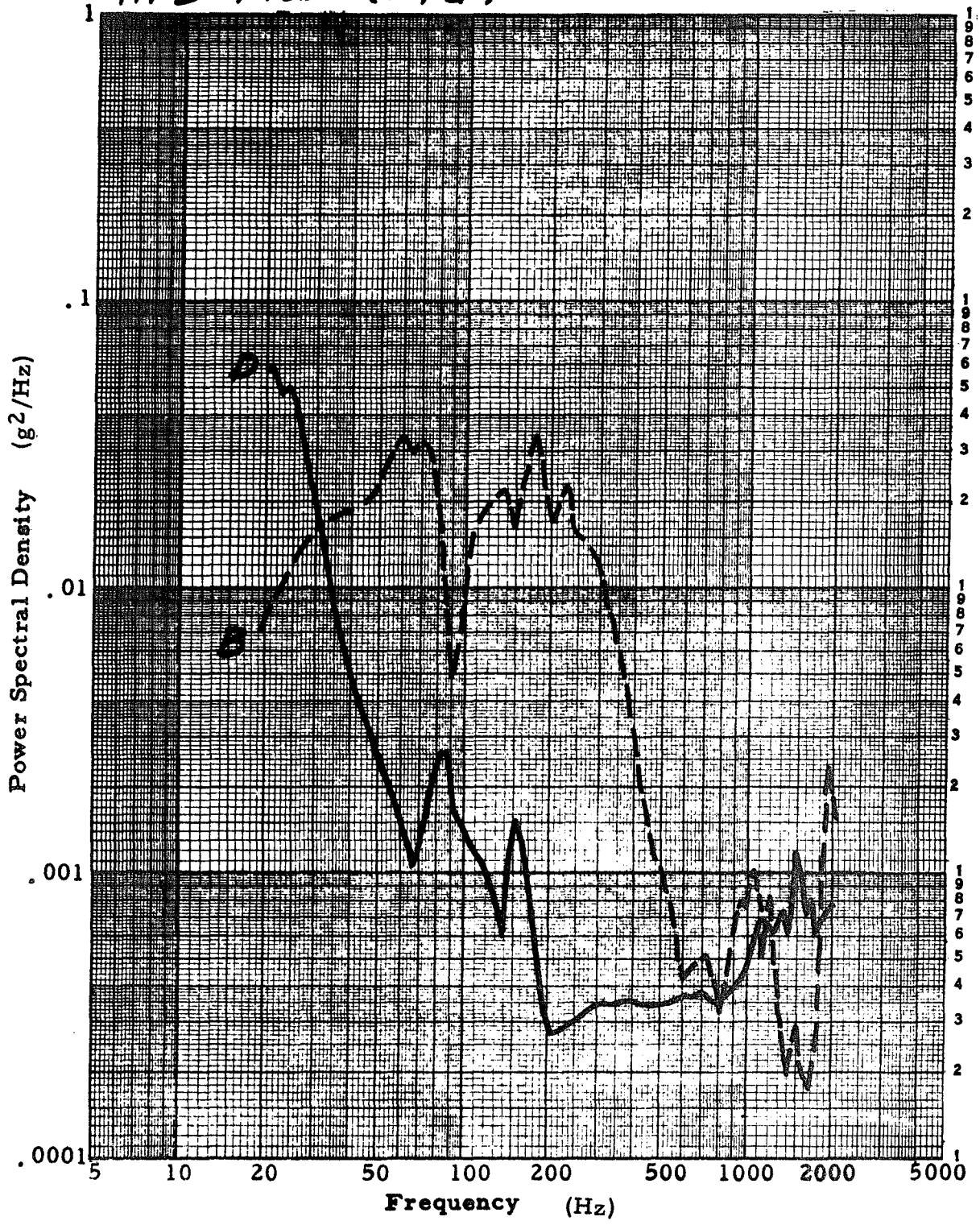
Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: y

Duration:

HFE Probe (F&G)



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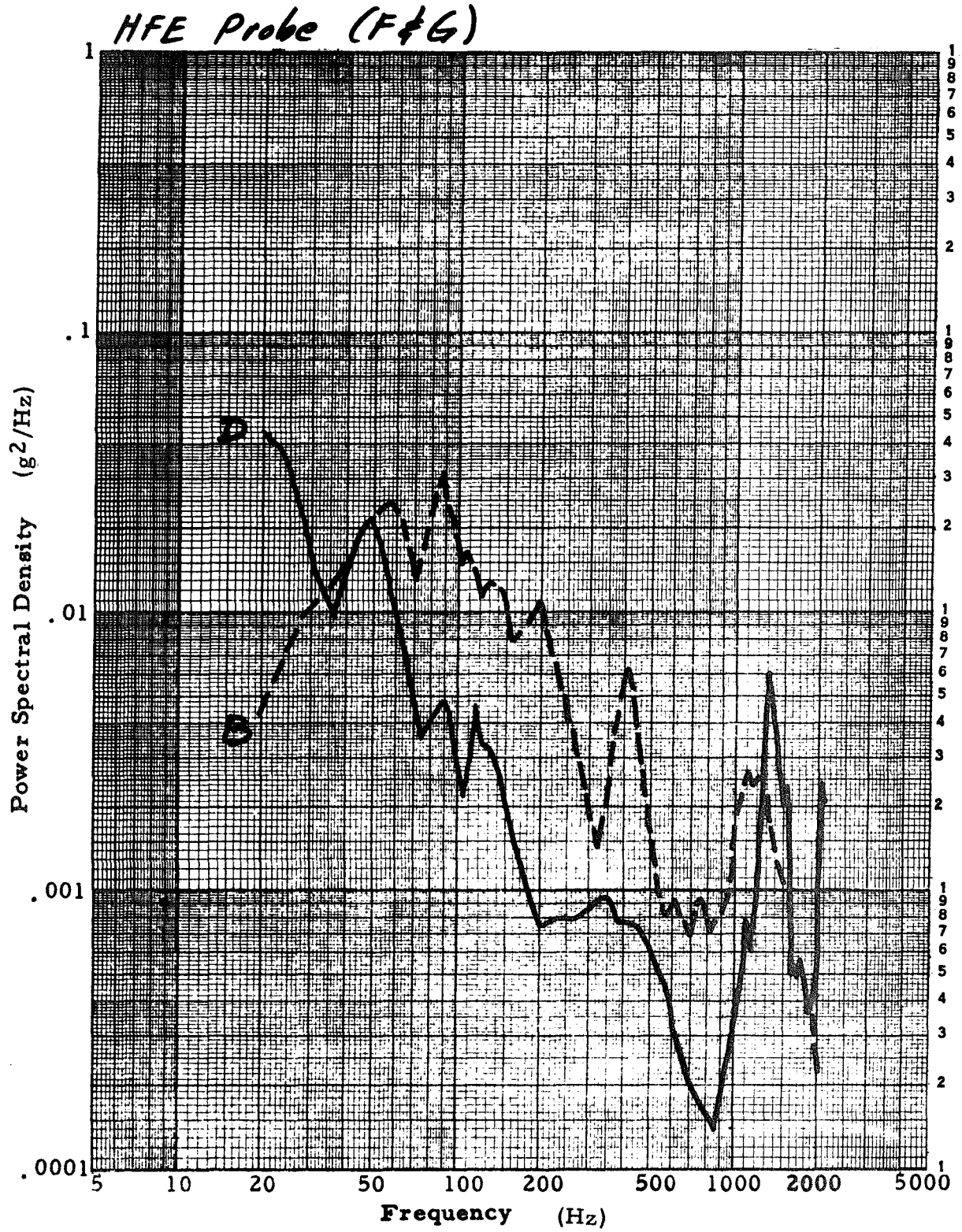
Lun. Des.

Axis: 3

RANDOM VIBRATION SPECTRUM

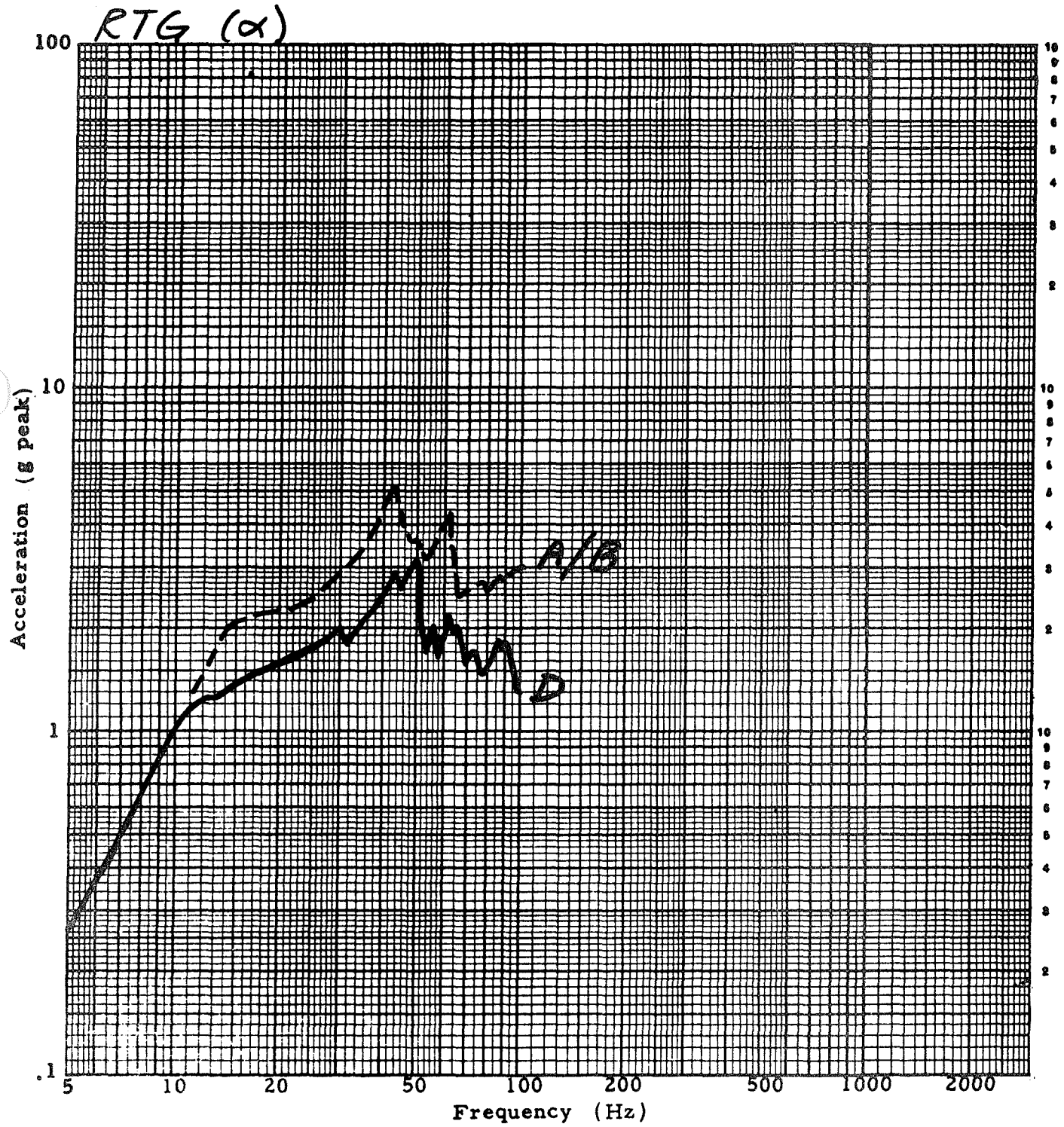
Duration:



SINUSOIDAL VIBRATION

Axis: X

Sweep Rate:

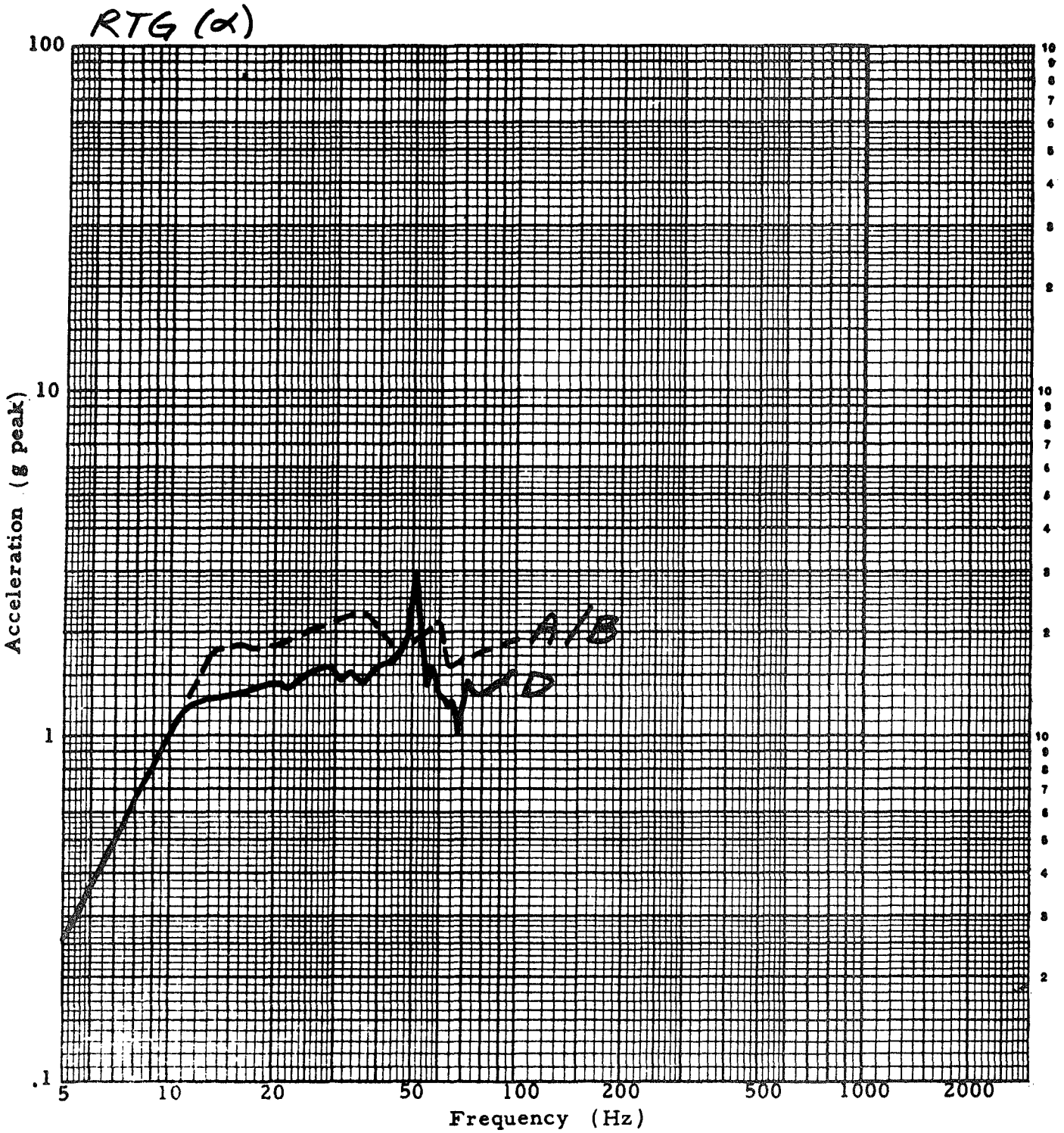


Bendix Aerospace Systems Division

SINUSOIDAL VIBRATION

Axis: Y

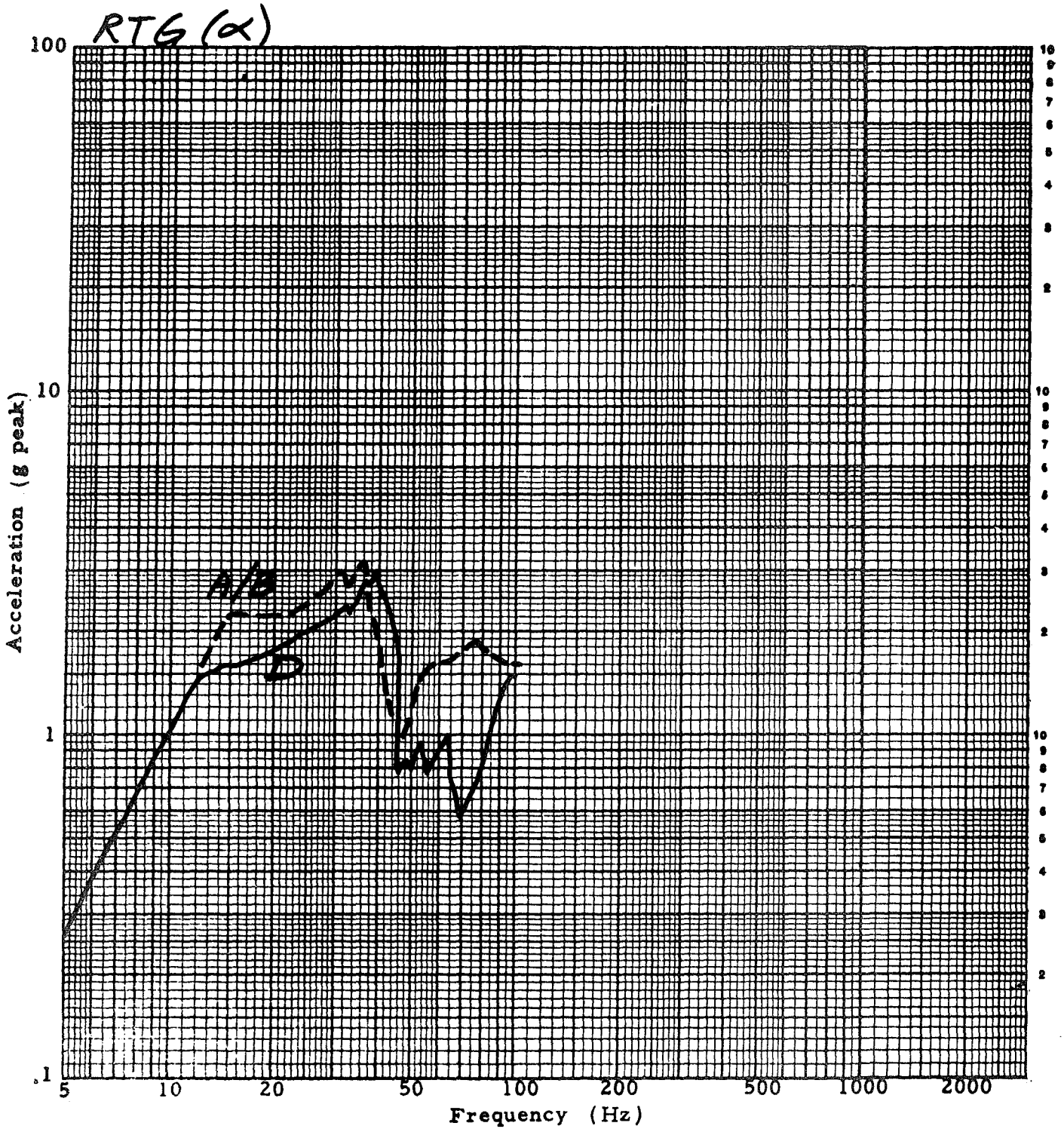
Sweep Rate:



SINUSOIDAL VIBRATION

Axis: Z

Sweep Rate:



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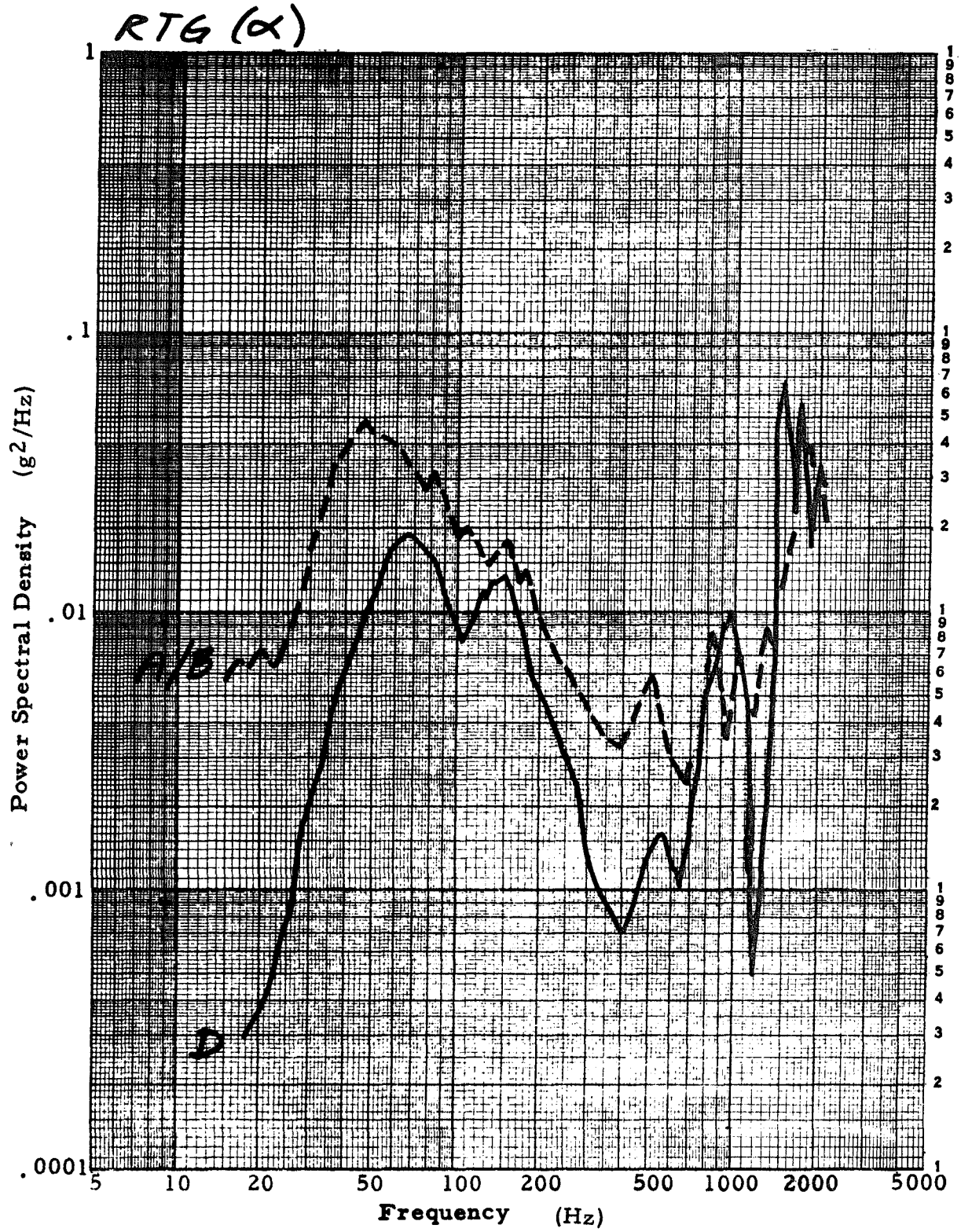
L & B

RANDOM VIBRATION SPECTRUM

Axis: X

Duration:



Aerospace Systems Division

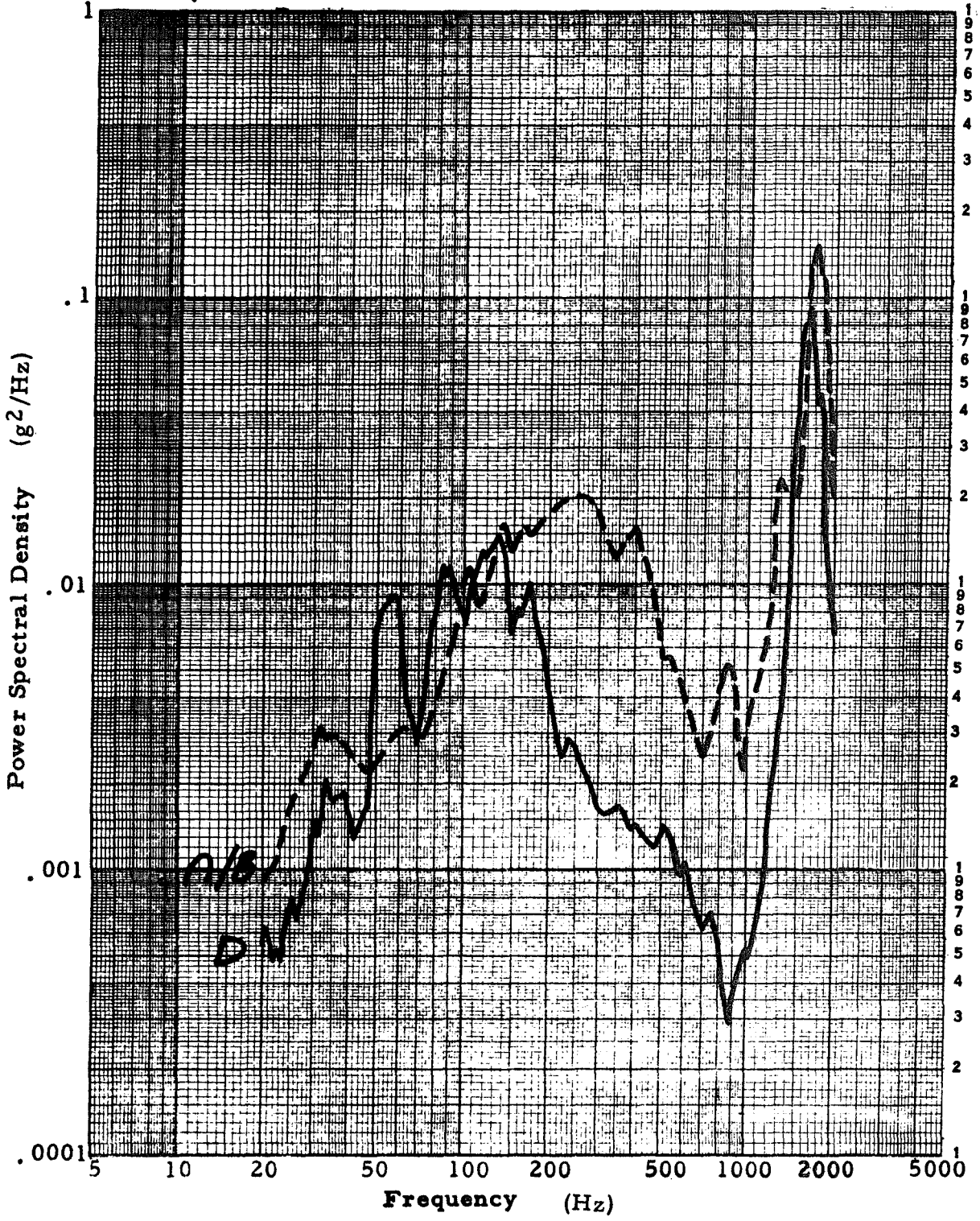
L≠B

RANDOM VIBRATION SPECTRUM

Axis: Y

Duration:

RTG(α)



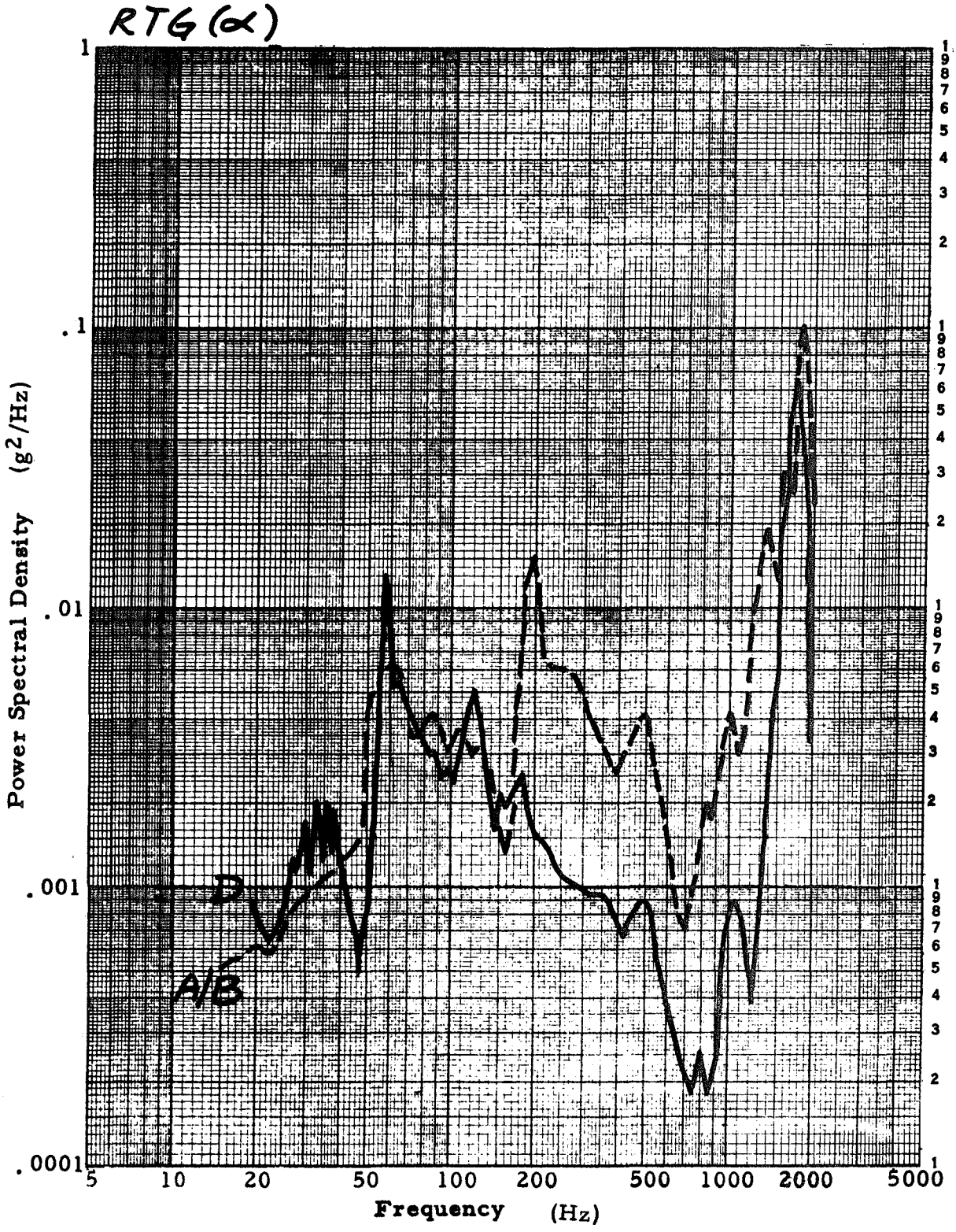
Bendix Aerospace Systems Division

L & B

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration:



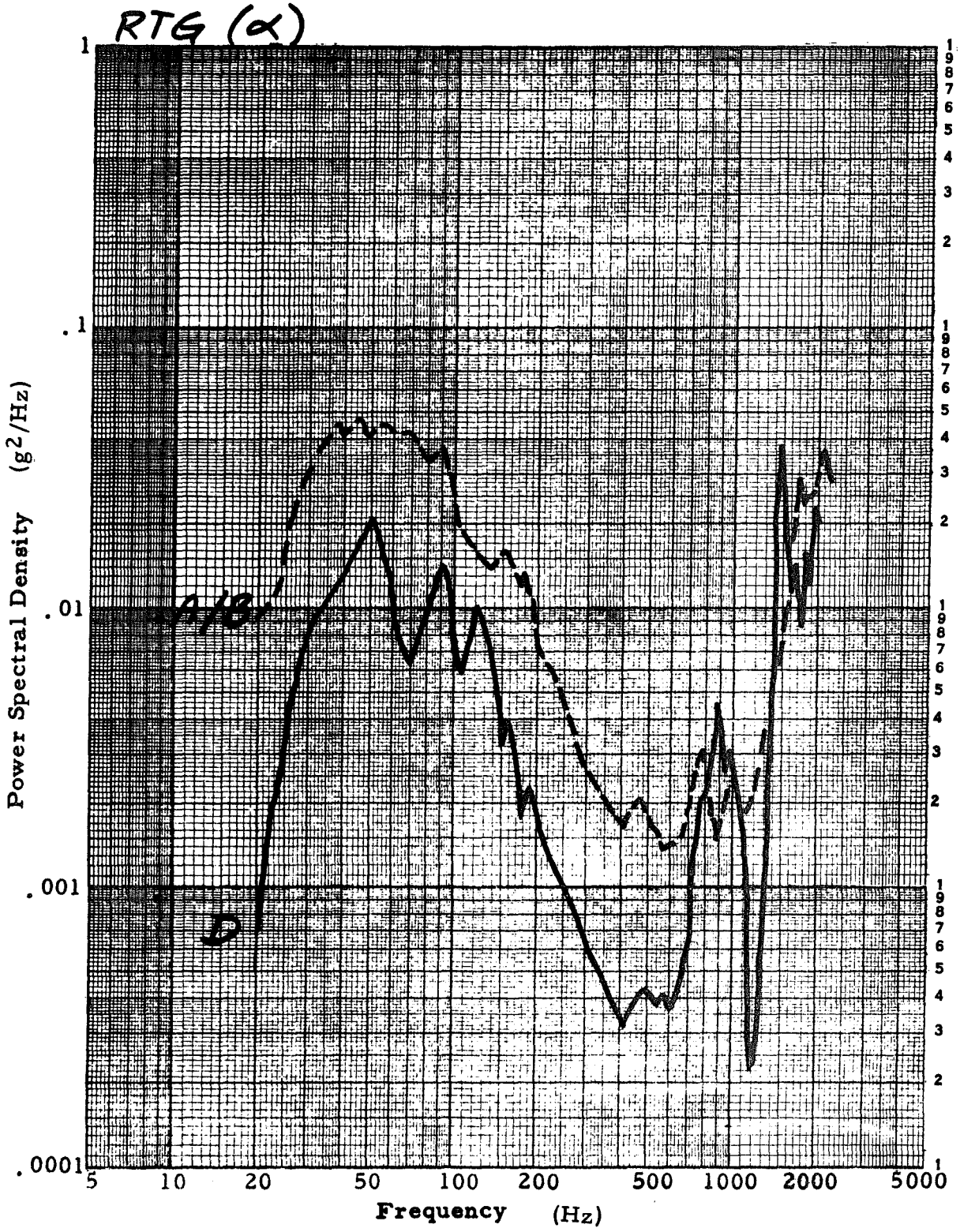
Bendix Aerospace Systems Division

Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: X

Duration:



440-91

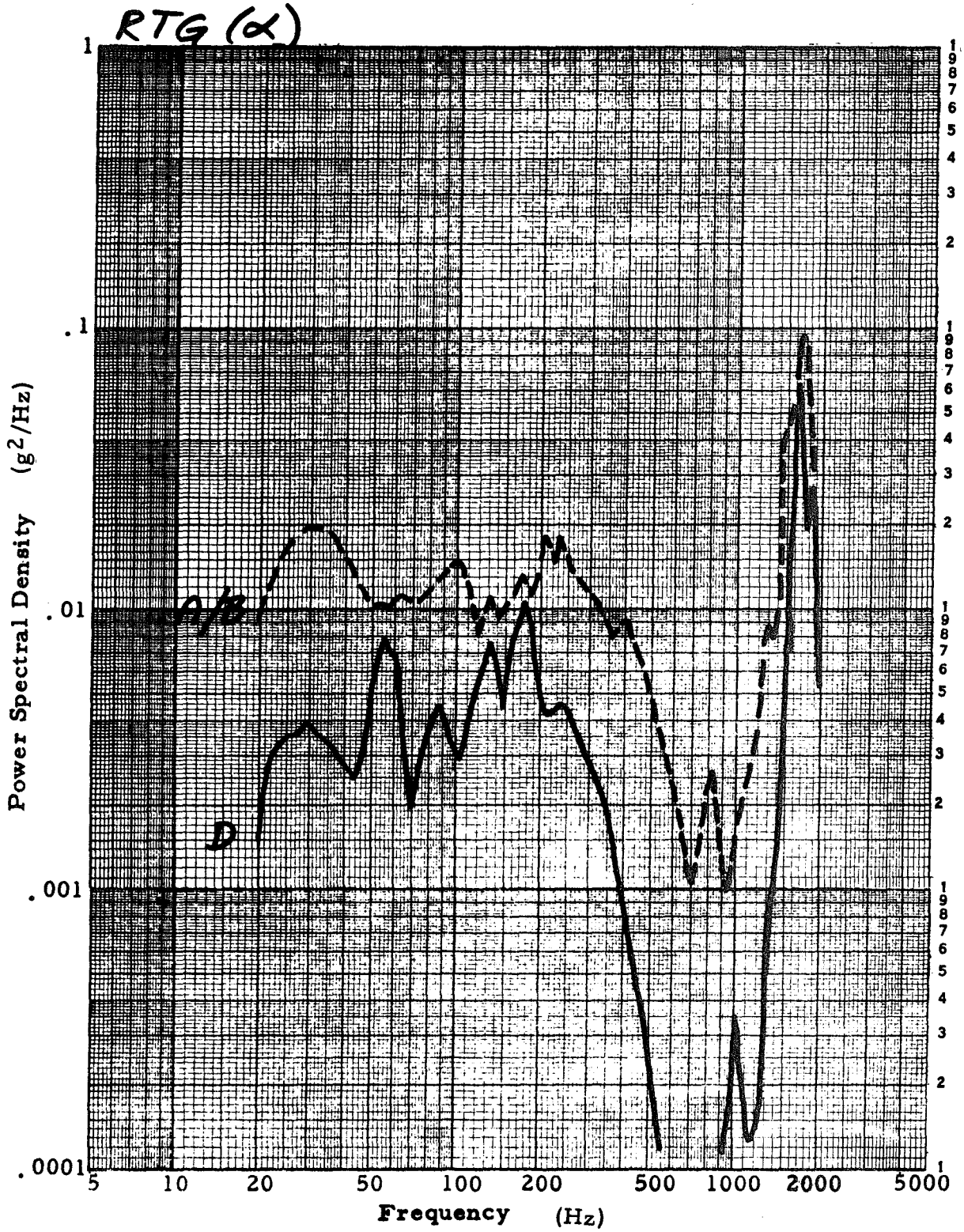
Aerospace Systems Division

Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: y

Duration:



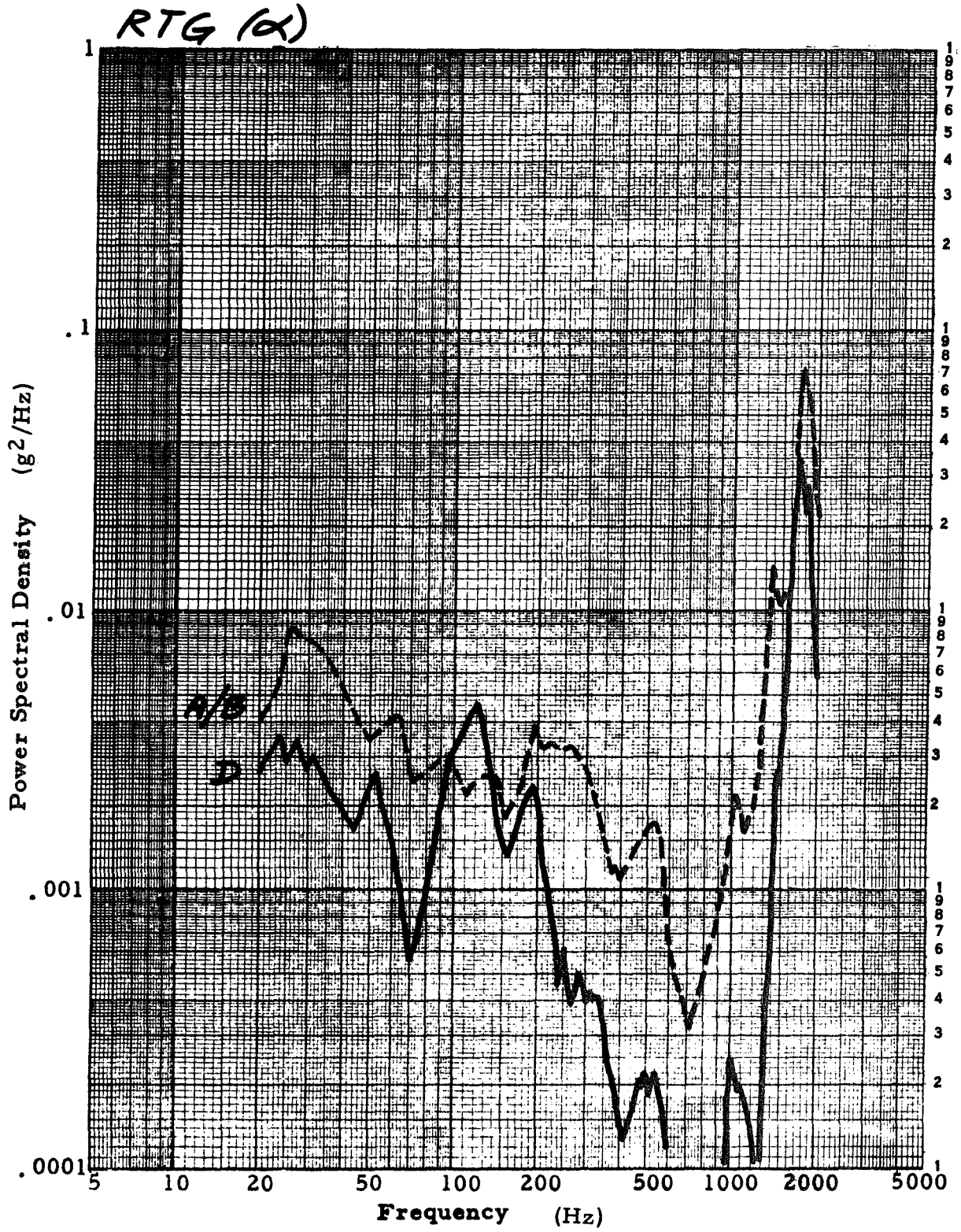
Bendix Aerospace Systems Division

Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration:

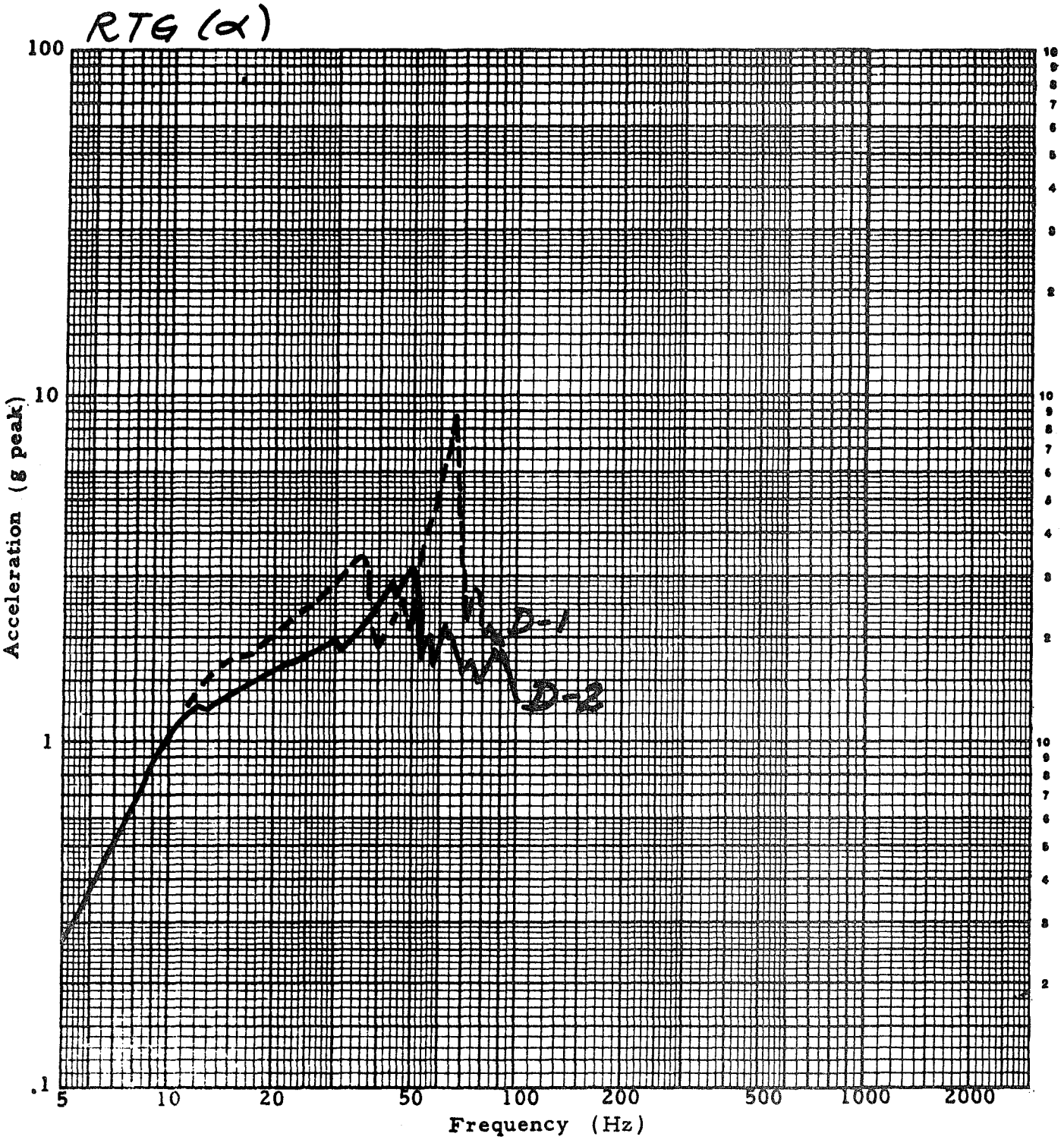


440-91

SINUSOIDAL VIBRATION

Axis: X

Sweep Rate:

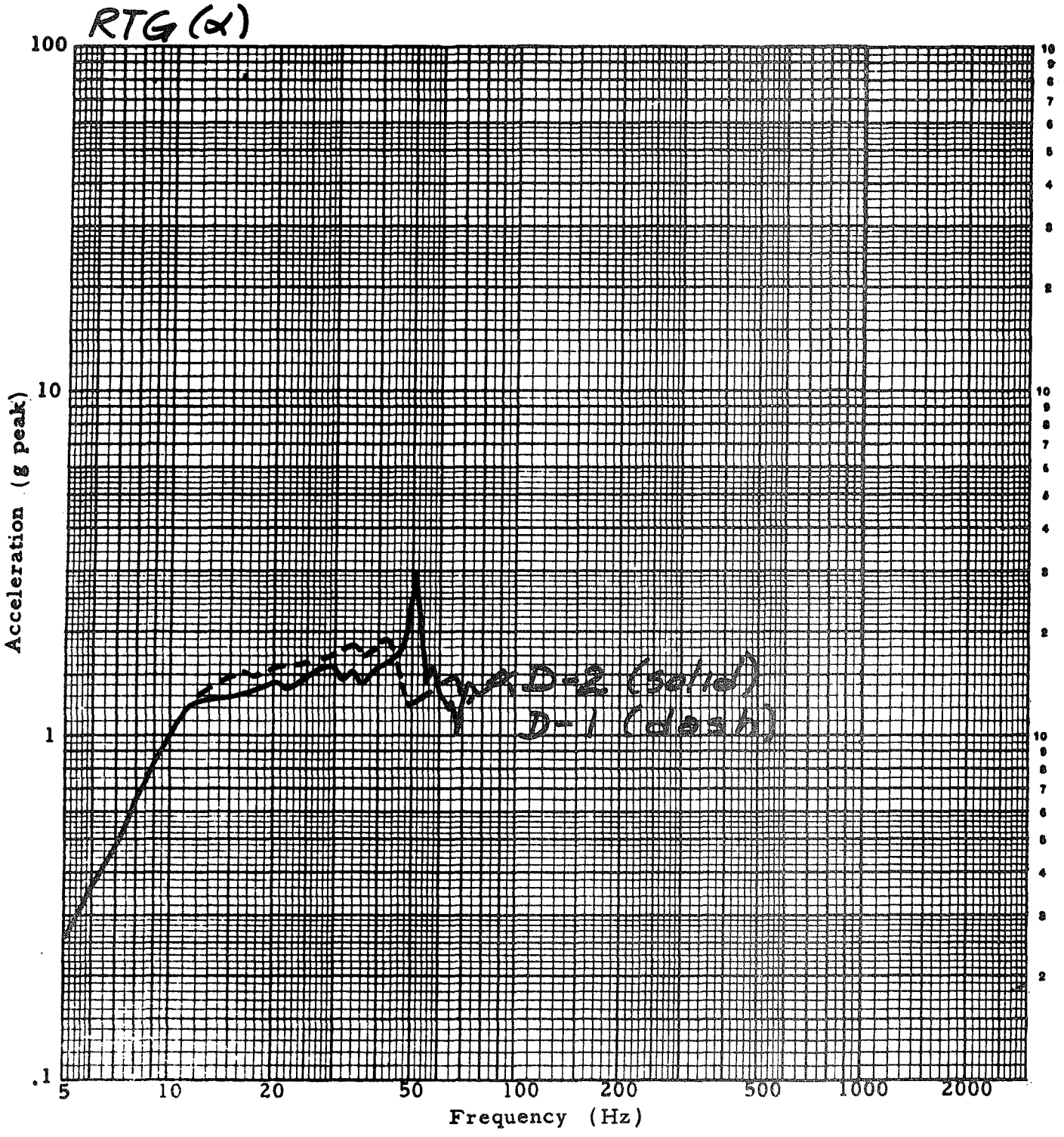


Bendix Aerospace Systems Division

SINUSOIDAL VIBRATION

Axis: y

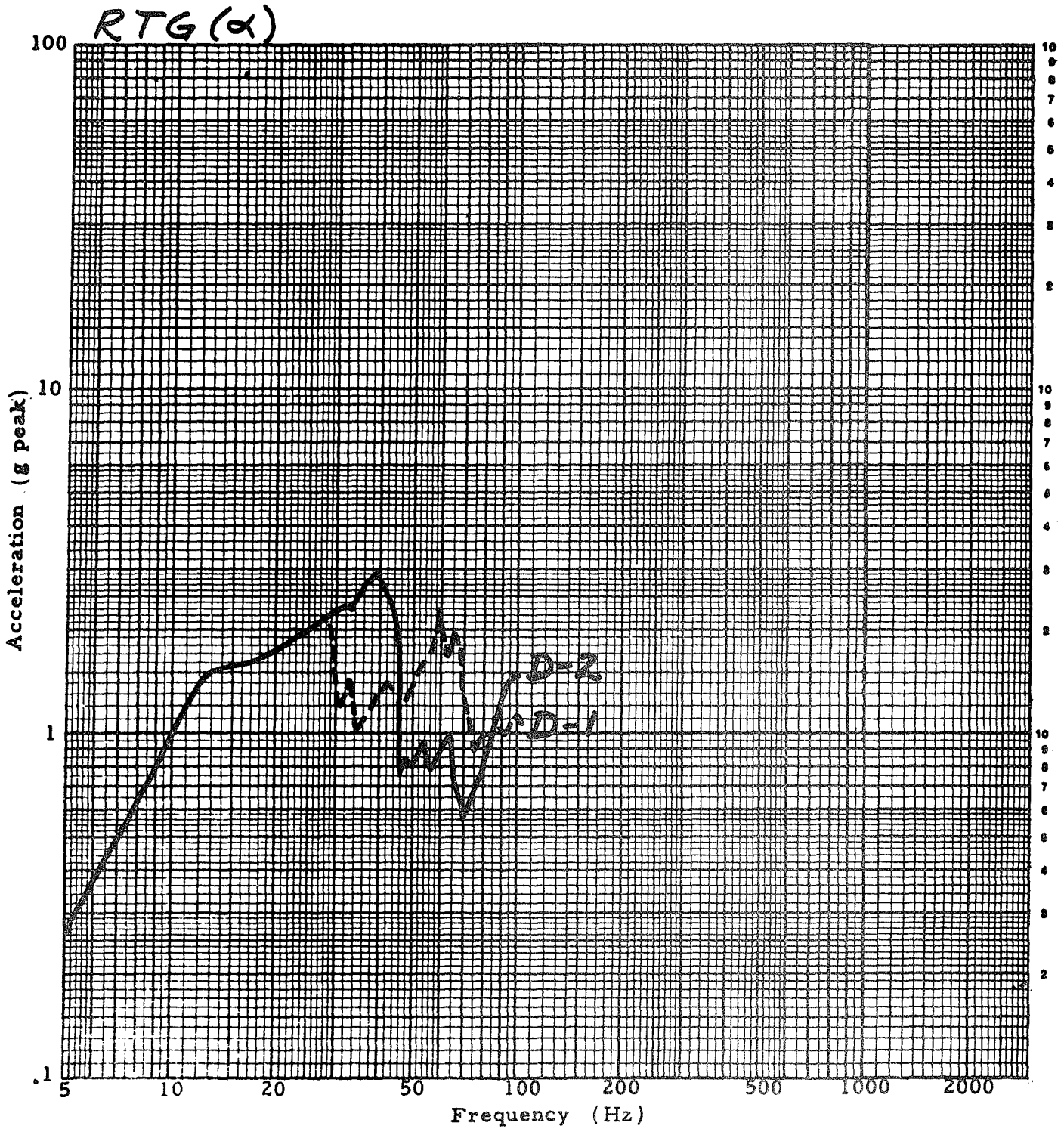
Sweep Rate:



SINUSOIDAL VIBRATION

Axis: Z

Sweep Rate:



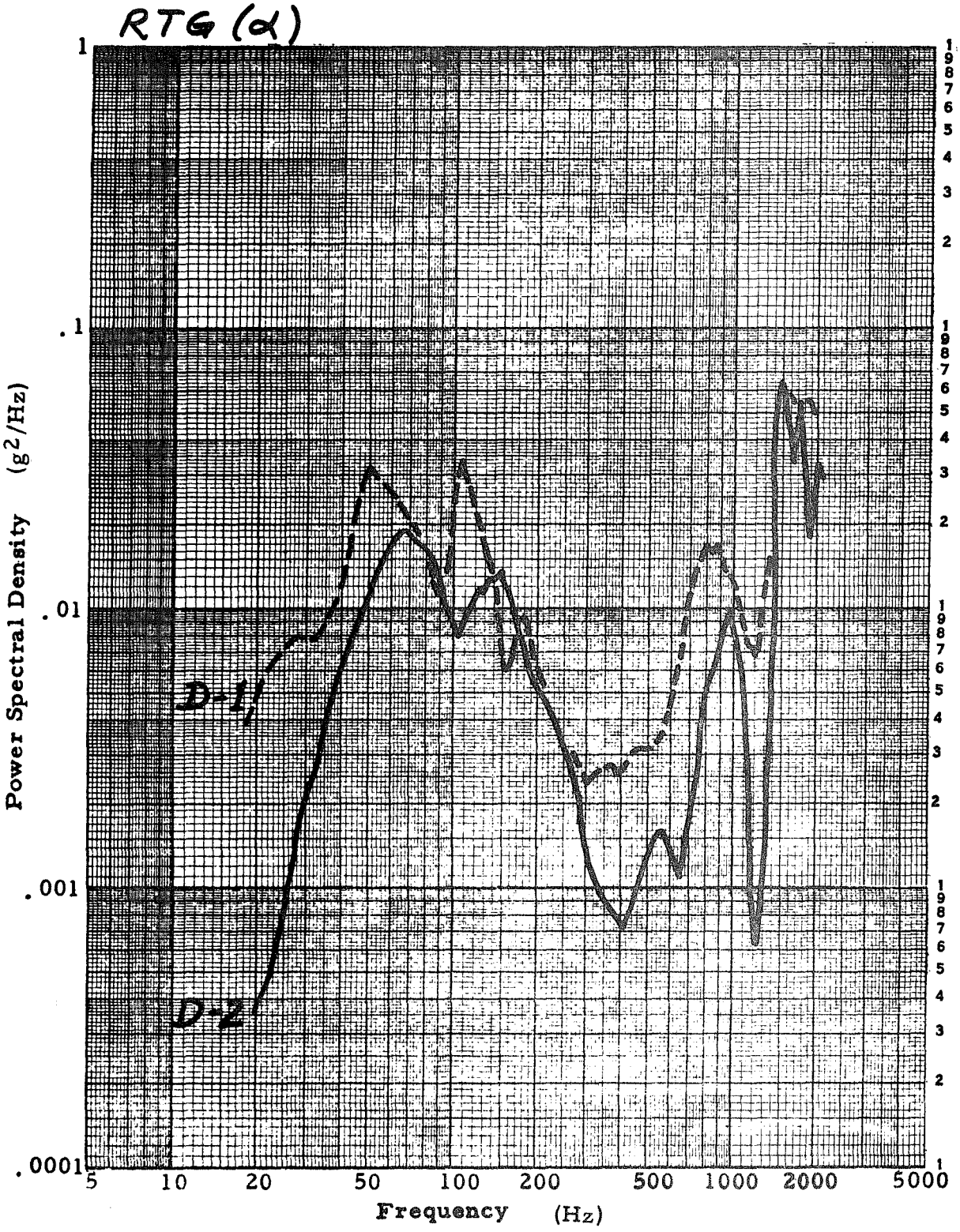
Bendix Aerospace Systems Division

L & B

RANDOM VIBRATION SPECTRUM

Axis: X

Duration:



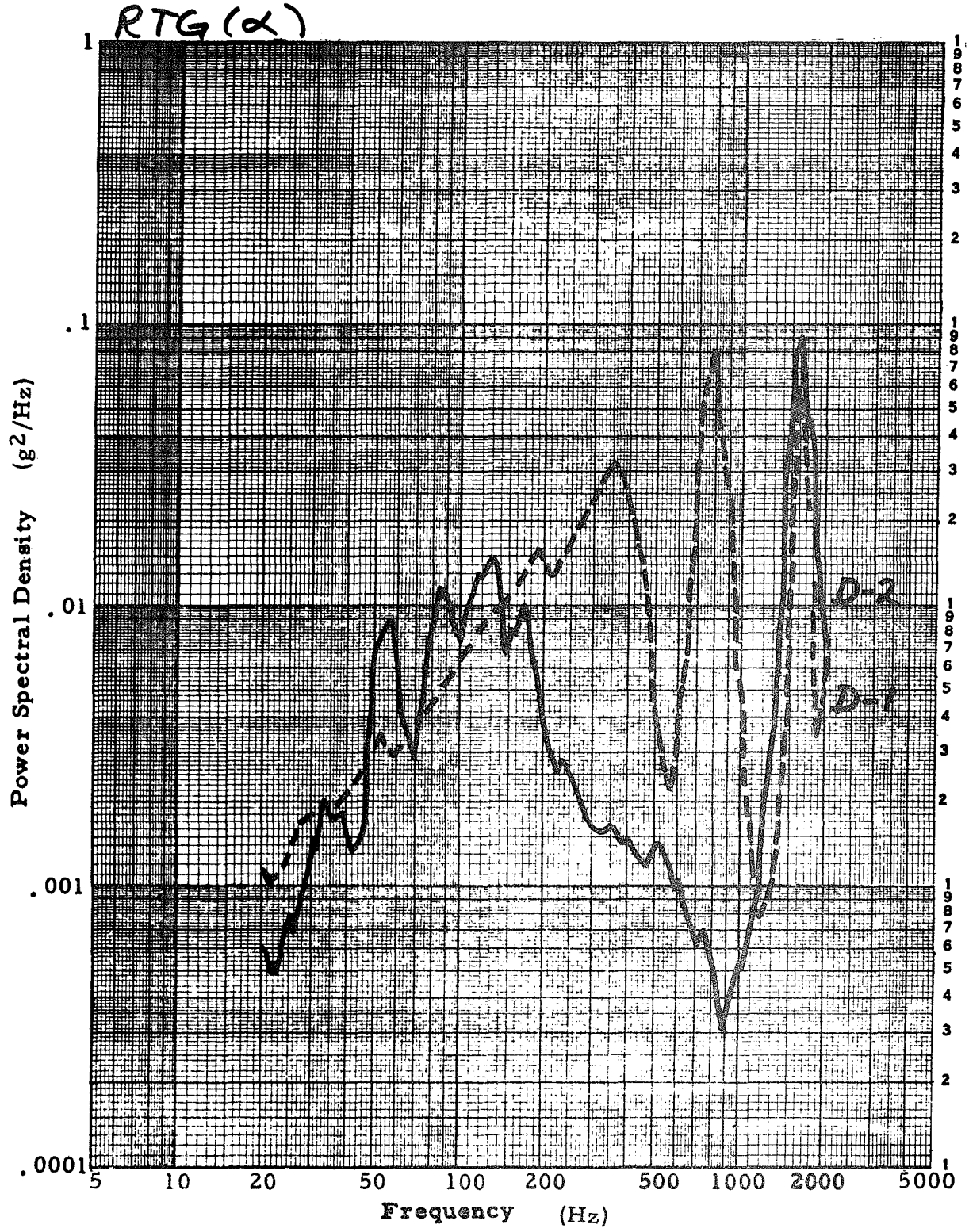
Bendix Aerospace Systems Division

L&B

RANDOM VIBRATION SPECTRUM

Axis: y

Duration:



Aerospace Systems Division

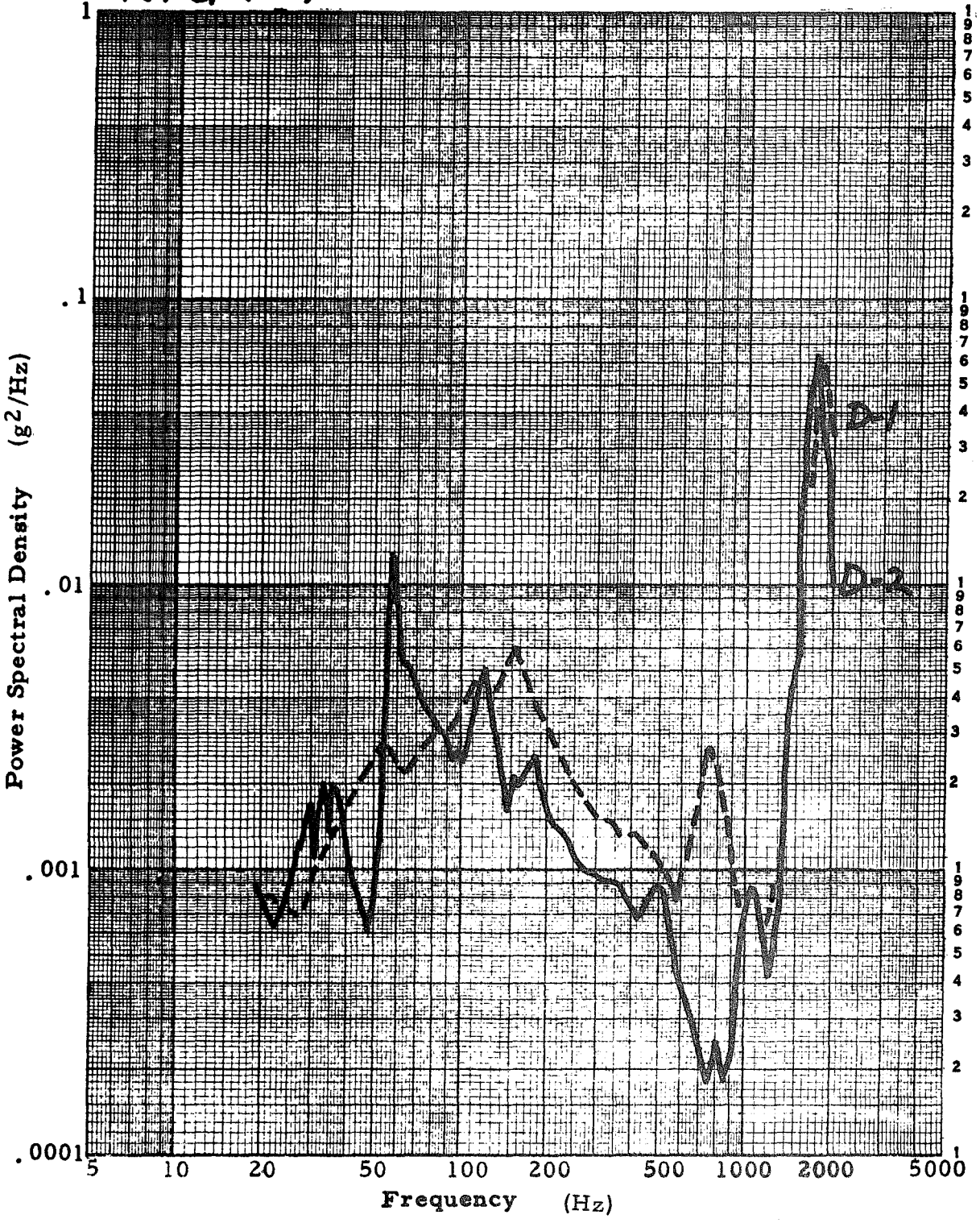
L & B

RANDOM VIBRATION SPECTRUM

Axis: Z

Duration:

RTG (α)



440-91

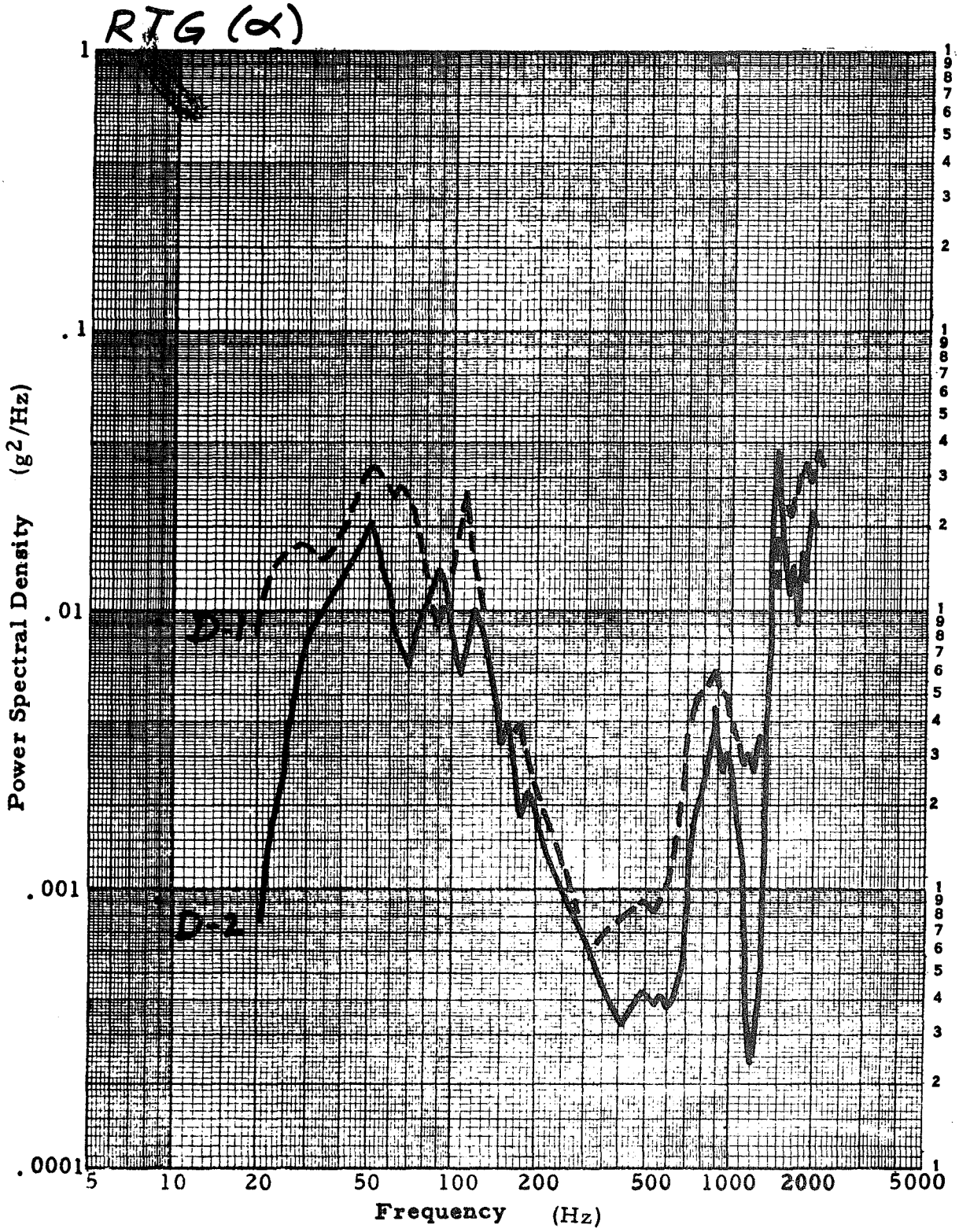
Aerospace Systems Division

Lun. Des.

RANDOM VIBRATION SPECTRUM

Axis: x

Duration:



Bendix Aerospace Systems Division

Lun. Des.

RANDOM VIBRATION SPECTRUM

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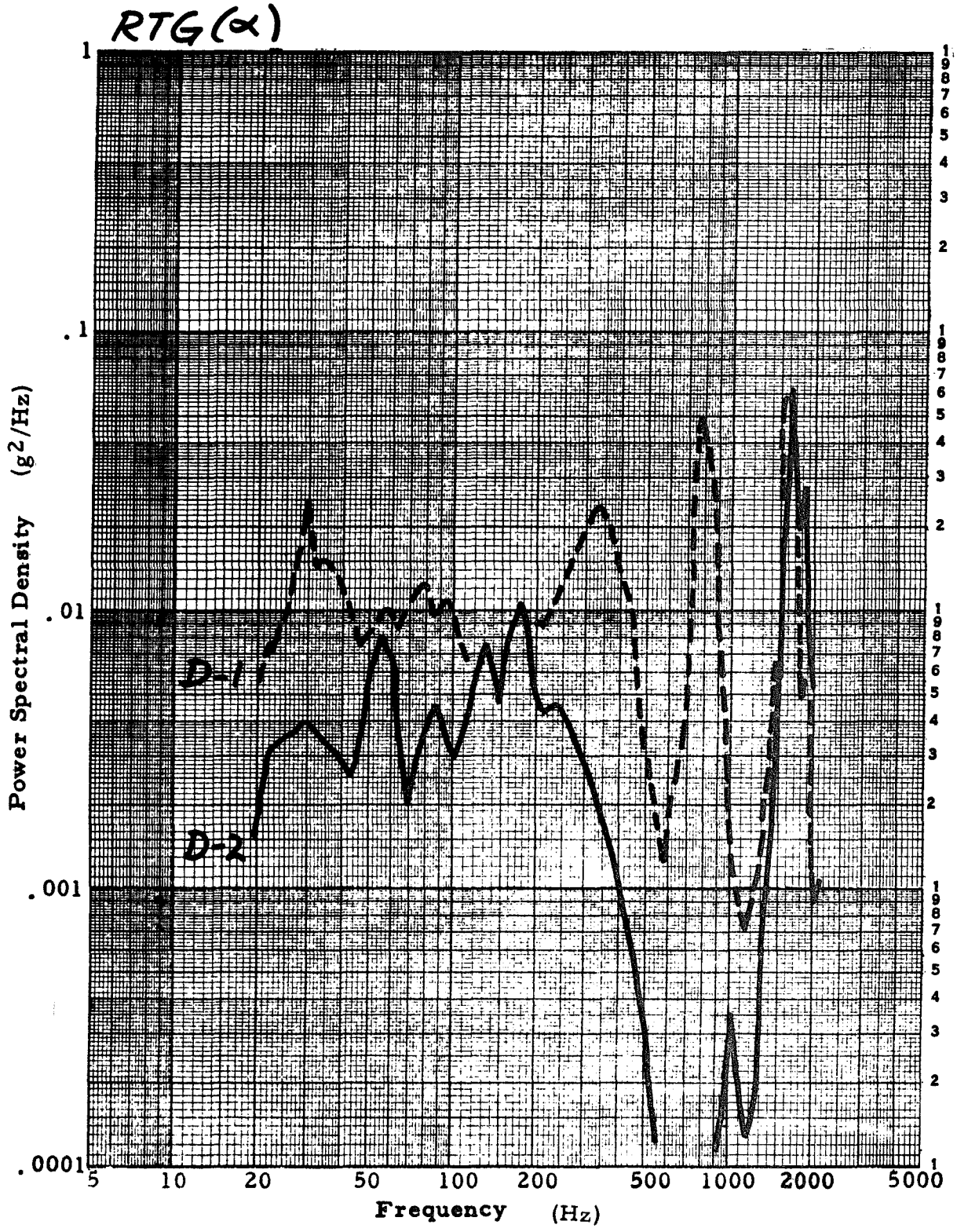

Aerospace Systems Division

Lun. Des.

RANDOM VIBRATION SPECTRUM

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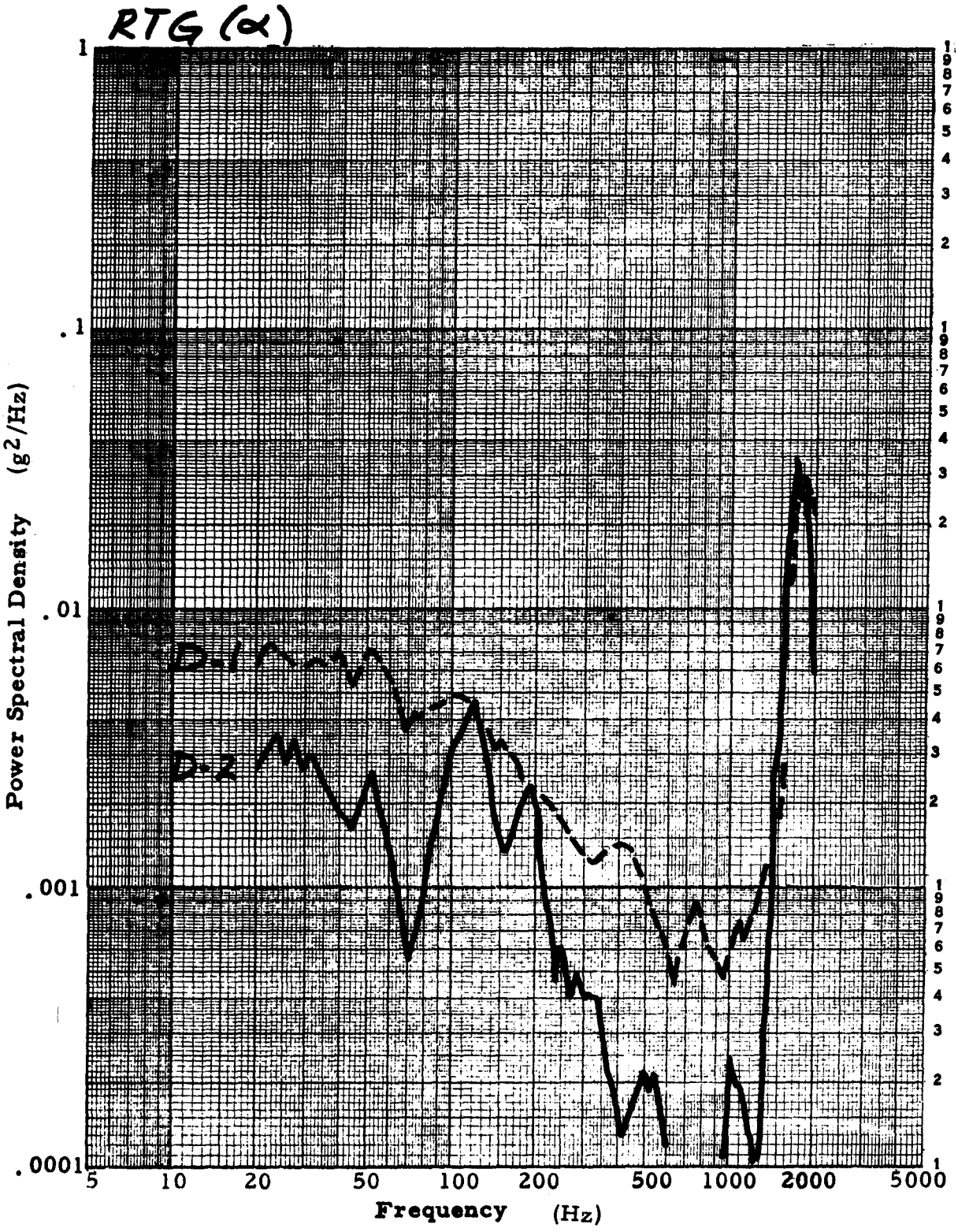
Duration:



3.0 REFERENCES

1. NASA/MSC letter No. EH3/4-28/L107/B106 (JAC)

2. NASA/MSC letter No. TD3/L023/68/B-26 (JAC)

3. NASA/MSC letter No. TD/11-12/68/B-323 (DWG)

4. AER 304, "Array D SP-1 Engineering Vibration Tests", 8/3/70

5. BxA letter No. 9712-25, "Engineering Vibration Test Results - Array D Subpack #1", 9/22/70

6. BxA letter No. 9712-76, "Array D SP-1 Qualification Status", 10/29/70

7. BxA letter No. 9712-88, "Qual D Subpack #2 Vibration Test Results and A-2 Subpack #2 Qualification Status", 11/6/70

8. BxA letter No. 9712-164, "Results of Qual D/SP-2 Pre-Qual Vibration Tests", 1/18/71

9. AER 312, "Array D SP-2 Qual Instrumentation", 9/21/70

10. AER 319A, "Qual D/SP-2 Retest-Shock & Vibration", 12/1/70