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DEVELOPMENT AND APPLICATION OF VIBROACOUSTIC STRUCTURAL DATA BANKS IN PREDICTING VIBRATION DESIGN AND TEST CRITERIA FOR ROCKET VEHICLE STRUCTURES

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16. ABSTRACT

This report presents a method of predicting broadband random vibration criteria for components on space vehicles. Large amounts of vibration and acoustic data obtained from flights and static firing tests of space vehicles were formulated into vibroacoustic data banks for structural categories of ring frame, skin stringer, and honeycomb.

The vibration spectra with their associated acoustic spectra are normalized to a reference acoustic spectrum. The individual normalized spectra are grouped according to definite structural characteristics and statistically analyzed to form the vibroacoustic data banks in this report.

These data banks represent the reference vibration criteria available for determining the new vehicle vibration criteria.

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DEFINITION OF SYMBOLS

Symbol	Definition
BW	bandwidth
CL	confidence level
f	frequency of vibration, Hz
f_i	the i^{th} center frequency, Hz
G	acceleration due to cyclic motion divided by the acceleration of gravity
G^2/ Hz	acceleration power spectral density of vibration structure (in terms of acceleration)
G_i(97.5% CL)	97.5 percent confidence level of $G_i(f)$ corrected for nonstandard normal distribution
$G_L(f)$	normalized acceleration power spectral density as a function of frequency, G^2/Hz
$G_M(f)$	measured acceleration power spectral density as a function of frequency, G^2/Hz
$G_N(f)$	new vehicle acceleration power spectral density as a function of frequency, G^2/Hz
$G_R(f)$	data bank acceleration power spectral density as a function of frequency, G^2/Hz
MARL	Mobile Acoustic Research Laboratory
Max Q	maximum dynamic pressure
M_N	mass per unit area of the new vehicles structure
M_R	mass per unit area of the data bank structure

DEFINITION OF SYMBOLS (Concluded)

Symbol	Definition
N	number of $G_i(f)$ or acceleration power spectral density spectra
$N_i(97.5\%)$	factor for positively skewed function
$P_L(f)$	reference acoustic pressure as a function of frequency, psi_{rms}
$P_M(f)$	measured acoustic pressure as a function of frequency, psi_{rms}
$P_N(f)$	new vehicle measured or predicted acoustic pressure as a function of frequency, psi_{rms}
$P_R(f)$	reference acoustic pressure as a function of frequency, psi_{rms}
S_i	a measure of how symmetrical a distribution is with respect to the mean
SSB	single sideband
X_i	the i^{th} input value, G^2/Hz or G/10 Hz bandwidth
$\overline{X}_i$	the mean or average of all values
σ_i	standard deviation or measure of dispersion of data points around their mean value
σ_i^2	variance or square of the standard deviation

DEVELOPMENT AND APPLICATION OF VIBROACOUSTIC STRUCTURAL DATA BANKS IN PREDICTING VIBRATION DESIGN AND TEST CRITERIA FOR ROCKET VEHICLE STRUCTURES

I. INTRODUCTION

This study presents a comprehensive and accurate semi-empirical method of predicting the acoustically induced broadband random vibration criteria for component installations located on space vehicles. Vibroacoustic structural data banks were developed from the more than 1285 vibration and acoustic measurements taken on static firings and flights of the Saturn vehicles and from the Mobile Acoustic Research Laboratory (MARL) testing program.

The MARL is a 12.19 m (40-ft) platform on wheels. Various large flight and development structures, such as instrument units, skirts, and interstages, were installed on the MARL and located in the acoustic near- and mid-fields and subjected to static firings of the various Saturn stages and engines at MSFC and MTF. The MARL test structures were instrumented and vibration and acoustic data were recorded during the static firings.

A vibroacoustic structural data bank is a statistical compilation of vibration and acoustic data which are categorized according to definite structural configurations, such as skin stringer, ring frame, and honeycomb. Simply stated, a vibroacoustic data bank indicates the vibration level for a given sound pressure level acting on a particular structural configuration.

An extensive examination of structural drawings for the Saturn vehicles and MARL test structures was made to define the structural parameters for the various data banks. The structural categories studied were ring frames, skin-stringer, and honeycomb.

Vibration and acoustic data obtained during static firings and flights of the Saturn vehicles as well as MARL data were recorded on data summarization sheets. Information such as data validity, slice time, and other elucidative information necessary for development of the data banks is contained on these sheets.

For a particular data bank, each of the vibration spectra with its associated acoustic spectrum were normalized to the reference acoustic spectrum shown on Figure 1. The reference acoustic spectrum has no special meaning other than that it is a typical Saturn V liftoff acoustic spectrum. The normalized vibration spectra were statistically analyzed to determine the mean and the 97.5-percent probability level spectra. The data banks were developed for both the liftoff and transonic environments which consider the differences in the spatial correlation of the random acoustic pressure fields.

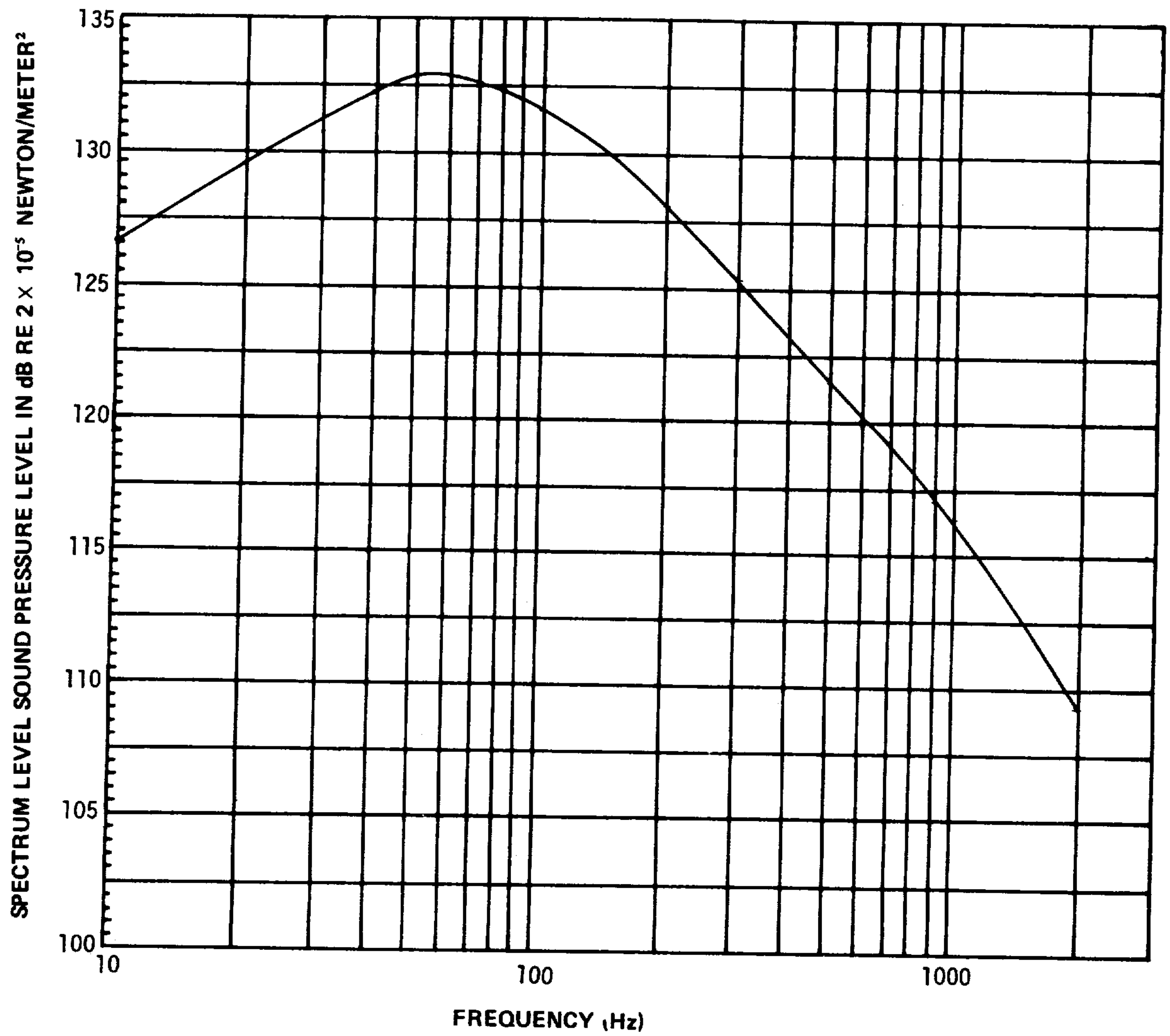


Figure 1. Reference acoustic spectrum to be applied to equations (1), (8), and (9).

In utilizing these data banks for determining vibration criteria for a new vehicle structure, the data bank that is closest to the new vehicle structural configuration is selected. The proper mass and sound pressure level adjustments are made to determine the vibration criteria for the unloaded new vehicle structure. Component vibration criteria for varying weight ranges are then determined from conventional mass attenuation techniques.

II. VIBROACOUSTIC STRUCTURAL DATA BANKS

A. Structural Characteristics

The Saturn launch vehicles have a complex structural definition consisting of ring frames, skin stringers, tanks, structural beams, etc. This report is concerned with those structures which respond to acoustic and aerodynamic forcing functions. Therefore, vibroacoustic data banks were developed only for those categories falling under the structural definition of ring frame, skin stringer, and honeycomb panels.

1. Ring frame — This type of structure is not directly susceptible to acoustic forcing functions, but receives motion from adjacent panels.

2. Skin stringer — This type of structure responds to acoustic forcing functions. The stiffener (stringer) response depends directly on the motion of the skin.

3. Honeycomb — This type of structure is directly excited by acoustic forcing functions.

The Saturn stages and MARL test structures were structurally defined by reviewing a large number of structural assembly drawings. Physical dimensions such as skin thickness, ring frame dimensions, stringer dimensions, honeycomb core density, and other pertinent structural definitions were assembled into structural configuration books. These books represent an exhaustive accumulation of structural information which was invaluable in defining the vibroacoustic structural data bank categories. The structural information along with the locations of the vibration and acoustic measurements were recorded on Data Summarization sheets. These data sheets were used to develop the vibroacoustic structural data banks.

B. Vibration and Acoustic Data

Vibration and acoustic data from static firings and flights of the Saturn launch vehicles and from MARL were assembled and categorized. Using the measurement location structural description, the data were divided into the three structural categories described in Section II. A. Each measurement number with the measurement direction, measurement location, zone number, data sequence number, slice time, test number, frequency range, data validity, and flight condition (liftoff, Mach 1 and Max Q) were listed on the Data Summarization sheets. Both valid and invalid data were listed to maintain a permanent record of all the data obtained from static firings and flights of Saturn launch vehicles and MARL tests. All valid vibration and acoustic measurements located on ring frame, skin stringer, or honeycomb structure were utilized in the vibroacoustic data banks with the exception of measurements located on component loaded structures. Component loaded structures were not considered in this study for the simple reason that any small change in the load would change the response of the structure.

There were approximately 1285 individual vibration and acoustic measurements located on the Saturn launch vehicles during flights, static firings, and MARL tests. Measurements located on engines, fuel lines, brackets, loaded panels, and beams were not used to derive the vibroacoustic data banks in this report. However, the vibration measurements in each structural category were individually evaluated to determine if they actually represented a ring frame, skin stringer, or honeycomb response. This close evaluation was necessary since some vibration measurements were located on the skin near a ring and could be more representative of a ring frame response rather than a skin-stringer response. The acoustic measurements were also summarized according to source variations such as static firing, liftoff, and transonic flight. Other pertinent information similar to that recorded for the vibration measurement locations was also recorded for each acoustic measurement.

The vibration data for numerous flight vehicle and static test locations have varied acoustic forcing functions. Each of the vibration spectrums with its associated acoustic spectrum was normalized to a reference acoustic spectrum.

C. Normalization Method

Vibration and acoustic data from data retention at MSFC were retrieved from the storage tapes and normalized to a reference acoustic forcing function.

To generate the vibroacoustic data banks, it is necessary to make all measured data compatible. Compatibility is achieved by normalizing all the measured vibration spectra and their acoustic spectra to the common acoustic forcing function shown in Figure 1. The reference acoustic spectrum has no special meaning other than that it is a typical Saturn liftoff acoustic spectrum.

The normalization was performed by the following equation:

$$G_L(f) = G_M(f) \left[\frac{P_L(f)}{P_M(f)} \right]^2 \tag{1}$$

where

$G_L(f)$ = Normalized power spectral density (G^2/Hz) as a function of frequency f .

$P_L(f)$ = Reference acoustic pressure (psi_{rms}) as a function of frequency f .

$G_M(f)$ = Measured power spectral density (G^2/Hz) as a function of frequency f .

$P_M(f)$ = Measured acoustic pressure (psi_{rms}) as a function of frequency f .

The output of the normalization program is power spectral density plots normalized to the reference acoustic spectrum. These individual plots are given a normalized vibration measurement number for identification and assembled into structural categories. After the normalization process, the individual normalized measurements are grouped into finalized vibroacoustic data banks. These groups were assembled on statistical analysis request forms and statistically analyzed.

D. Statistical Analysis of Vibroacoustic Structural Data Banks

After the vibration data have been normalized to the standard acoustic spectrum, the data are assembled into finalized vibroacoustic data banks for statistical analysis. A mean and 97.5-percent confidence level spectra are derived for each structural category specified by the structural characteristics in Section II.A. The specific structural categories are divided into individual subdivisions depending on dimensional variations of the ring frames, skin stringer, and honeycomb panels. Each group or vibroacoustic data bank consists of N spectral density spectra, each composed of 400 input values covering the range from 5 to 2000 Hz in 5-Hz increments.

These 400 input values of X_i (power spectral density, G^2/Hz or rms amplitude in G/10 Hz bandwidth) for each spectra were defined at center frequencies of f_i (Hz). The mean value $\overline{X}_i$ is the average of all values. In equation form, the mean is:

$$\overline{X}_i = \frac{1}{N} \sum_{i=1}^{N} X_i \quad . \tag{2}$$

The mean square value is the average of the squared values. The variance is the mean squared value about the mean. In equation form, the variance is:

$$\sigma_i^2 = \frac{1}{N-1} \sum_{i=1}^{N} (X_i - \overline{X}_i)^2 \quad . \tag{3}$$

The standard deviation is the positive square root of the variance. The standard deviation is:

$$\sigma_i = \left[\sum_{i=1}^{N} \frac{(X_i - \overline{X}_i)^2}{N - 1} \right]^{1/2} \quad . \tag{4}$$

To determine the confidence level it is necessary to determine the skewness. Most statistical distributions are not symmetrical with respect to their mean and are therefore classified to be skewed. In equation form, the skewness is:

$$S_i = \frac{[N(N-1)]^{1/2}}{N-2} \; \frac{\sum_{i=1}^{N} (X_i - \overline{X}_i)^3}{N \left[\sqrt{\sum_{i=1}^{N} \frac{(X_i - \overline{X}_i)^2}{N}} \right]^3} \quad . \tag{5}$$

For a collection of data samples, the confidence level in Reference 1 can be used to determine G_i(97.5 percent CL):

$$G_i(97.5\%\ CL) = \overline{X}_i + N_i \sigma_i \qquad (6)$$

where:

$G_i(97.5\%\ CL)$ = 97.5 percentile confidence level in the i^{th} frequency increment.

$\overline{X}_i$ = mean of the data samples in the i^{th} frequency increment.

σ_i = the standard deviation of the data samples in the i^{th} frequency increment.

N_i = the N factor of the i^{th} frequency increment.

The effects on the N_i factor of higher moments are ignored. For a positively skewed function, the factor N_i can be found from:

$$N_i(97.5\%) = 1.96 \exp\left(0.2055\ S_i - 0.0155\ S_i^2\right) \quad . \qquad (7)$$

The vibroacoustic data bank normalized vibration data samples were statistically analyzed using the above equations. The results of this analysis are plots of power spectral density (G^2/Hz) and rms amplitude (G/10 Hz BW) versus frequency from 10 to 2000 Hz. Each vibroacoustic data bank spectral plot includes a plot of the mean and 97.5-percent confidence level. The 84.13-percent confidence level, sigma, skewness, kurtosis, and N factor for 5 Hz band from 0 to 2000 Hz were also calculated, but are not presented in this report. The mean and 97.5-percent confidence level composites were also calculated and are presented with the individual vibroacoustic data bank parametric listings.

III. VIBROACOUSTIC STRUCTURAL DATA BANKS

A. General

The vibroacoustic data banks summarized in Figures A-1 through A-120 have been arranged into vehicle diameter categories of 6.71 m (22 ft) and 10.06 m (33 ft). Individual ring frame, skin stringer, and honeycomb structural categories are defined under each vehicle diameter. Each structural category is subdivided into longitudinal, radial, and tangential directions and into subdivisions based on structural dimensions. The data banks are further subdivided into conditions of static firing, liftoff, Mach 1, and maximum dynamic pressure. A condition representing combined conditions of liftoff and static firing was developed. Also, a transonic condition representing the combined conditions of Mach 1 and maximum dynamic pressure was developed.

B. Ring Frame Data Banks

There are 43 ring frame vibroacoustic data banks presented in this report for the conditions mentioned above. Each ring frame data bank consists of a parametric listing, a mean and 97.5 percent confidence level of the power spectral density (G^2/Hz) and the rms amplitude (G/10 Hz bandwidth). The ring frame data banks with related parameters are presented in Figures A-1 through A-86.

C. Skin-Stringer Data Banks

There are 16 skin-stringer vibroacoustic data banks presented in this report. Each skin-stringer data bank consists of a parametric listing, power spectral density, and rms amplitude plots of the mean and 97.5-percent confidence level. Figures A-87 through A-118 show the skin-stringer data banks.

D. Honeycomb Data Bank

One honeycomb vibroacoustic data bank was developed from the available vibration and acoustic data. The honeycomb data bank consists of a parametric listing, power spectral density, and rms amplitude plots of the mean and 97.5-percent confidence levels. Figures A-119 and A-120 show the honeycomb data bank.

IV. APPLICATION OF VIBROACOUSTIC DATA BANKS

A. Utilization of Vibroacoustic Data Banks

The vibroacoustic data banks presented in Figures A-1 through A-120 have been defined for vehicle diameter, flight conditions, static firings, and various parametric categories. The following procedures should be followed to determine vibration criteria for a new vehicle structure:

1. Select a data bank from Figures A-1 through A-120 which best represents the new vehicle local structural configuration. Tables 1, 2, and 3 provide the data bank structural parameters for making this selection.

2. When the most representative data bank is selected, make necessary mass and acoustic pressure adjustments according to equation (8) to determine vibration criteria for unloaded new vehicle structure:

$$G_N(f) = G_R(f) \left[\frac{P_N(f)}{P_R(f)}\right]^2 \cdot \left[\frac{M_R}{M_N}\right]^2 \tag{8}$$

where:

$G_N(f)$ = New vehicle power spectral density (G^2/Hz) as a function of frequency f.

$G_R(f)$ = Data bank power spectral density (G^2/Hz) as a function of frequency f.

$P_N(f)$ = New vehicle measured or predicted acoustic pressure (psi_{rms}) as a function of frequency f.

$P_R(f)$ = Reference acoustic pressure (psi_{rms}) as a function of frequency f.

M_N = Mass per unit area of new structure.

M_R = Mass per unit area of data bank structure.

TABLE 1. RING FRAME DATA BANKS

Skin Thickness, cm (in.)	Ring Frame Weight, kg/m (lb/ft)	Data Bank Sensitive Axis	Flight or Test Condition	Data Bank Figures
0.081 (0.032)	1.414 (0.95)	Longitudinal	Liftoff Mach 1 Max Q Mach 1, Max Q	A-1, A-2 A-3, A-4 A-5, A-6 A-7, A-8
0.081 (0.032)	1.414 (0.95)	Tangential	Liftoff Mach 1 Max Q Mach 1, Max Q	A-9, A-10 A-11, A-12 A-13, A-14 A-15, A-16
0.081 (0.032)	1.414 (0.95)	Radial	Liftoff Mach 1 Max Q Mach 1, Max Q	A-17, A-18 A-19, A-20 A-21, A-22 A-23, A-24
0.102 (0.040)	3.735 (2.51)	Radial	Liftoff Mach 1	A-25, A-26 A-27, A-28
0.102 (0.040) to 0.180 (0.071)	1.622 (1.09) to 2.232 (1.50)	Radial	Liftoff Mach 1 Max Q Mach 1, Max Q	A-29, A-30 A-31, A-32 A-33, A-34 A-35, A-36
0.254 (0.10)	8.229 (5.53)	Radial	Static Firing	A-37, A-38
0.20 (0.08) to 0.330 (0.130)	6.949 (4.67) to 11.830 (7.95)	Parallel to Thrust Structure	Static Firing	A-39, A-40
0.330 (0.130)	16.948 (11.39)	Normal to Thrust Structure	Static Firing	A-41, A-42
0.470 (0.185)	7.068 (4.75)	Longitudinal	Liftoff Mach 1 Max Q Mach 1, Max Q	A-43, A-44 A-45, A-46 A-47, A-48 A-49, A-50
0.470 (0.185)	7.068 (4.75)	Radial	Liftoff Mach 1 Max Q Mach 1, Max Q Static Firing Liftoff, Static Firing	A-51, A-52 A-53, A-54 A-55, A-56 A-57, A-58 A-59, A-60 A-61, A-62
0.953 (0.375)	43.241 (29.06)	Longitudinal	Liftoff Mach 1 Max Q Mach 1, Max Q Static Firing Liftoff, Static Firing	A-63, A-64 A-65, A-66 A-67, A-68 A-69, A-70 A-71, A-72 A-73, A-74
0.953 (0.375)	43.241 (29.06)	Radial	Liftoff Mach 1 Max Q Mach 1, Max Q Static Firing Liftoff, Static Firing	A-75, A-76 A-77, A-78 A-79, A-80 A-81, A-82 A-83, A-84 A-85, A-86

TABLE 2. SKIN-STRINGER DATA BANKS

Skin Thickness, cm (in.)	Ring Separation, cm (in.)	Stringer Weight, kg/m (lb/ft)	Stringer Separation, cm (in.)	Data Bank Sensitive Axis	Flight or Test Condition	Data Bank Figures
0.102 (0.040)	48.26 (19.0)	2.098 (1.41)	21.51 (8.47)	Normal to Interstage	Liftoff	A-87, A-88
0.102 (0.040)	91.44 (36.0)	1.056 (0.71)	21.92 (8.63)	Longitudinal	Liftoff Mach 1 Max Q Mach 1, Max Q	A-89, A-90 A-91, A-92 A-93, A-94 A-95, A-96
0.102 (0.040)	91.44 (36.0)	1.056 (0.71)	21.92 (8.63)	Tangential	Liftoff Mach 1 Max Q Mach 1, Max Q	A-97, A-98 A-99, A-100 A-101, A-102 A-103, A-104
0.102 (0.040)	91.44 (36.0)	1.056 (0.71)	21.92 (8.63)	Radial	Liftoff Mach 1	A-105, A-106 A-107, A-108
0.180 (0.071)	68.58 (27.0)	1.240 (0.86)	14.63 (5.76)	Longitudinal	Static Firing	A-109, A-110
0.180 (0.071)	68.58 (27.0)	1.240 (0.86)	14.63 (5.76)	Radial	Mach 1 Max Q Mach 1, Max Q Static Firing	A-111, A-112 A-113, A-114 A-115, A-116 A-117, A-118

TABLE 3. HONEYCOMB DATA BANKS

Overall Thickness, cm (in.)	Core Density, 2.768×10^4 kg/m^3 (lb/in.^{3})	Outer Plate Thickness, cm (in.)	Data Bank Sensitive Axis	Flight or Test Condition	Data Bank Figures
2.54 (1.0)	0.0049 (0.0018)	0.076 (0.030)	Radial	Static Firing	A-119, A-120

If the rms amplitude (G/10 Hz bandwidth) data banks are required for an unloaded new vehicle structure, equation (9) should be used. In this equation, the values for $G_N(f)$ and $G_R(f)$ are the rms amplitudes for the new vehicle and data bank, respectively.

$$G_N(f) = G_R(f) \left[\frac{P_N(f)}{P_R(f)}\right] \cdot \left[\frac{M_R}{M_N}\right] \quad . \tag{9}$$

3. Component vibration criteria for varying weight ranges can be determined from conventional mass attenuation techniques.

B. Telemetry Attenuation

The vibration and acoustic data obtained during flights of the Saturn launch vehicles are considered questionable below approximately 250 Hz. . This error is contributed to the inability of the single sideband telemetry system to maintain a flat frequency response below 250 Hz. When using the flight vibroacoustic data banks, the correction as presented in Figure 2 should be added to the data bank amplitude values below 250 cps. This correction should be applied only to those vibroacoustic data banks which are so noted.

V. CONCLUSIONS AND RECOMMENDATIONS

The vibroacoustic structural data banks that were developed herein represent an advancement in the method of predicting the structural response caused by an acoustic or aerodynamic forcing function. It is recommended that when using these vibroacoustic data banks, engineering judgment should be used in selecting the data bank which best represents the new vehicle structure. This is necessary since an exact structural relationship between the data bank structure and the new vehicle structure will more than likely not occur.

George C. Marshall Space Flight Center
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama 35812, September 29, 1972

M 215

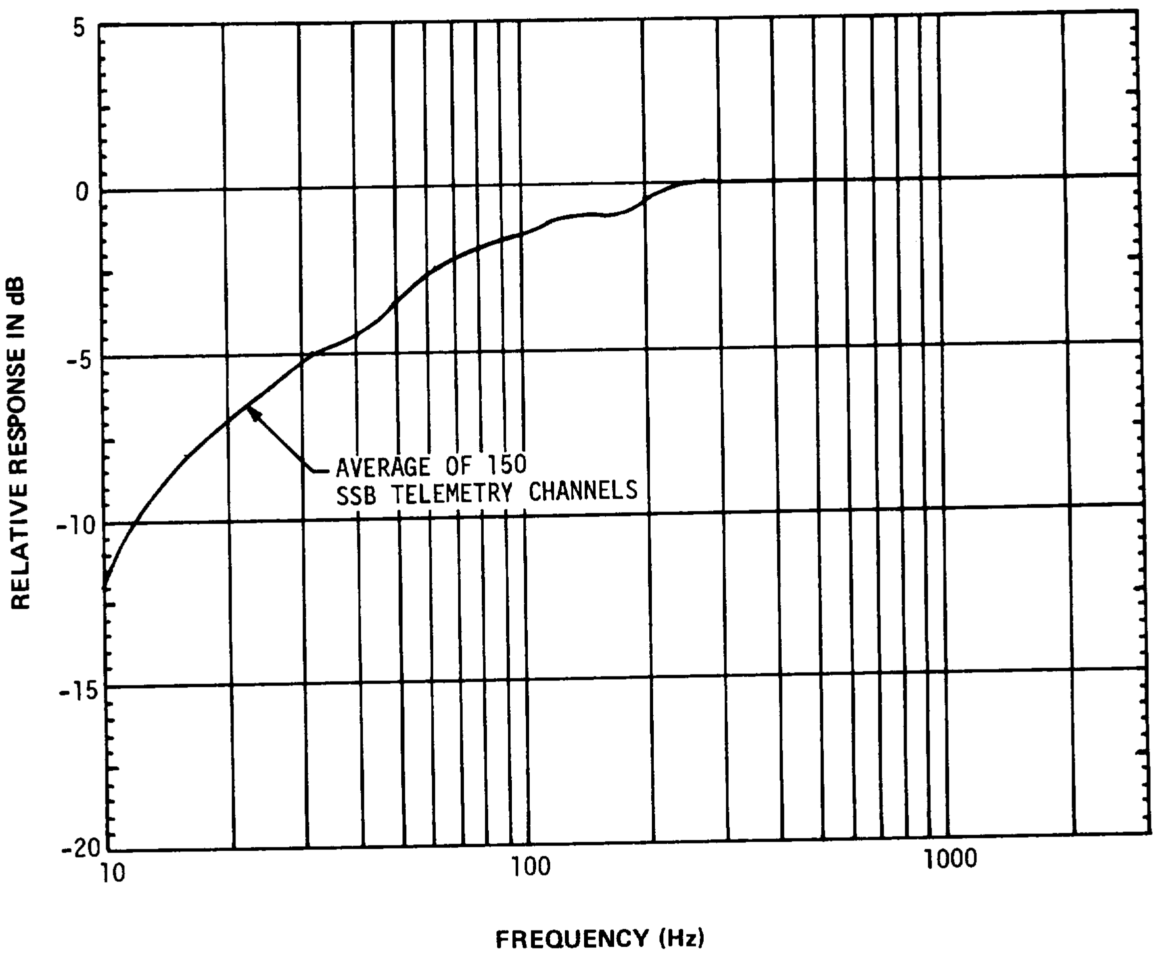


Figure 2. Attenuation of low frequency data from single sideband telemetry system.

APPENDIX A

VIBROACOUSTIC STRUCTURAL DATA BANK PLOTS

1. Ring Frame Data Banks

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.47
COMPOSITE 97.5 – 14.45
VEHICLE DIAMETER – 6.7 m (22 ft)

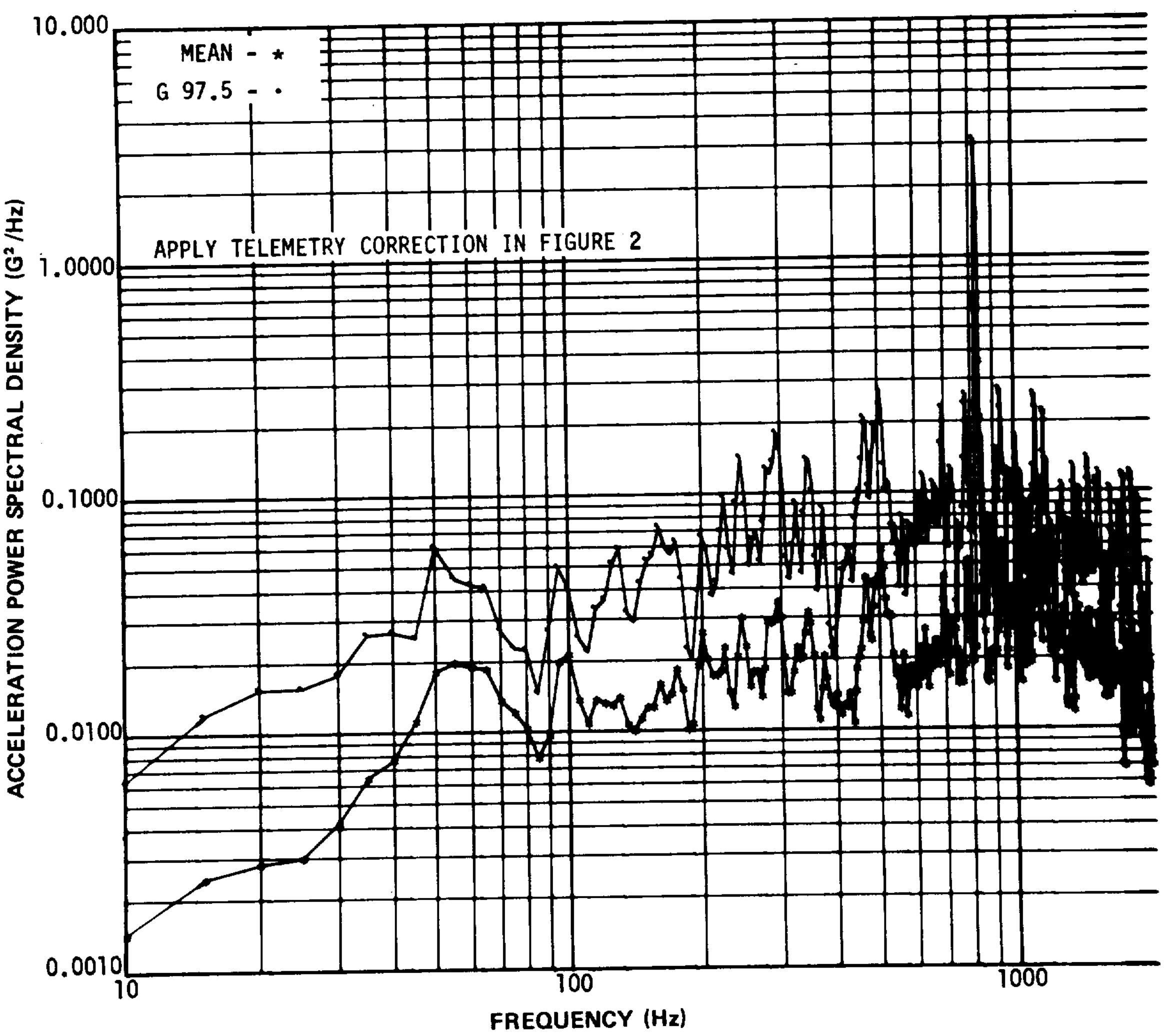


Figure A-1. Ring frame acceleration power spectral density, longitudinal, liftoff

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.47
COMPOSITE 97.5 – 14.45
VEHICLE DIAMETER – 6.7 m (22 ft)

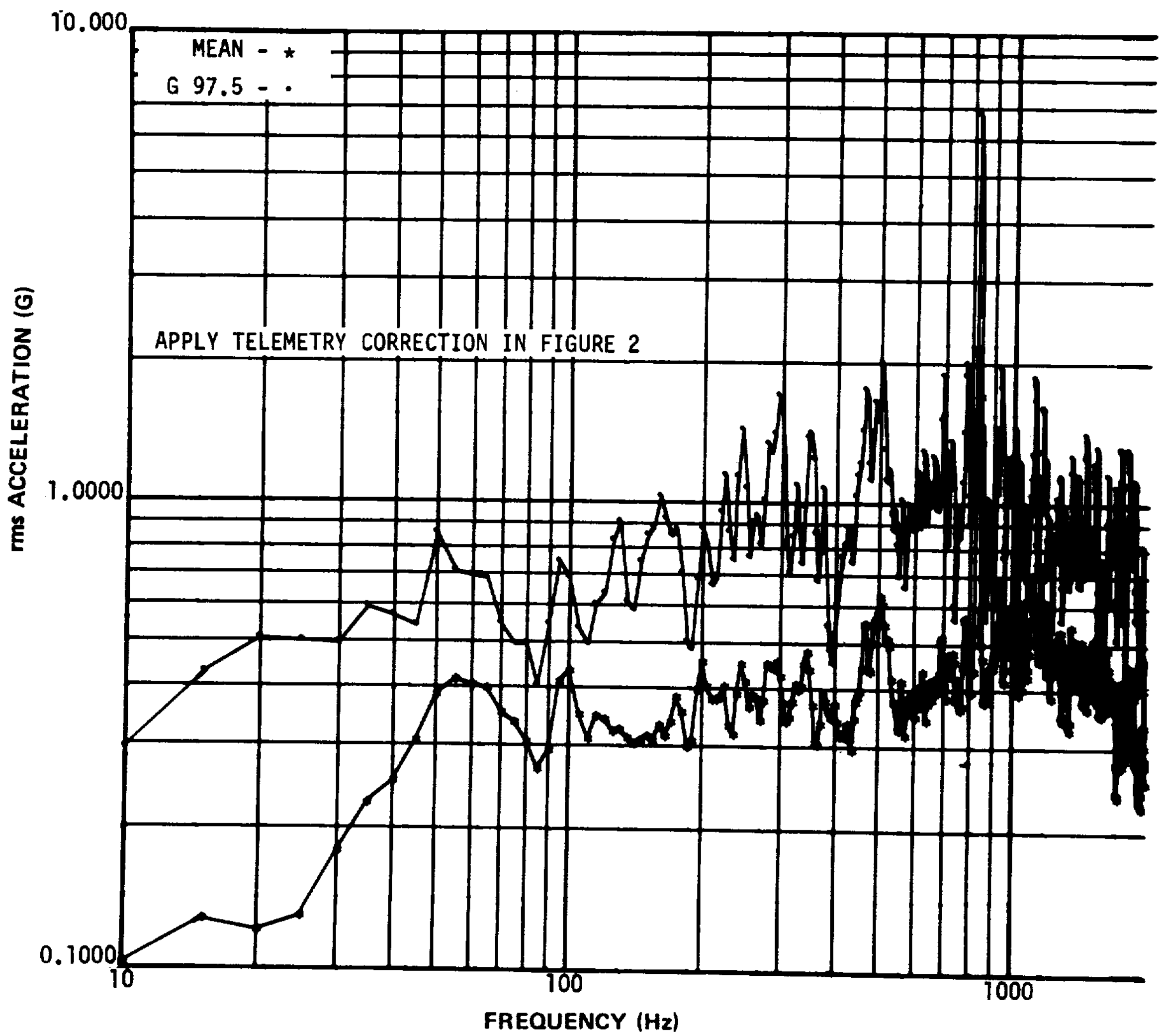


Figure A-2. Ring frame rms acceleration, longitudinal, liftoff

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.51
COMPOSITE 97.5 – 15.86
VEHICLE DIAMETER – 6.7 m (22 ft)

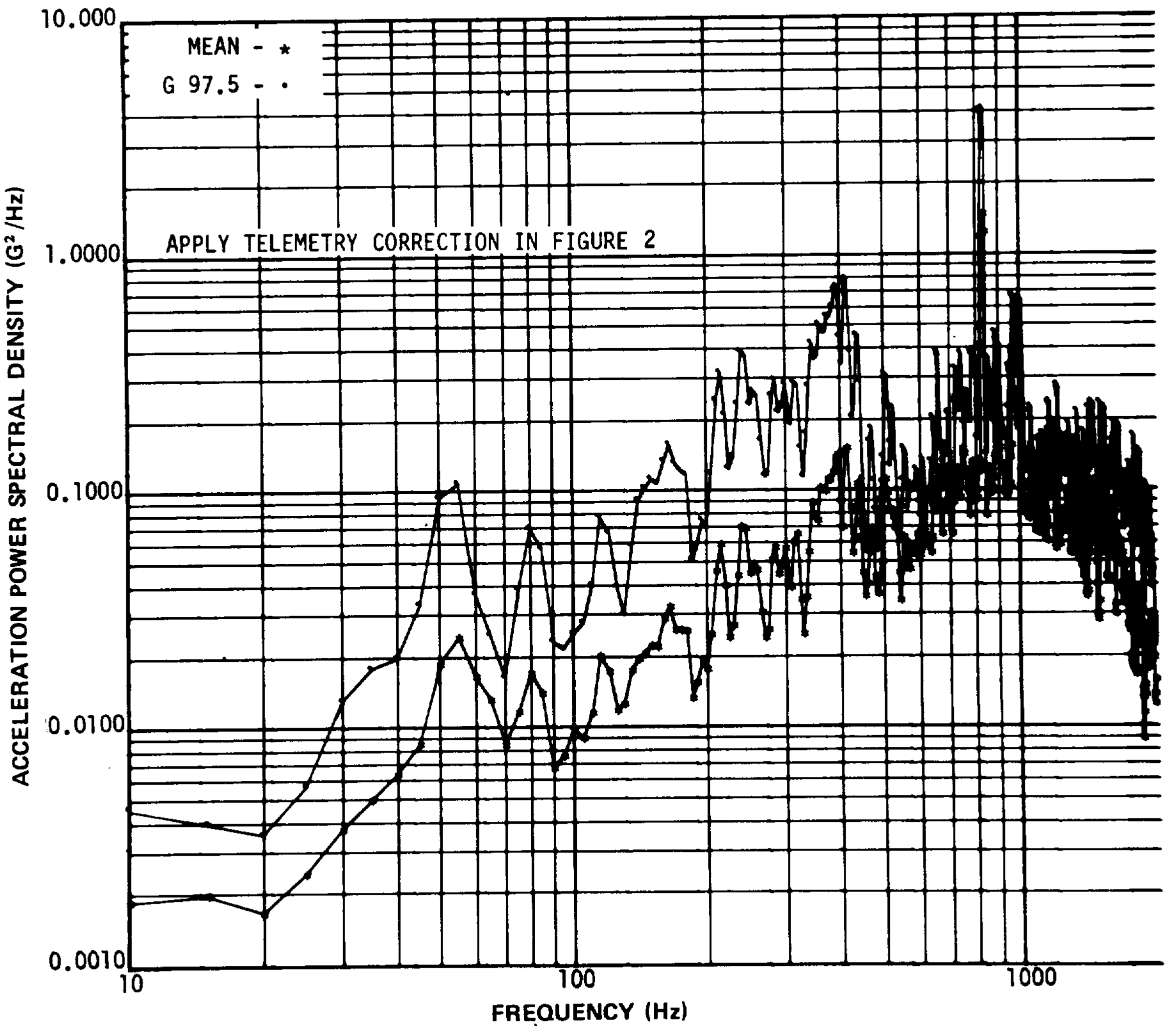


Figure A-3. Ring frame acceleration power spectral density, longitudinal, Mach 1.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.51
COMPOSITE 97.5 – 15.86
VEHICLE DIAMETER – 6.7 m (22 ft)

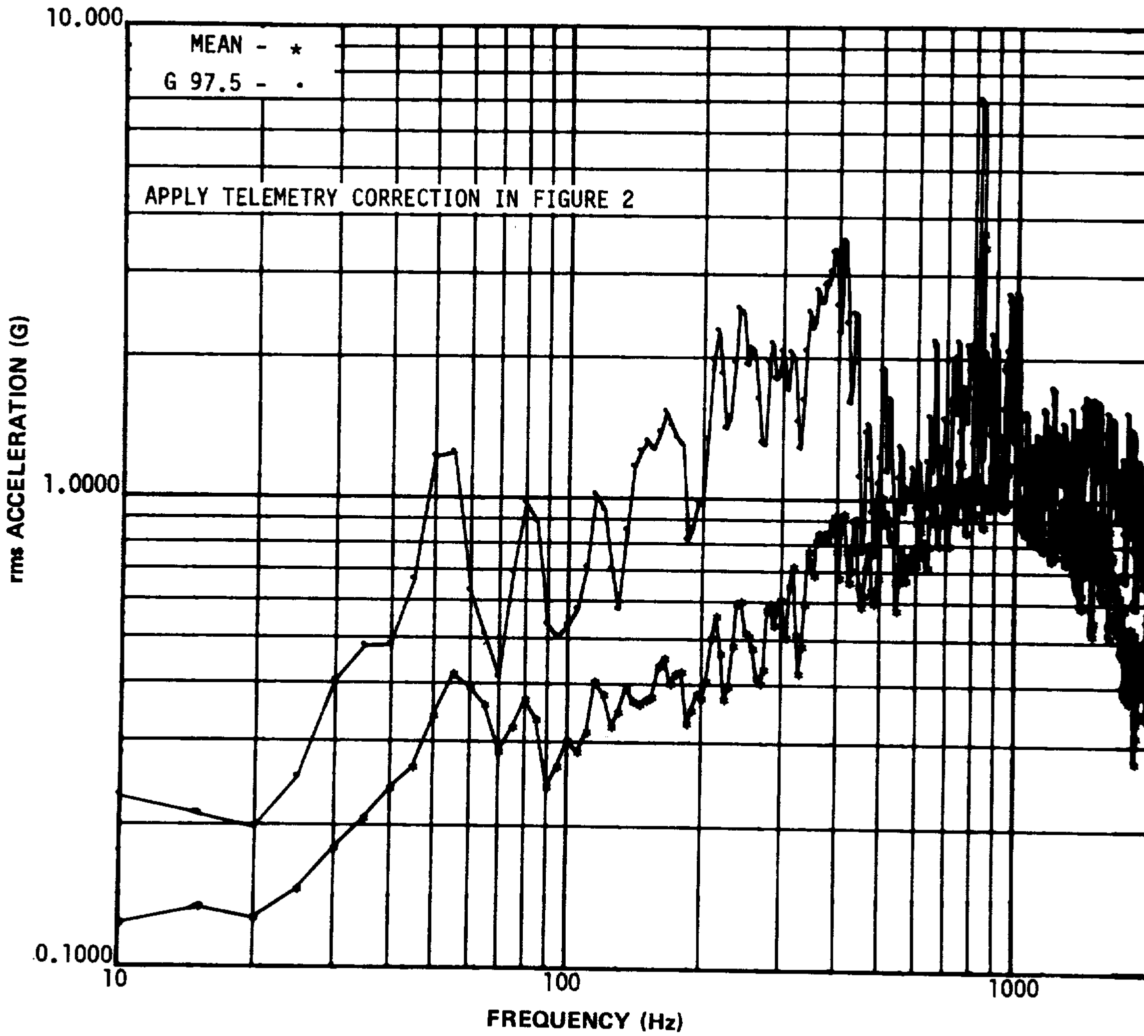


Figure A-4. Ring frame rms acceleration, longitudinal, Mach 1.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 10.76
COMPOSITE 97.5 – 21.00
VEHICLE DIAMETER – 6.7 m (22 ft)

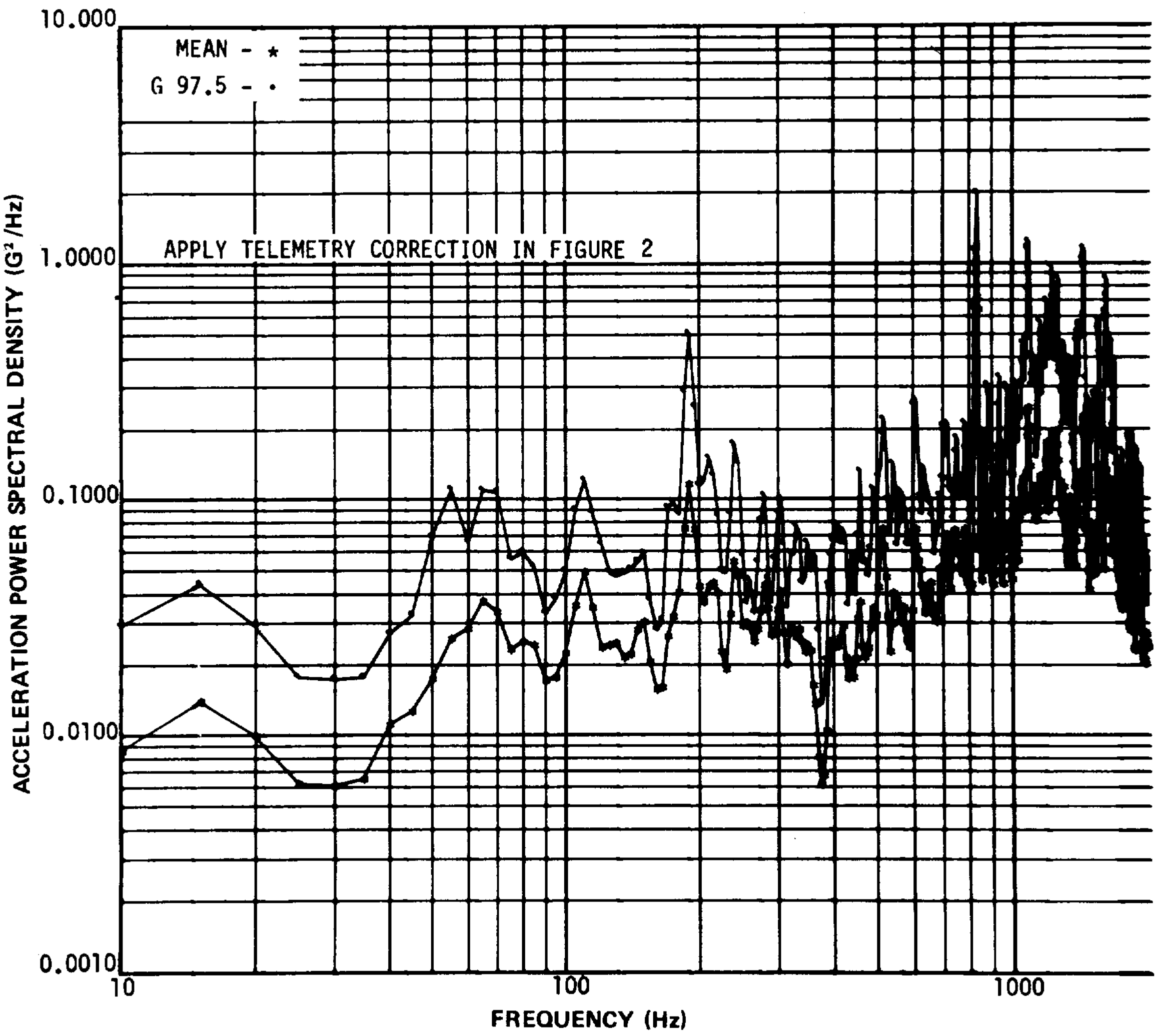


Figure A-5. Ring frame acceleration power spectral density, longitudinal, max Q.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 10.76
COMPOSITE 97.5 – 21.00
VEHICLE DIAMETER – 6.7 m (22 ft)

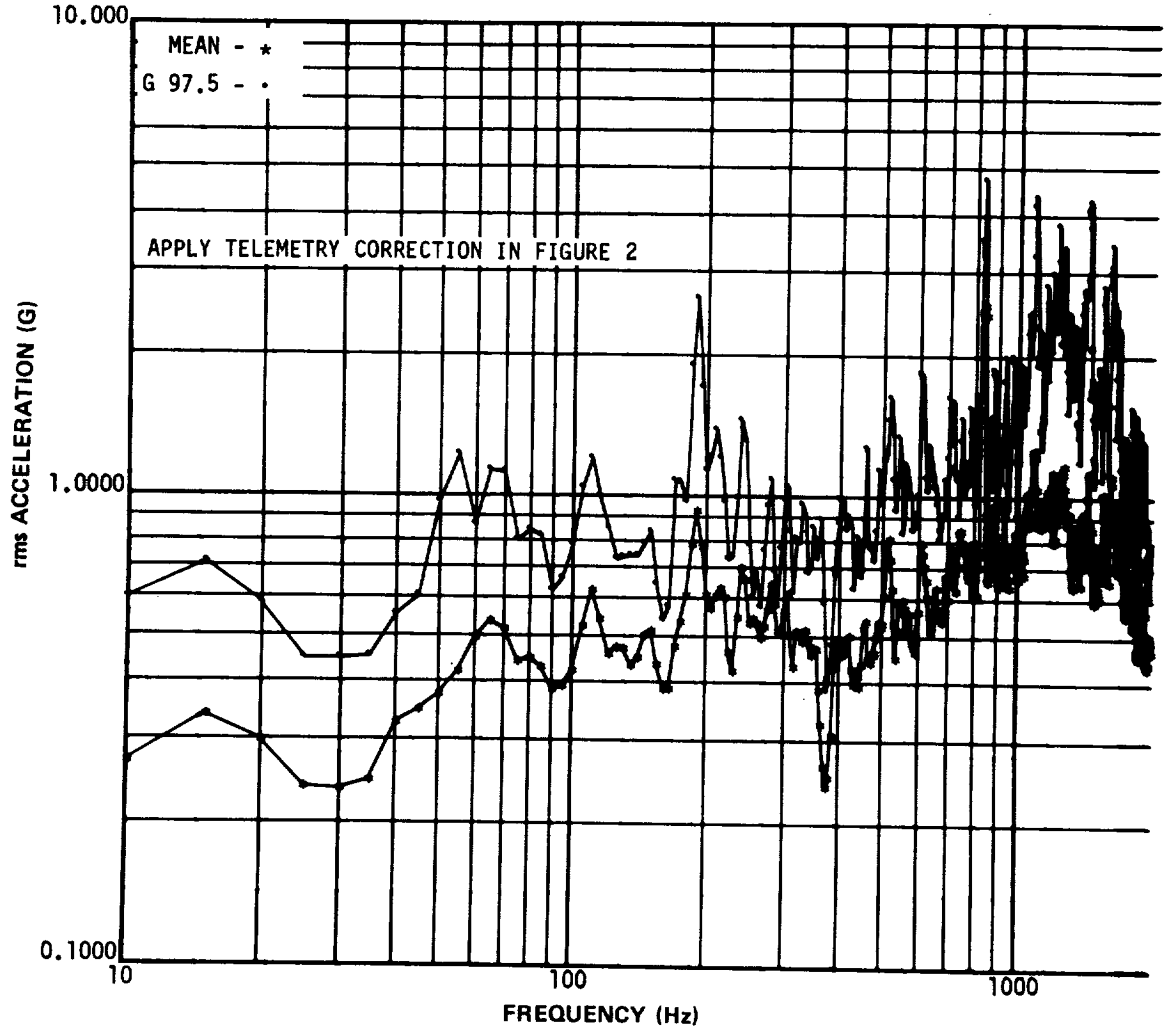


Figure A-6. Ring frame rms acceleration, longitudinal, max Q.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 11.64
COMPOSITE 97.5 – 17.50
VEHICLE DIAMETER – 6.7 m (22 ft)

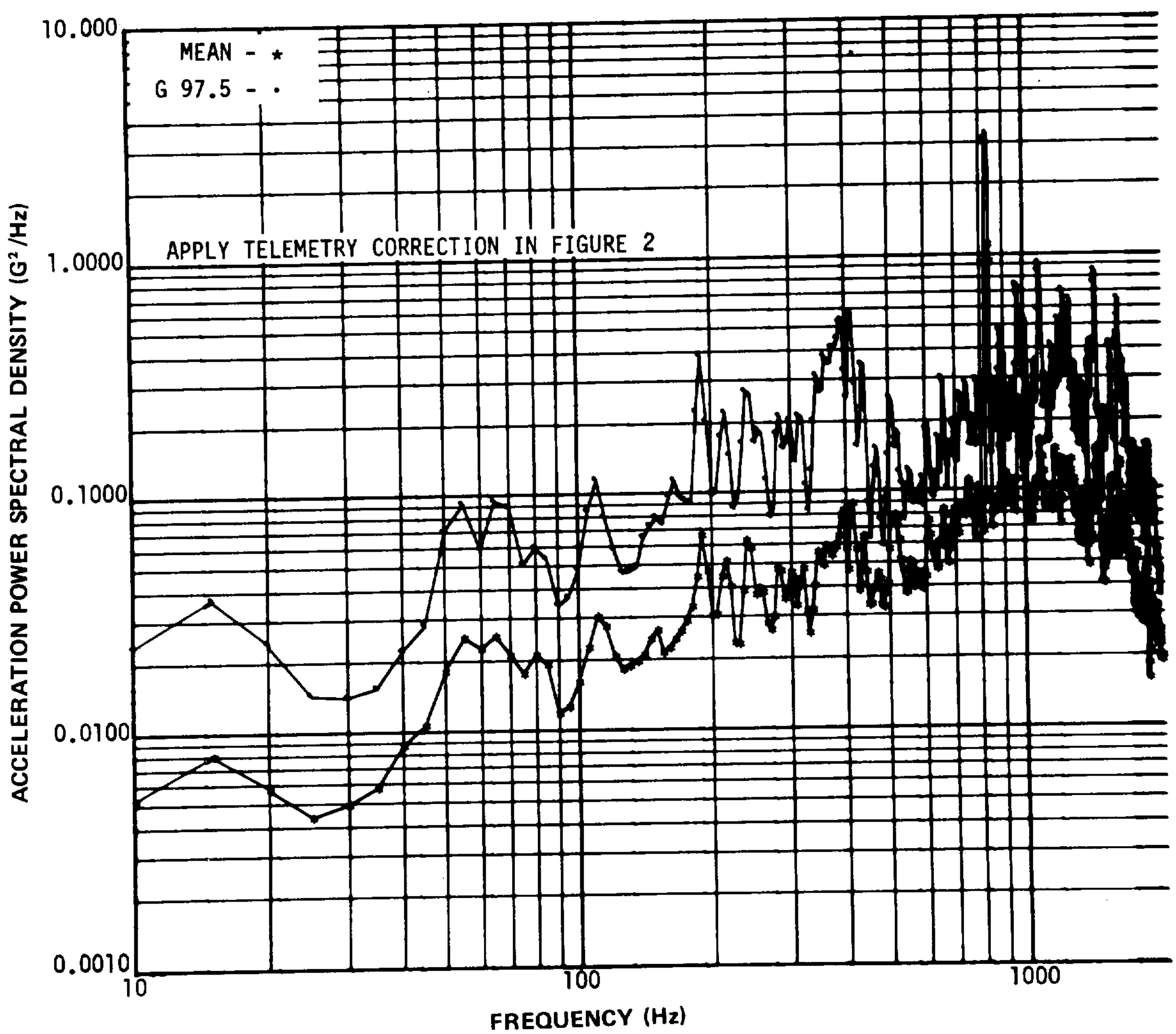


Figure A-7. Ring frame acceleration power spectral density, longitudinal, transonic.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 11.64
COMPOSITE 97.5 – 17.50
VEHICLE DIAMETER – 6.7 m (22 ft)

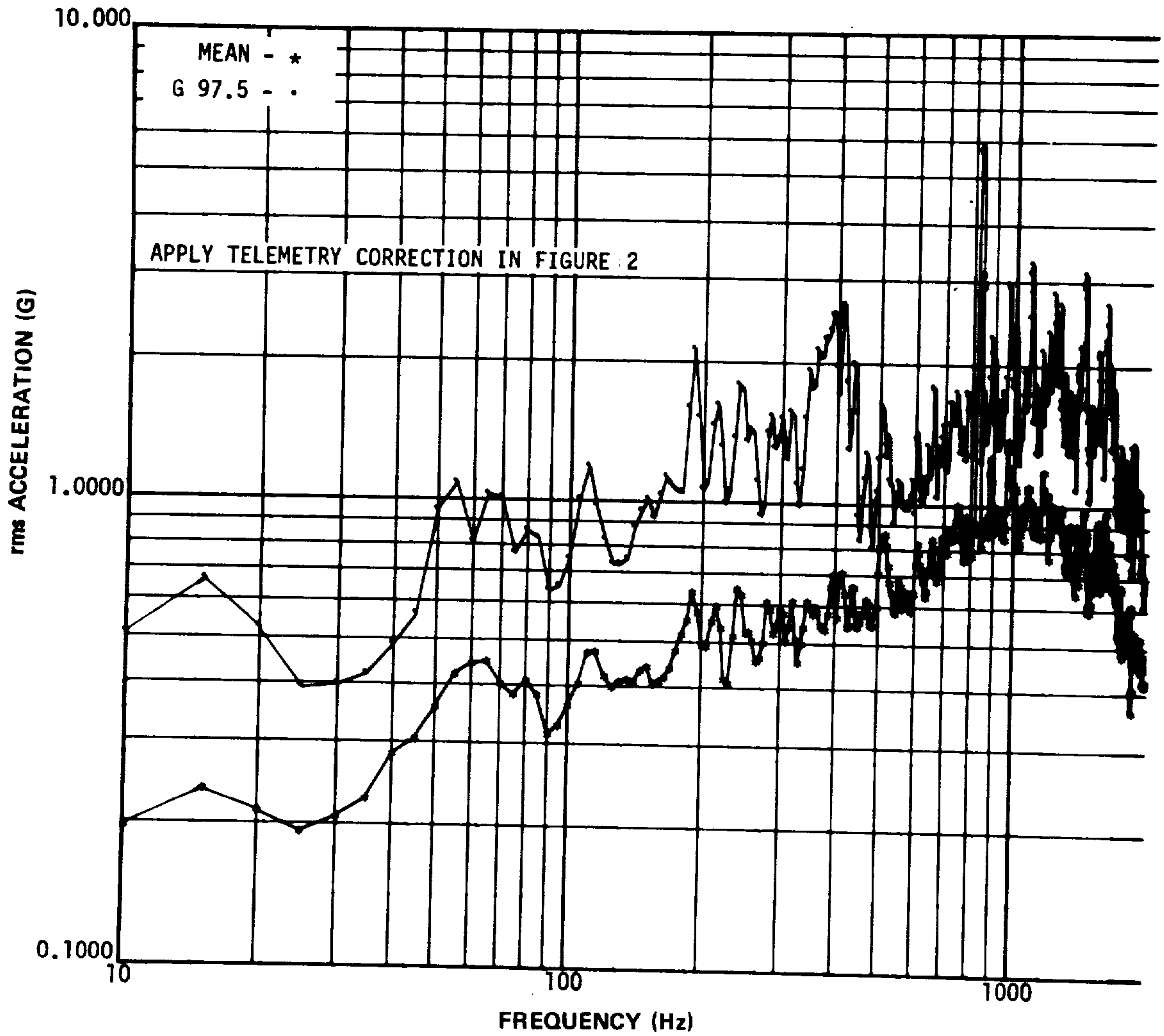


Figure A-8. Ring frame rms acceleration, longitudinal, transonic.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.96
COMPOSITE 97.5 – 16.94
VEHICLE DIAMETER – 6.7 m (22 ft)

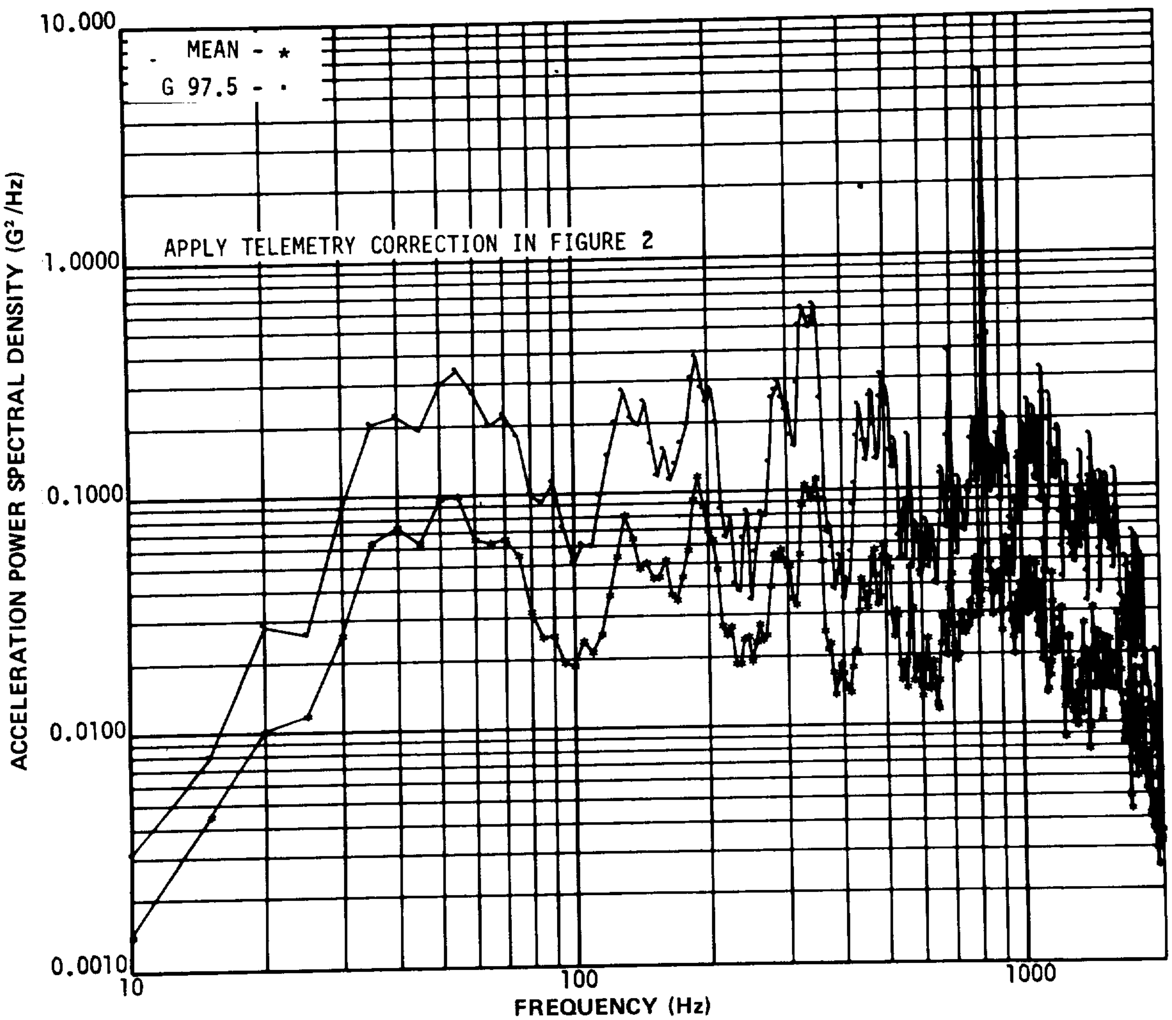


Figure A-9. Ring frame acceleration power spectral density, tangential, liftoff.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.96
COMPOSITE 97.5 – 16.94
VEHICLE DIAMETER – 6.7 m (22 ft)

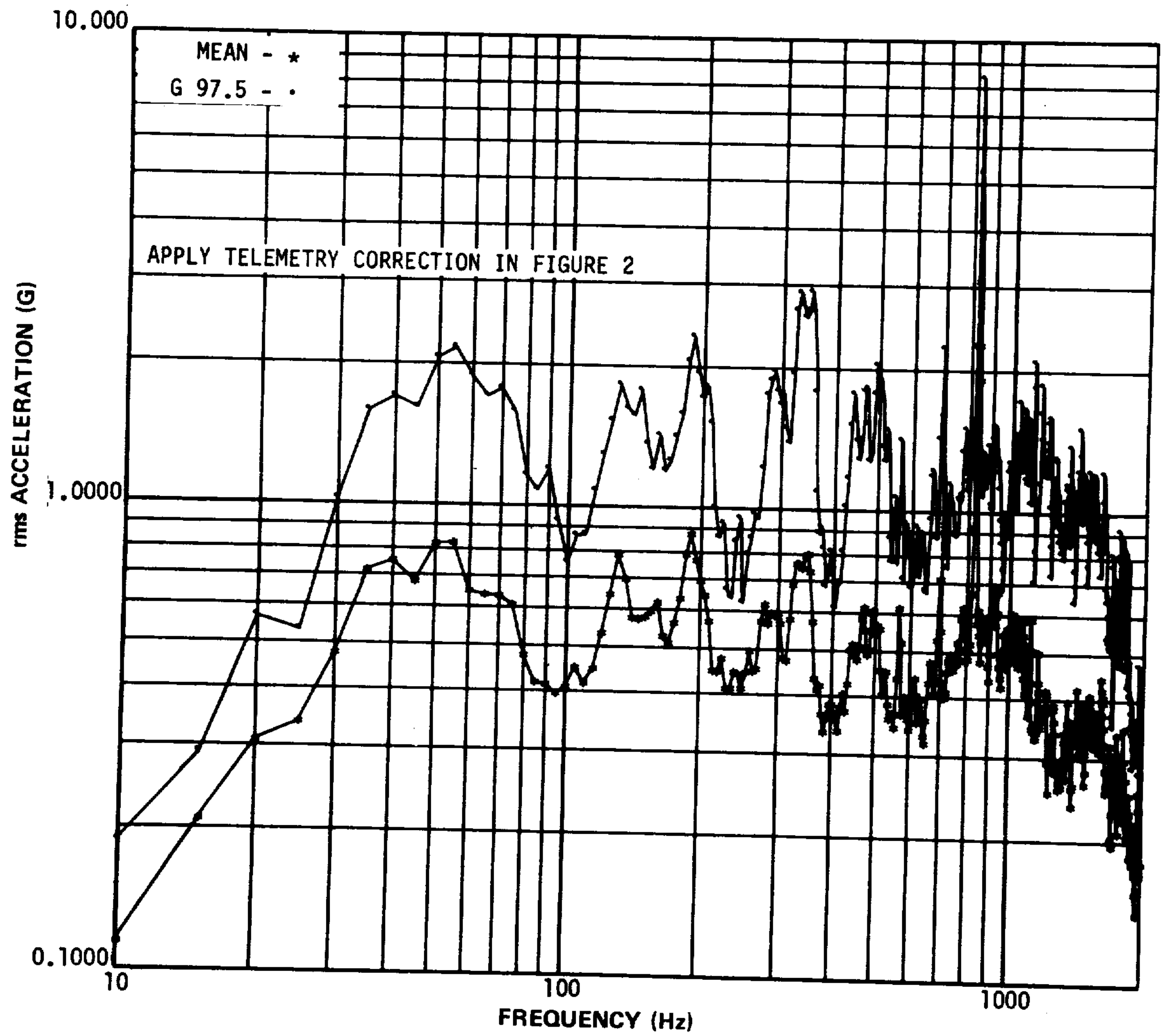


Figure A-10. Ring frame rms acceleration, tangential, liftoff.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 15.21
COMPOSITE 97.5 – 24.83
VEHICLE DIAMETER – 6.7 m (22 ft)

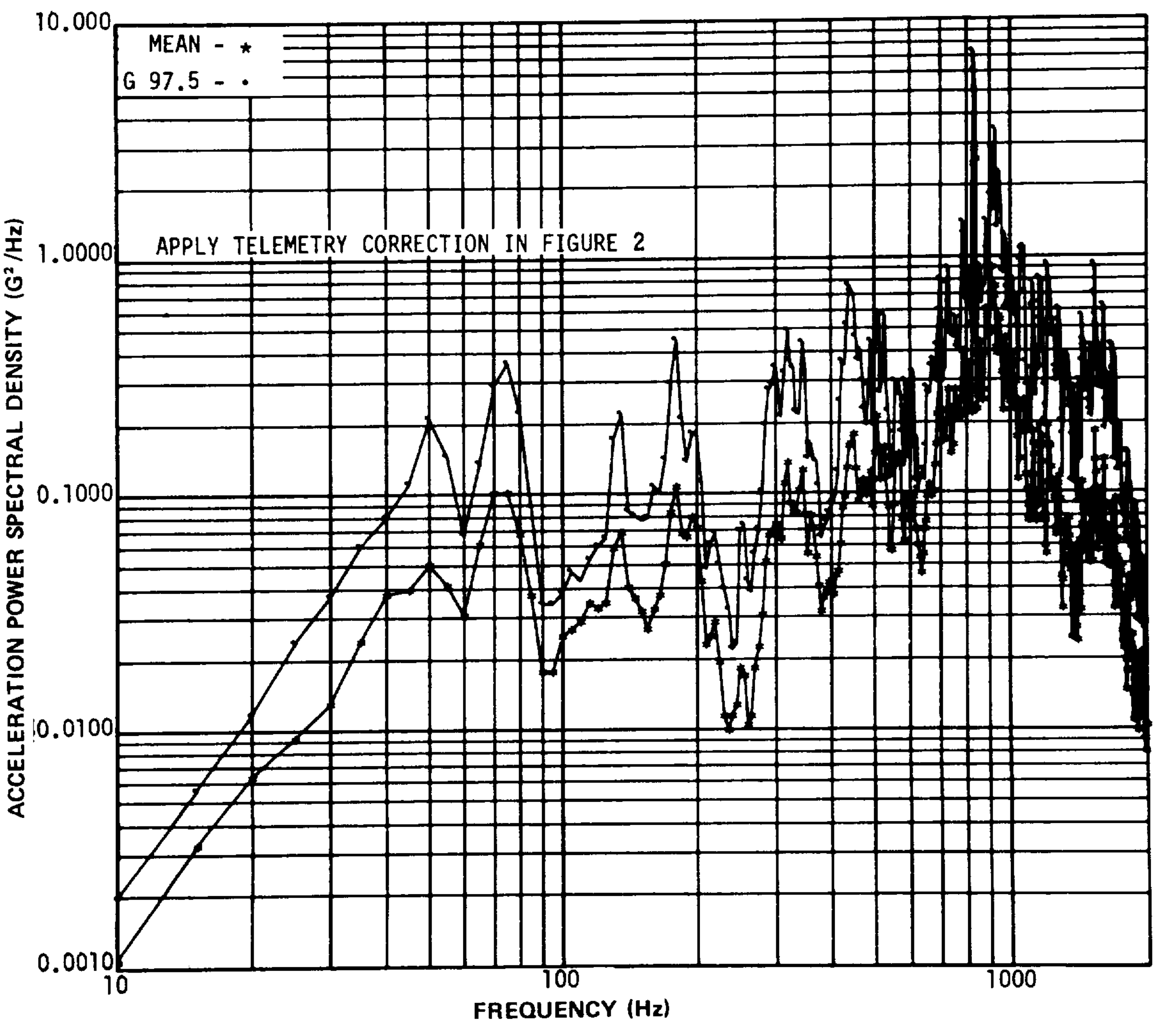


Figure A-11. Ring frame acceleration power spectral density, tangential, Mach 1.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 15.21
COMPOSITE 97.5 – 24.83
VEHICLE DIAMETER – 6.7 m (22 ft)

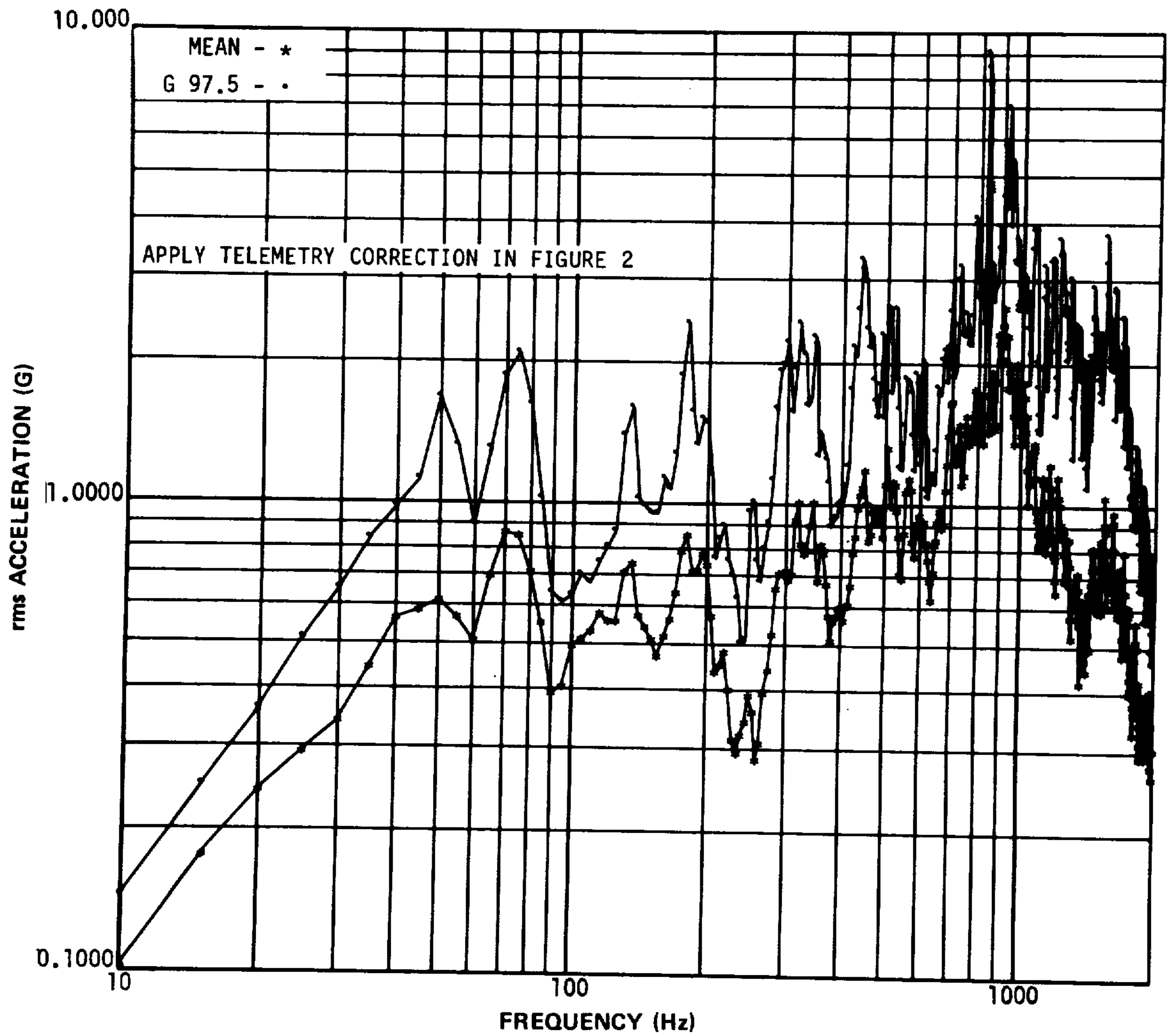


Figure A-12. Ring frame rms acceleration, tangential, Mach 1.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 7.50
COMPOSITE 97.5 – 20.35
VEHICLE DIAMETER – 6.7 m (22 ft)

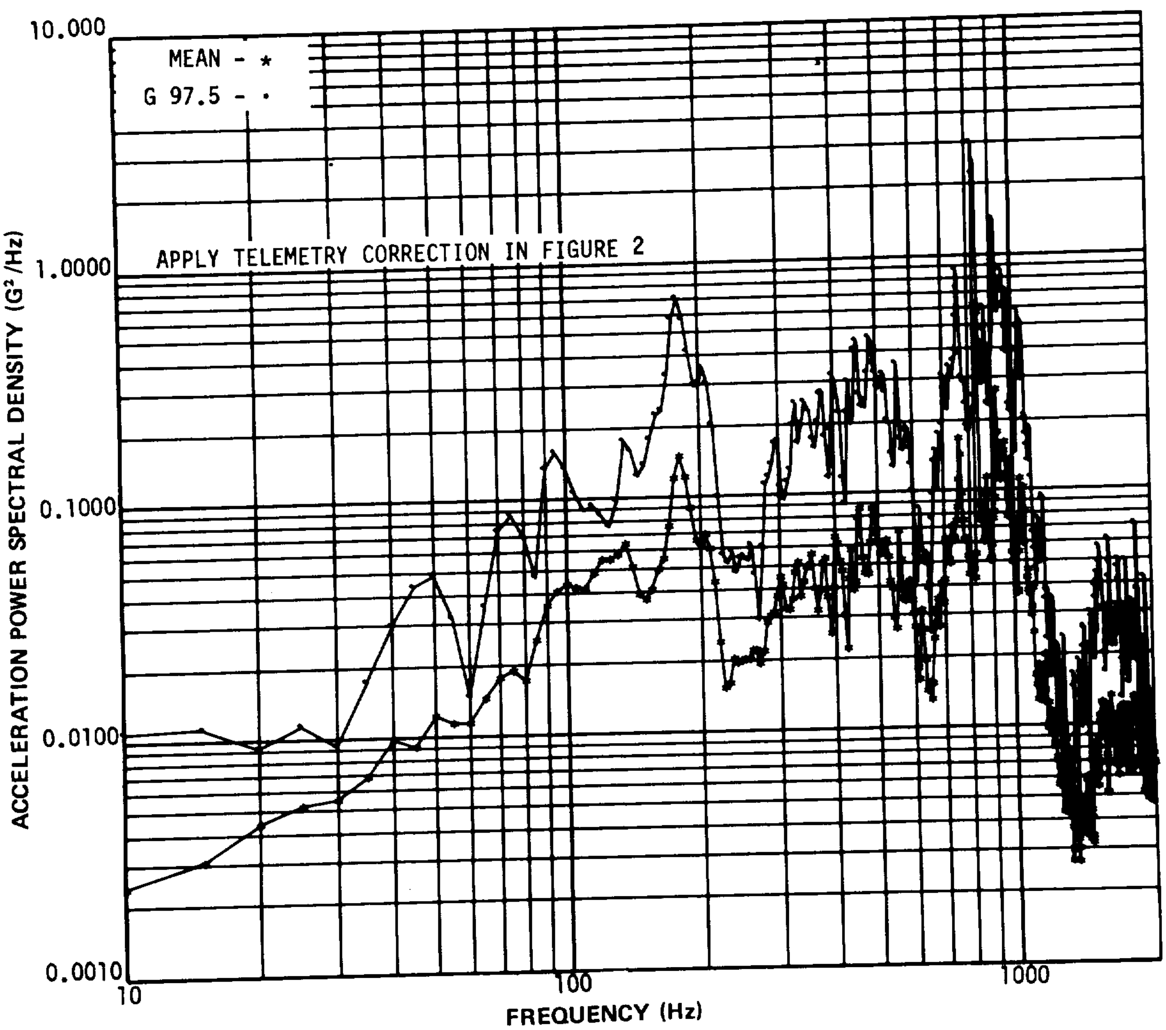


Figure A-13. Ring frame acceleration power spectral density, tangential, max Q.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 7.50
COMPOSITE 97.5 – 20.35
VEHICLE DIAMETER – 6.7 m (22 ft)

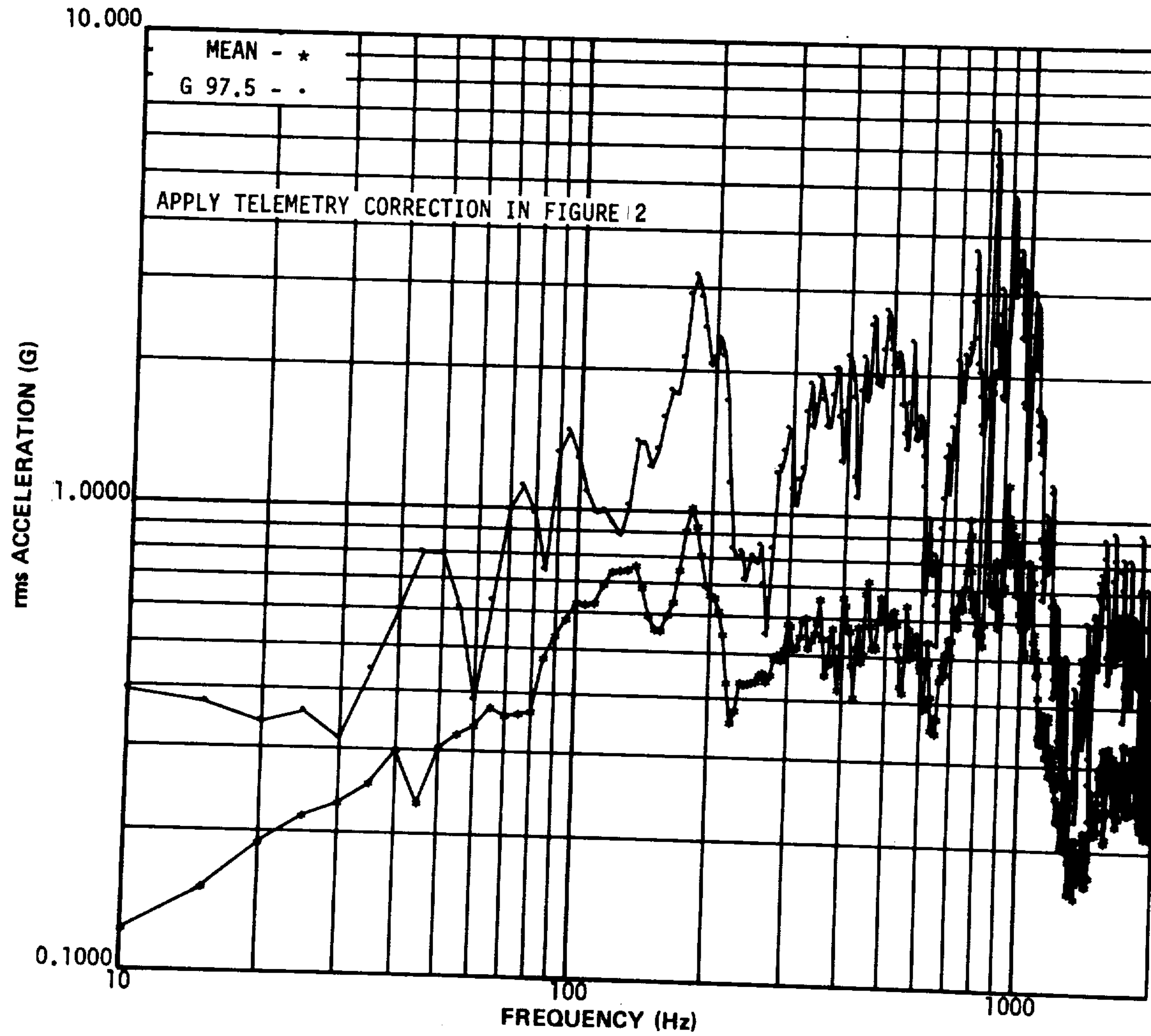


Figure A-14. Ring frame rms acceleration, tangential, max Q.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 11.08
COMPOSITE 97.5 – 27.87
VEHICLE DIAMETER – 6.7 m (22 ft)

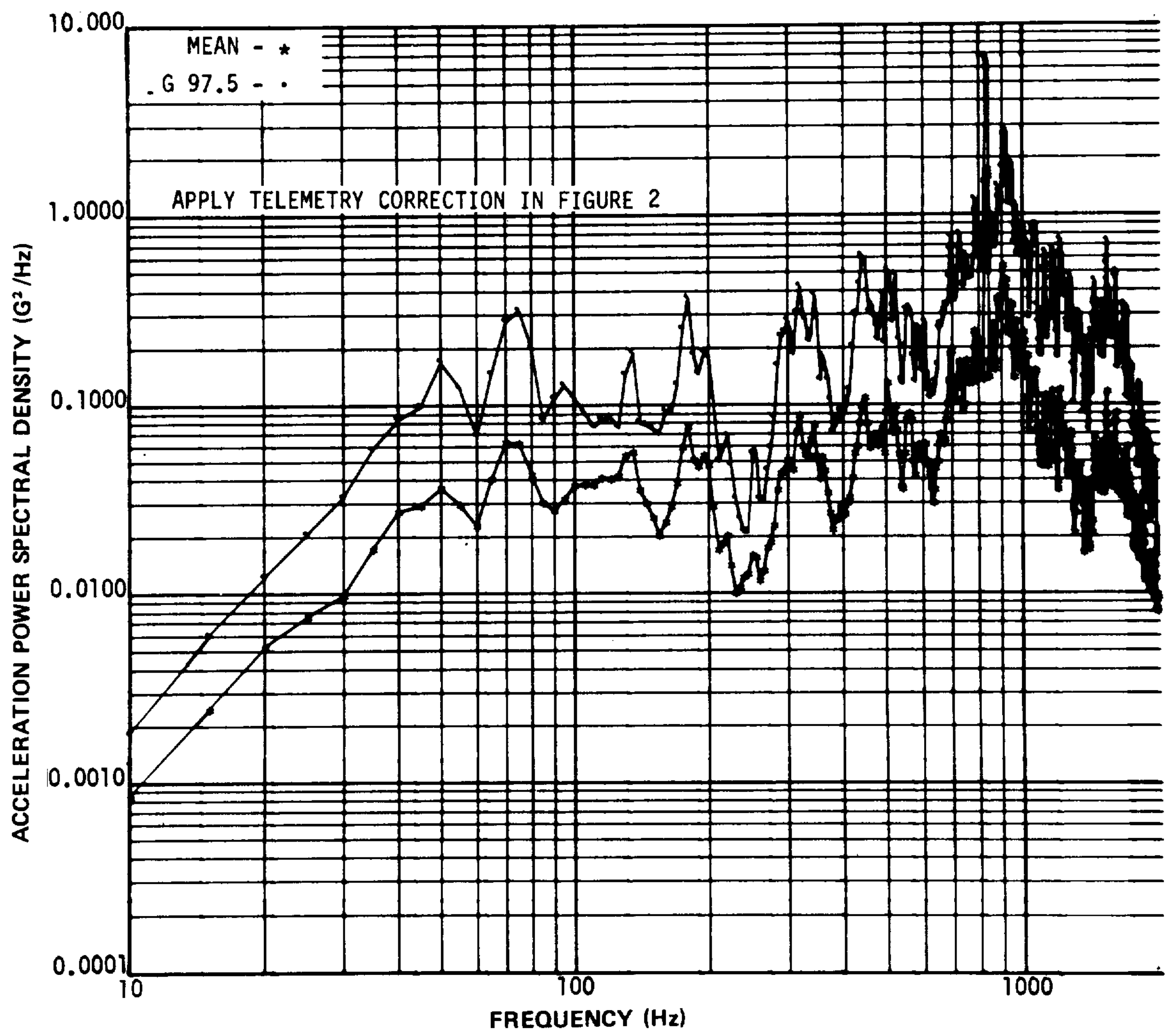


Figure A-15. Ring frame acceleration power spectral density, tangential, transonic.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 11.08
COMPOSITE 97.5 – 27.87
VEHICLE DIAMETER – 6.7 m (22 ft)

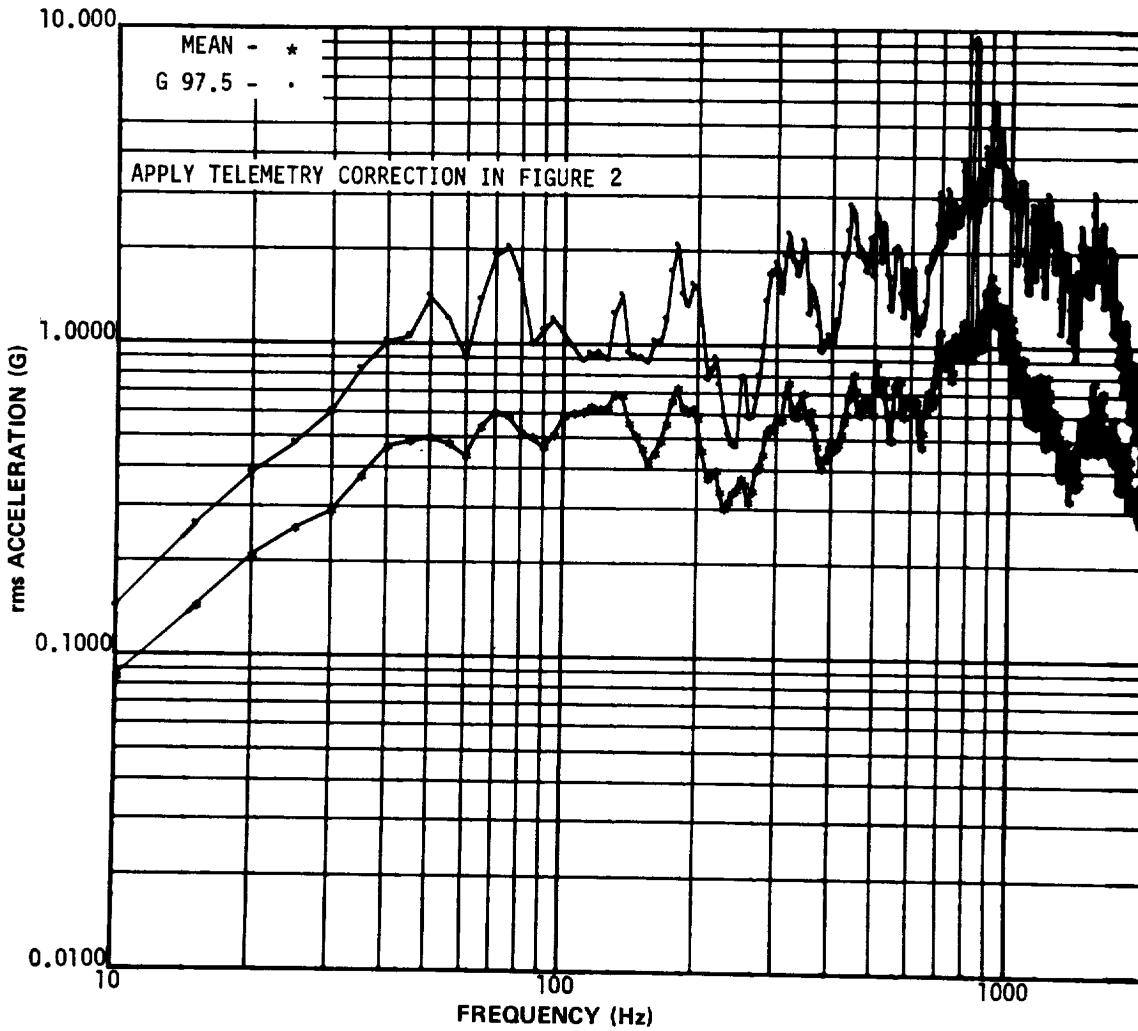


Figure A-16. Ring frame rms acceleration, tangential, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 16.90
COMPOSITE 97.5 – 37.19
VEHICLE DIAMETER – 6.7 m (22 ft)

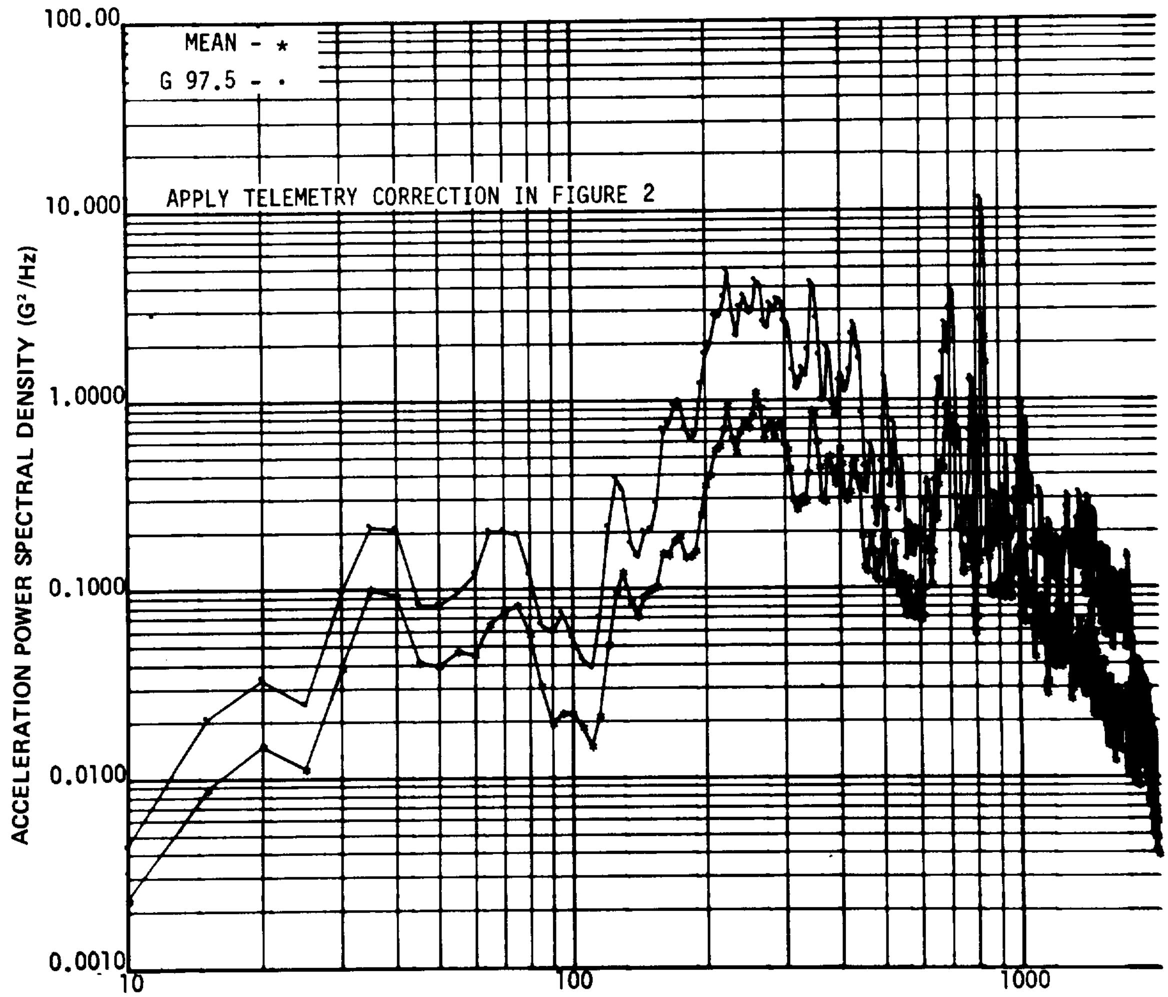


Figure A-17. Ring frame acceleration power spectral density, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 16.90
COMPOSITE 97.5 – 37.19
VEHICLE DIAMETER – 6.7 m (22 ft)

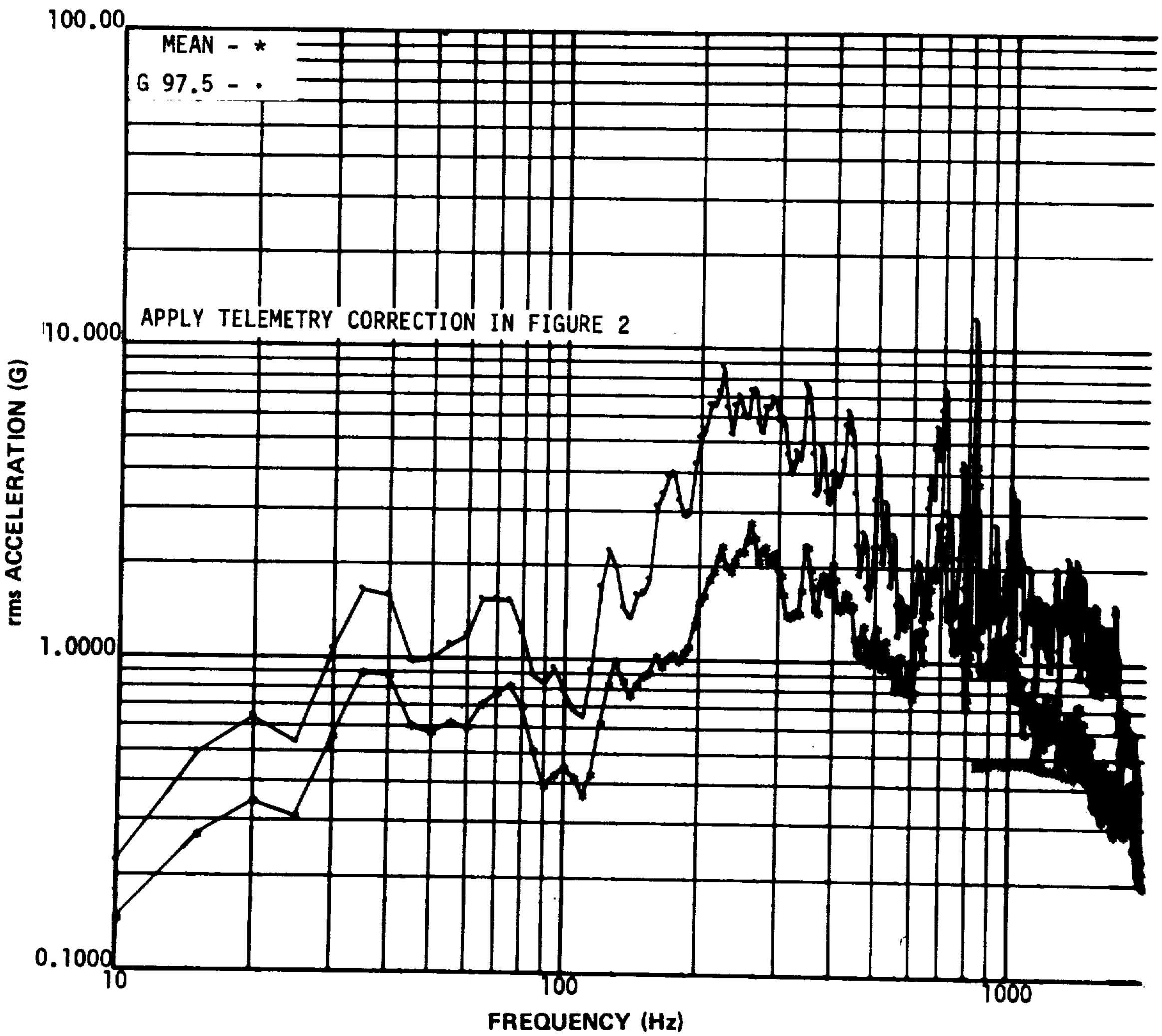


Figure A-18. Ring frame rms acceleration, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 14.30
COMPOSITE 97.5 – 30.54
VEHICLE DIAMETER – 6.7 m (22 ft)

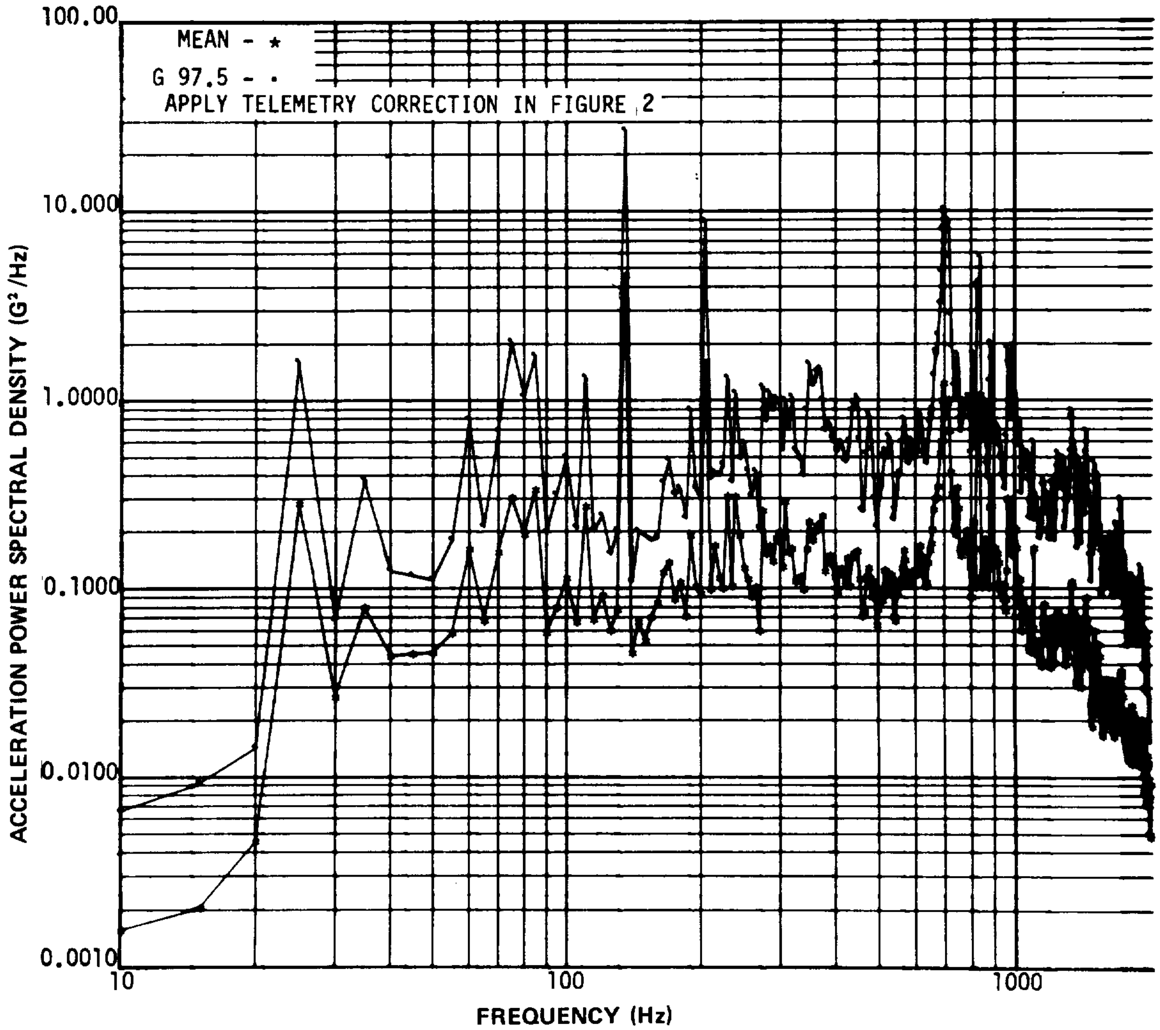


Figure A-19. Ring frame acceleration power spectral density, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 14.30
COMPOSITE 97.5 – 30.54
VEHICLE DIAMETER – 6.7 m (22 ft)

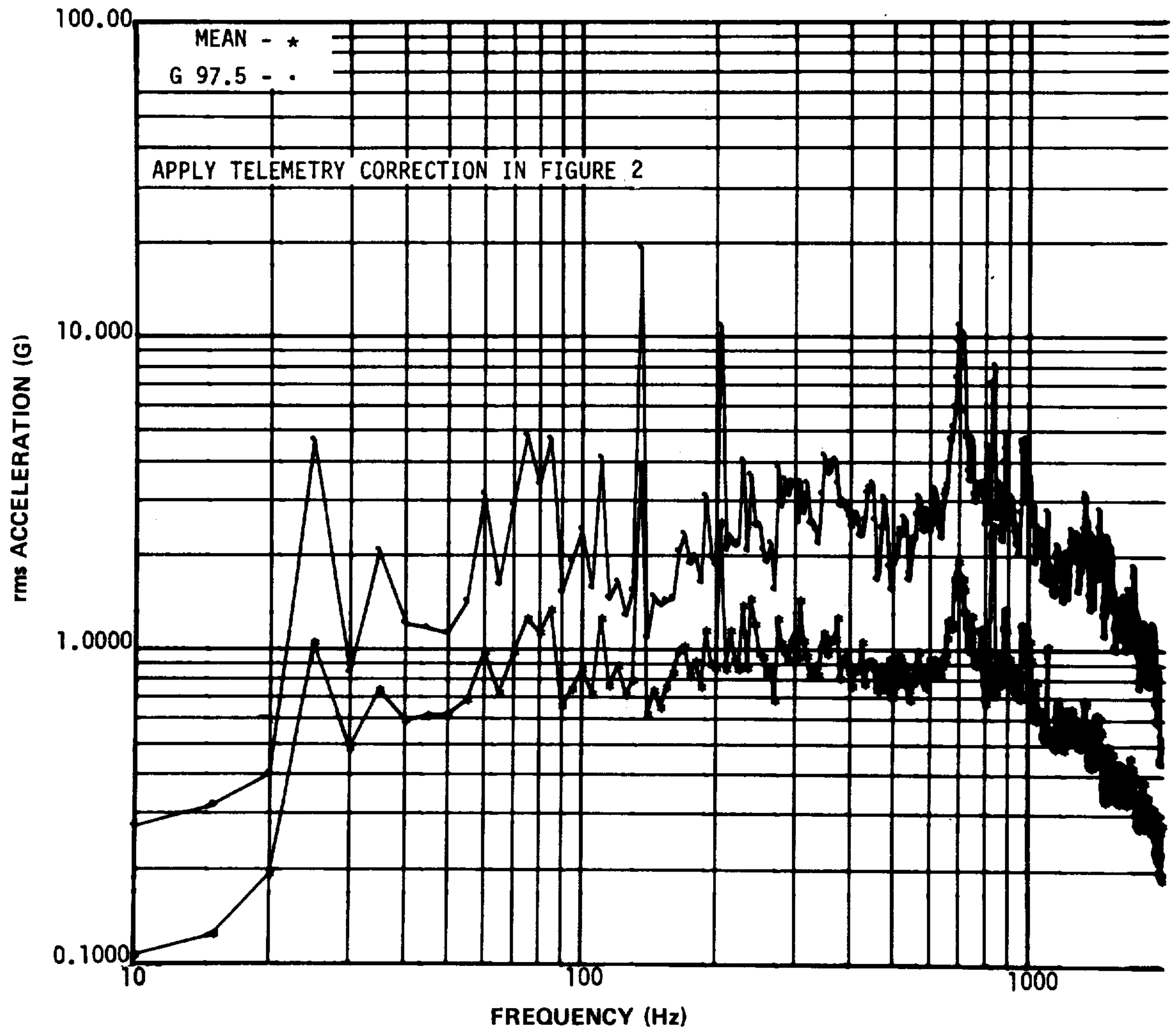


Figure A-20. Ring frame rms acceleration, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 19.25
COMPOSITE 97.5 – 30.33
VEHICLE DIAMETER – 6.7 m (22 ft)

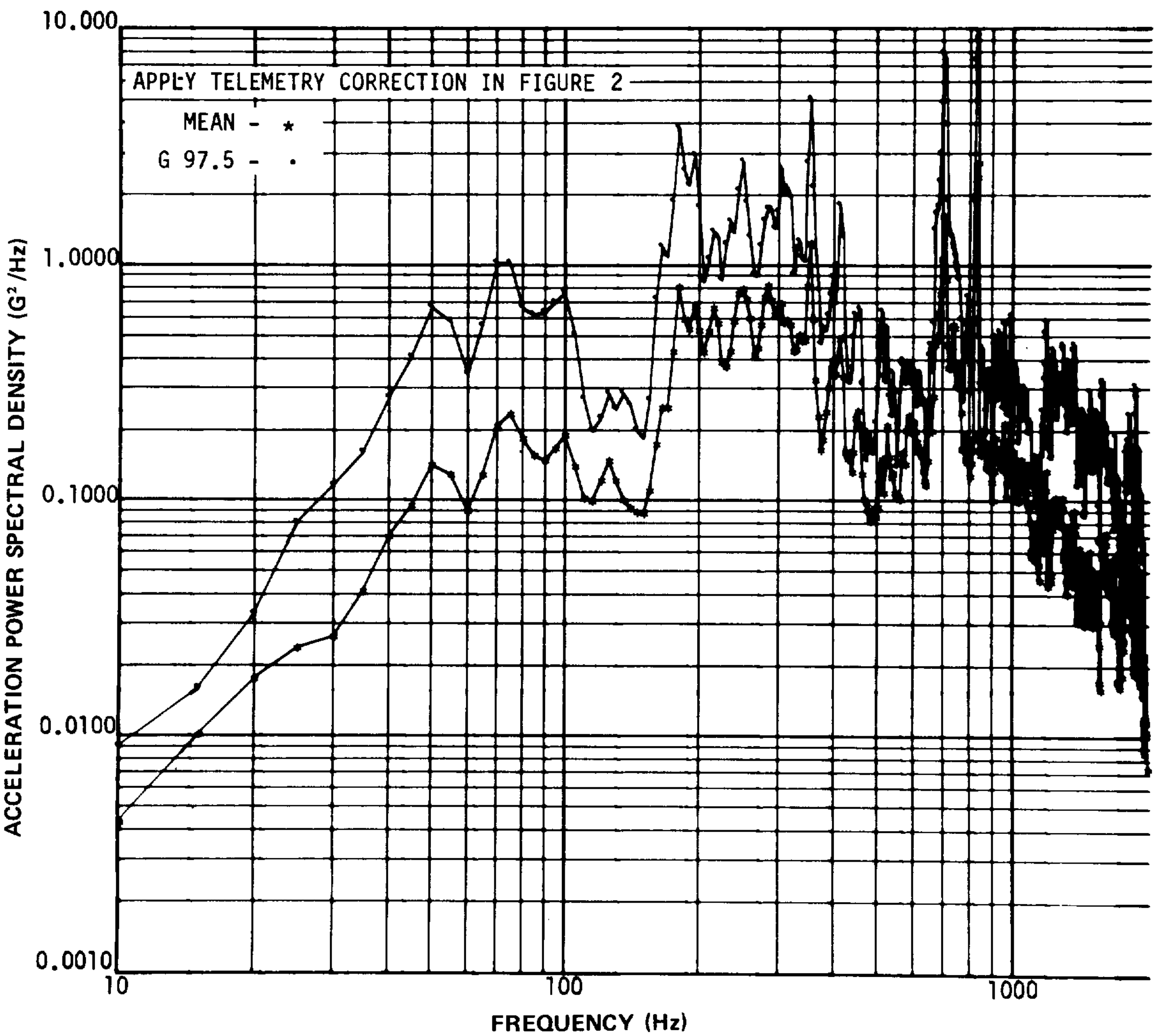


Figure A-21. Ring frame acceleration power spectral density, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST
CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 19.25
COMPOSITE 97.5 – 30.33
VEHICLE DIAMETER – 6.7 m (22 ft)

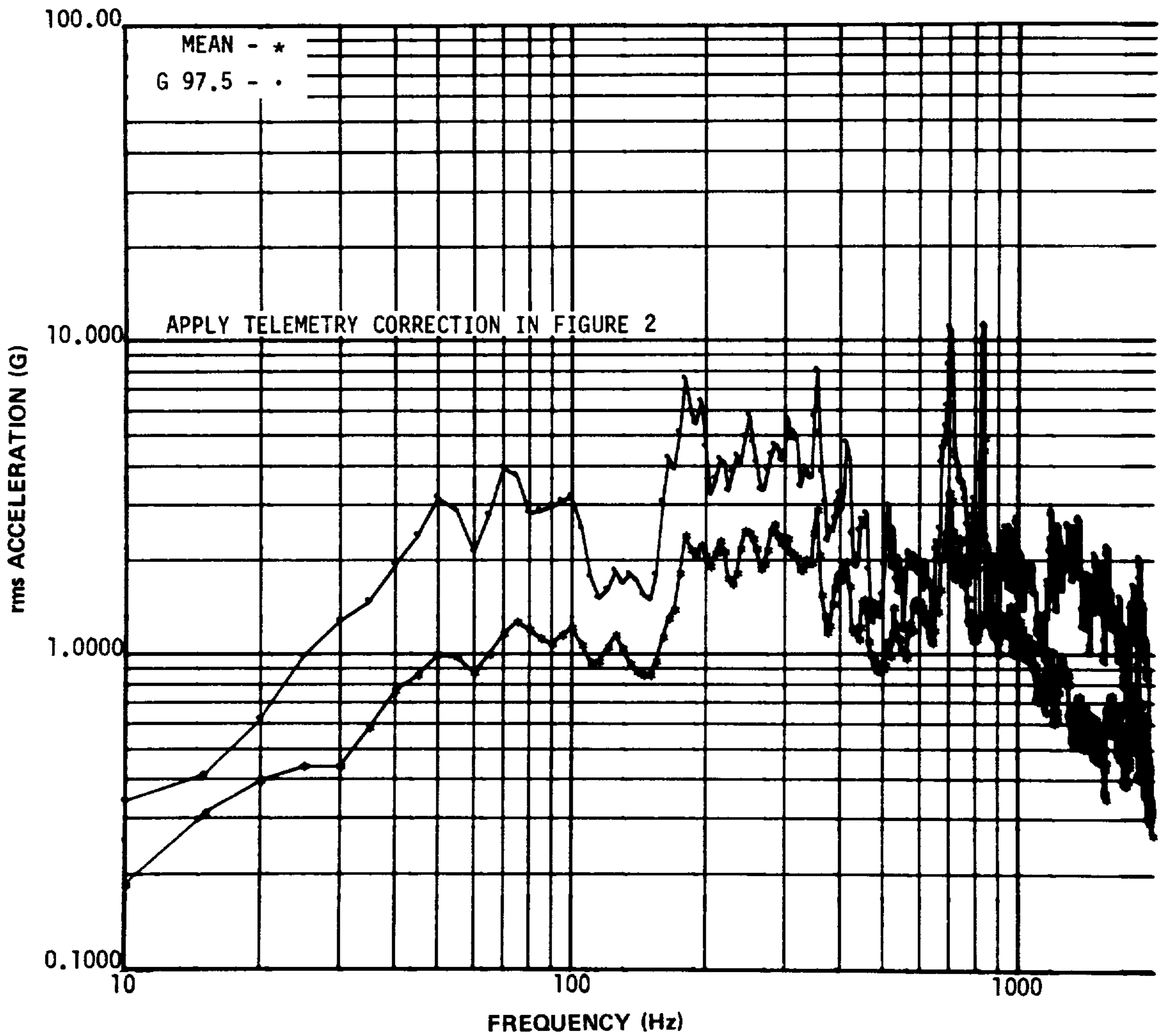


Figure A-22. Ring frame rms acceleration, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 20.20
COMPOSITE 97.5 – 30.68
VEHICLE DIAMETER – 6.7 m (22 ft)

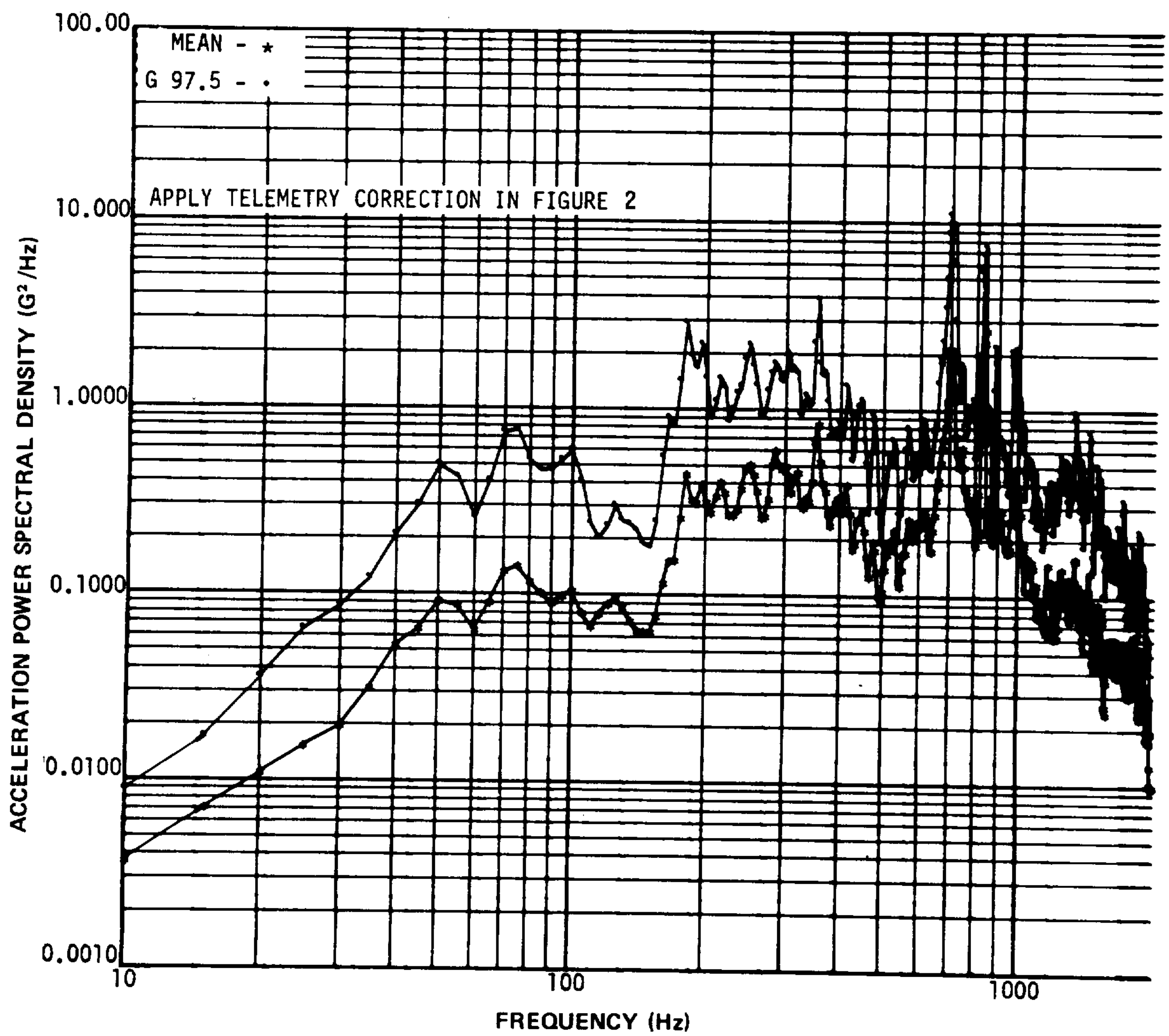


Figure A-23. Ring frame acceleration power spectral density, radial, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .081 cm (.032 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.41 kg/m (.95 lb/ft)
STRINGER SEPARATION – 19.18 cm (7.55 in.)
STRINGER WEIGHT – .70 kg/m (.47 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 20.20
COMPOSITE 97.5 – 30.68
VEHICLE DIAMETER – 6.7 m (22 ft)

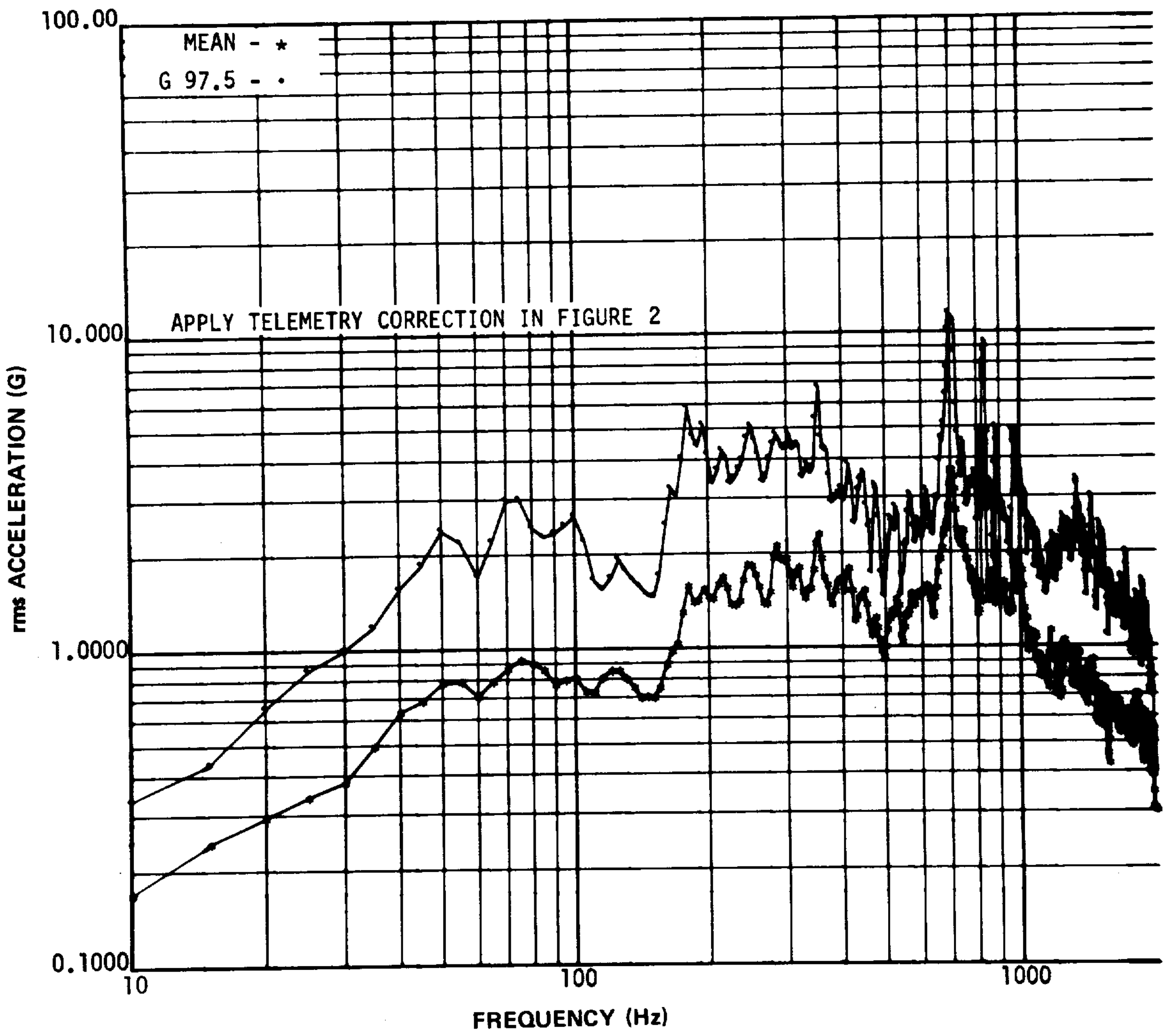


Figure A-24. Ring frame rms acceleration, radial, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .10 cm (.040 in.)
RING SEPARATION – N/A
RING WEIGHT – 3.73 kg/m (2.51 lb/ft)
STRINGER SEPARATION – 22 cm (8.63 in.)
STRINGER WEIGHT – 1.06 kg/m (.71 lb/ft)

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.44
COMPOSITE 97.5 – 29.24
VEHICLE DIAMETER – 10.06 m (33 ft)

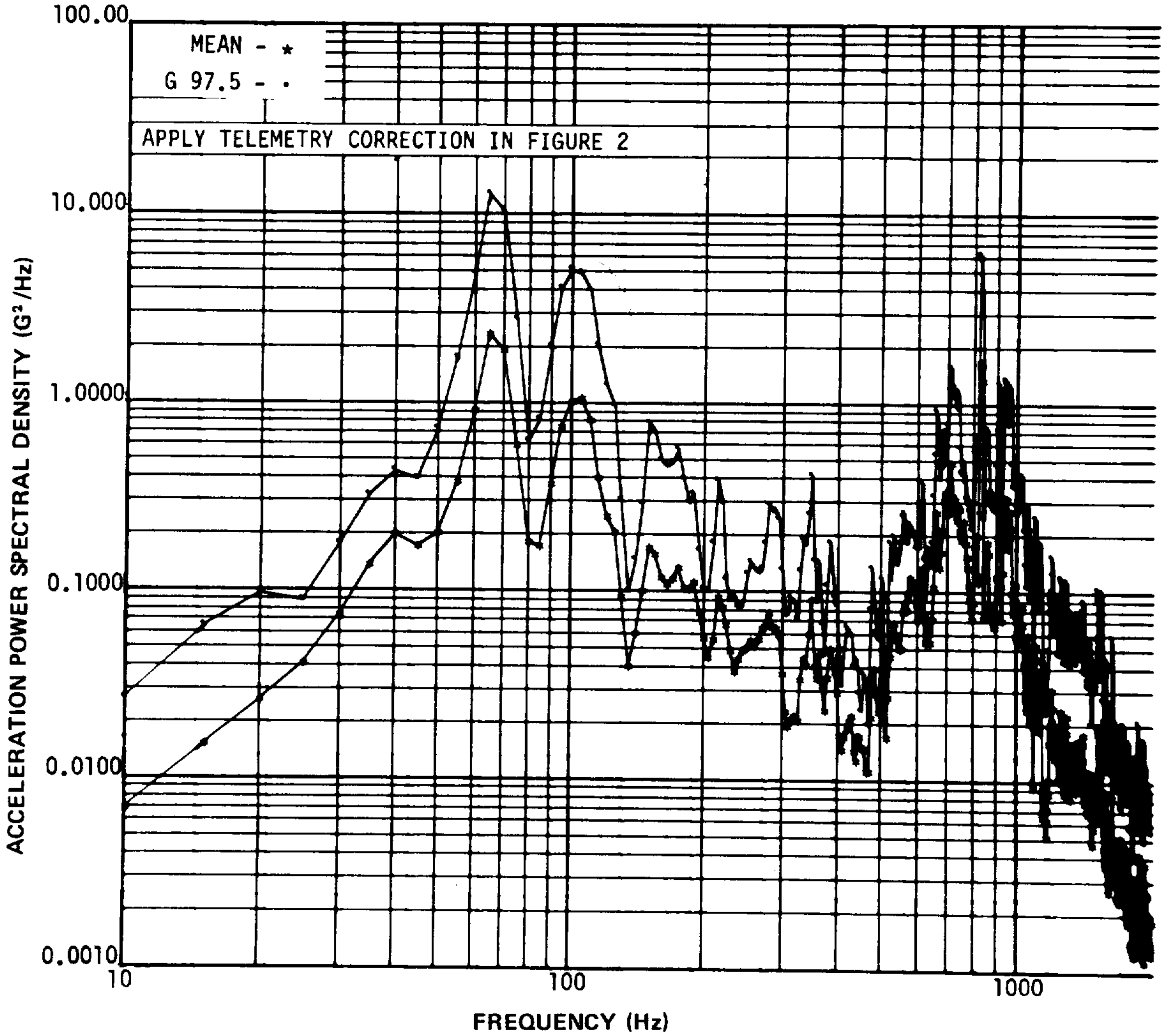


Figure A-25. Ring frame acceleration power spectral density, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .10 cm (.040 in.)
RING SEPARATION – N/A
RING WEIGHT – 3.73 kg/m (2.51 lb/ft)
STRINGER SEPARATION – 22 cm (8.63 in.)
STRINGER WEIGHT – 1.06 kg/m (.71 lb/ft)

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.44
COMPOSITE 97.5 – 29.24
VEHICLE DIAMETER – 10.06 m (33 ft)

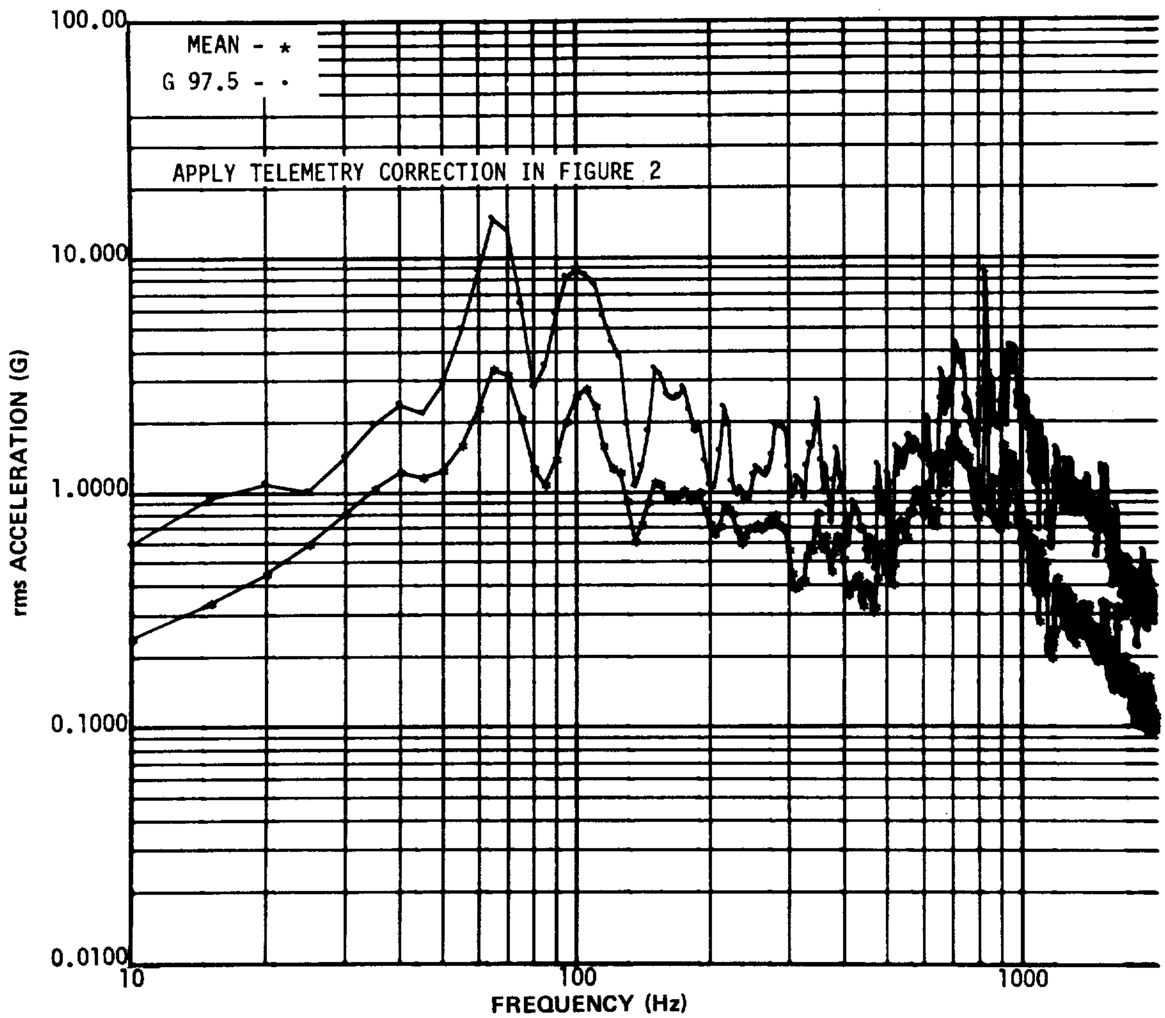


Figure A-26. Ring frame rms acceleration, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – 1.0 cm (.40 in.)
RING SEPARATION – N/A
RING WEIGHT – 3.73 kg/m (2.51 lb/ft)
STRINGER SEPARATION – 22 cm (8.63 in.)
STRINGER WEIGHT – 1.06 kg/m (.71 lb/ft)

FLIGHT OR TEST
CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.24
COMPOSITE 97.5 – 27.87
VEHICLE DIAMETER – 10.06 m (33 ft)

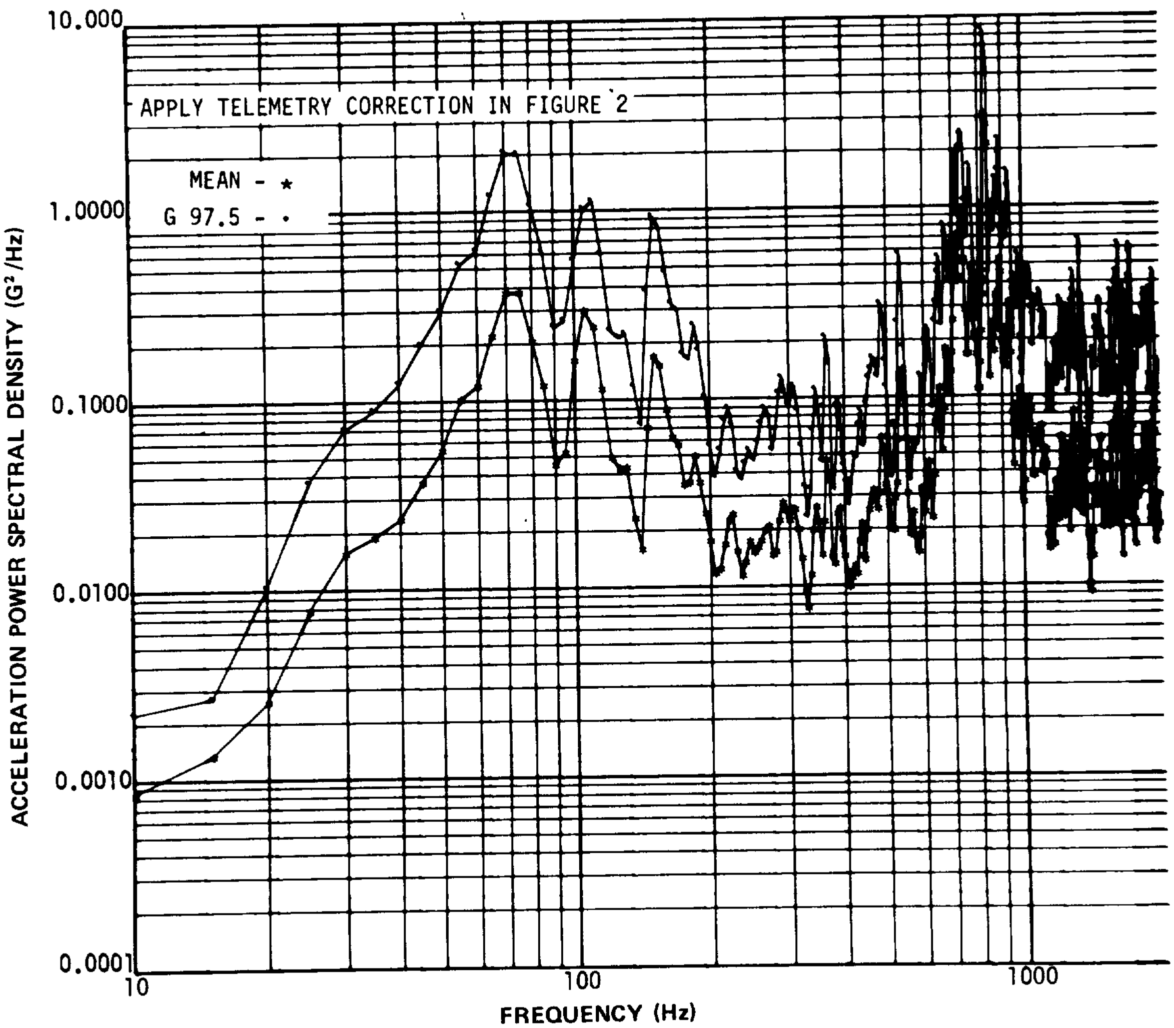


Figure A-27. Ring frame acceleration power spectral density, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – 1.0 cm (.40 in.)
RING SEPARATION – N/A
RING WEIGHT – 3.73 kg/m (2.51 lb/ft)
STRINGER SEPARATION – 22 cm (8.63 in.)
STRINGER WEIGHT – 1.06 kg/m (.71 lb/ft)

FLIGHT OR TEST
CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.24
COMPOSITE 97.5 – 27.87
VEHICLE DIAMETER – 10.06 m (33 ft)

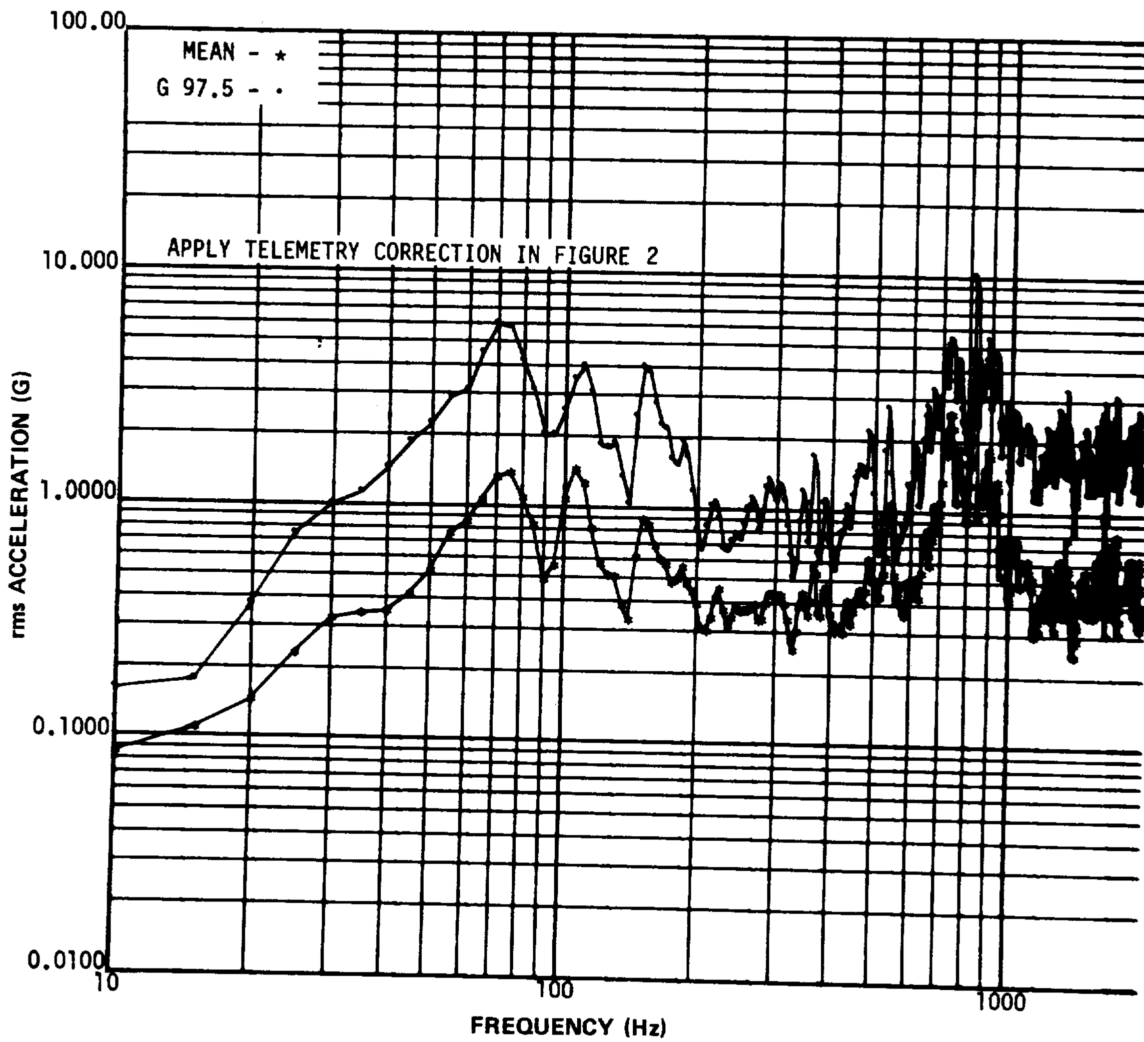


Figure A-28. Ring frame rms acceleration, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .10 to .18 cm
(.040 to .071 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.62 to 2.22 kg/m
(1.09 to 1.49 lb/ft)
STRINGER SEPARATION – 14.63 to 21.92 cm
(5.76 to 8.63 in.)

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 17.03
COMPOSITE 97.5 – 34.71
VEHICLE DIAMETER – 10.06 m (33 ft)
STRINGER WEIGHT – 1.06 to 1.488 kg/m
(.71 to 1.0 lb/ft)

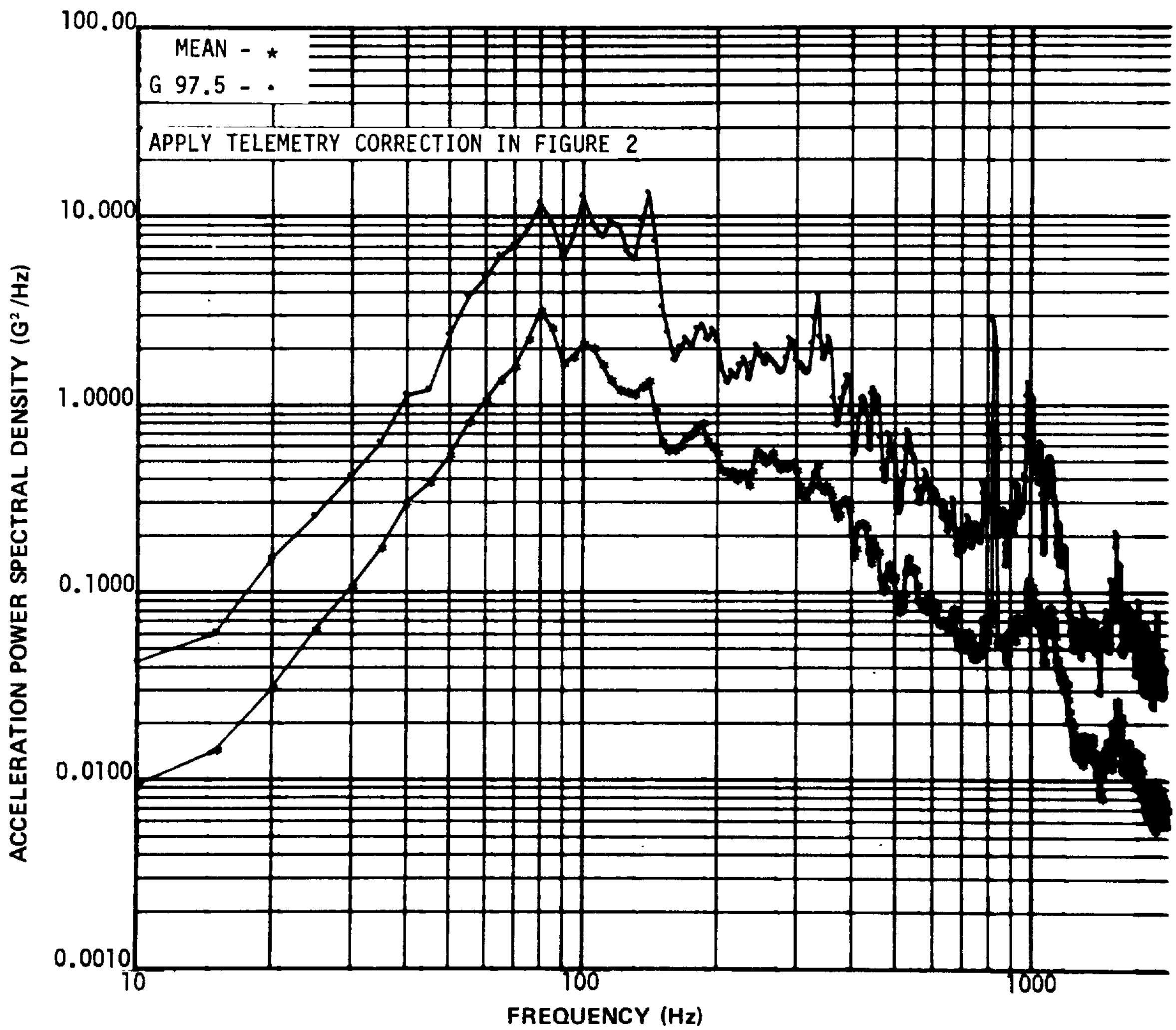


Figure A-29. Ring frame acceleration power spectral density, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .10 to .18 cm
(.040 to .071 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.62 to 2.22 kg/m
(1.09 to 1.49 lb/ft)
STRINGER SEPARATION – 14.63 to 21.92 cm
(5.76 to 8.63 in.)

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 17.03
COMPOSITE 97.5 – 34.71
VEHICLE DIAMETER – 10.06 m (33 ft)
STRINGER WEIGHT – 1.06 to 1.488 kg/m
(.71 to 1.0 lb/ft)

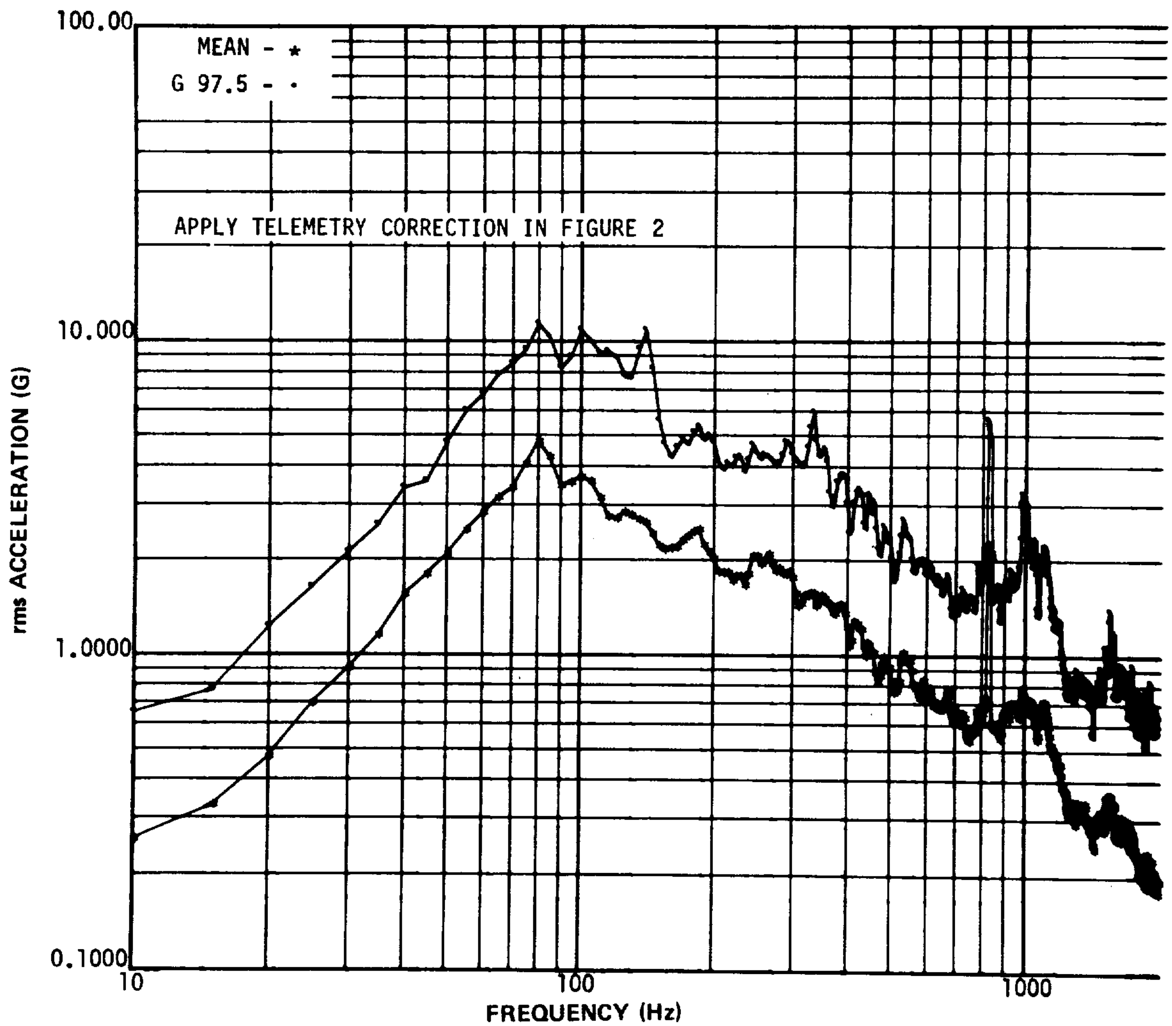


Figure A-30. Ring frame rms acceleration, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .10 to .18 cm
(.040 to .071 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.62 to 2.22 kg/m
(1.09 to 1.49 lb/ft)
STRINGER SEPARATION – 14.63 to 21.92 cm
(5.76 to 8.63 in.)

FLIGHT OR TEST
CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 13.32
COMPOSITE 97.5 – 42.33
VEHICLE DIAMETER – 10.06 m (33 ft)
STRINGER WEIGHT – 1.06 to 1.488 kg/m
(.71 to 1.0 lb/ft)

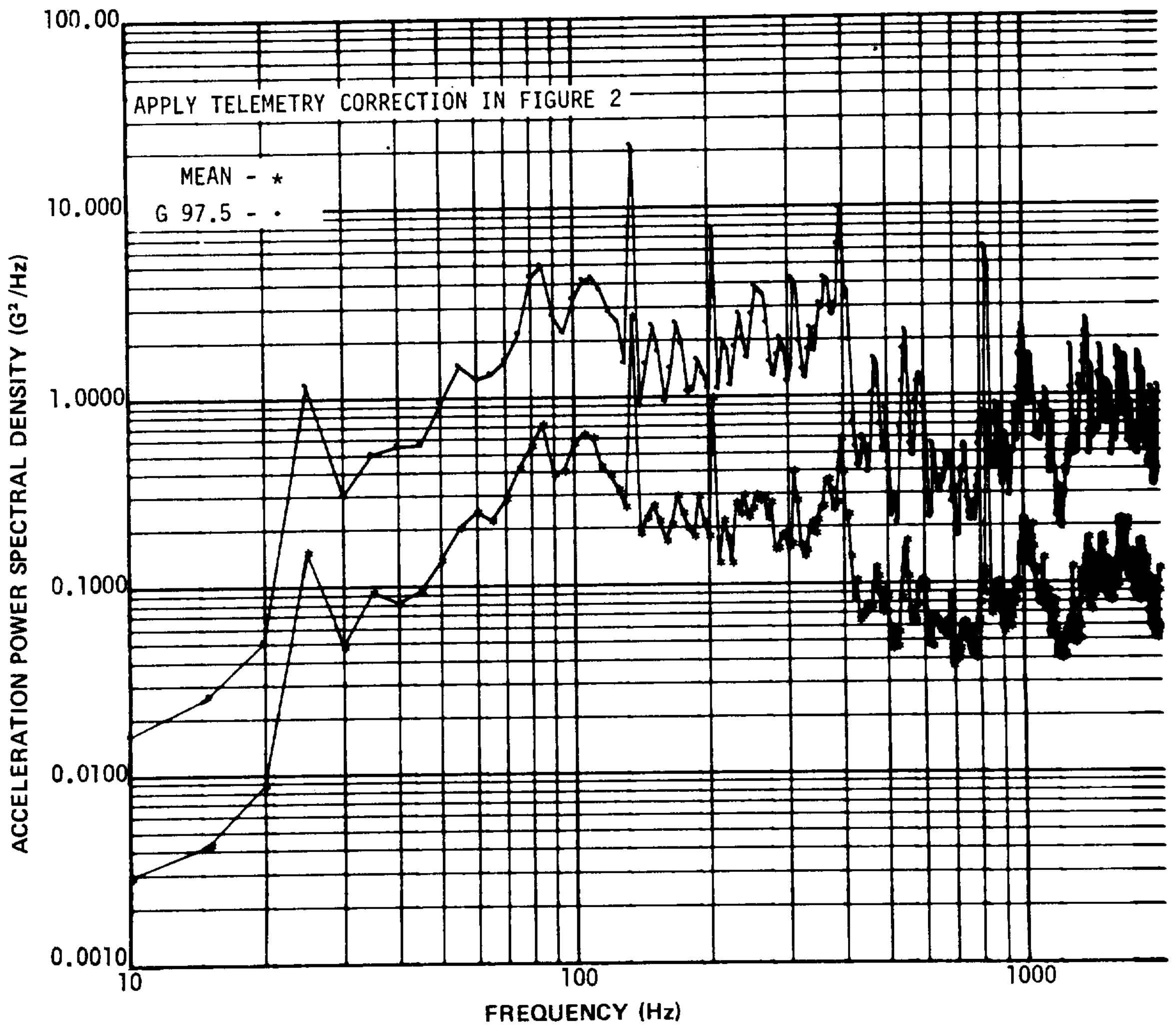


Figure A-31. Ring frame acceleration power spectral density, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .10 to .18 cm (.040 to .071 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.62 to 2.22 kg/m (1.09 to 1.49 lb/ft)
STRINGER SEPARATION – 14.63 to 21.92 cm (5.76 to 8.63 in.)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 13.32
COMPOSITE 97.5 – 42.33
VEHICLE DIAMETER – 10.06 m (33 ft)
STRINGER WEIGHT – 1.06 to 1.488 kg/m (.71 to 1.0 lb/ft)

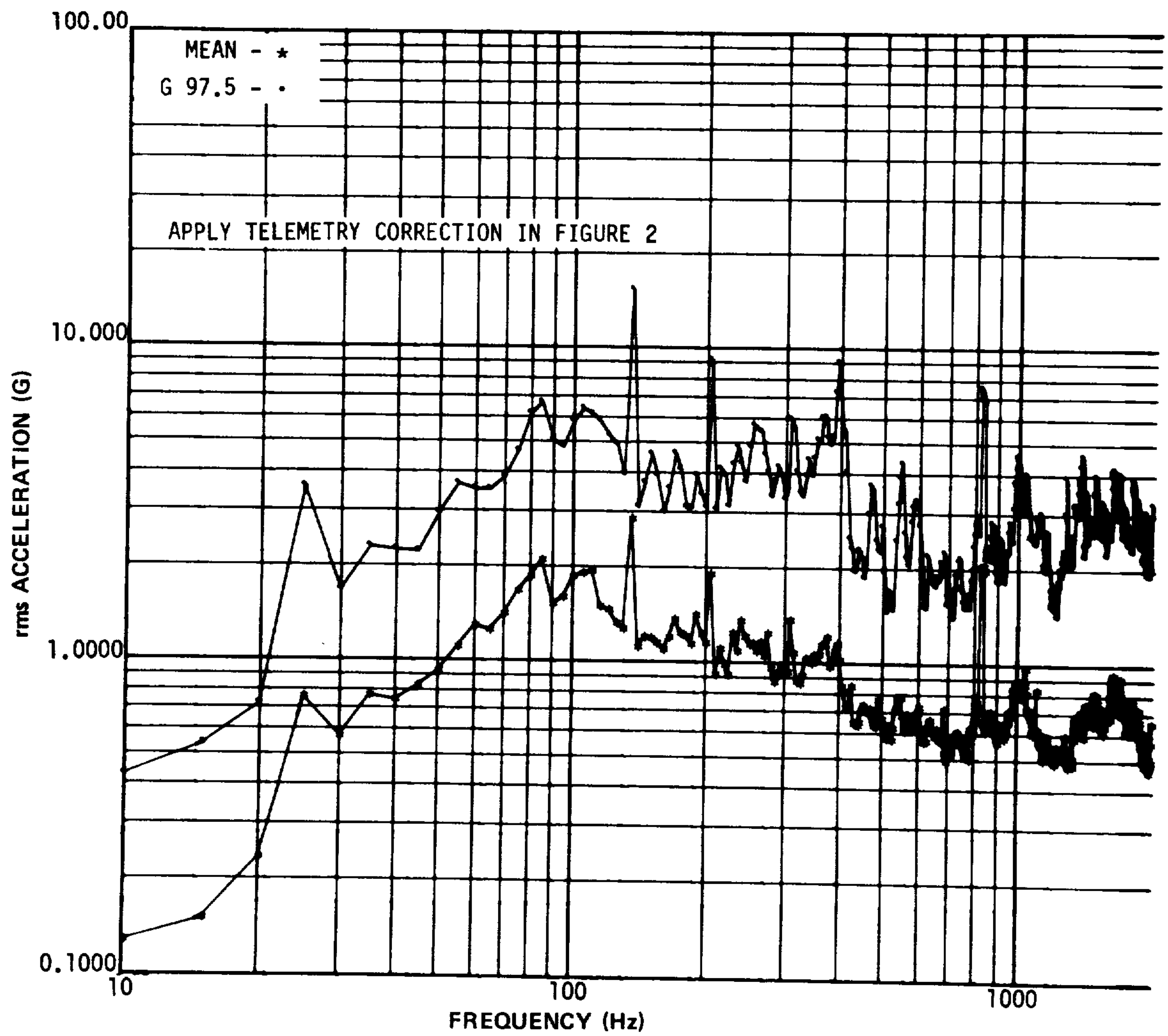


Figure A-32. Ring frame rms acceleration, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .10 to .18 cm
(.040 to .071 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.62 to 2.22 kg/m
(1.09 to 1.49 lb/ft)
STRINGER SEPARATION – 14.63 to 21.92 cm
(5.76 to 8.63 in.)

FLIGHT OR TEST
CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.53
COMPOSITE 97.5 – 25.83
VEHICLE DIAMETER – 10.06 m (33 ft)
STRINGER WEIGHT – 1.06 to 1.488 kg/m
(.71 to 1.0 lb/ft)

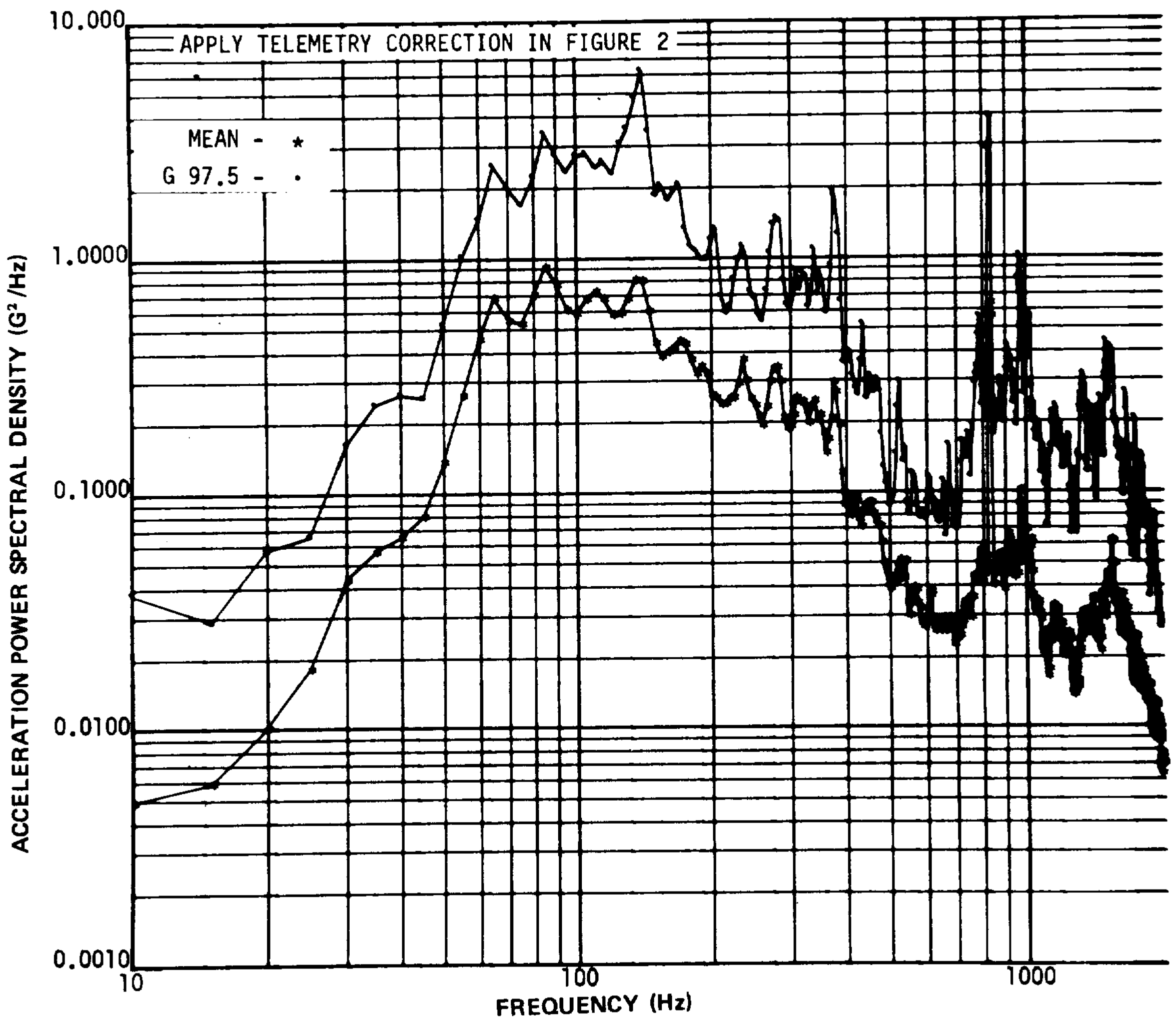


Figure A-33. Ring frame acceleration power spectral density, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .10 to .18 cm
(.040 to .071 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.62 to 2.22 kg/m
(1.09 to 1.49 lb/ft)
STRINGER SEPARATION – 14.63 to 21.92 cm
(5.76 to 8.63 in.)

FLIGHT OR TEST
CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.53
COMPOSITE 97.5 – 25.83
VEHICLE DIAMETER – 10.06 m (33 ft)
STRINGER WEIGHT – 1.06 to 1.488 kg/m
(.71 to 1.0 lb/ft)

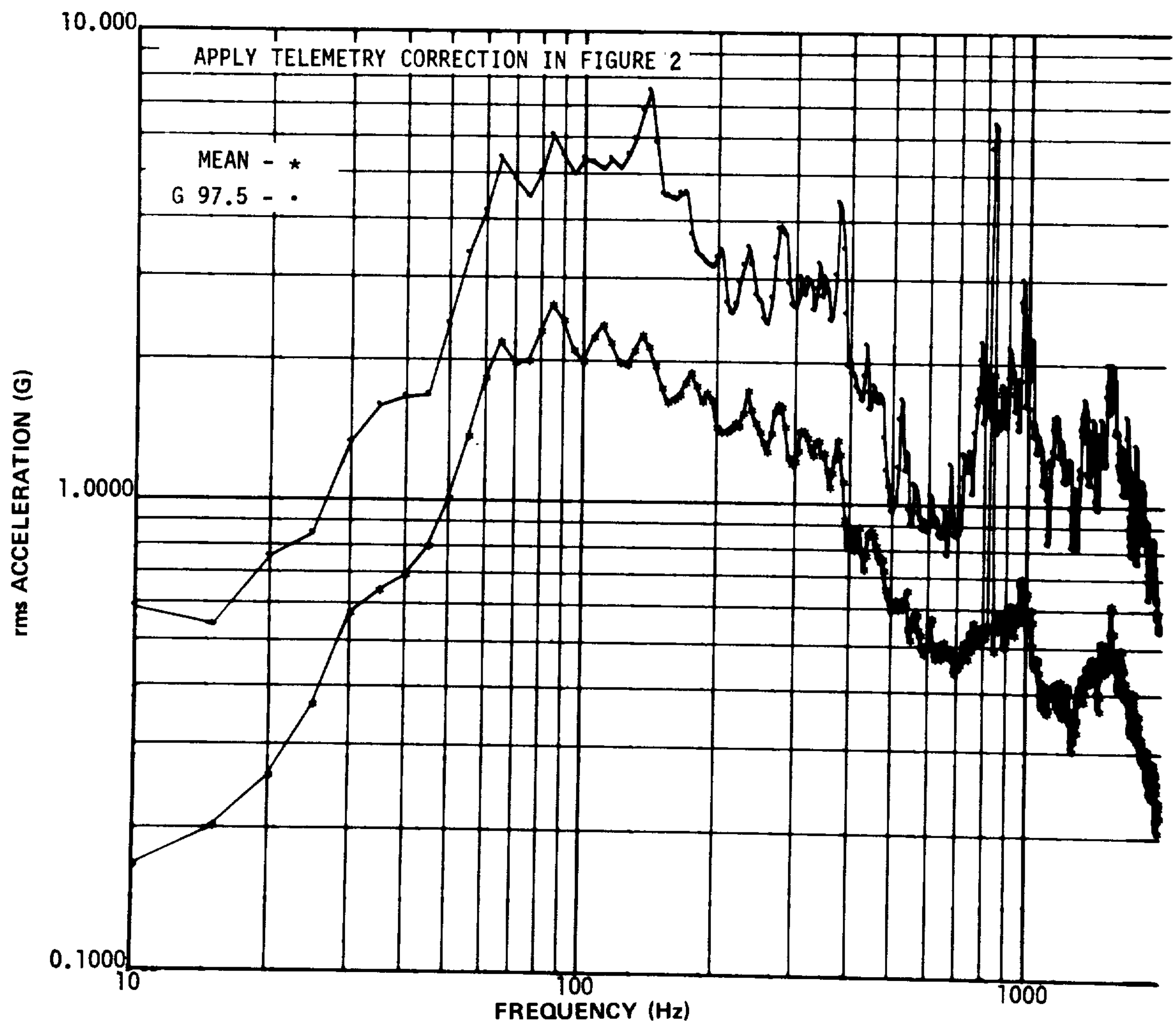


Figure A-34. Ring frame rms acceleration, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .10 to .18 cm
(.040 to .071 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.62 to 2.22 kg/m
(1.09 to 1.49 lb/ft)
STRINGER SEPARATION – 14.63 to 21.92 cm
(5.76 to 8.63 in.)

FLIGHT OR TEST CONDITION –
TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.94
COMPOSITE 97.5 – 36.46
VEHICLE DIAMETER – 10.06 m (33 ft)
STRINGER WEIGHT – 1.06 to 1.488 kg/m
(.71 to 1.0 lb/ft)

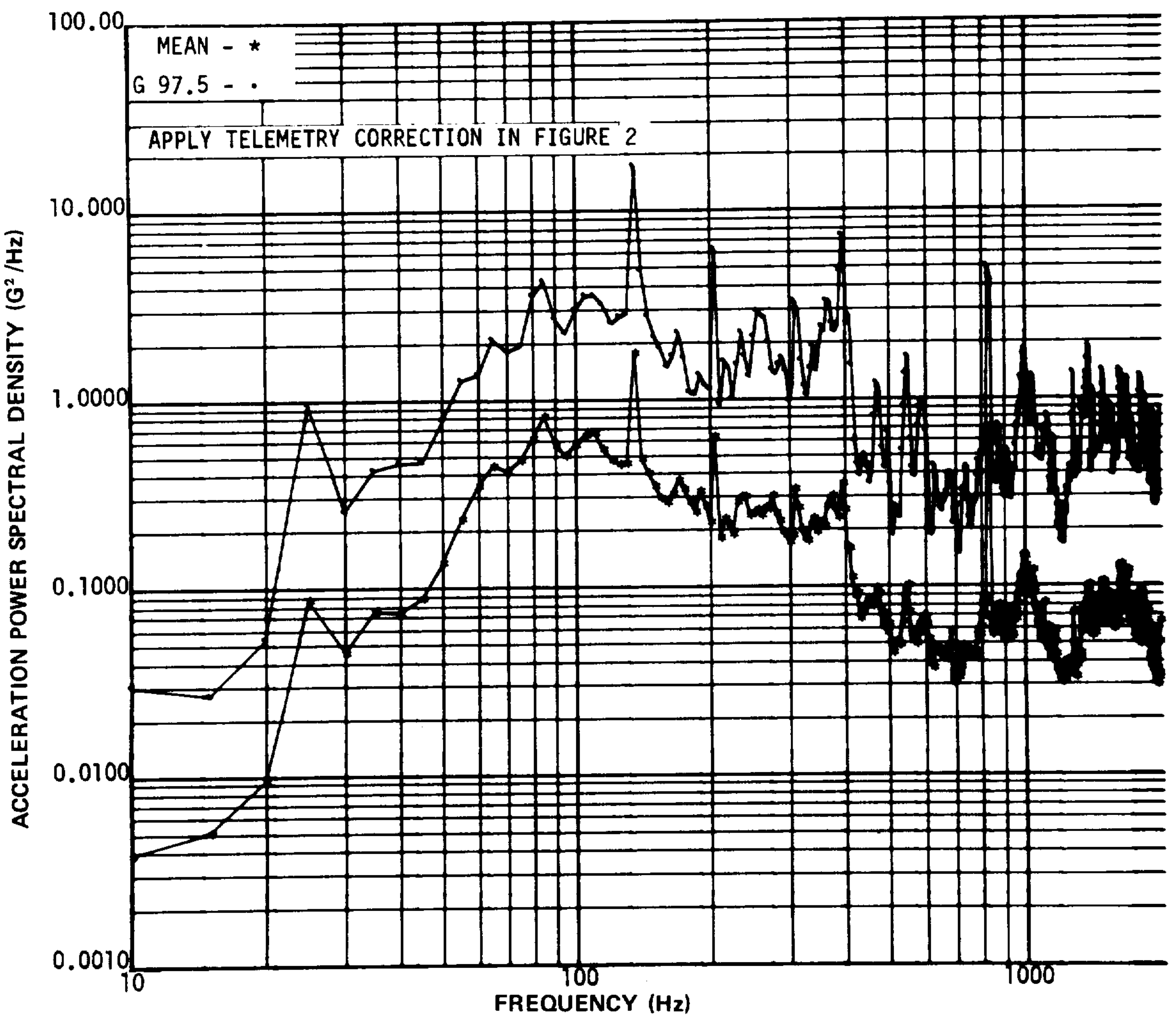


Figure A-35. Ring frame acceleration power spectral density, radial, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .16 to .18 cm
(.040 to .071 in.)
RING SEPARATION – N/A
RING WEIGHT – 1.62 to 2.22 kg/m
(1.09 to 1.49 lb/ft)
STRINGER SEPARATION – 14.63 to 21.92 cm
(5.76 to 8.63 in.)

FLIGHT OR TEST CONDITION –
TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 12.94
COMPOSITE 97.5 – 36.46
VEHICLE DIAMETER – 10.06 m (33 ft)
STRINGER WEIGHT – 1.06 to 1.488 kg/m
(.71 to 1.0 lb/ft)

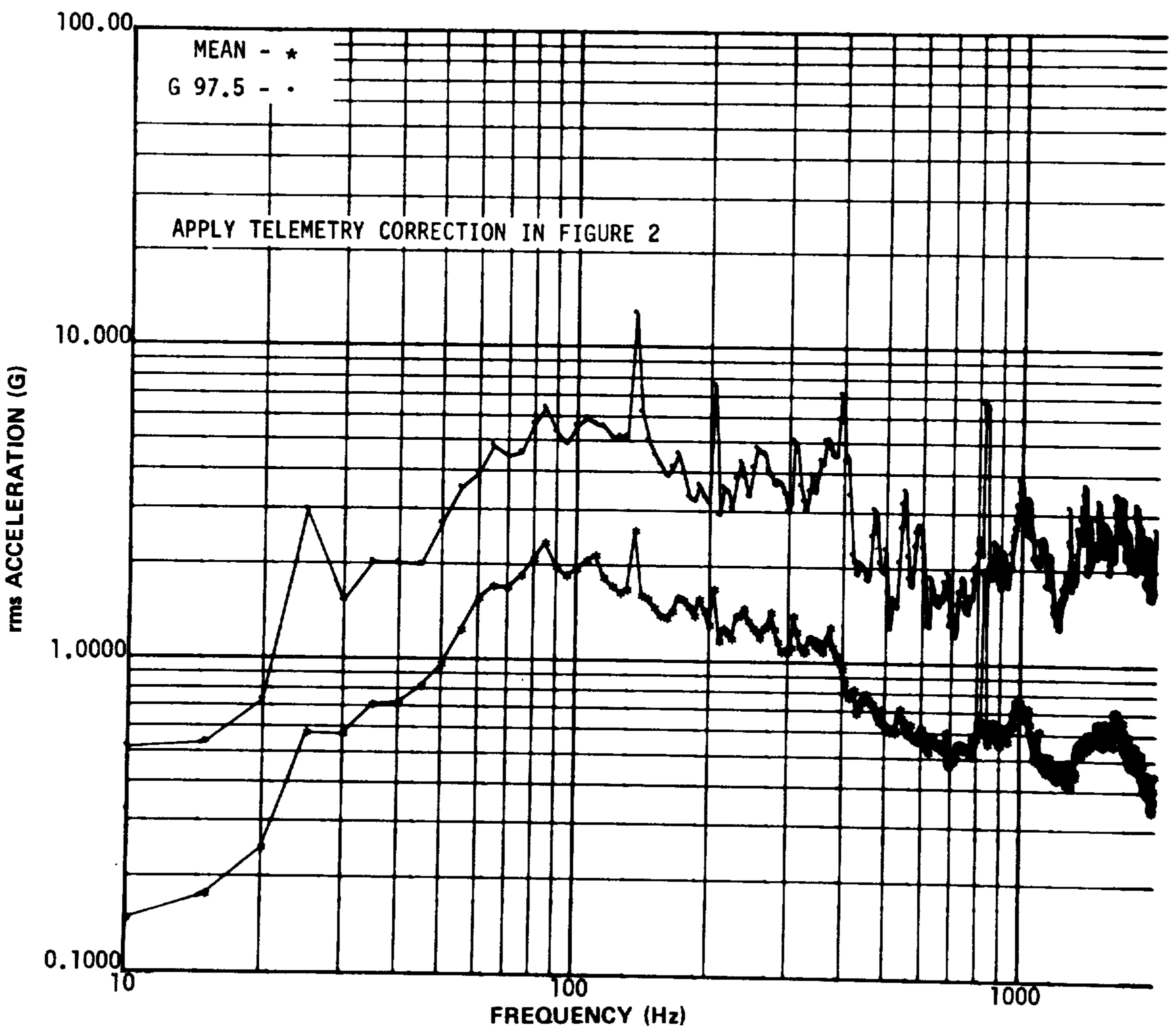


Figure A-36. Ring frame rms acceleration, radial, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .254 cm (.10 in.)
RING SEPARATION – N/A
RING WEIGHT – 8.23 kg/m (5.53 lb/ft)
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.488 kg/m (1.0 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.62
COMPOSITE 97.5 – 19.77
VEHICLE DIAMETER – 10.06 m (33 ft)

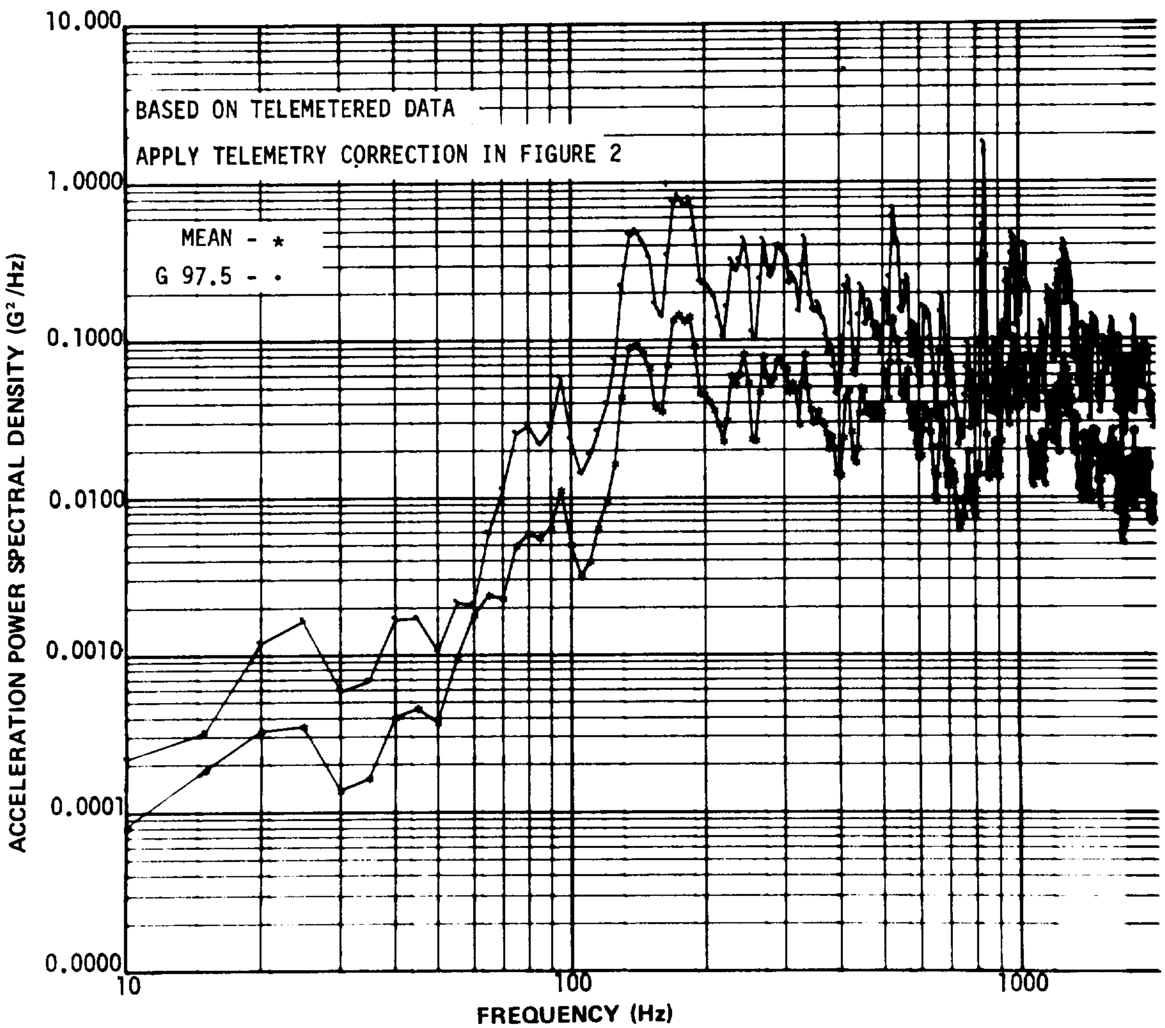


Figure A-37. Ring frame acceleration power spectral density, radial, static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .254 cm (.10 in.)
RING SEPARATION – N/A
RING WEIGHT – 8.23 kg/m (5.53 lb/ft)
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.488 kg/m (1.0 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.62
COMPOSITE 97.5 – 19.77
VEHICLE DIAMETER – 10.06 m (33 ft)

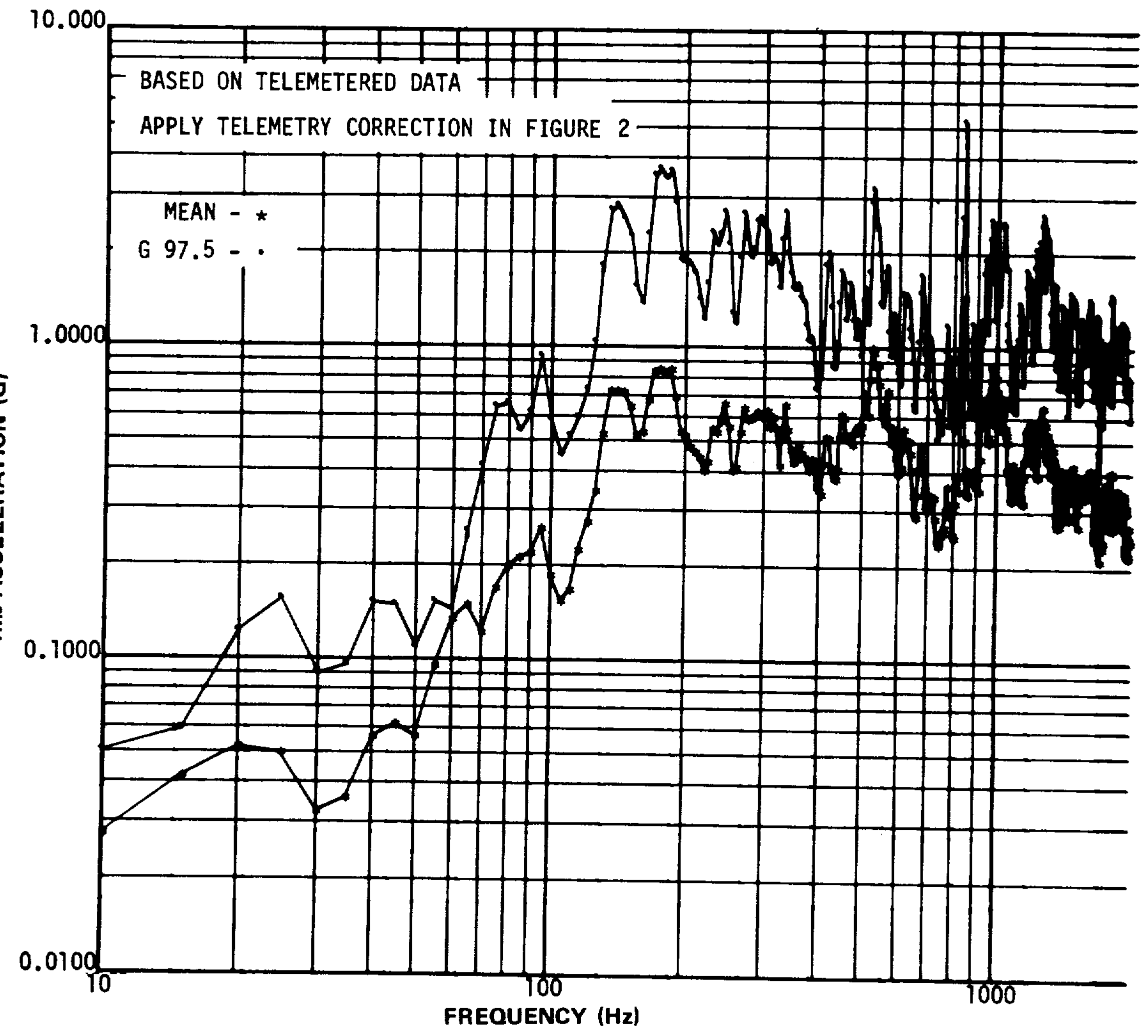


Figure A-38. Ring frame rms acceleration, radial, static firing.

DIRECTION – PARALLEL TO THRUST STRUCTURE
SKIN THICKNESS – .20 to .33 cm
(.08 to .13 in.)
RING SEPARATION – N/A
RING WEIGHT – 6.95 to 11.83 kg/m
(4.67 to 7.95 lb/ft)
STRINGER SEPARATION – 12.32 cm (4.85 in.)

FLIGHT OR TEST CONDITION –
STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 4.12
COMPOSITE 97.5 – 6.84
VEHICLE DIAMETER – 7.68 m (25.2 ft)
STRINGER WEIGHT – 1.58 kg/m (1.04 lb/ft)

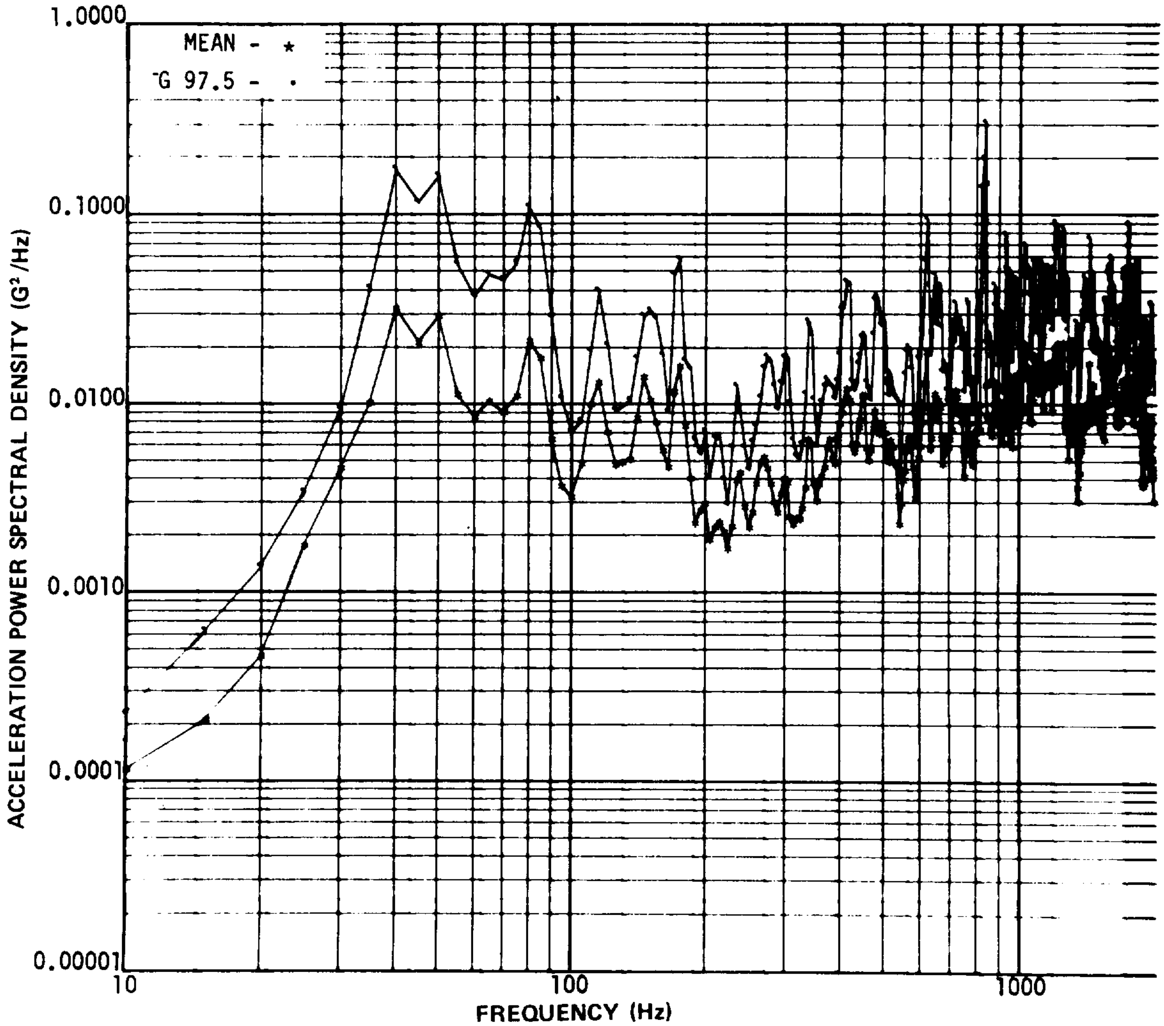


Figure A-39. Ring frame acceleration power spectral density, parallel to thrust structure, static firing.

DIRECTION – PARALLEL TO THRUST STRUCTURE
SKIN THICKNESS – .20 to .33 cm (.08 to .13 in.)
RING SEPARATION – N/A
RING WEIGHT – 6.95 to 11.83 kg/m (4.67 to 7.95 lb/ft)
STRINGER SEPARATION – 12.32 cm (4.85 in.)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 4.12
COMPOSITE 97.5 – 6.84
VEHICLE DIAMETER – 7.68 m (25.2 ft)
STRINGER WEIGHT – 1.58 kg/m (1.04 lb/ft)

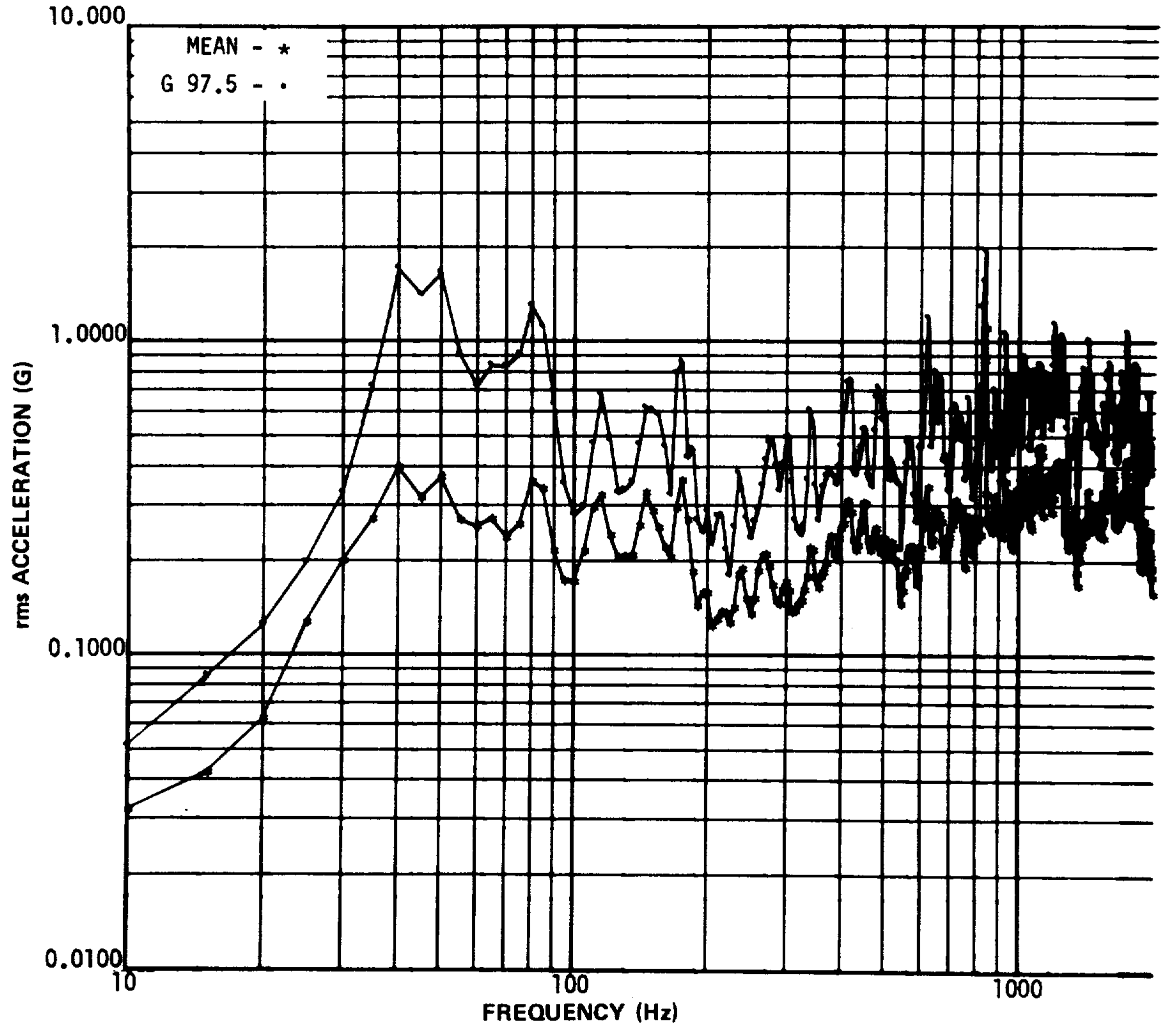


Figure A-40. Ring frame rms acceleration, parallel to thrust structure, static firing.

DIRECTION – NORMAL TO THRUST STRUCTURE
SKIN THICKNESS – .33 cm (.13 in.)
RING SEPARATION – N/A
RING WEIGHT – 16.95 kg/m (11.39 lb/ft)
STRINGER SEPARATION – 17.07 cm (6.72 in.)
STRINGER WEIGHT – 1.58 kg/m (1.04 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.94
COMPOSITE 97.5 – 11.53
VEHICLE DIAMETER – 5.33 m (17.5 ft)

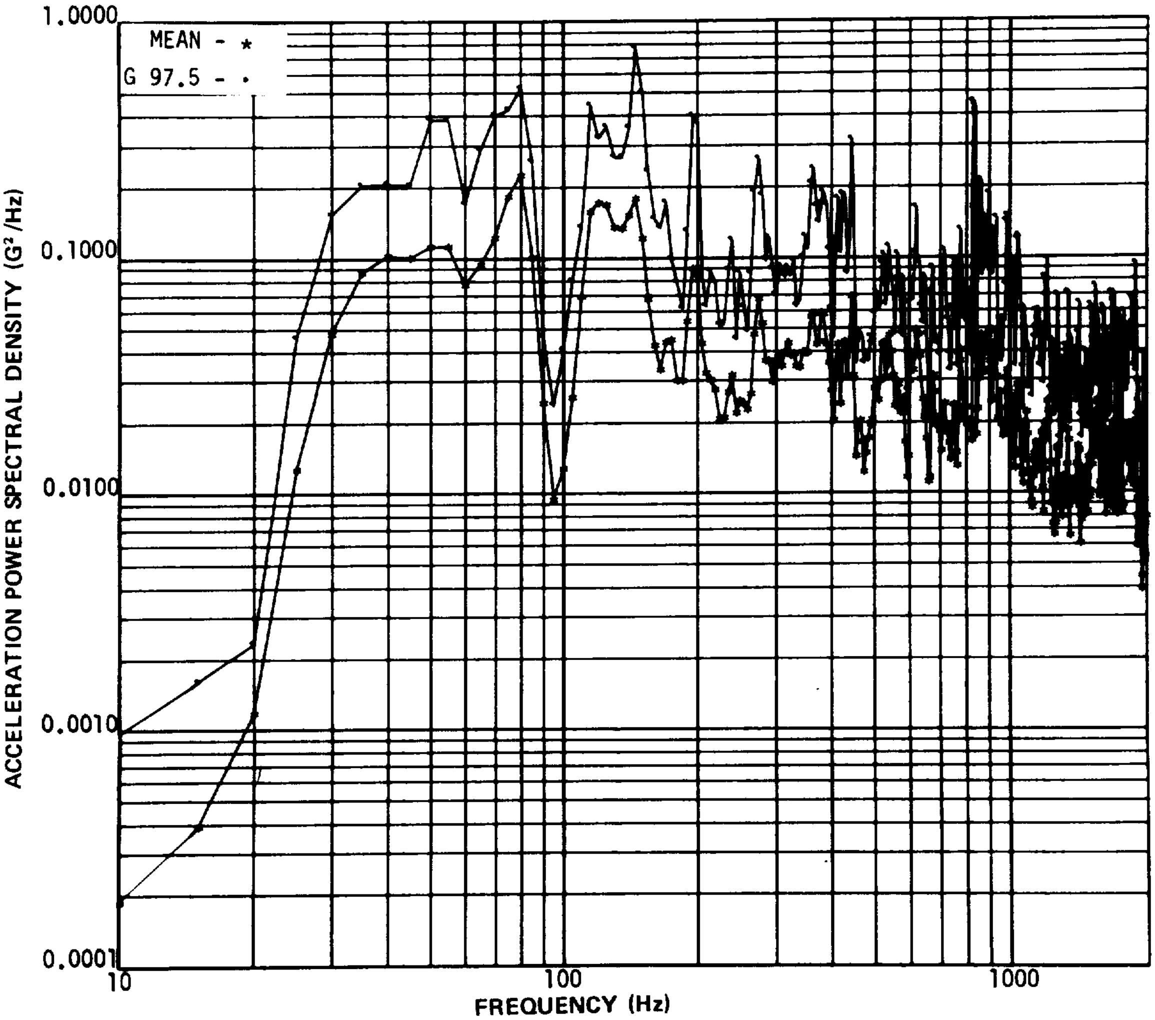


Figure A-41. Ring frame acceleration power spectral density, normal to thrust structure, static firing.

DIRECTION – NORMAL TO THRUST STRUCTURE
SKIN THICKNESS – .33 cm (.13 in.)
RING SEPARATION – N/A
RING WEIGHT – 16.95 kg/m (11.39 lb/ft)
STRINGER SEPARATION – 17.07 cm (6.72 in.)
STRINGER WEIGHT – 1.58 kg/m (1.04 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.94
COMPOSITE 97.5 – 11.53
VEHICLE DIAMETER – 5.33 m (17.5 ft)

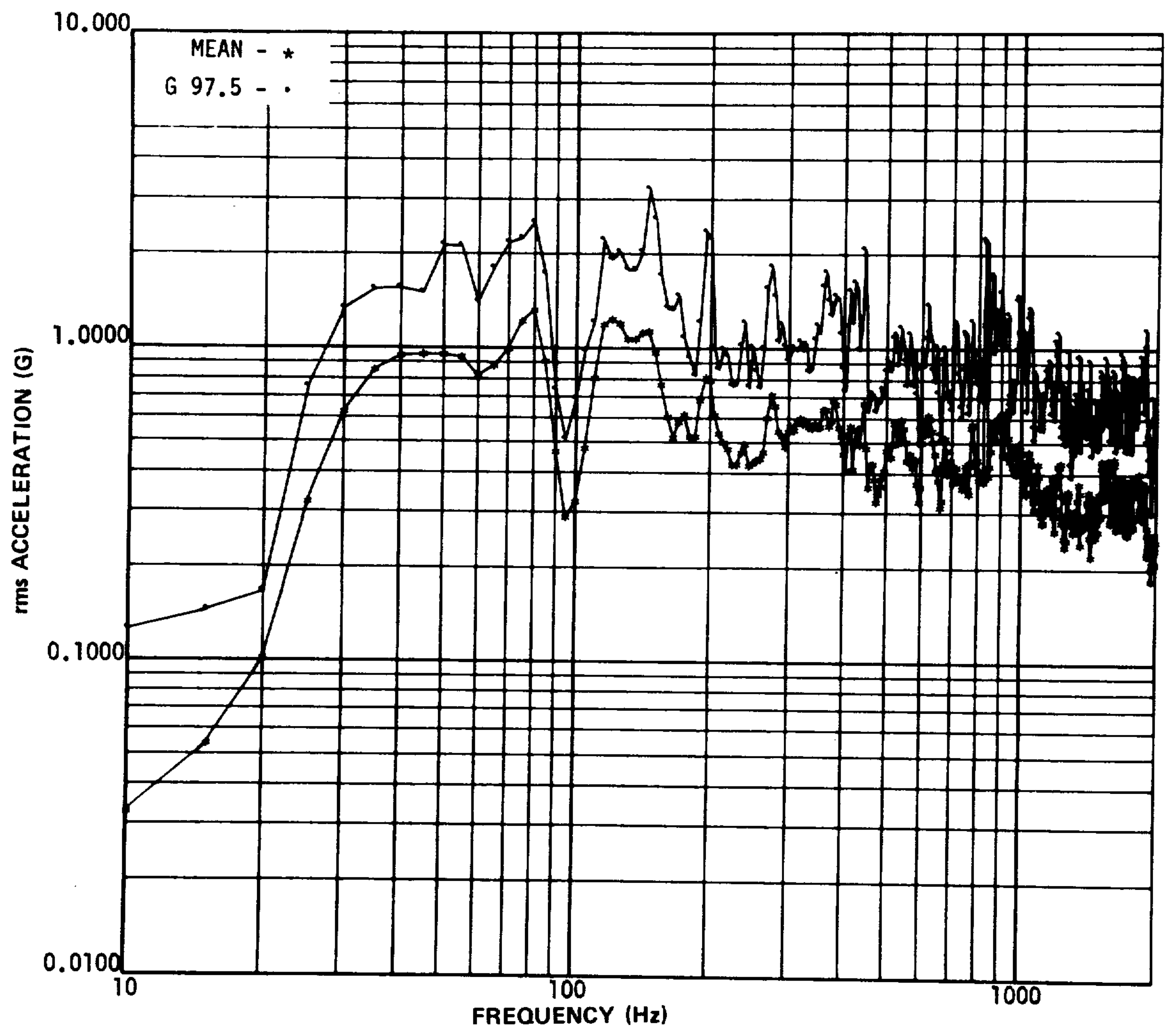


Figure A-42. Ring frame rms acceleration, normal to thrust structure, static firing.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.61
COMPOSITE 97.5 – 9.71
VEHICLE DIAMETER – 10.06 m (33 ft)

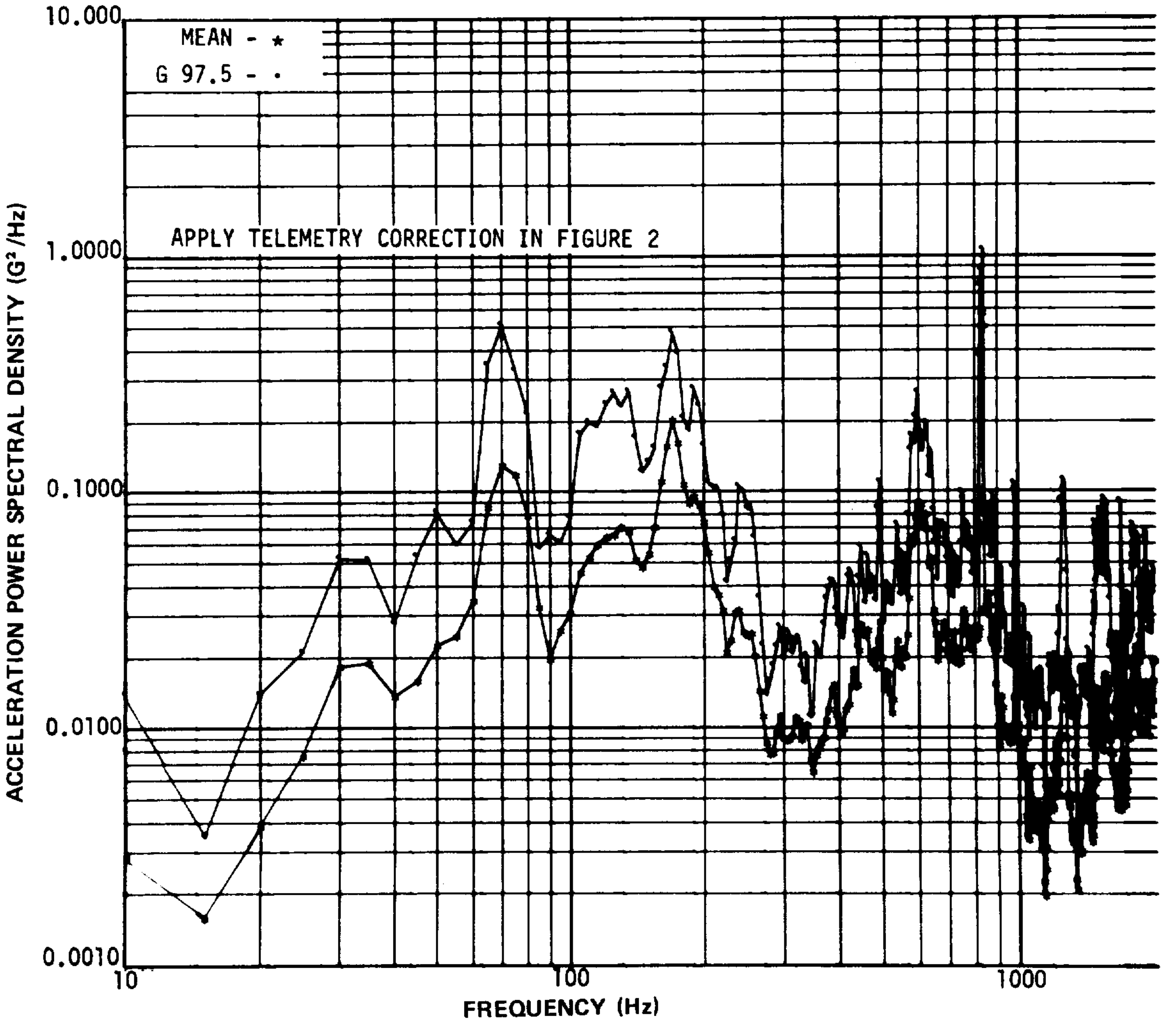


Figure A-43. Ring frame acceleration power spectral density, longitudinal, liftoff.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST
CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.61
COMPOSITE 97.5 – 9.71
VEHICLE DIAMETER – 10.06 m (33 ft)

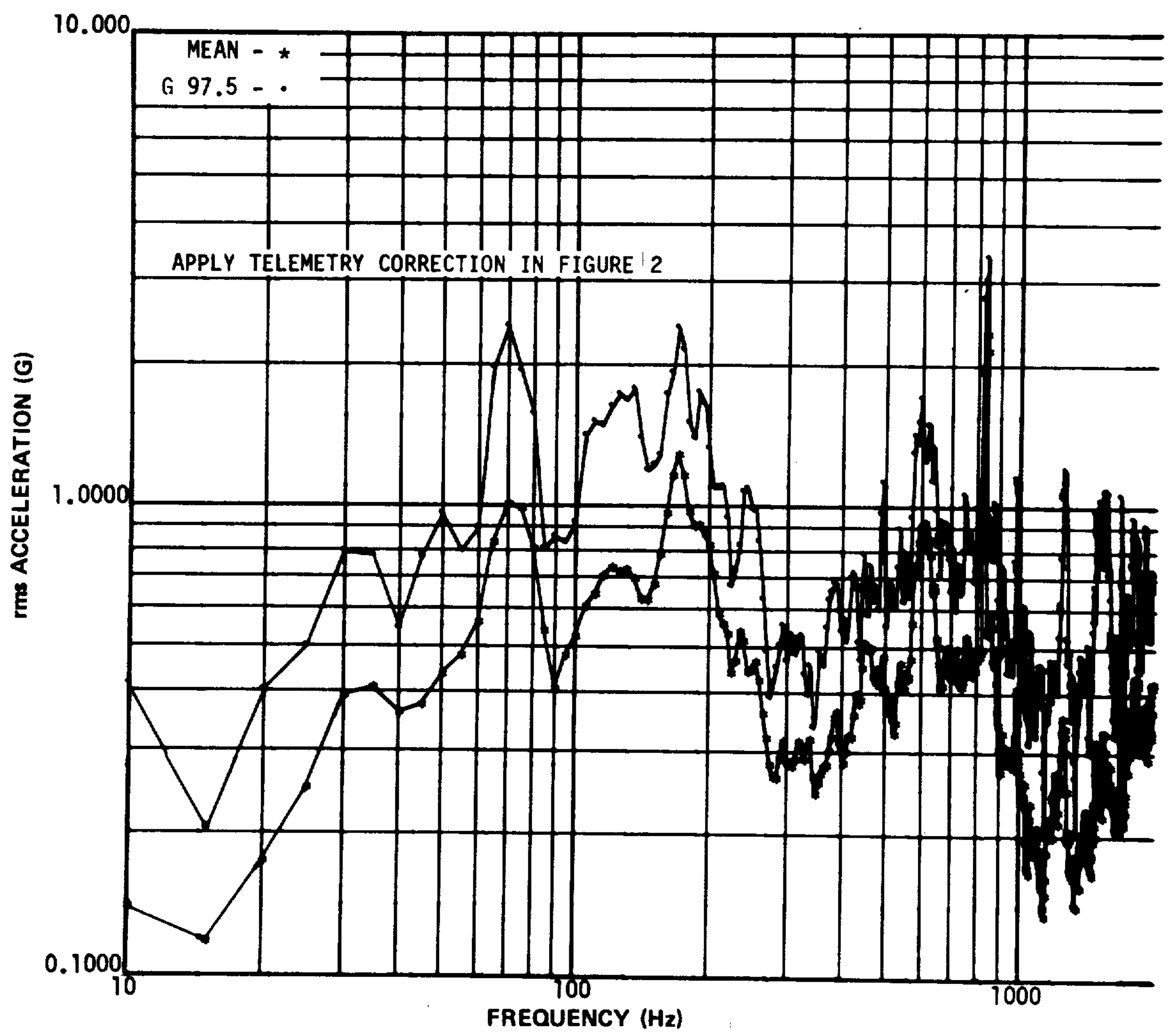


Figure A-44. Ring frame rms acceleration, longitudinal, liftoff.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.03 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 14.30
COMPOSITE 97.5 – 18.73
VEHICLE DIAMETER – 10.06 m (33 ft)

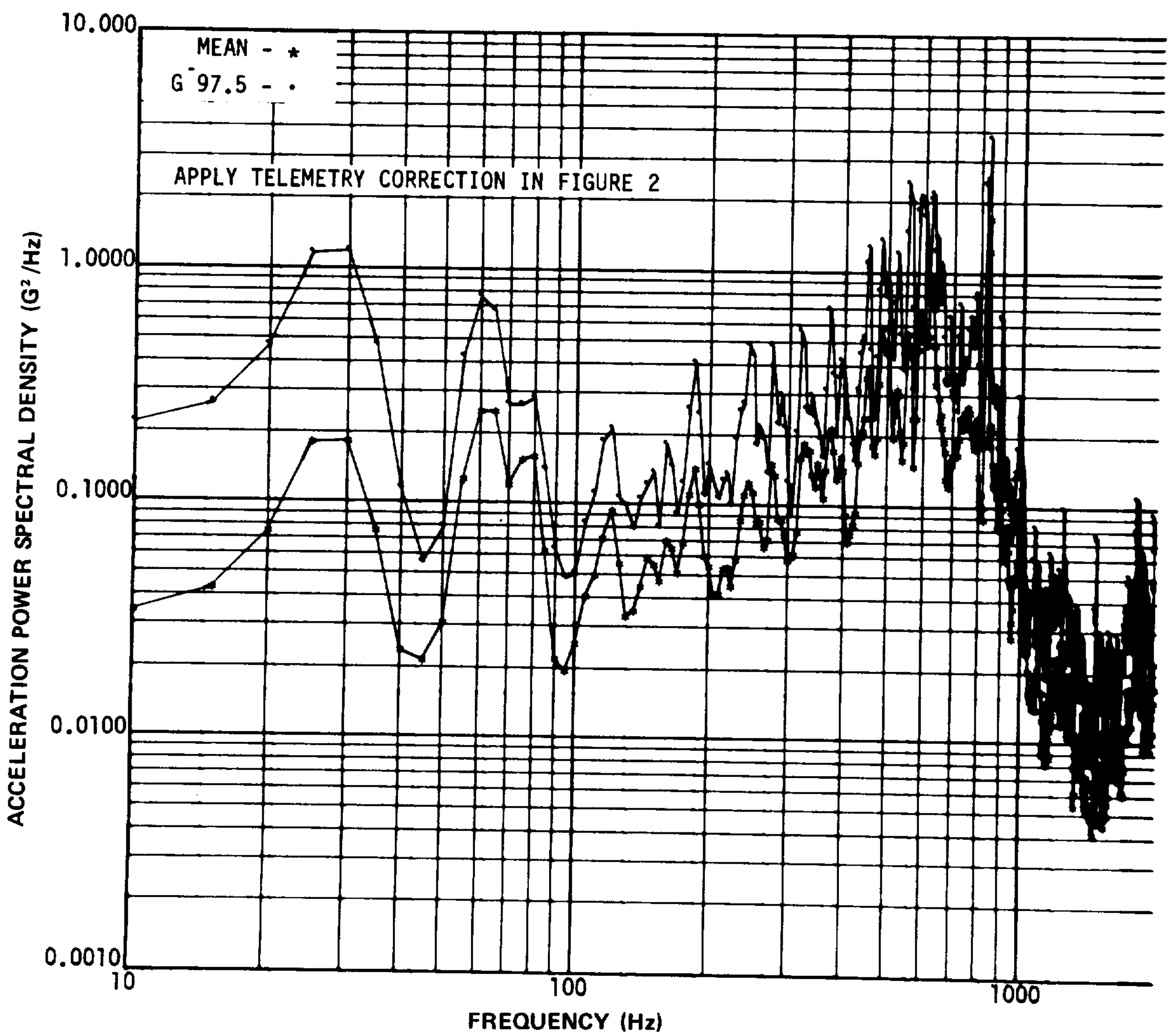


Figure A-45. Ring frame acceleration power spectral density, longitudinal, Mach 1.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION –
MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 14.30
COMPOSITE 97.5 – 18.73
VEHICLE DIAMETER – 10.06 m (33 ft)

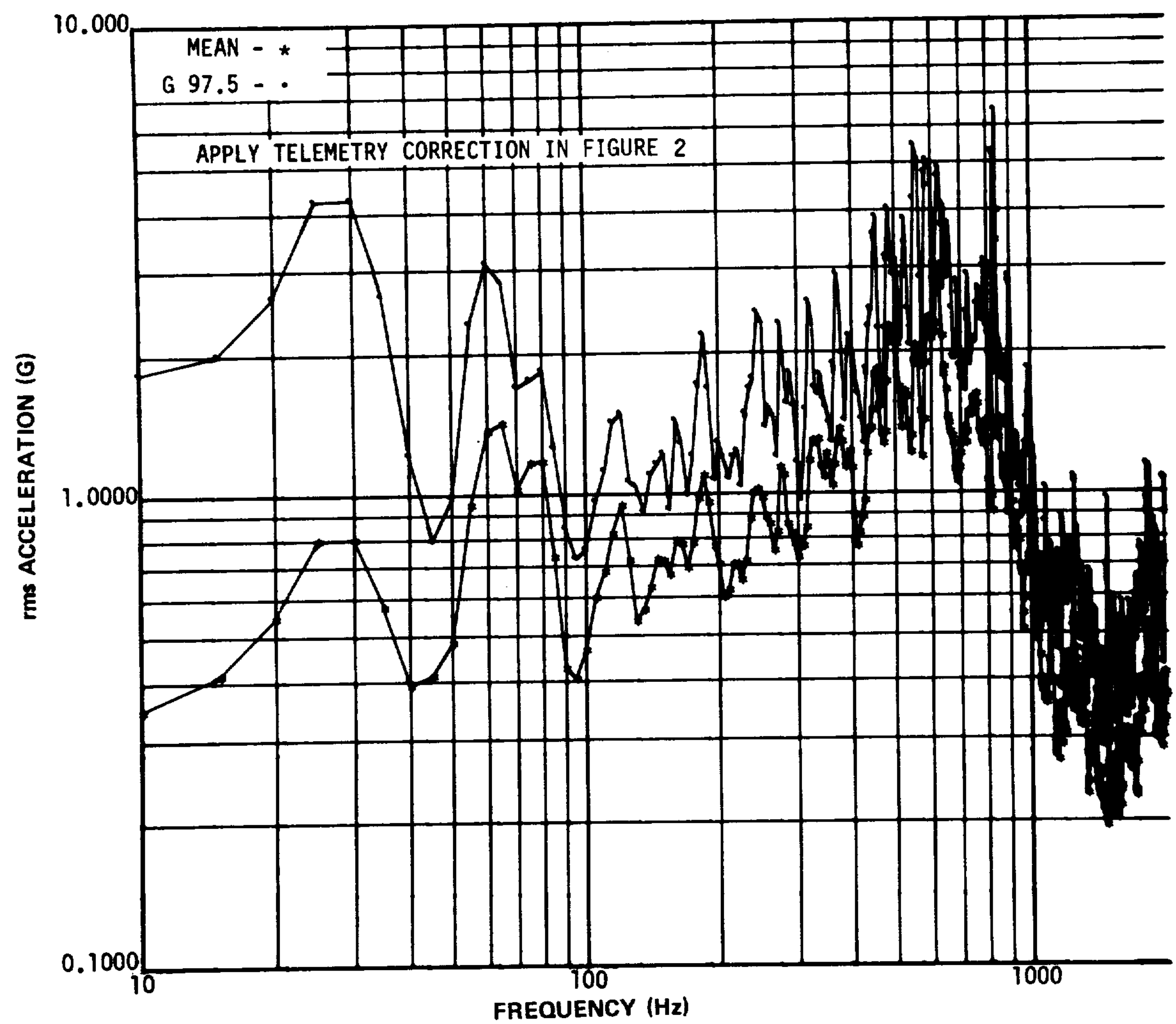


Figure A-46. Ring frame rms acceleration, longitudinal, Mach 1.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 23.10
COMPOSITE 97.5 – 50.67
VEHICLE DIAMETER – 10.06 m (33 ft)

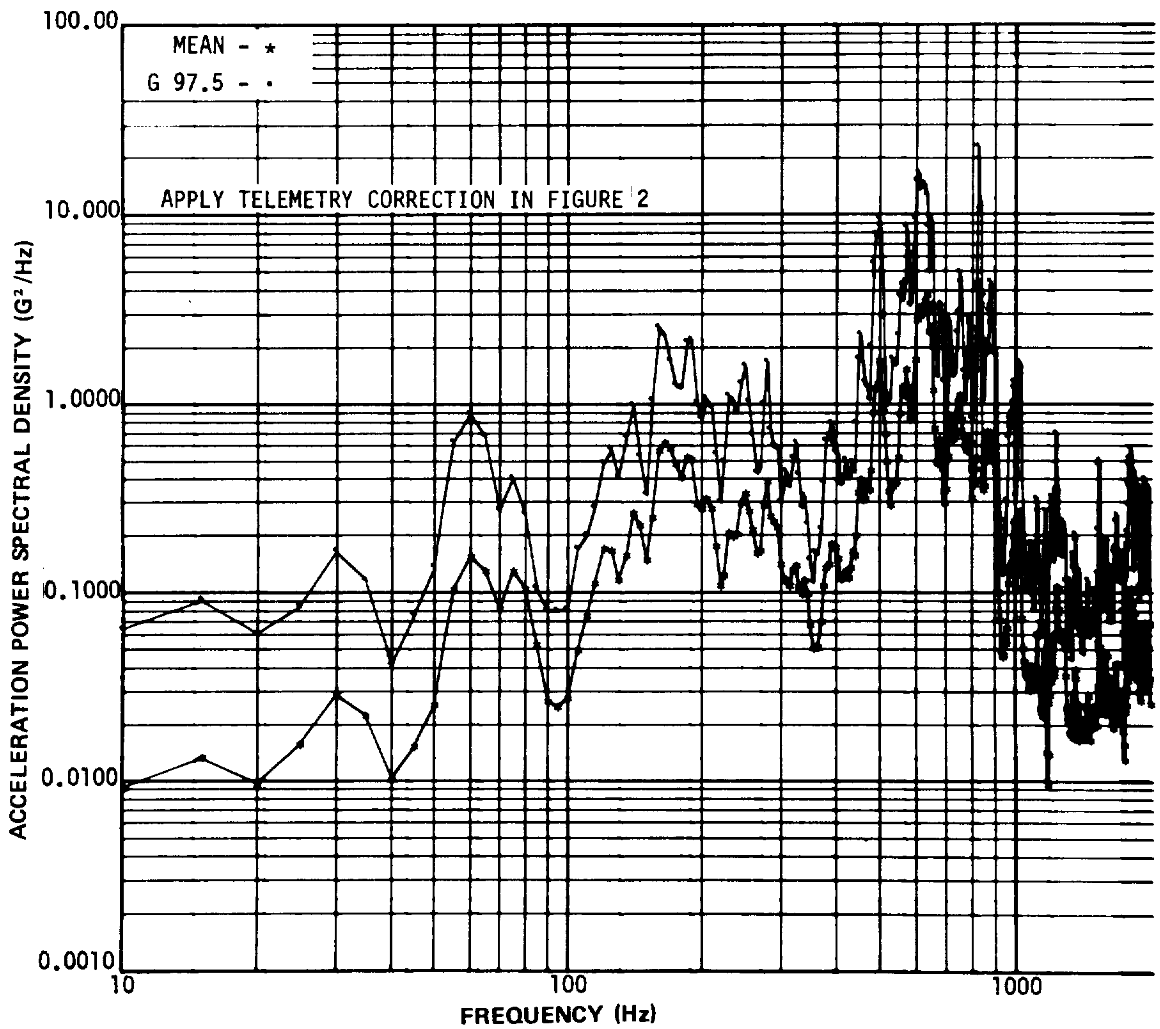


Figure A-47. Ring frame acceleration power spectral density, longitudinal, max Q.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 23.10
COMPOSITE 97.5 – 50.67
VEHICLE DIAMETER – 10.06 m (33 ft)

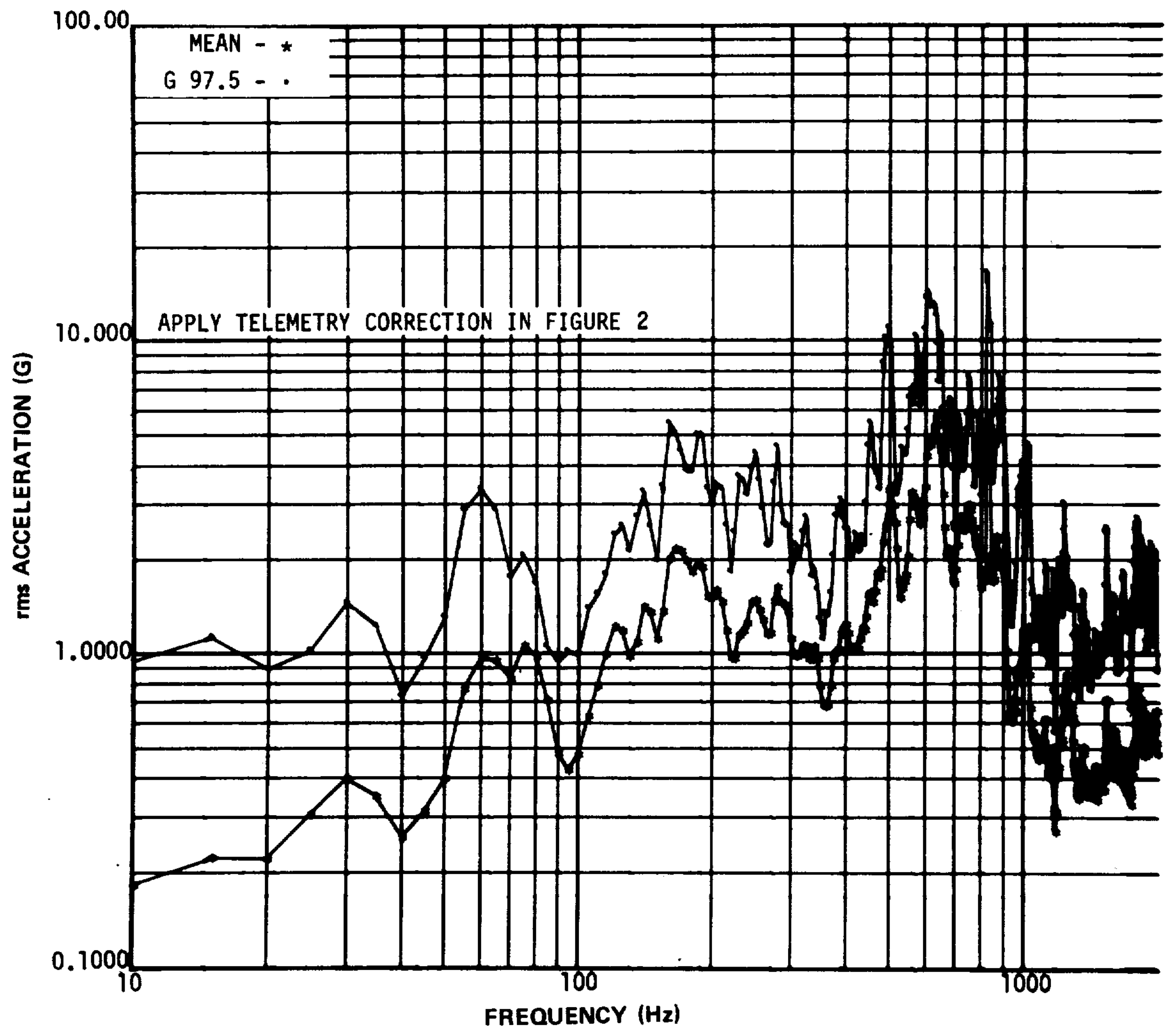


Figure A-48. Ring frame rms acceleration, longitudinal, Max Q.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 19.19
COMPOSITE 97.5 – 44.31
VEHICLE DIAMETER – 10.06 m (33 ft)

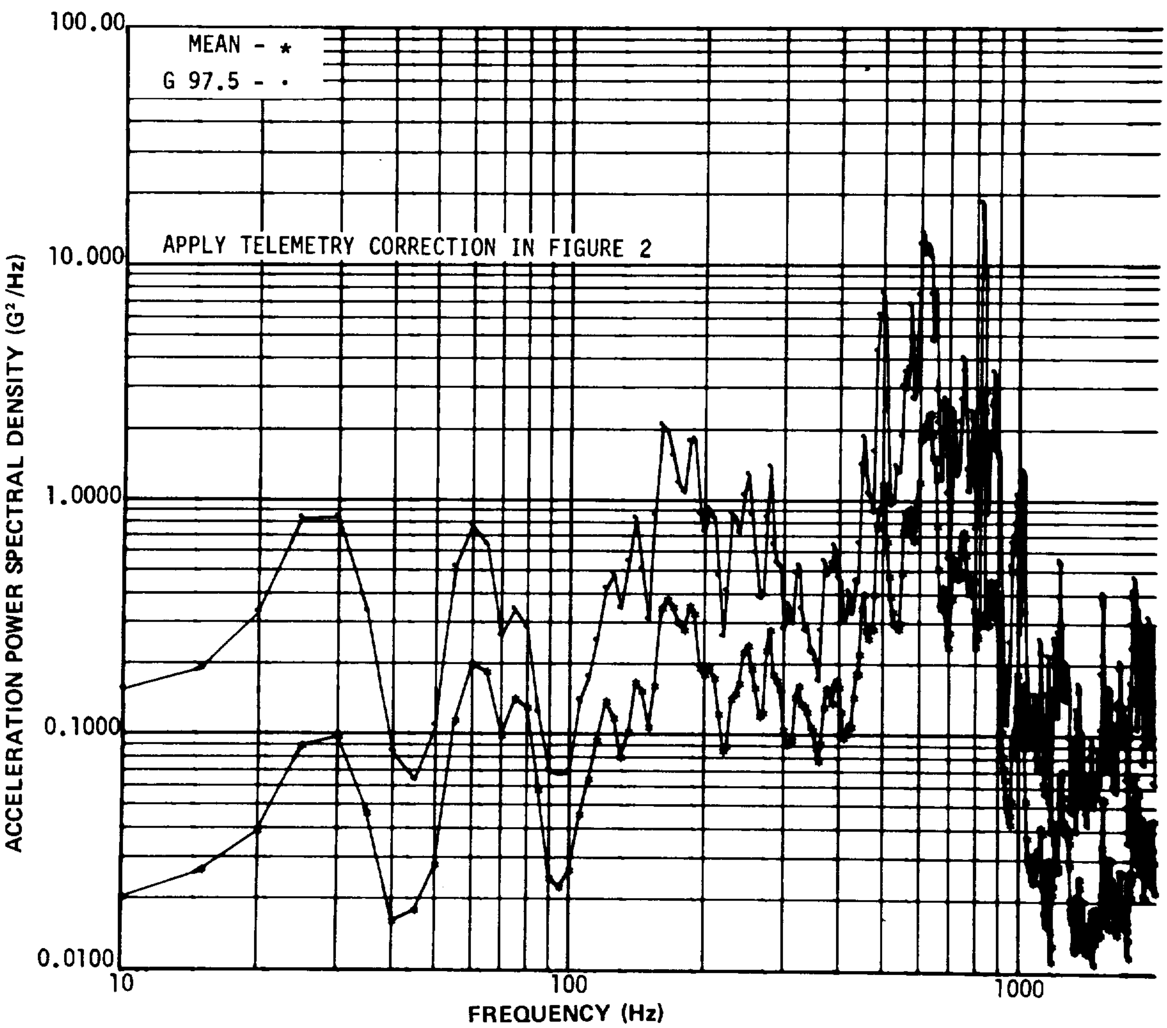


Figure A-49. Ring frame acceleration power spectral density, longitudinal, transonic.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 19.19
COMPOSITE 97.5 – 44.31
VEHICLE DIAMETER – 10.06 m (33 ft)

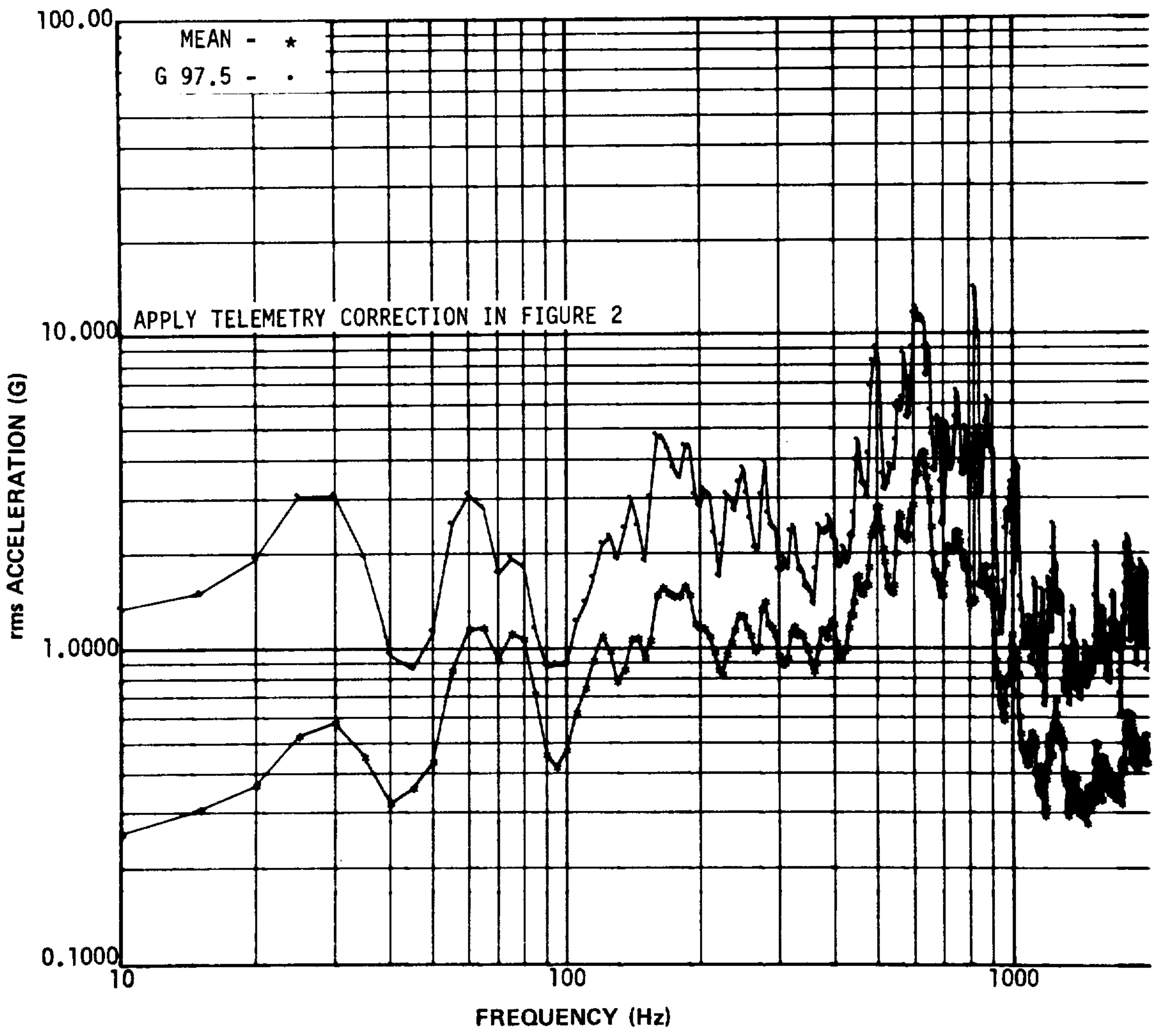


Figure A-50. Ring frame rms acceleration, longitudinal, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 11.56
COMPOSITE 97.5 – 21.04
VEHICLE DIAMETER – 10.06 m (33 ft)

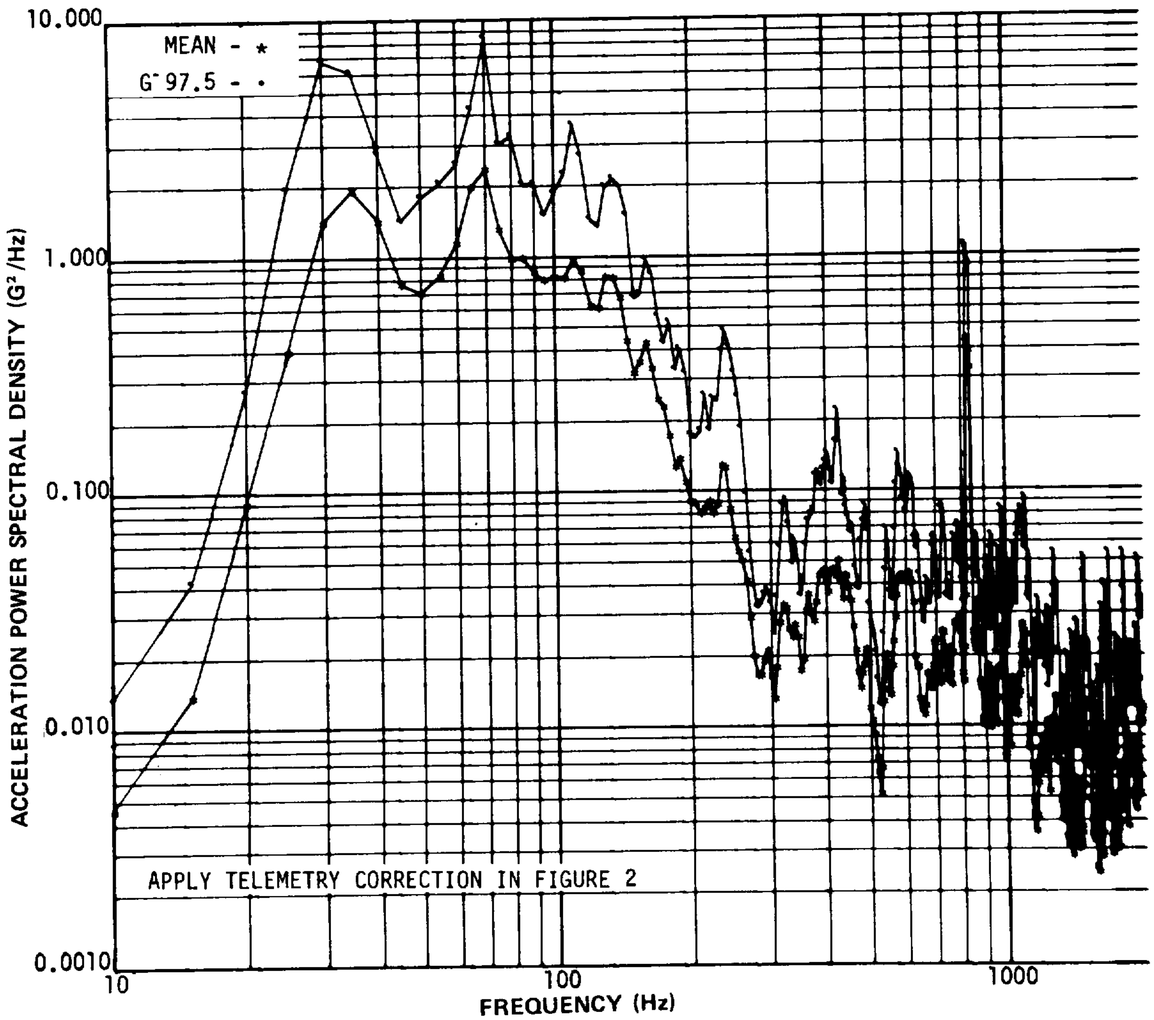


Figure A-51. Ring frame acceleration power spectral density, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 11.56
COMPOSITE 97.5 – 21.04
VEHICLE DIAMETER – 10.06 m (33 ft)

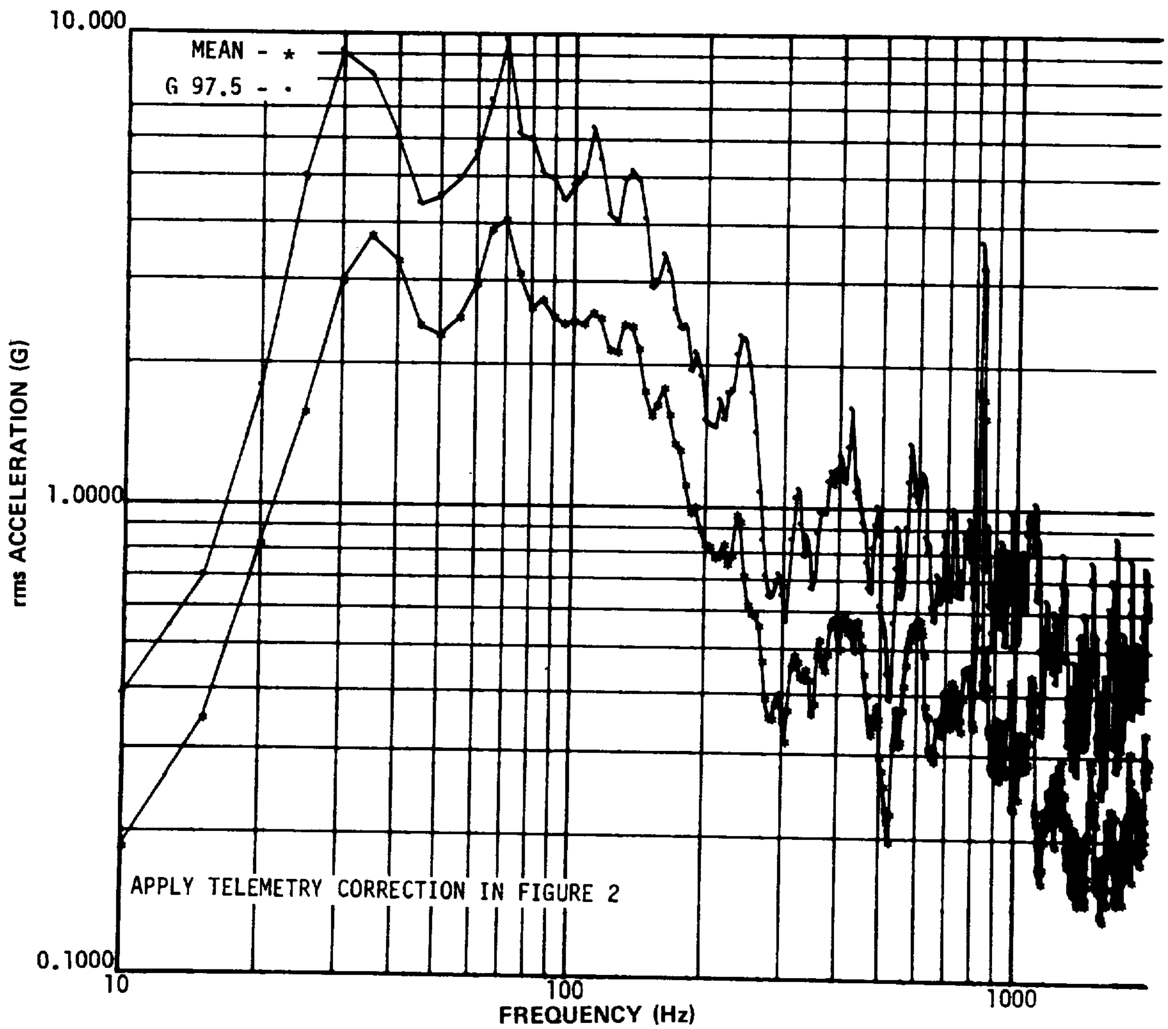


Figure A-52. Ring frame rms acceleration, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 19.84
COMPOSITE 97.5 – 47.12
VEHICLE DIAMETER – 10.06 m (33 ft)

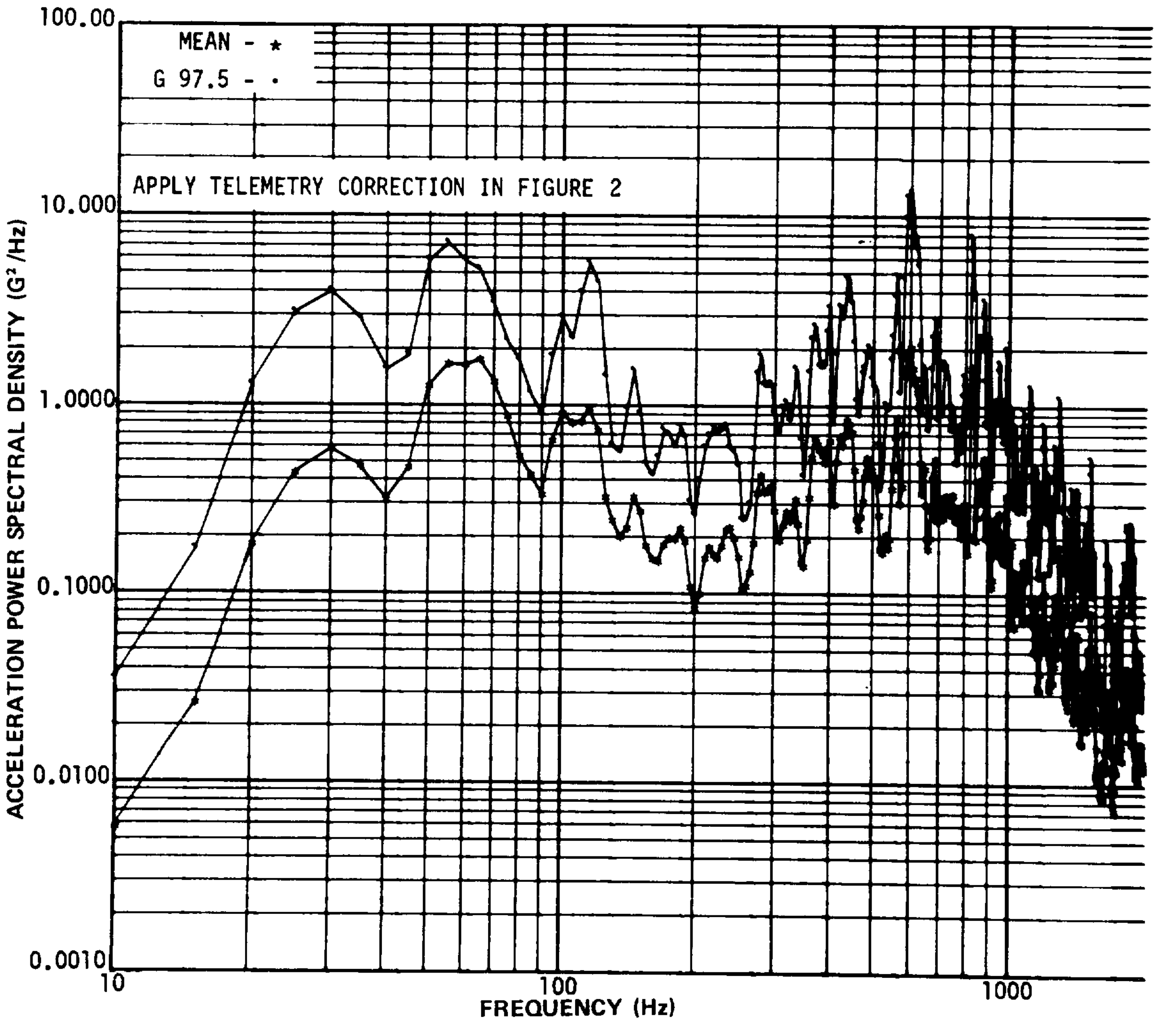


Figure A-53. Ring frame acceleration power spectral density, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 19.84
COMPOSITE 97.5 – 47.12
VEHICLE DIAMETER – 10.06 m (33 ft)

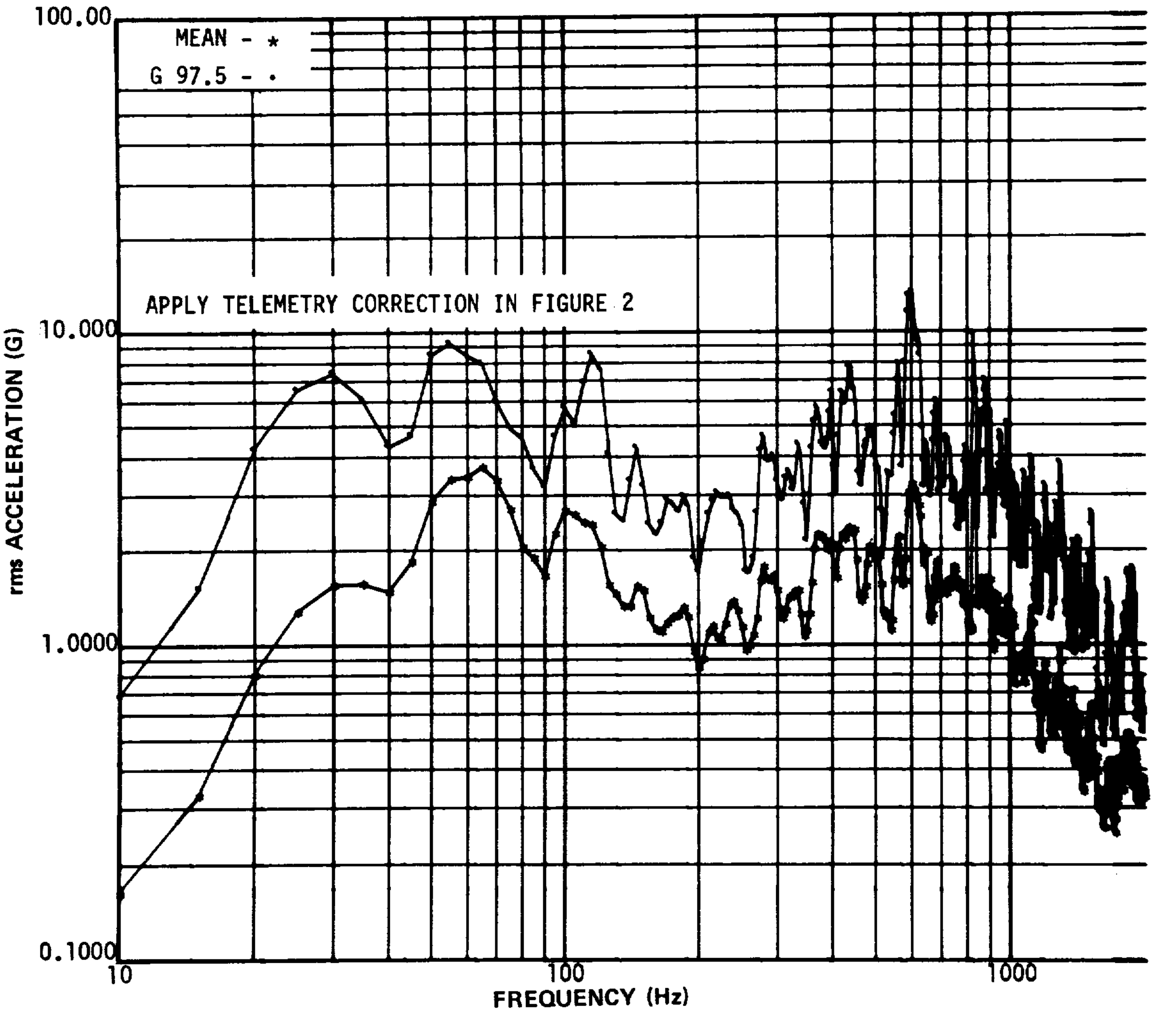


Figure A-54. Ring frame rms acceleration, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 22.54
COMPOSITE 97.5 – 39.53
VEHICLE DIAMETER – 10.06 m (33 ft)

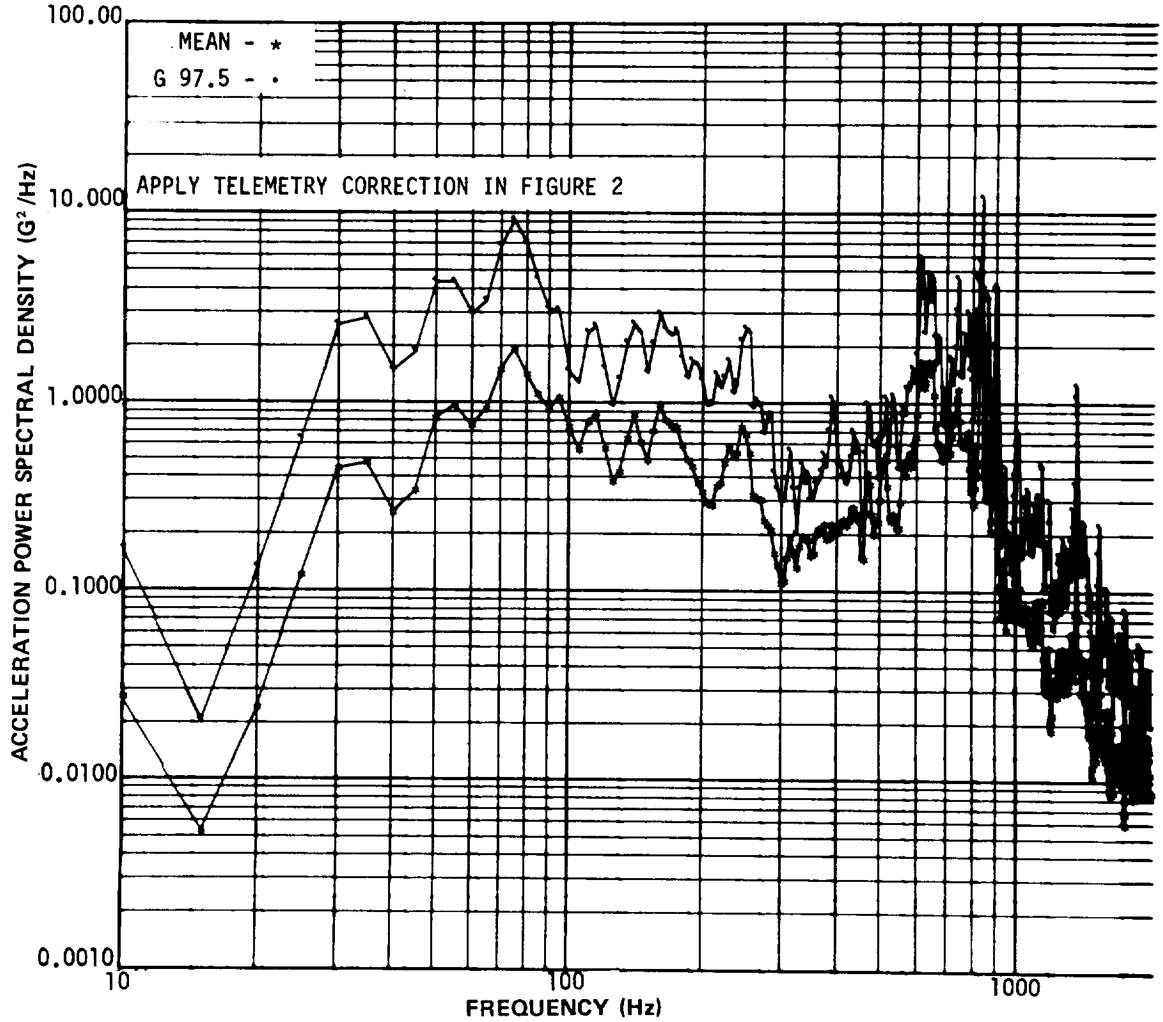


Figure A-55. Ring frame acceleration power spectral density, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 22.54
COMPOSITE 97.5 – 39.53
VEHICLE DIAMETER – 10.06 m (33 ft)

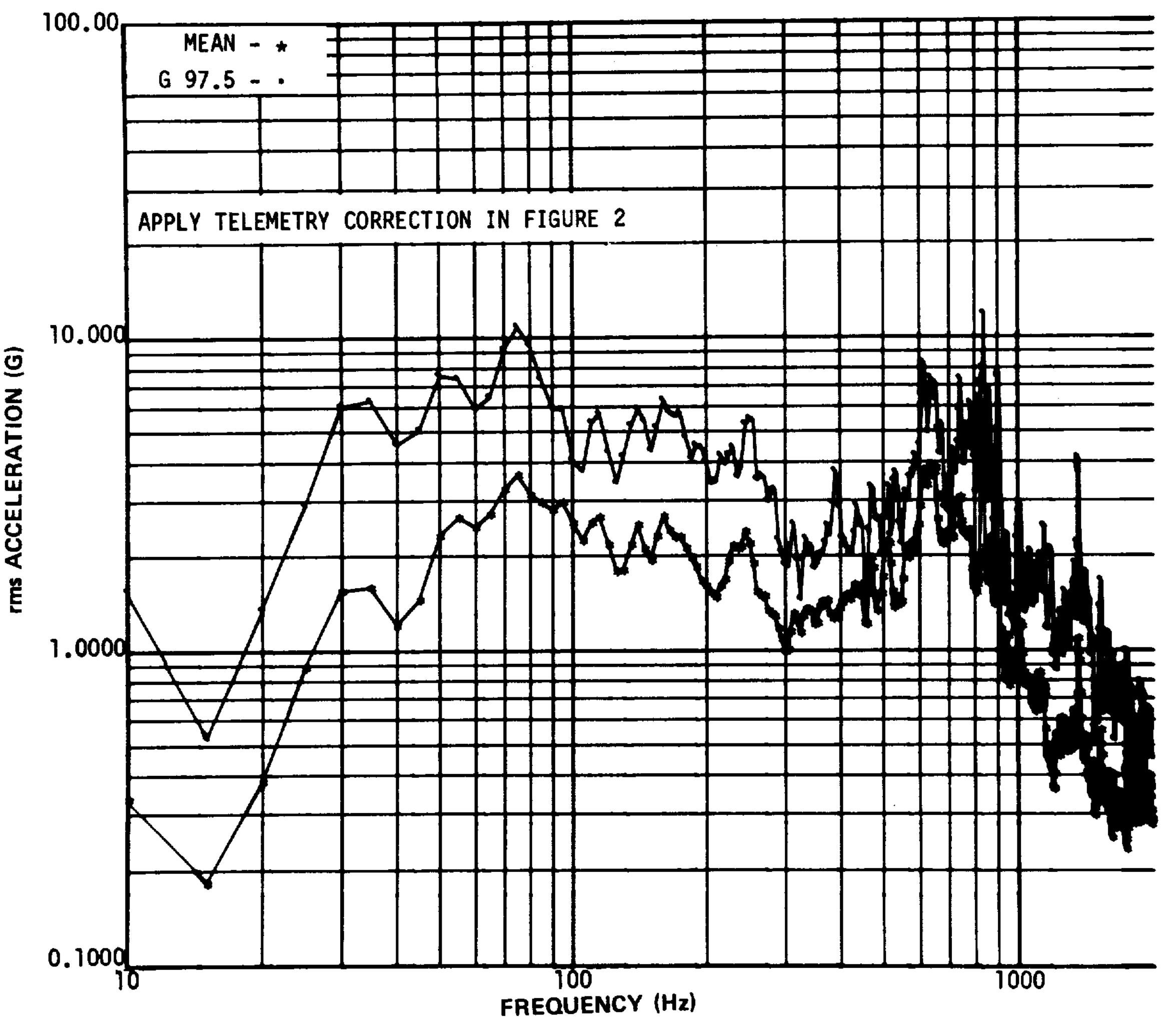


Figure A-56. Ring frame rms acceleration, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 21.04
COMPOSITE 97.5 – 41.95
VEHICLE DIAMETER – 10.06 m (33 ft)

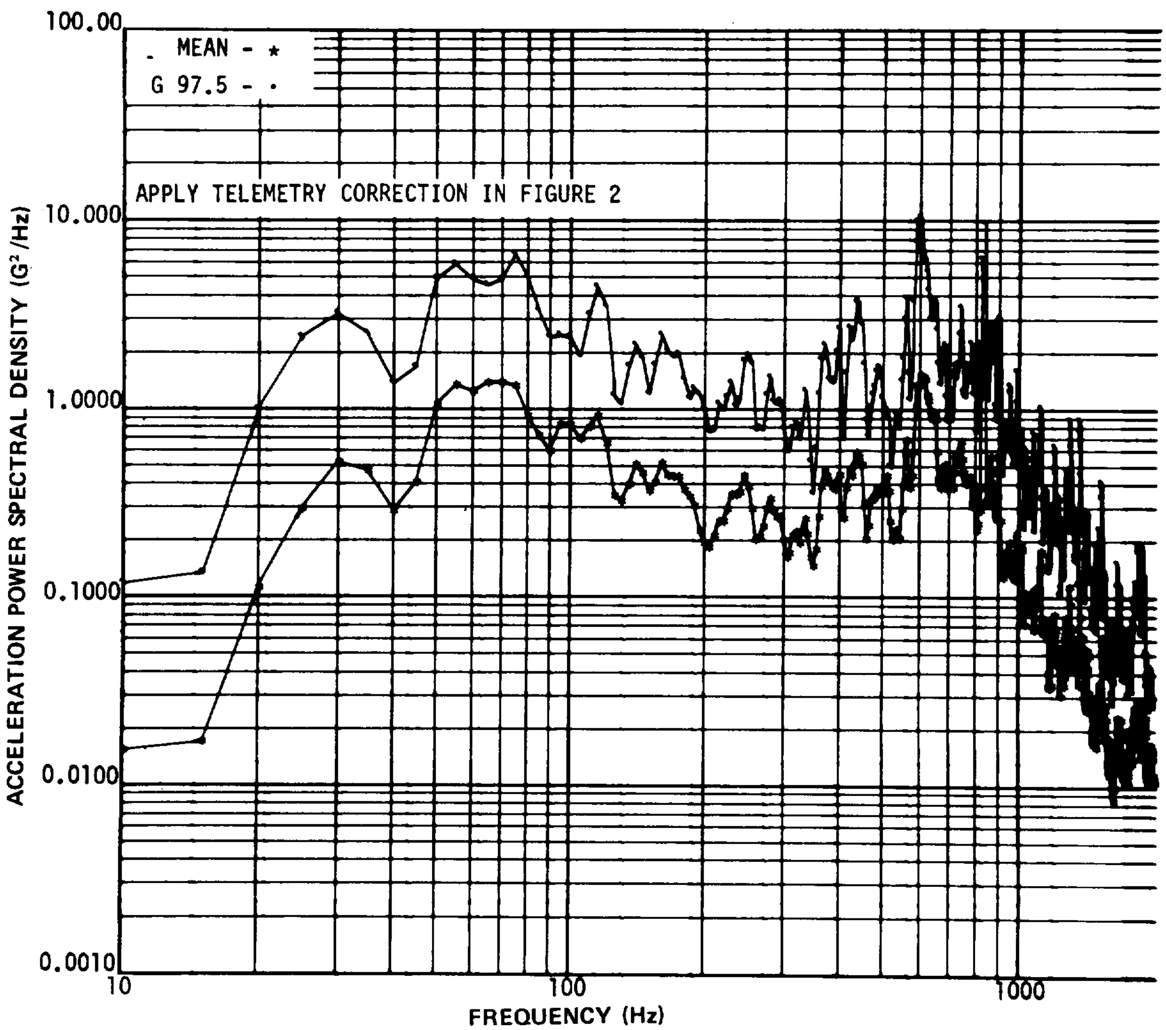


Figure A-57. Ring frame acceleration power spectral density, radial, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION –
TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 21.04
COMPOSITE 97.5 – 41.95
VEHICLE DIAMETER – 10.06 m (33 ft)

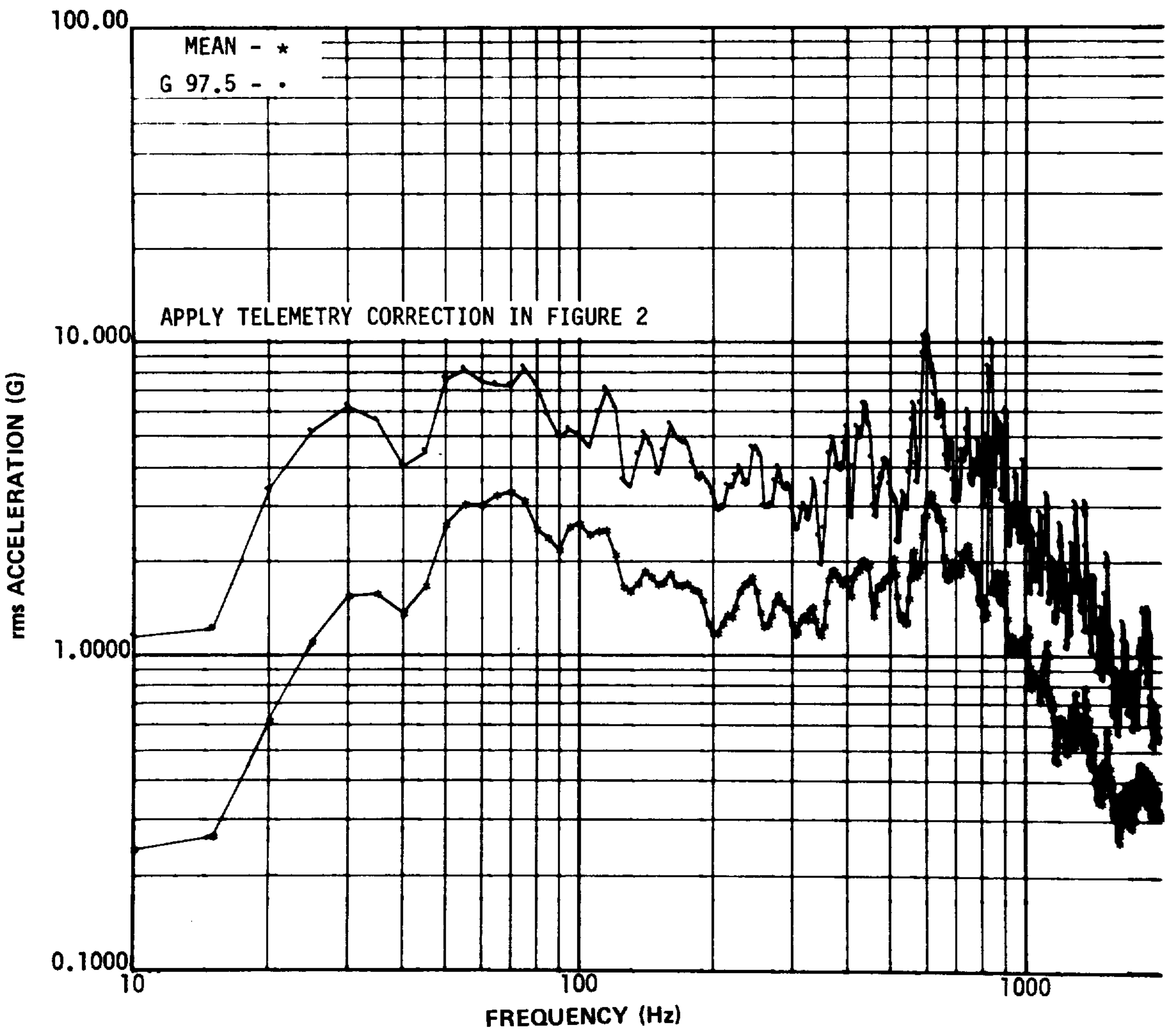


Figure A-58. Ring frame rms acceleration, radial, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 27.48
COMPOSITE 97.5 – 66.20
VEHICLE DIAMETER – 10.06 m (33 ft)

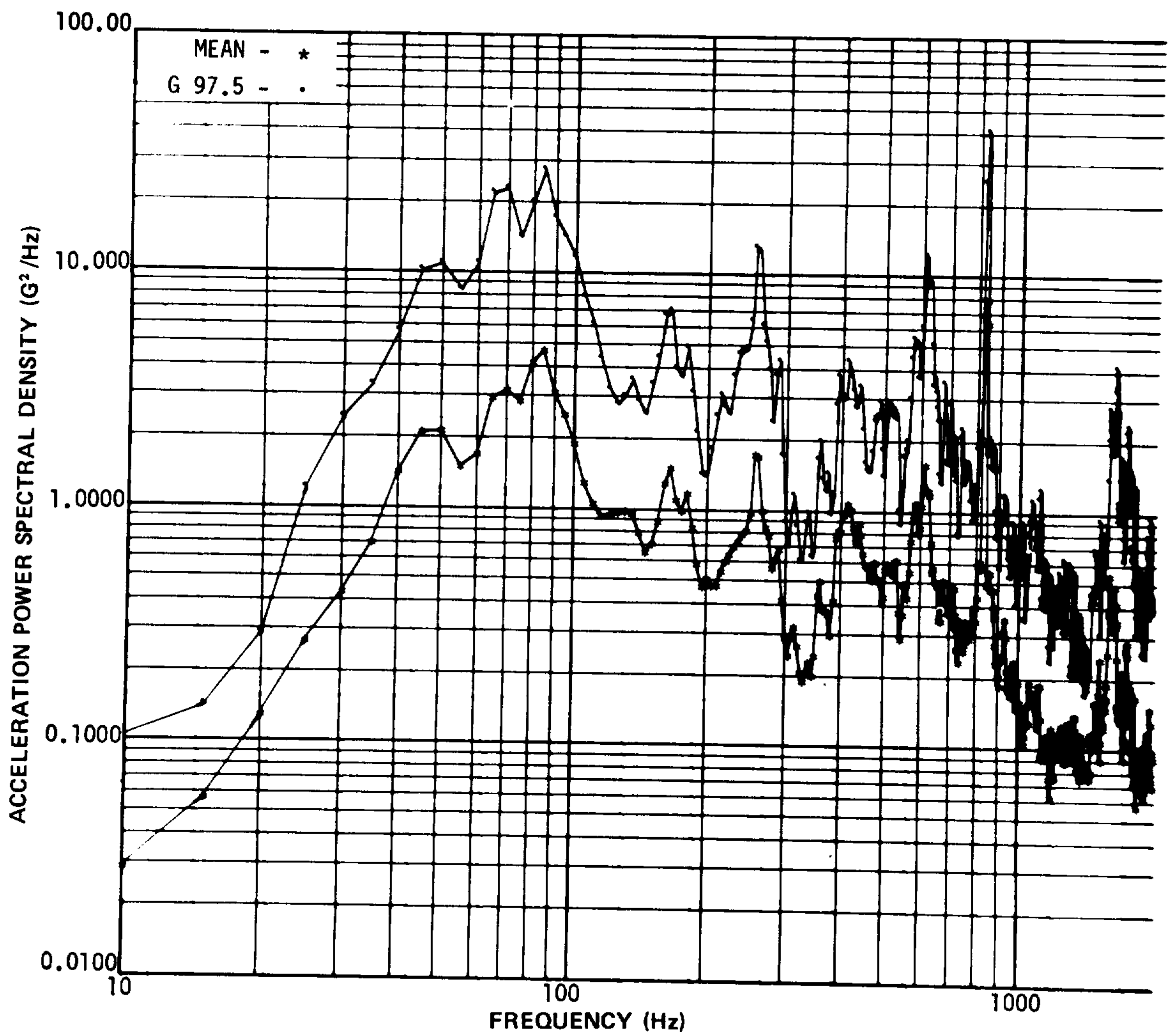


Figure A-59. Ring frame acceleration power spectral density, radial, static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 27.48
COMPOSITE 97.5 – 66.20
VEHICLE DIAMETER – 10.06 m (33 ft)

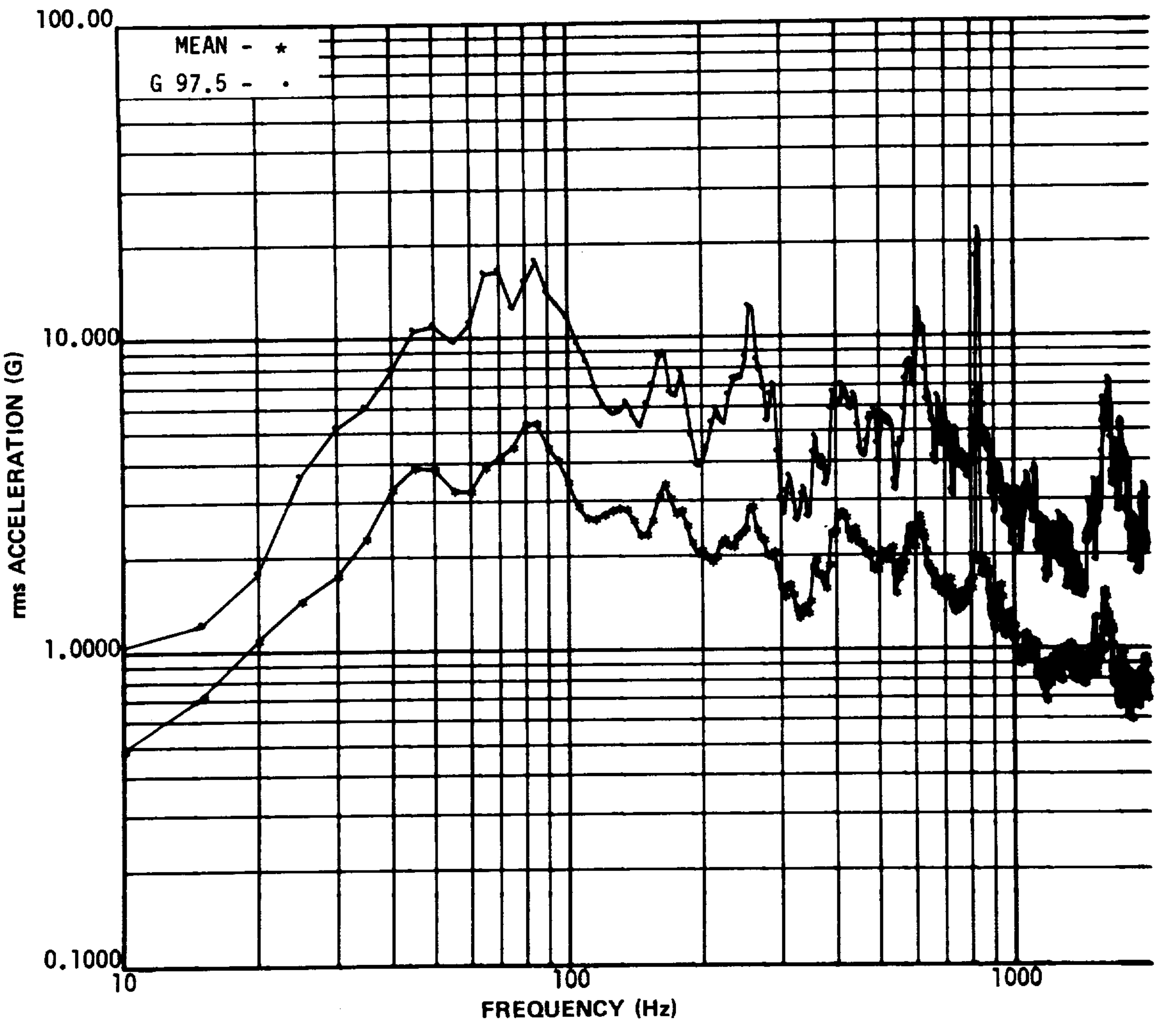


Figure A-60. Ring frame rms acceleration, radial, static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – LIFTOFF AND STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 21.69
COMPOSITE 97.5 – 58.28
VEHICLE DIAMETER – 10.06 m (33 ft)

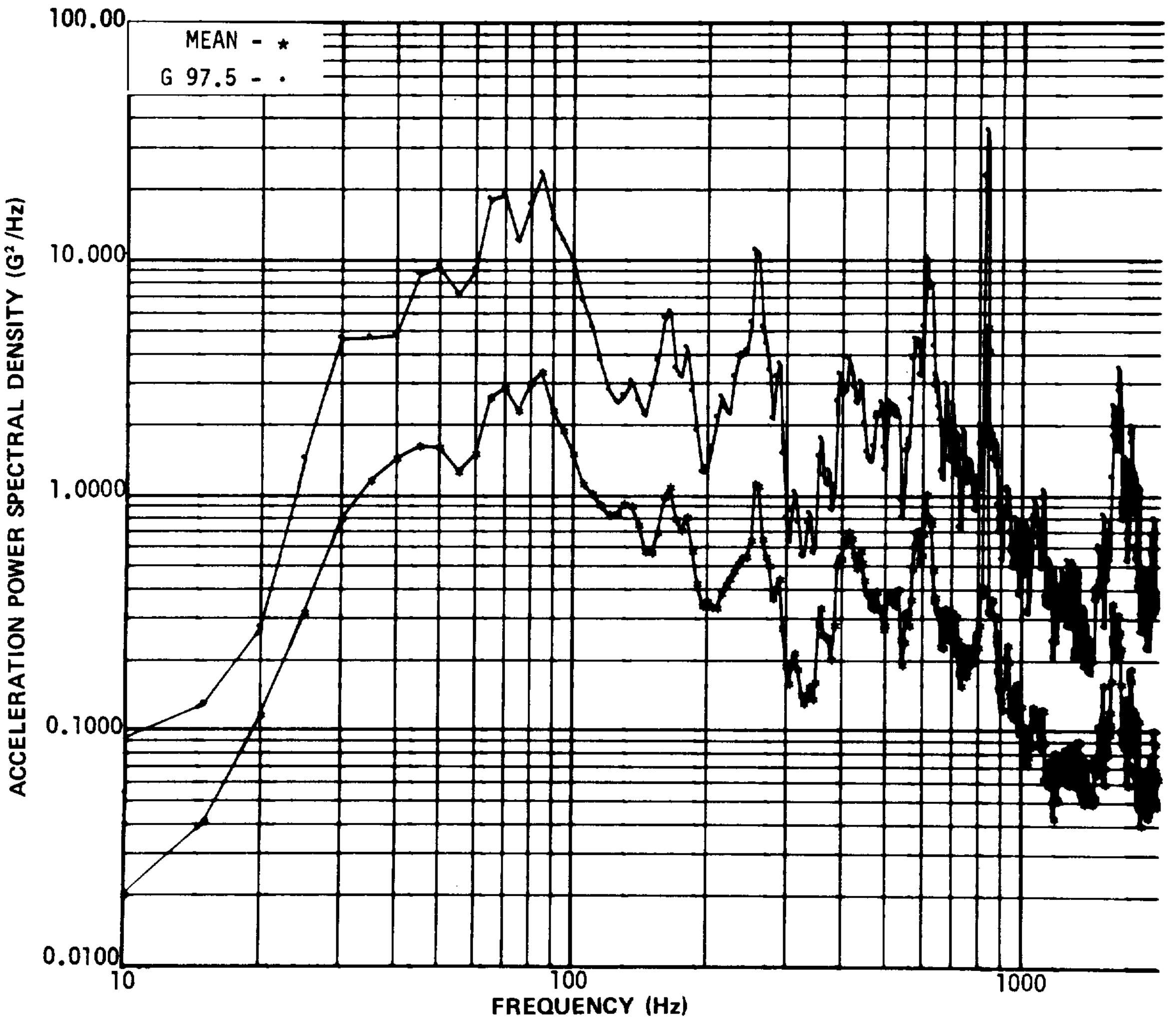


Figure A-61. Ring frame acceleration power spectral density, radial, liftoff and static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .47 cm (.185 in.)
RING SEPARATION – N/A
RING WEIGHT – 7.068 kg/m (4.75 lb/ft)
STRINGER SEPARATION – 20.02 cm (7.88 in.)
STRINGER WEIGHT PER FOOT – N/A

FLIGHT OR TEST CONDITION – LIFTOFF AND STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 21.69
COMPOSITE 97.5 – 58.28
VEHICLE DIAMETER – 10.06 m (33 ft)

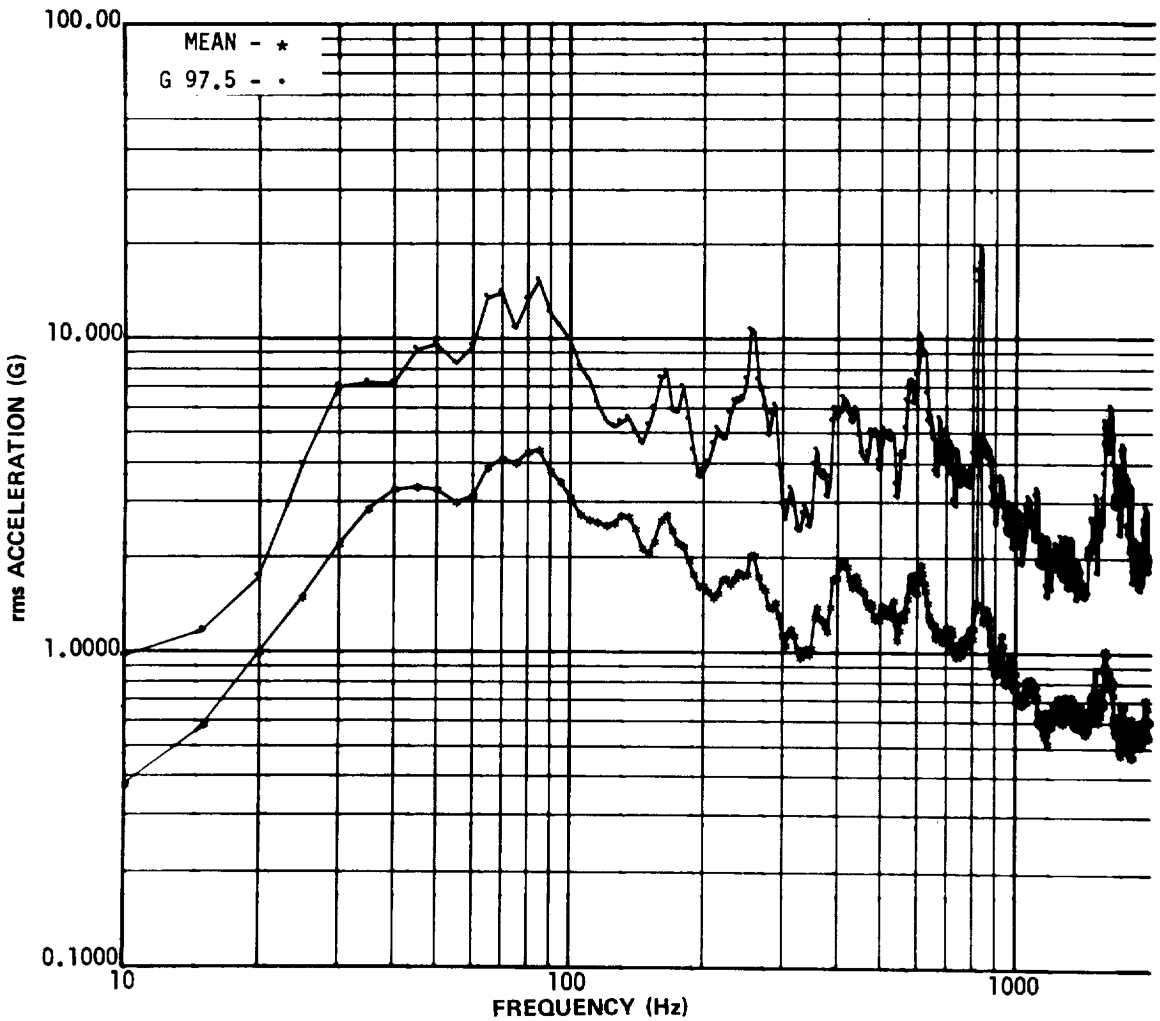


Figure A-62. Ring frame rms acceleration, radial, liftoff and static firing.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 20.74
COMPOSITE 97.5 – 79.76
VEHICLE DIAMETER – 10.06 m (33 ft)

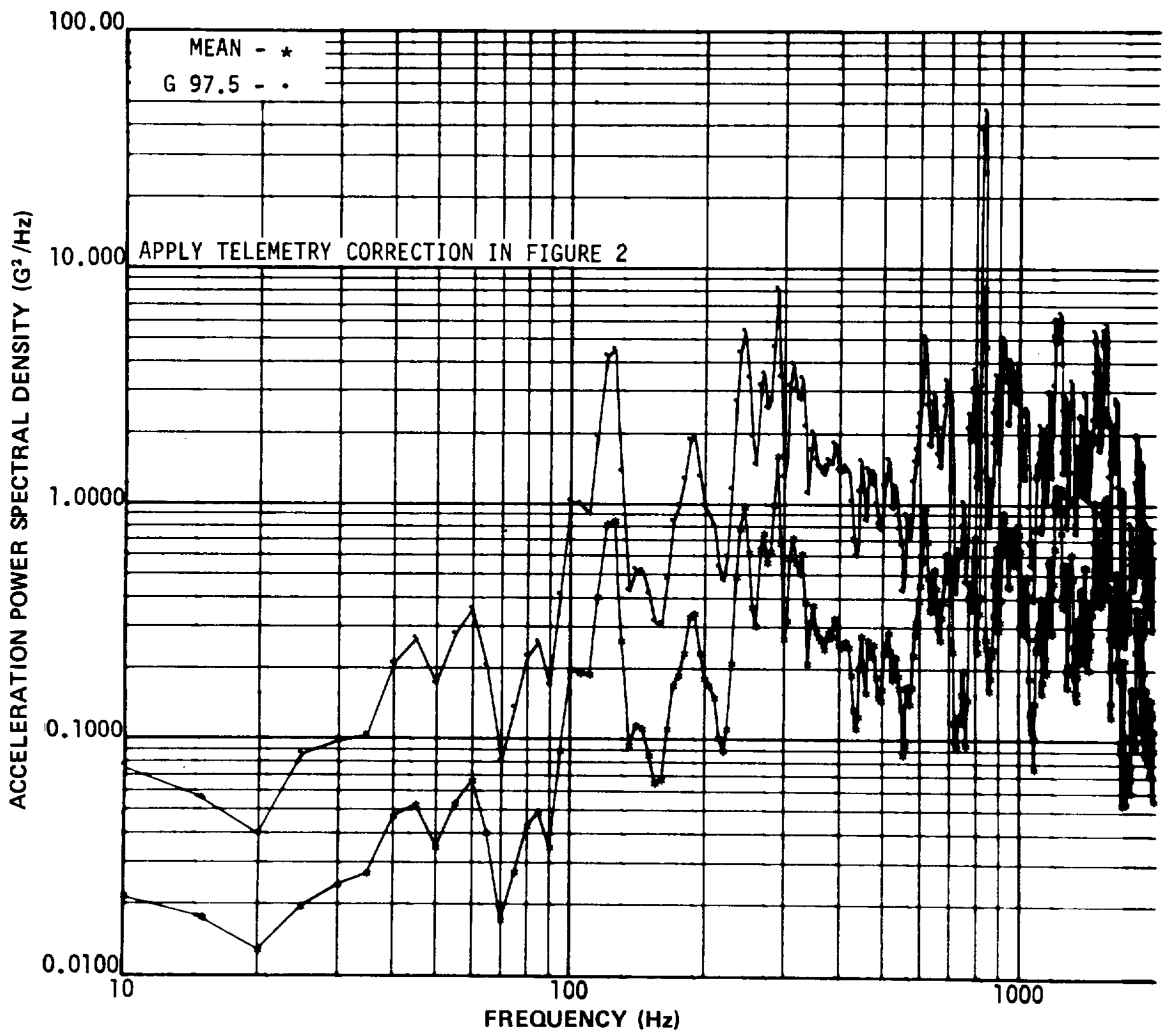


Figure A-63. Ring frame acceleration power spectral density, longitudinal, liftoff.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 20.74
COMPOSITE 97.5 – 79.76
VEHICLE DIAMETER – 10.06 m (33 ft)

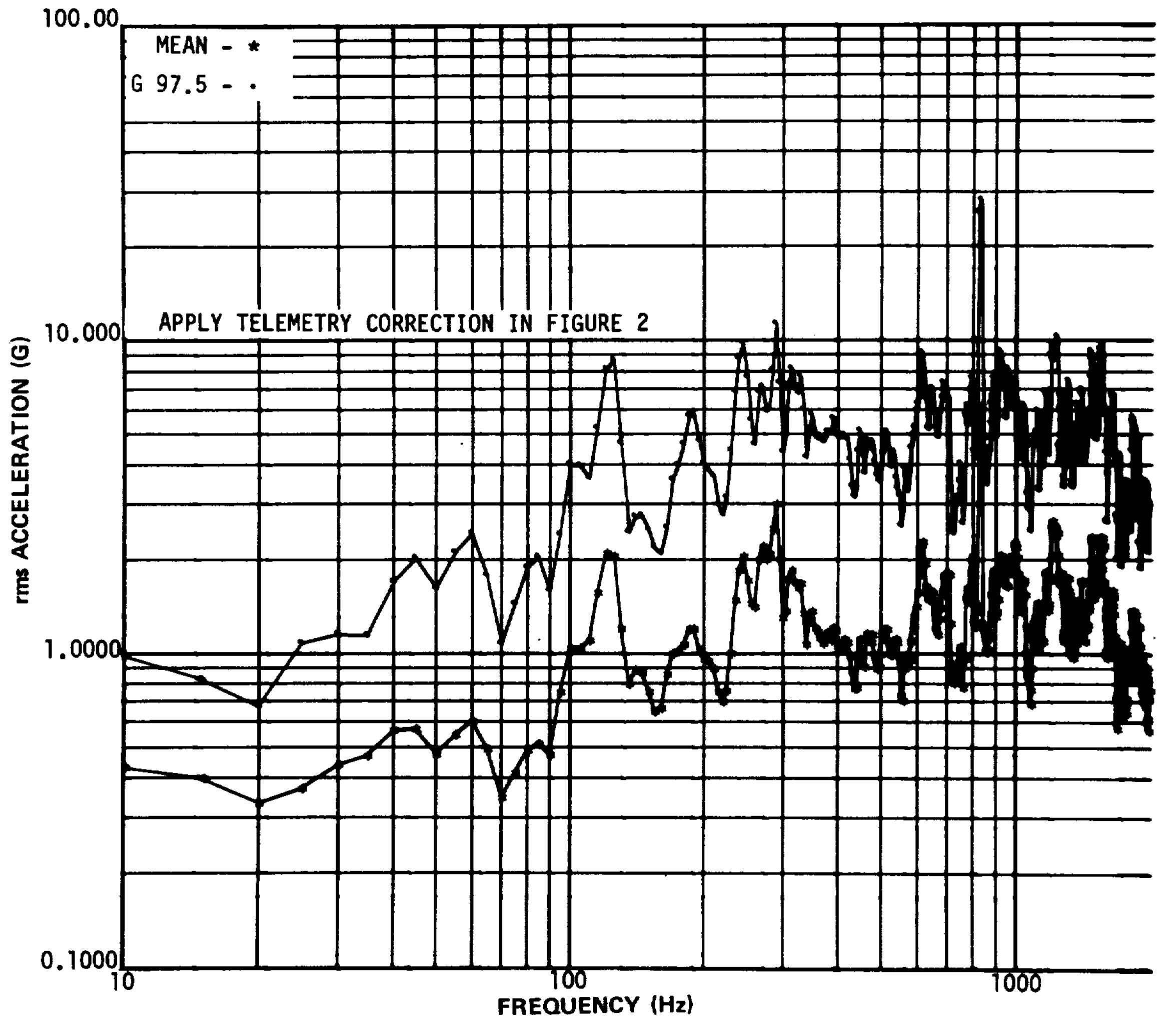


Figure A-64. Ring frame rms acceleration, longitudinal, liftoff.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 18.01
COMPOSITE 97.5 – 32.77
VEHICLE DIAMETER – 10.06 m (33 ft)

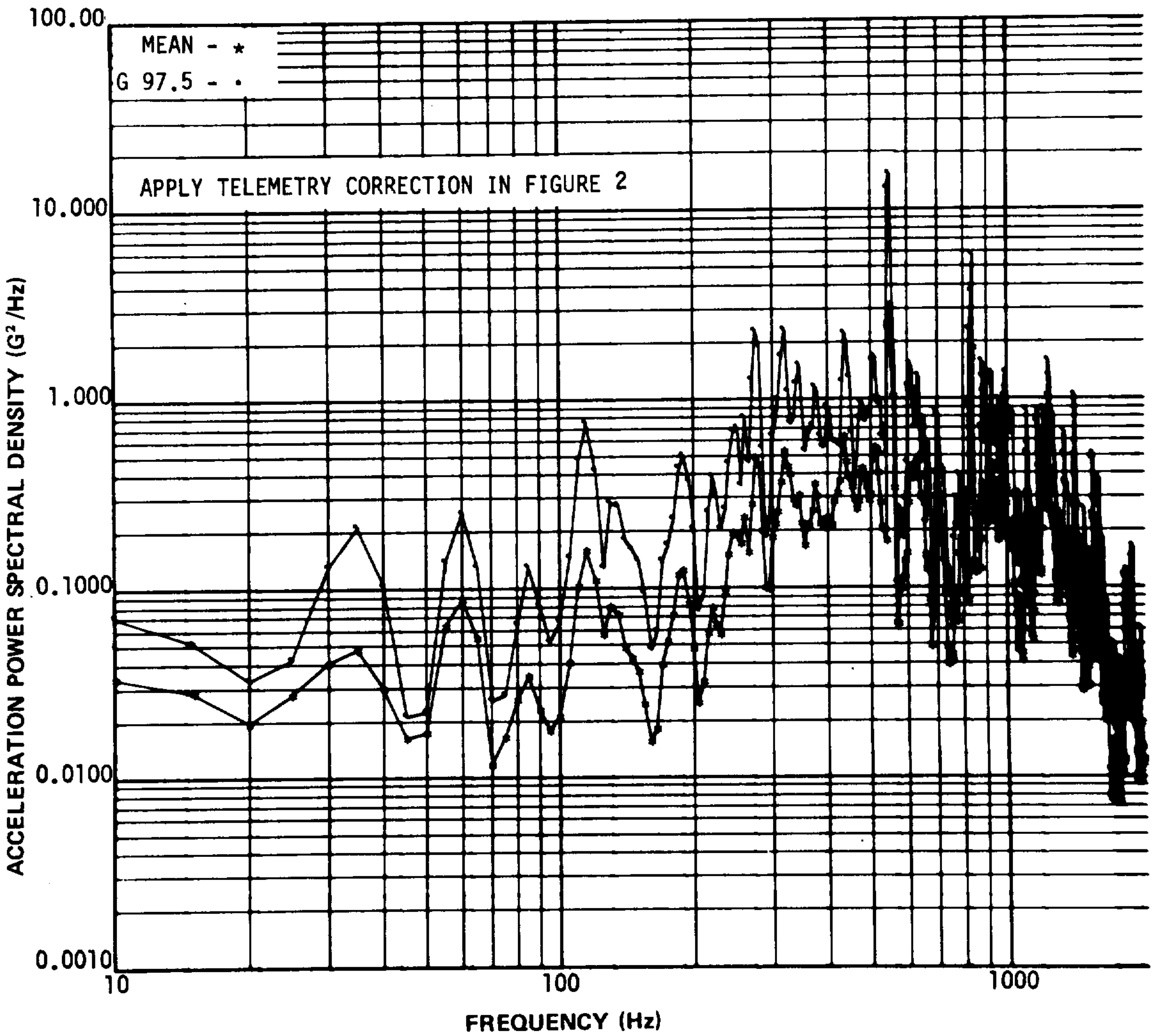


Figure A-65. Ring frame acceleration power spectral density, longitudinal, Mach 1.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 18.01
COMPOSITE 97.5 – 32.77
VEHICLE DIAMETER – 10.06 m (33 ft)

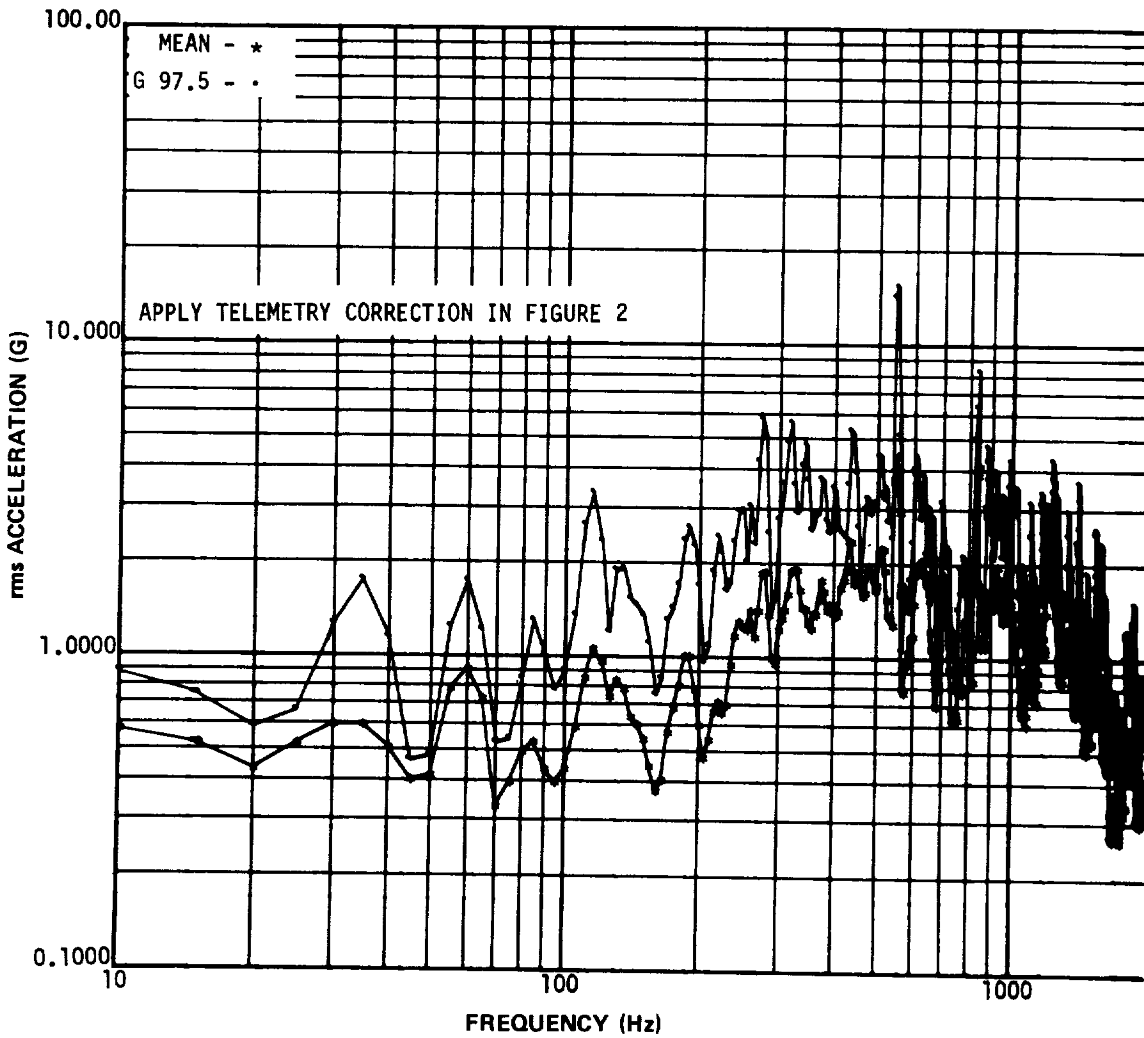


Figure A-66. Ring frame rms acceleration, longitudinal, Mach 1.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – 9.53 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION –
MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 16.08
COMPOSITE 97.5 – 35.08
VEHICLE DIAMETER – 10.06 m (33 ft)

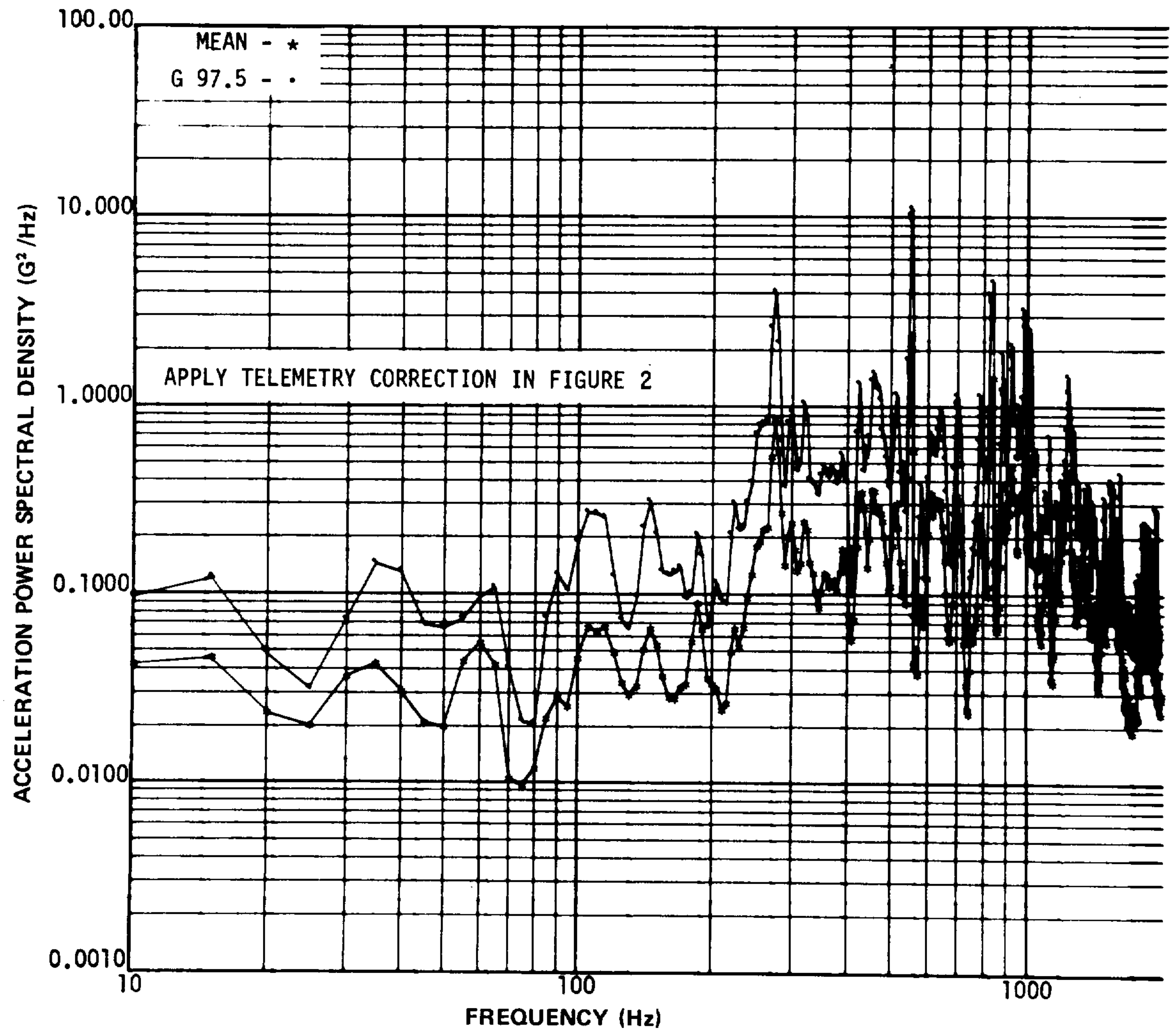


Figure A-67. Ring frame acceleration power spectral density, longitudinal, max Q.

DIRECTION – LONGITUDINAL	FLIGHT OR TEST CONDITION – MAX Q
SKIN THICKNESS – .953 cm (.375 in.)	MATERIAL – ALUMINUM
RING SEPARATION – N/A	COMPOSITE MEAN – 16.08
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)	COMPOSITE 97.5 – 35.08
STRINGER SEPARATION – 24.69 cm (9.72 in.)	VEHICLE DIAMETER – 10.06 m (33 ft)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)	

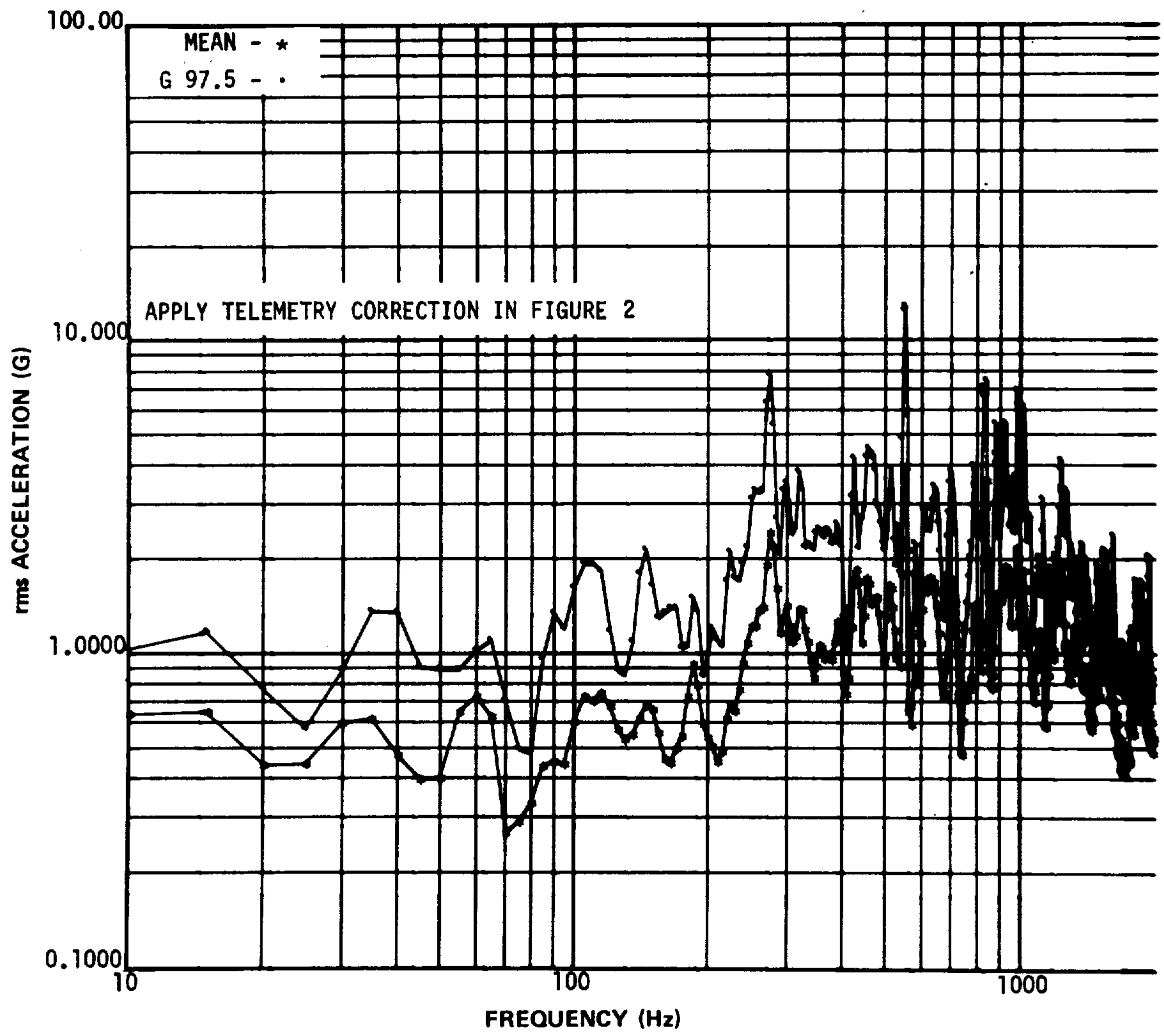


Figure A-68. Ring frame rms acceleration, longitudinal, Max Q.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – 9.53 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 17.04
COMPOSITE 97.5 – 30.46
VEHICLE DIAMETER – 10.06 m (33 ft)

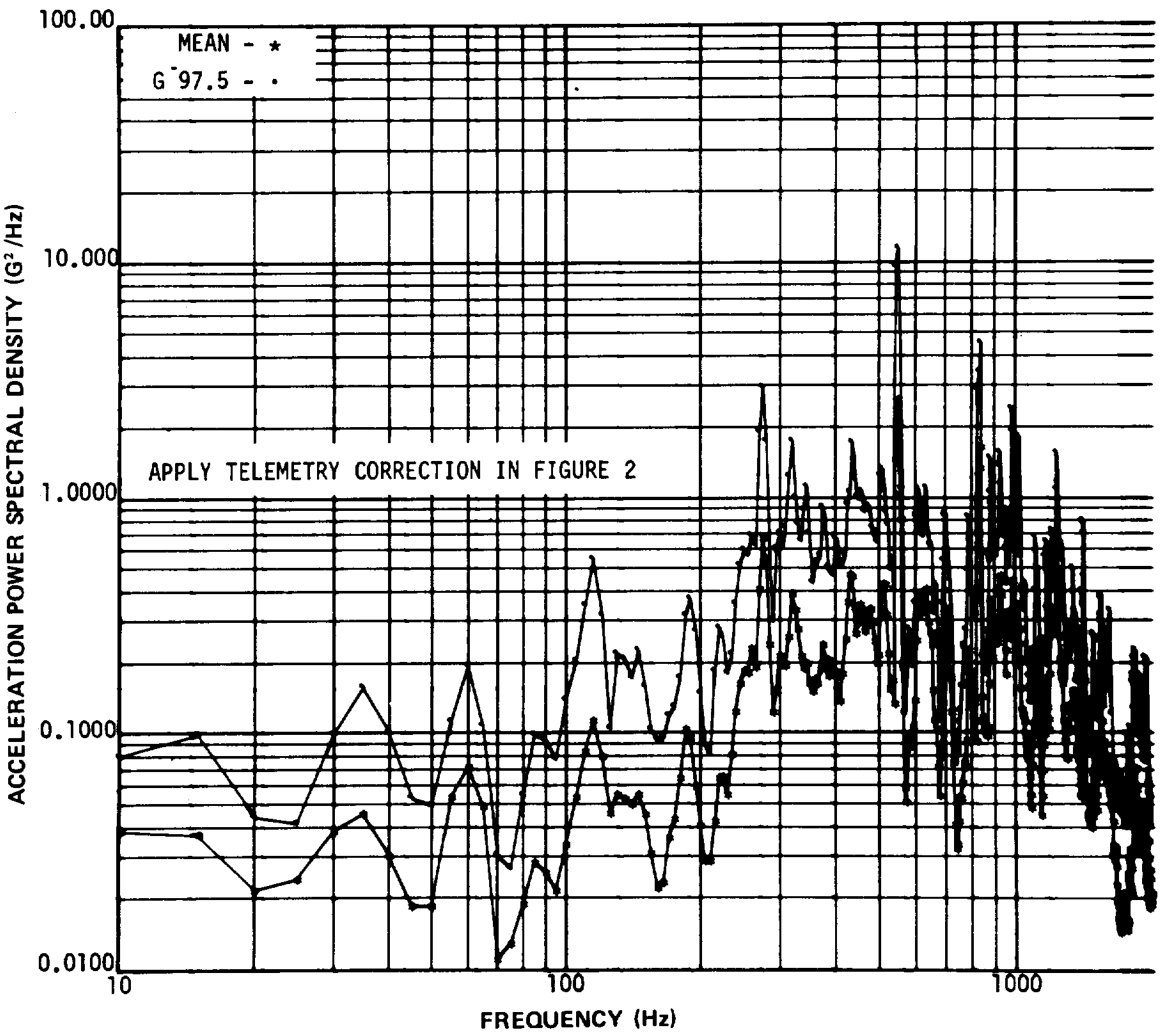


Figure A-69. Ring frame acceleration power spectral density, longitudinal, transonic.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 5.50
COMPOSITE 97.5 – 30.46
VEHICLE DIAMETER – 10.06 m (33 ft)

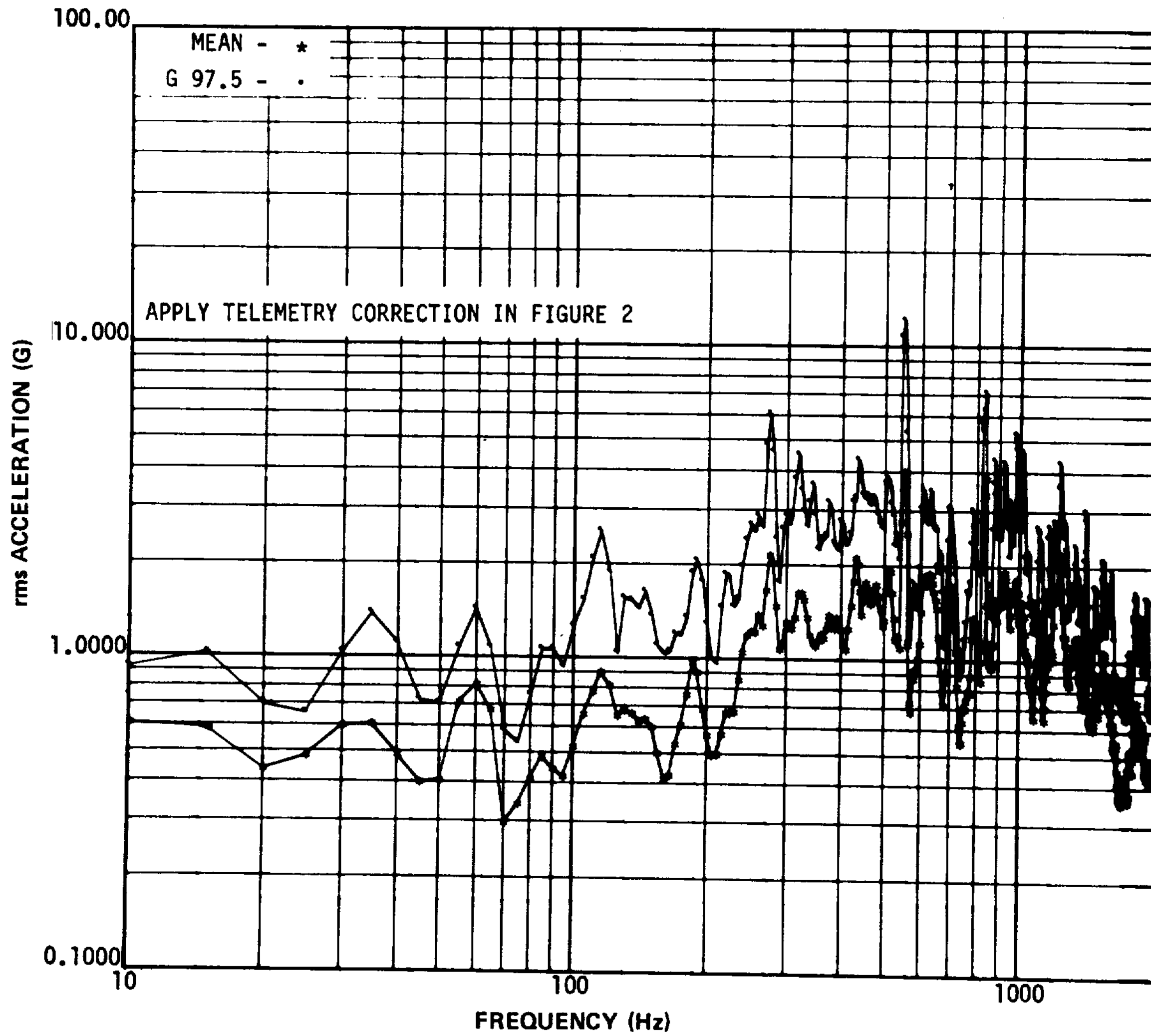


Figure A-70. Ring frame rms acceleration, longitudinal, transonic.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 5.50
COMPOSITE 97.5 – 7.09
VEHICLE DIAMETER – 10.06 m (33 ft)

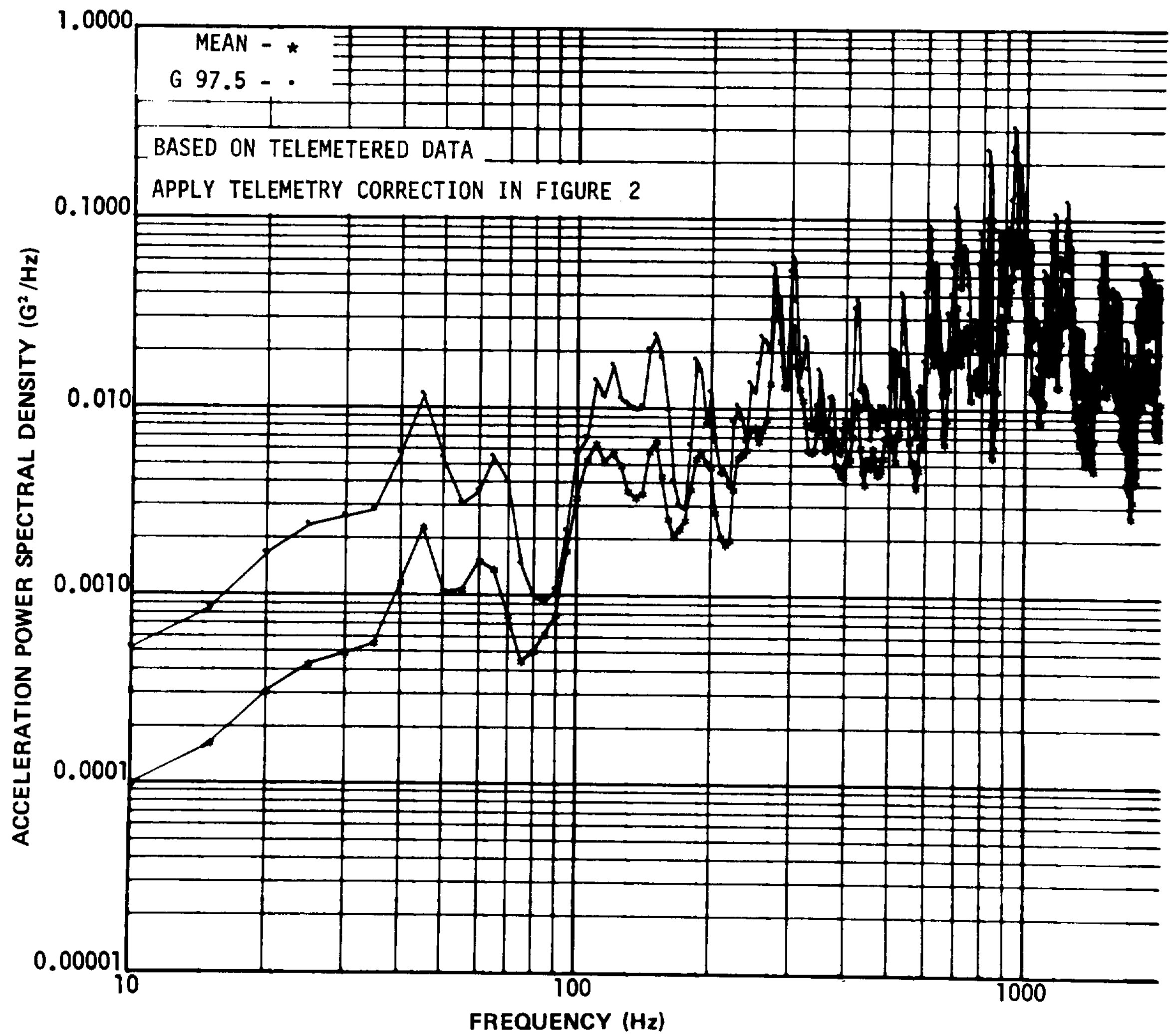


Figure A-71. Ring frame acceleration power spectral density, longitudinal, static firing.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 5.50
COMPOSITE 97.5 – 7.09
VEHICLE DIAMETER – 10.06 m (33 ft)

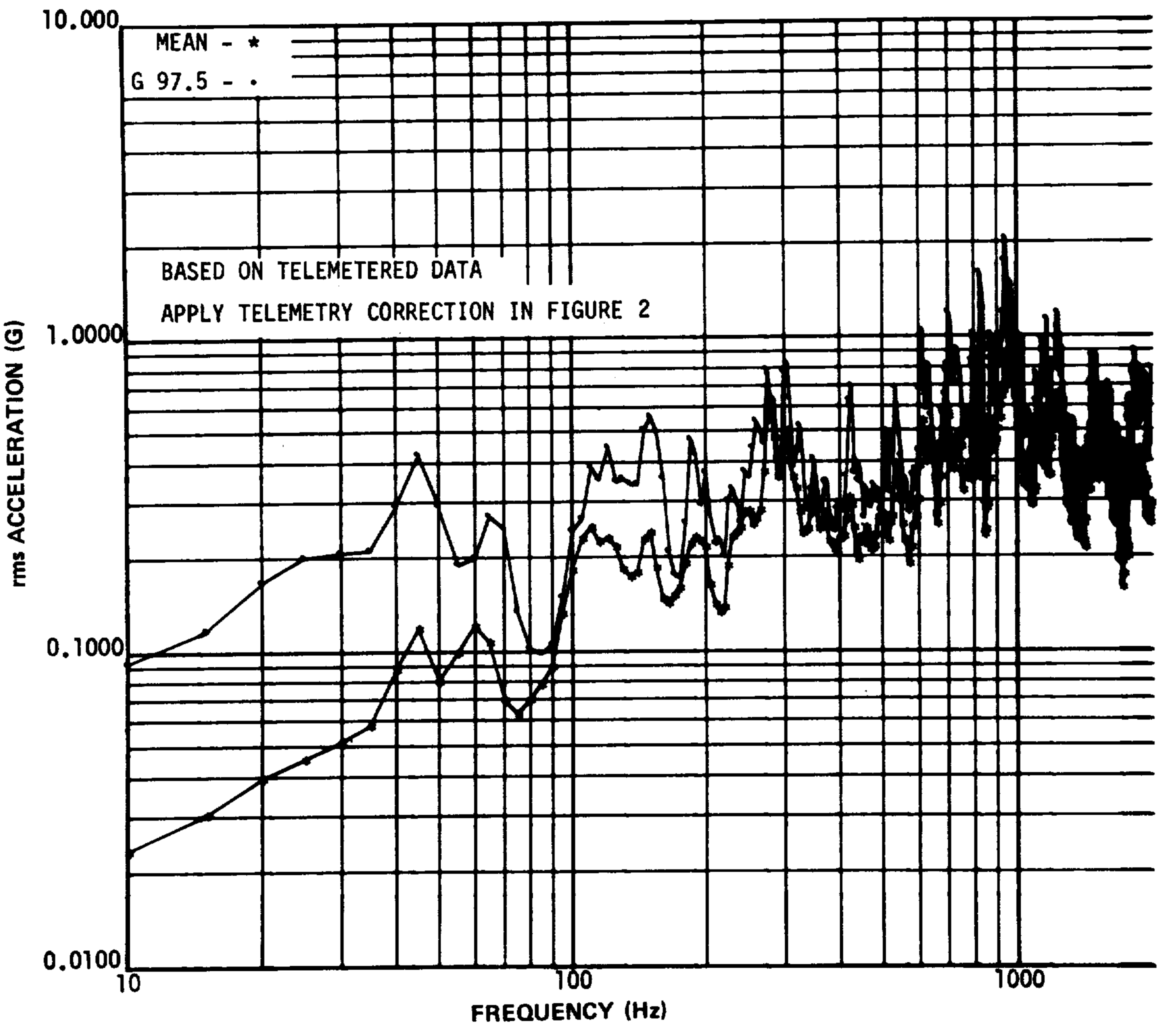


Figure A-72. Ring frame rms acceleration, longitudinal, static firing.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION –
LIFTOFF AND STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 13.12
COMPOSITE 97.5 – 61.29
VEHICLE DIAMETER – 10.06 m (33 ft)

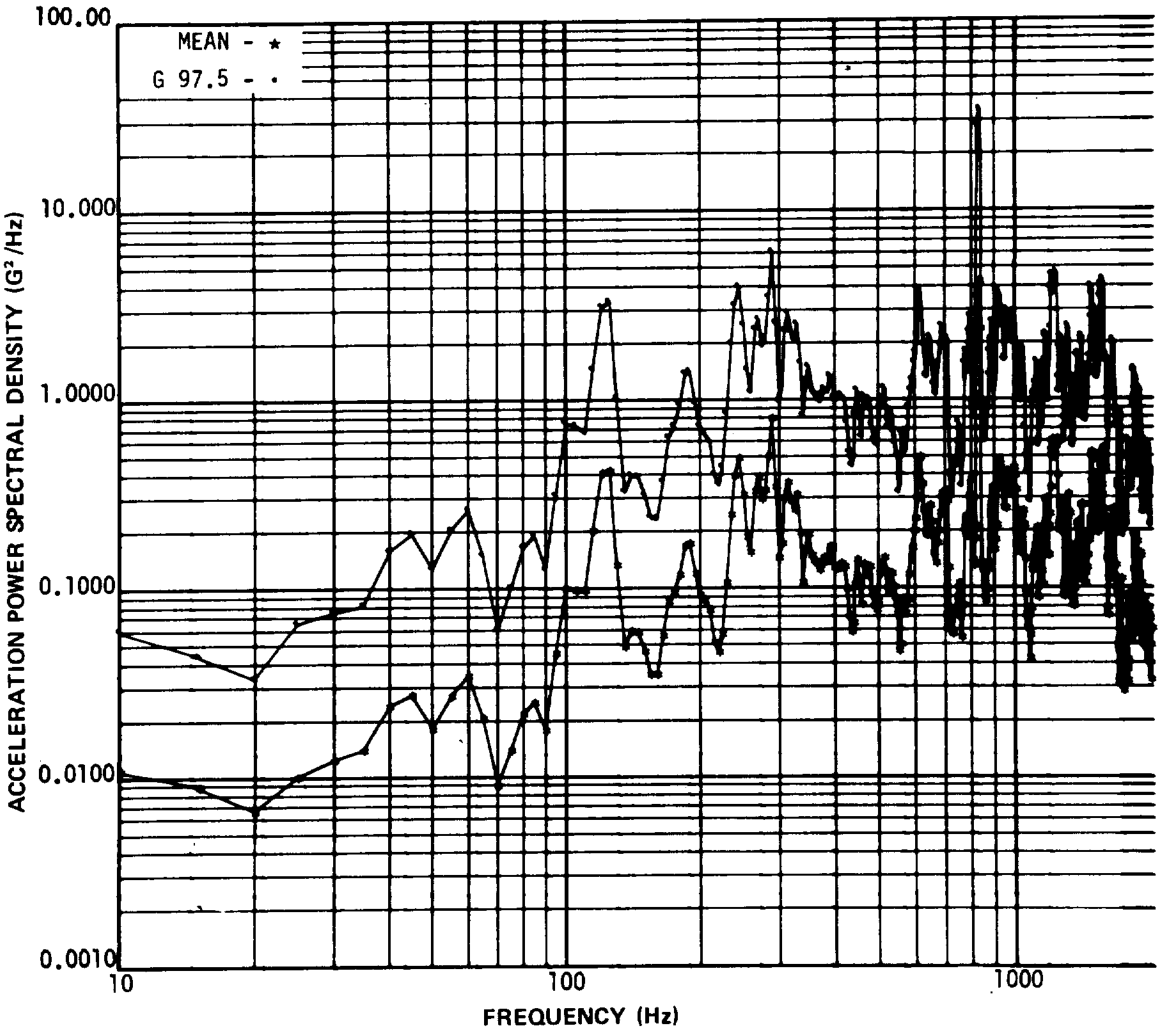


Figure A-73. Ring frame acceleration power spectral density, longitudinal, liftoff and static firing.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF AND STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 13.12
COMPOSITE 97.5 – 61.29
VEHICLE DIAMETER – 10.06 m (33 ft)

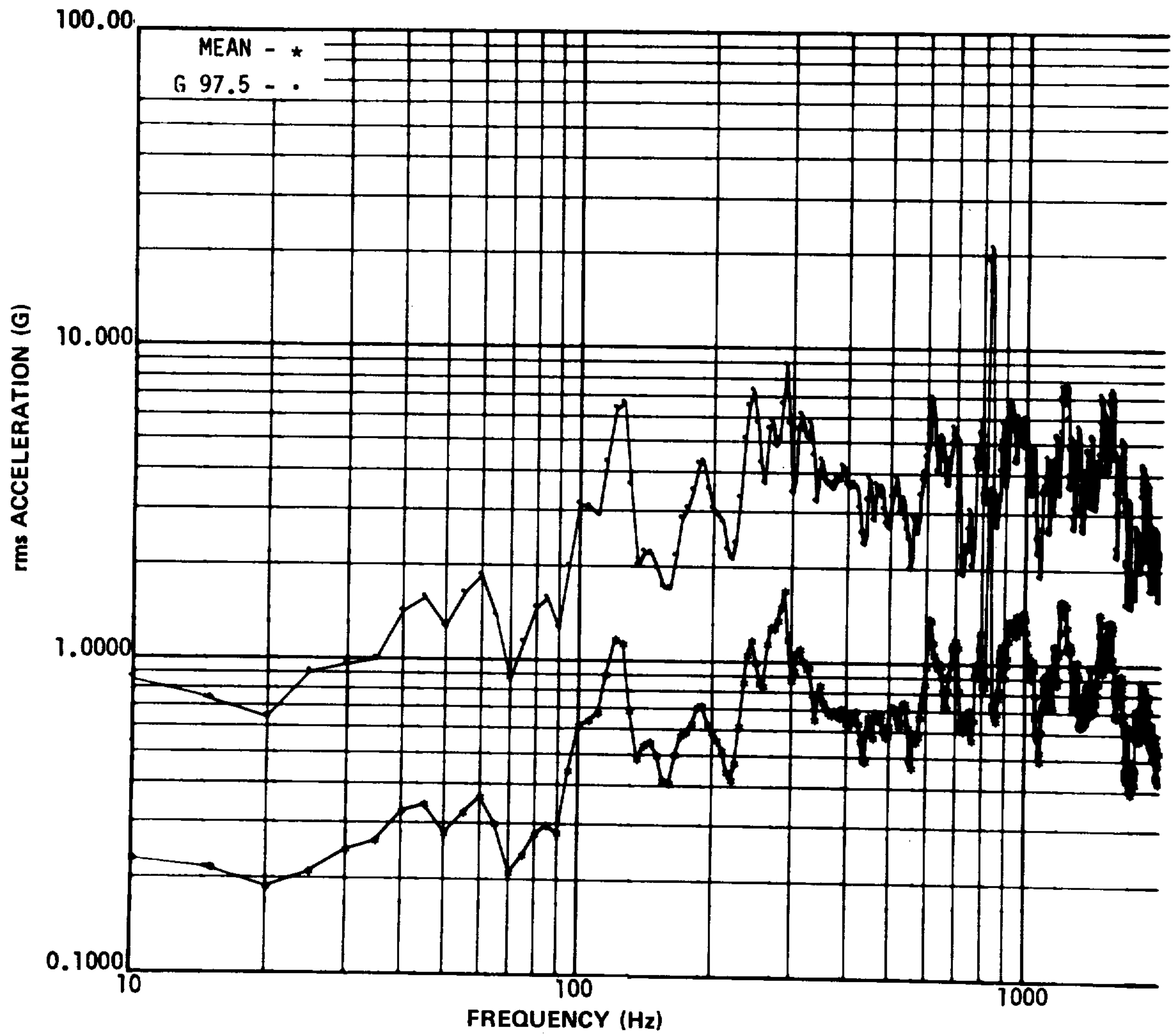


Figure A-74. Ring frame rms acceleration, longitudinal, liftoff and static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 5.48
COMPOSITE 97.5 – 8.52
VEHICLE DIAMETER – 10.06 m (33 ft)

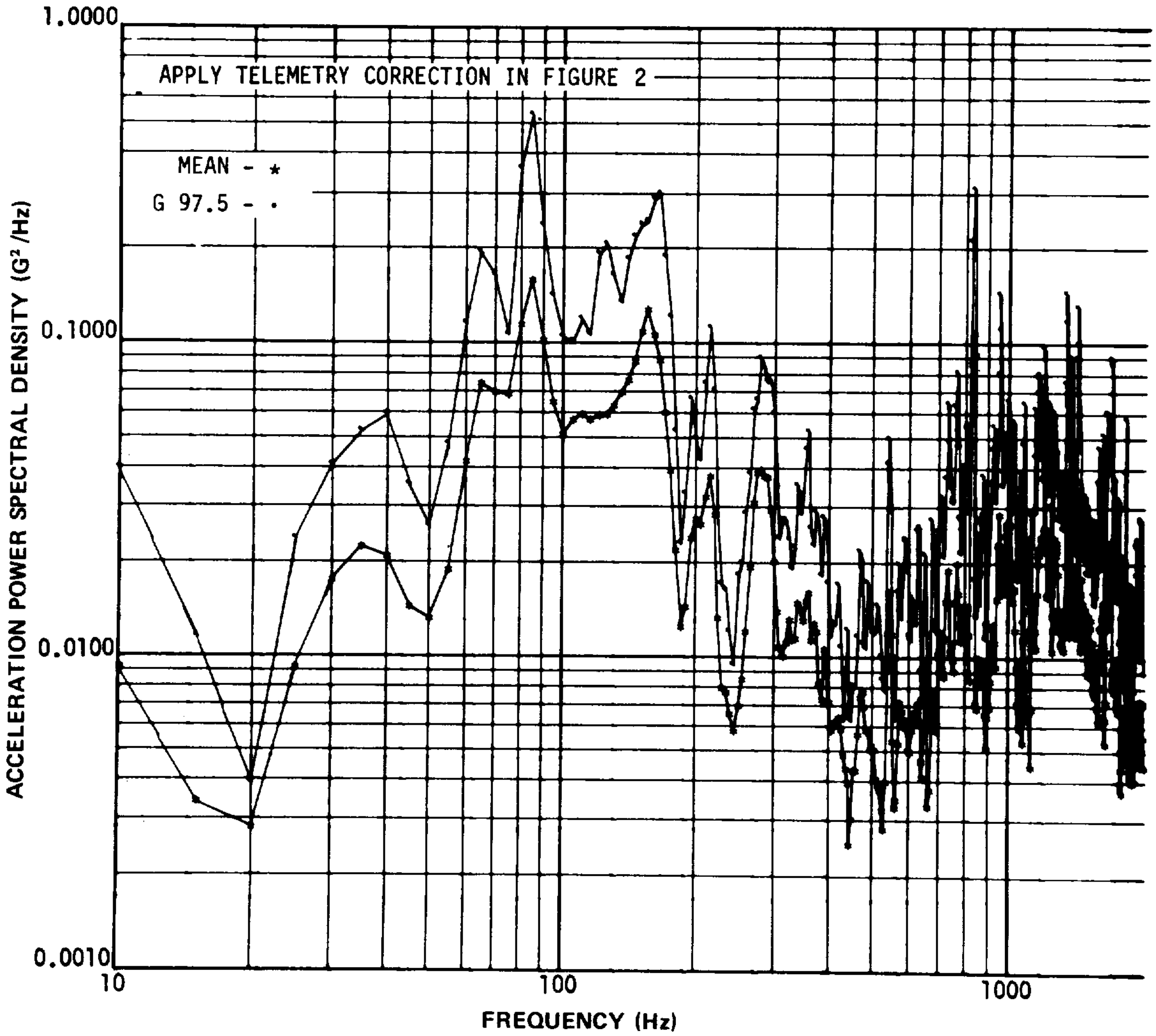


Figure A-75. Ring frame acceleration power spectral density, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 5.48
COMPOSITE 97.5 – 8.52
VEHICLE DIAMETER – 10.06 m (33 ft)

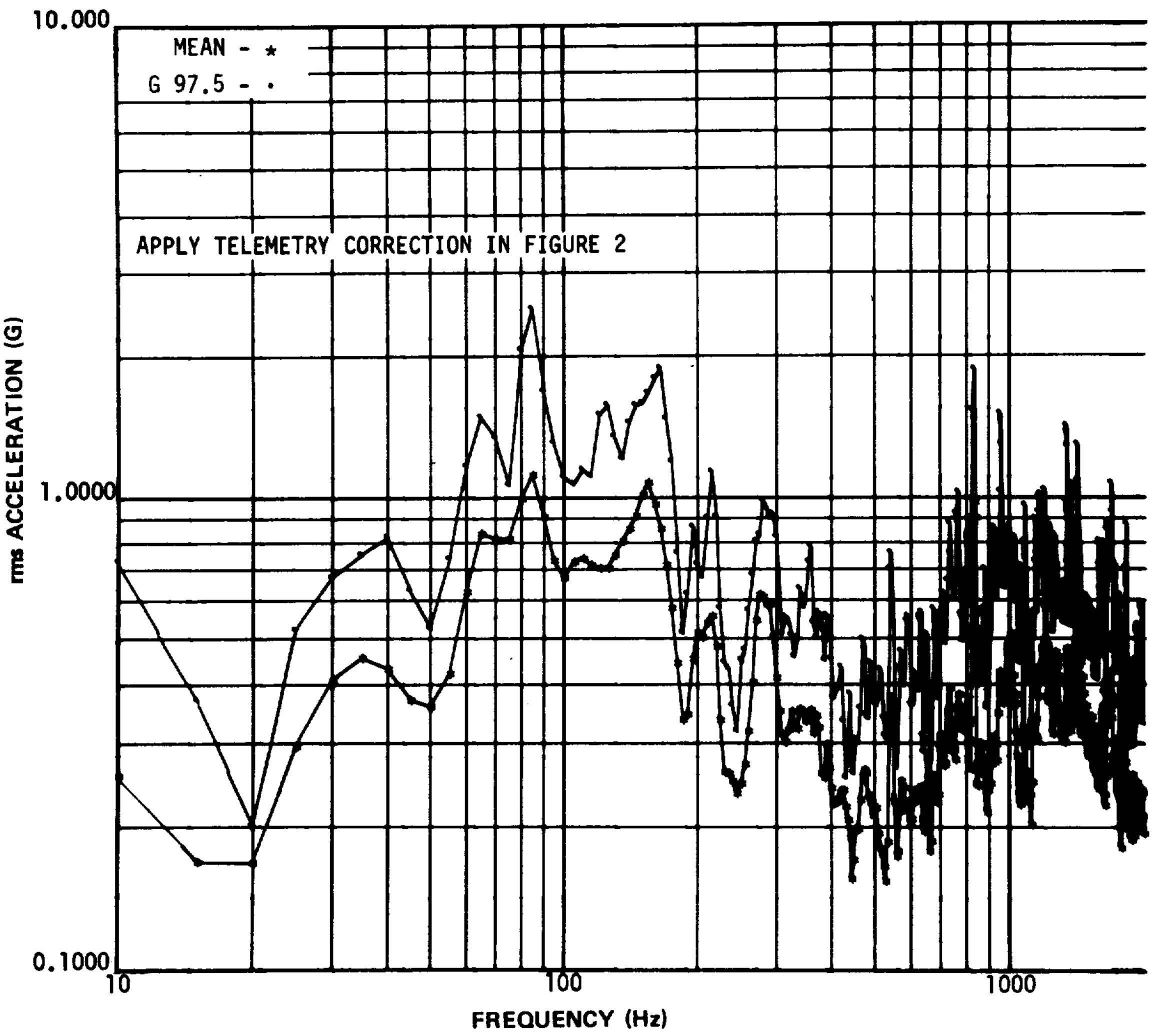


Figure A-76. Ring frame rms acceleration, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 10.95
COMPOSITE 97.5 – 19.82
VEHICLE DIAMETER – 10.06 m (33 ft)

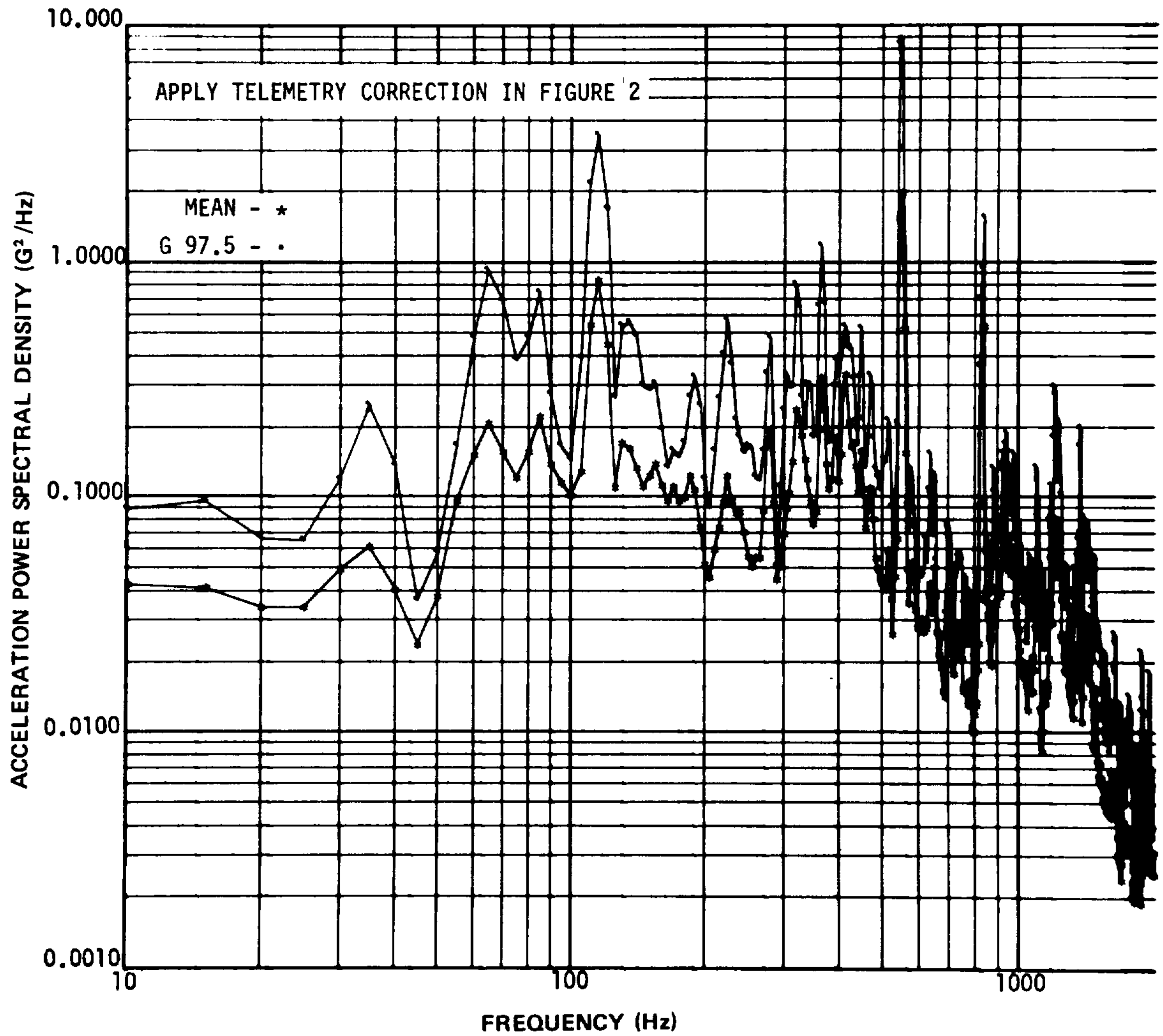


Figure A-77. Ring frame acceleration power spectral density, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 10.95
COMPOSITE 97.5 – 19.82
VEHICLE DIAMETER – 10.06 m (33 ft)

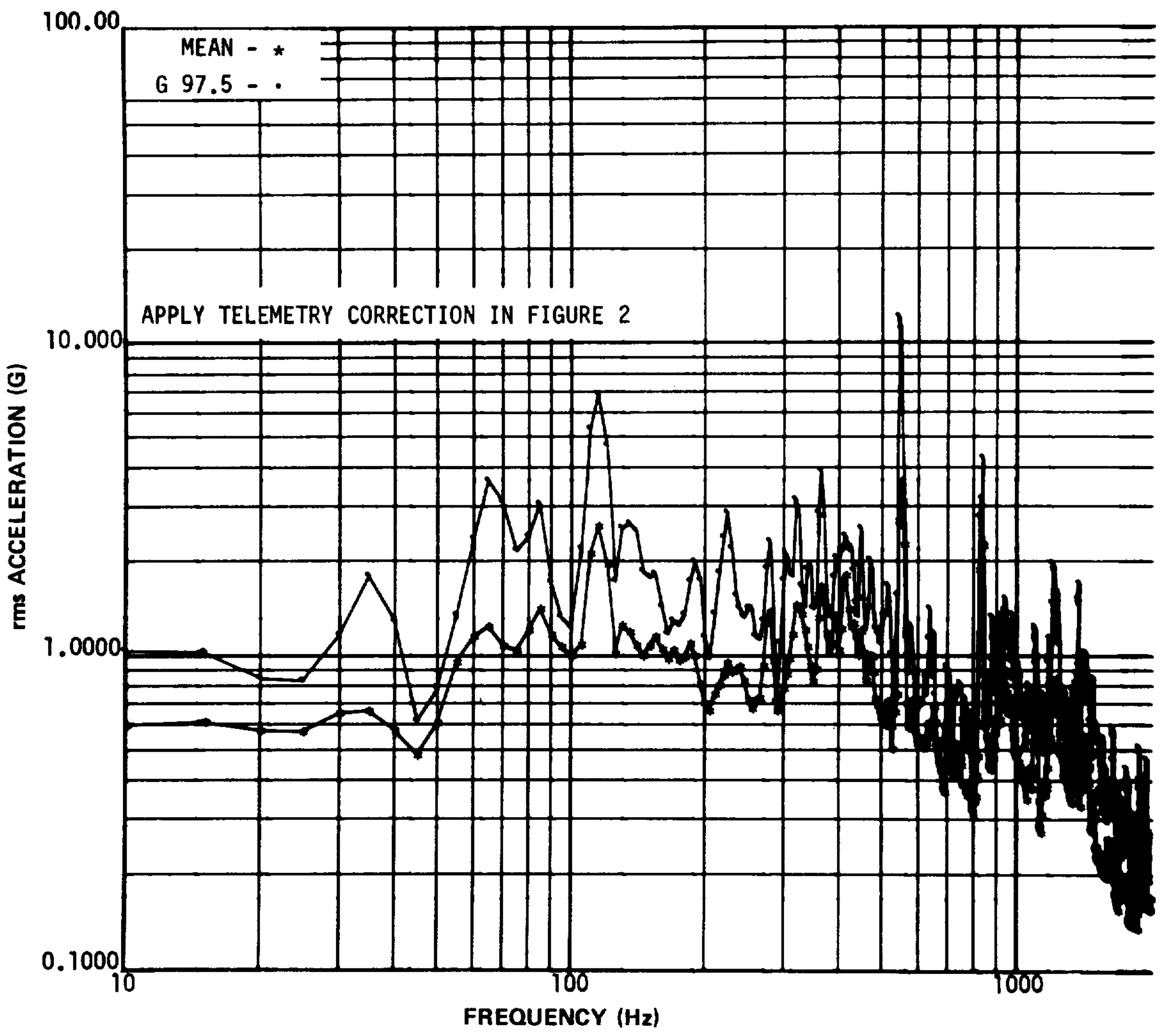


Figure A-78. Ring frame rms acceleration, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 9.86
COMPOSITE 97.5 – 18.83
VEHICLE DIAMETER – 10.06 m (33 ft)

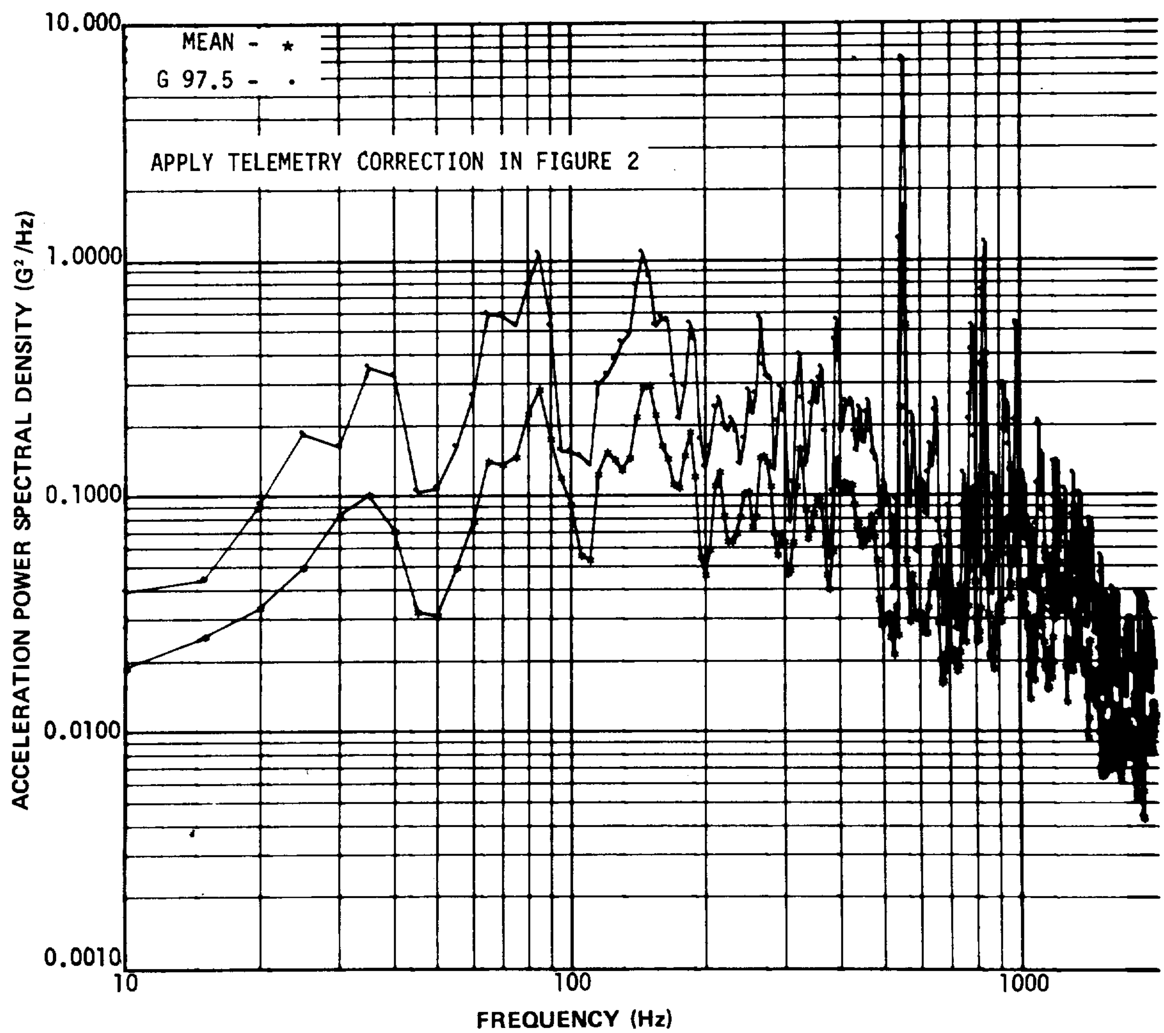


Figure A-79. Ring frame acceleration power spectral density, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 9.86
COMPOSITE 97.5 – 18.83
VEHICLE DIAMETER – 10.06 m (33 ft)

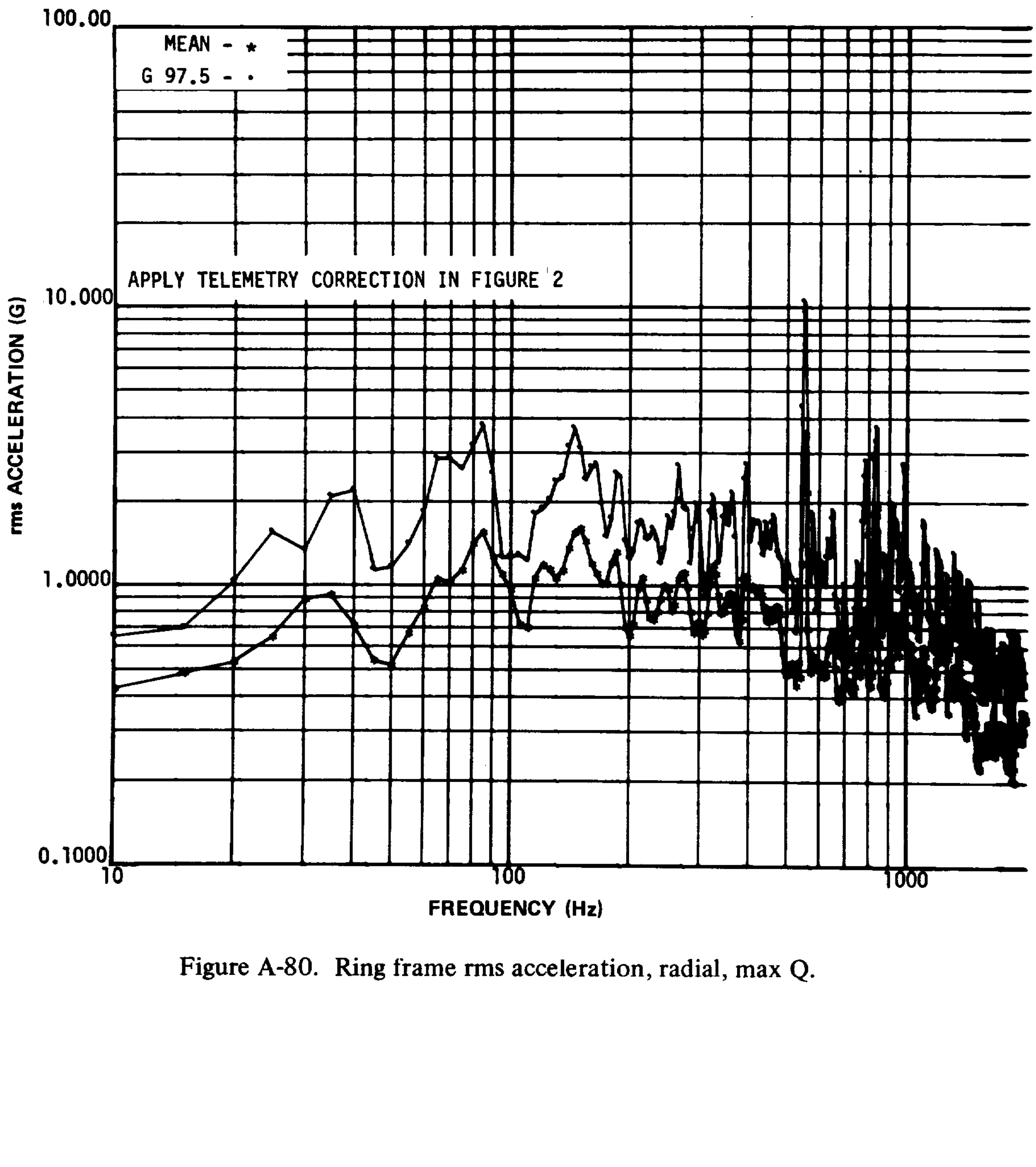


Figure A-80. Ring frame rms acceleration, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 10.41
COMPOSITE 97.5 – 17.98
VEHICLE DIAMETER – 10.06 m (33 ft)

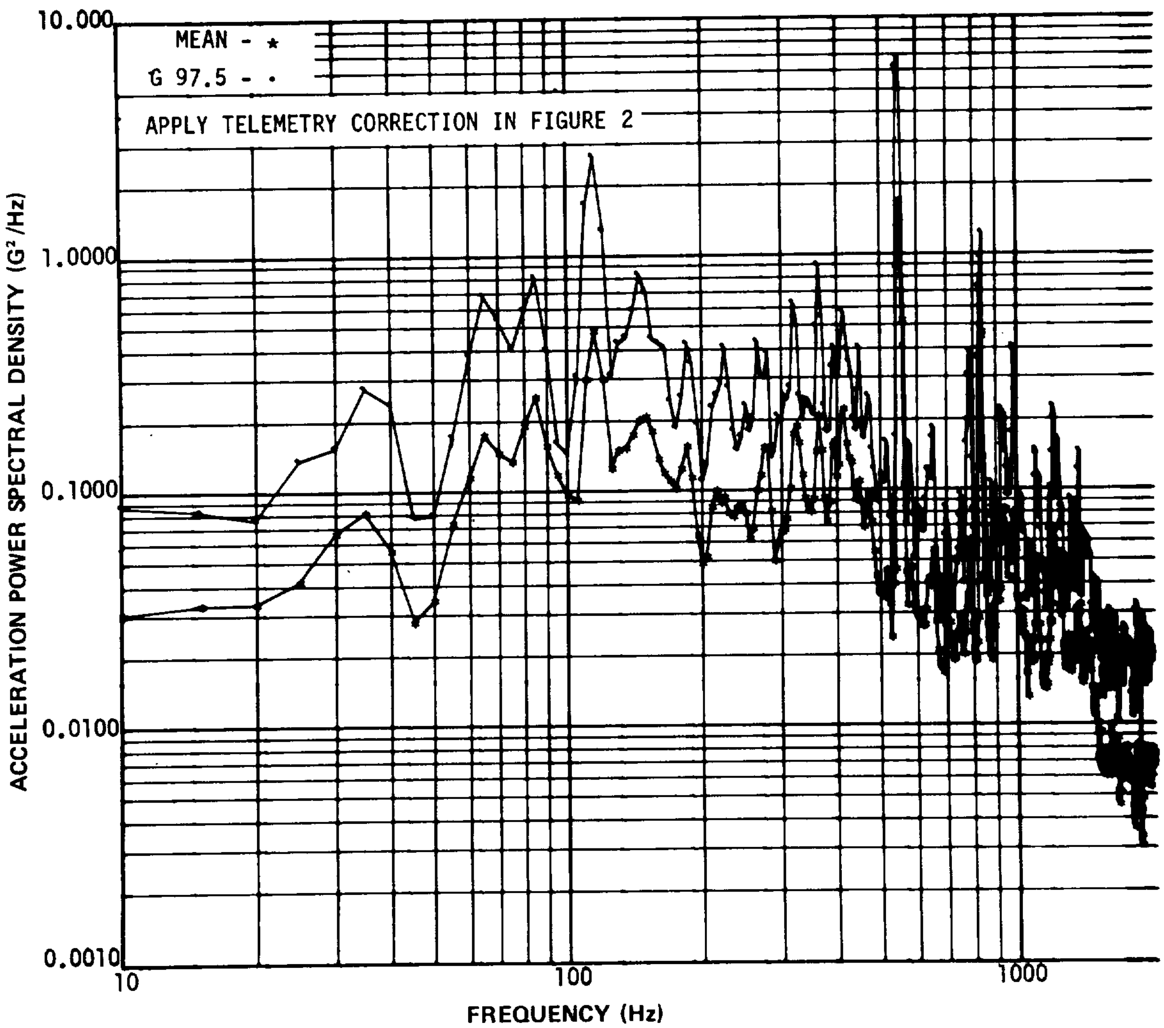


Figure A-81. Ring frame acceleration power spectral density, radial, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 10.41
COMPOSITE 97.5 – 17.98
VEHICLE DIAMETER – 10.06 m (33 ft)

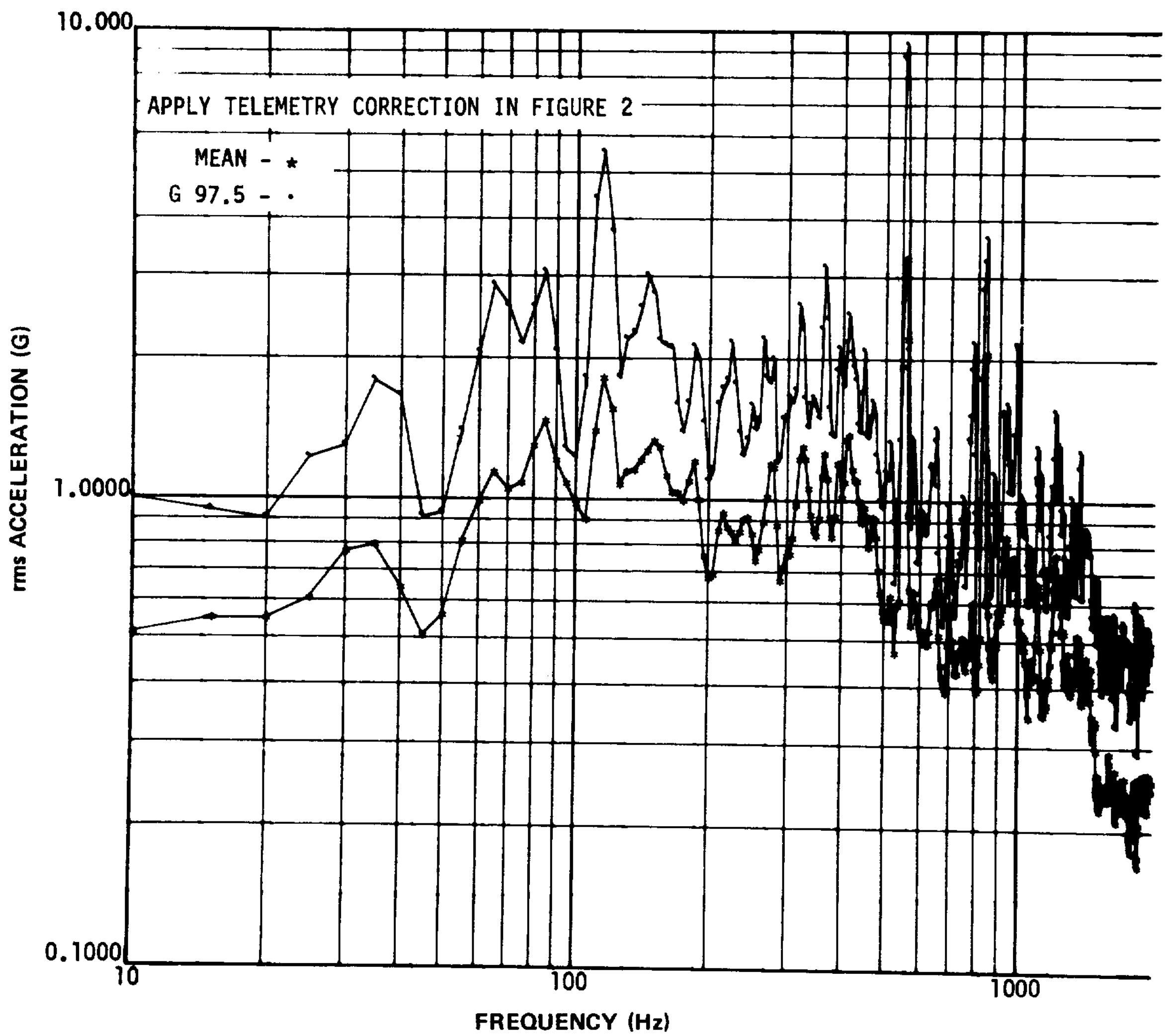


Figure A-82. Ring frame rms acceleration, radial, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.08
COMPOSITE 97.5 – 8.68
VEHICLE DIAMETER – 10.06 m (33 ft)

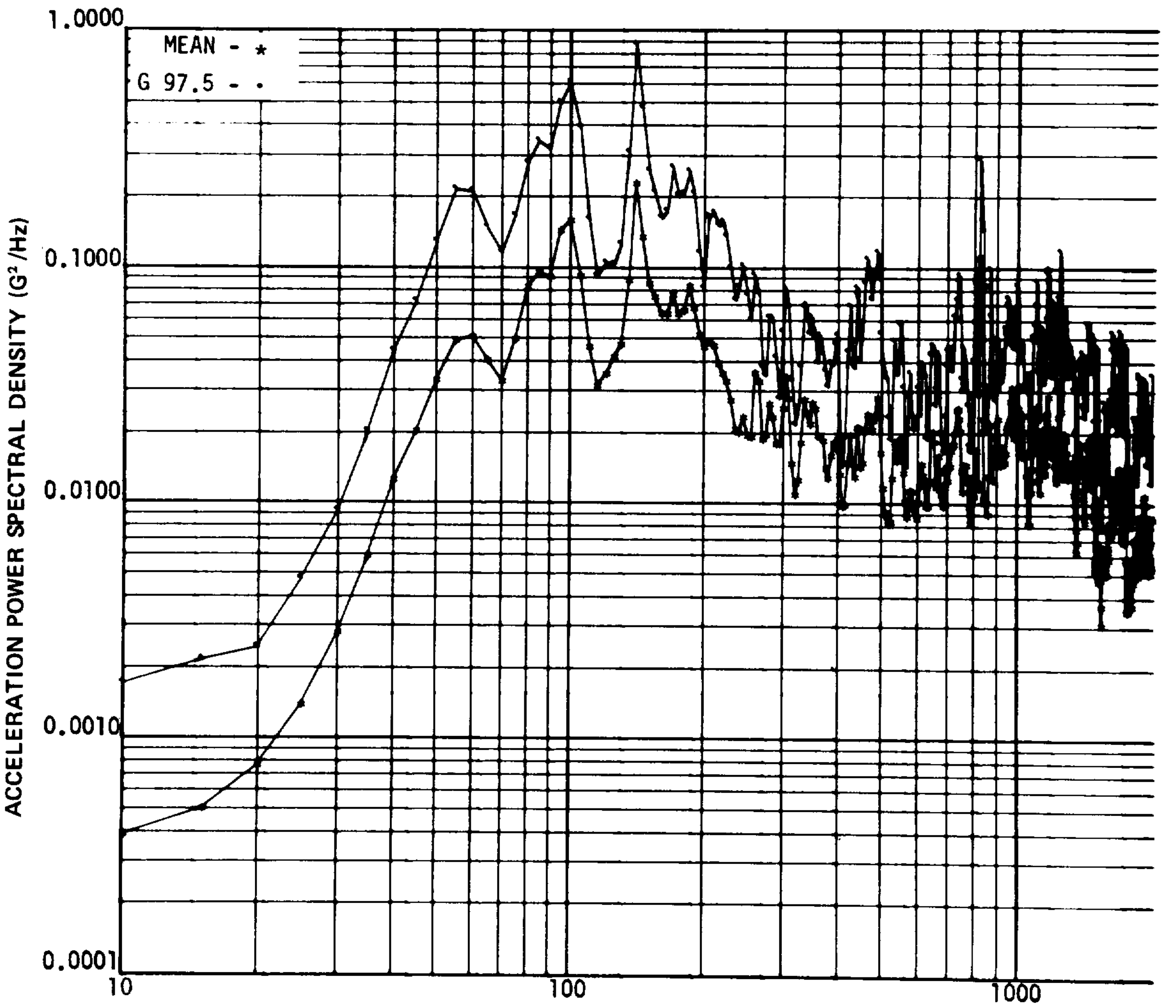


Figure A-83. Ring frame acceleration power spectral density, radial, static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.08
COMPOSITE 97.5 – 8.68
VEHICLE DIAMETER – 10.06 m (33 ft)

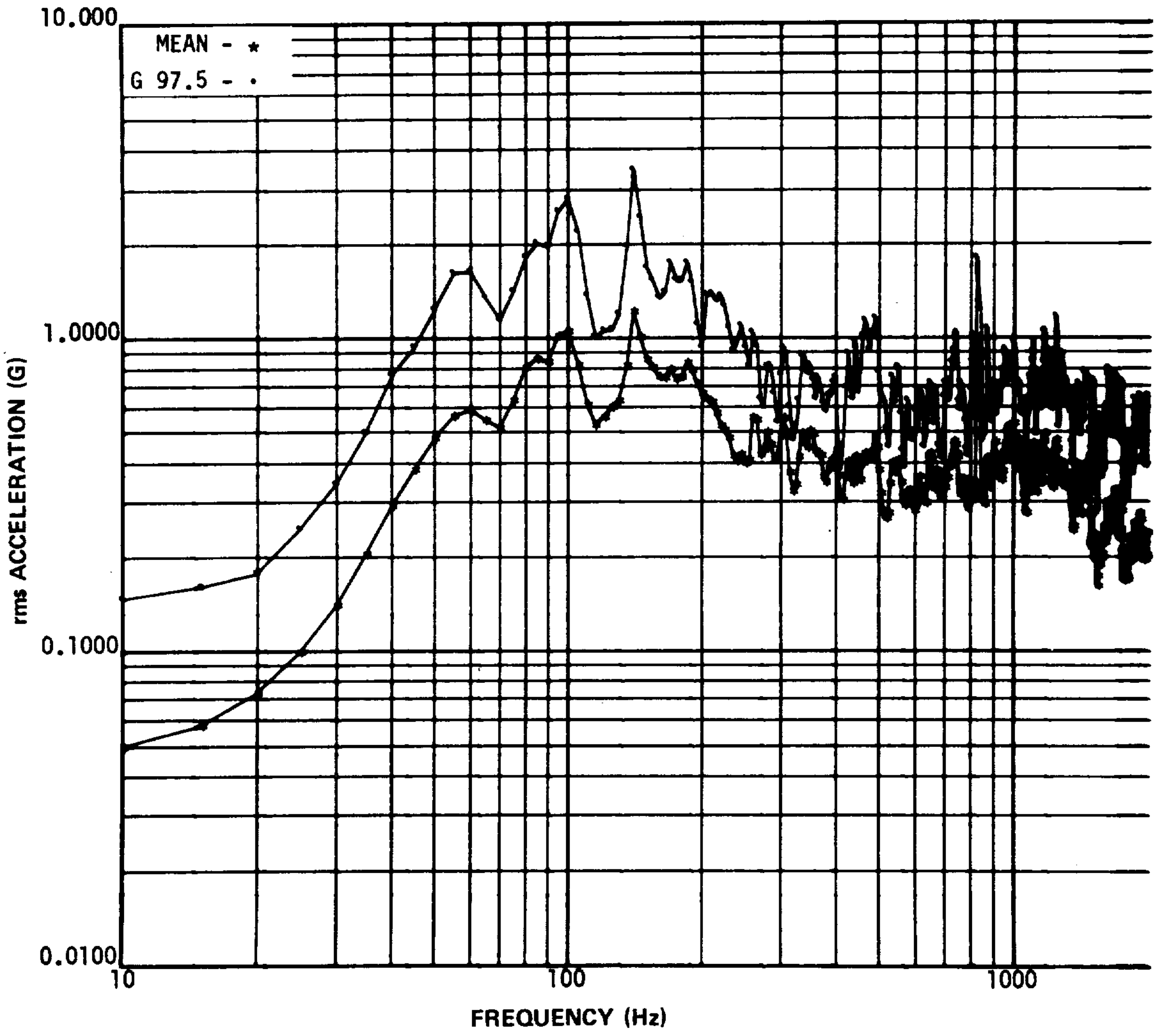


Figure A-84. Ring frame rms acceleration, radial, static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF AND STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 5.86
COMPOSITE 97.5 – 8.59
VEHICLE DIAMETER – 10.06 m (33 ft)

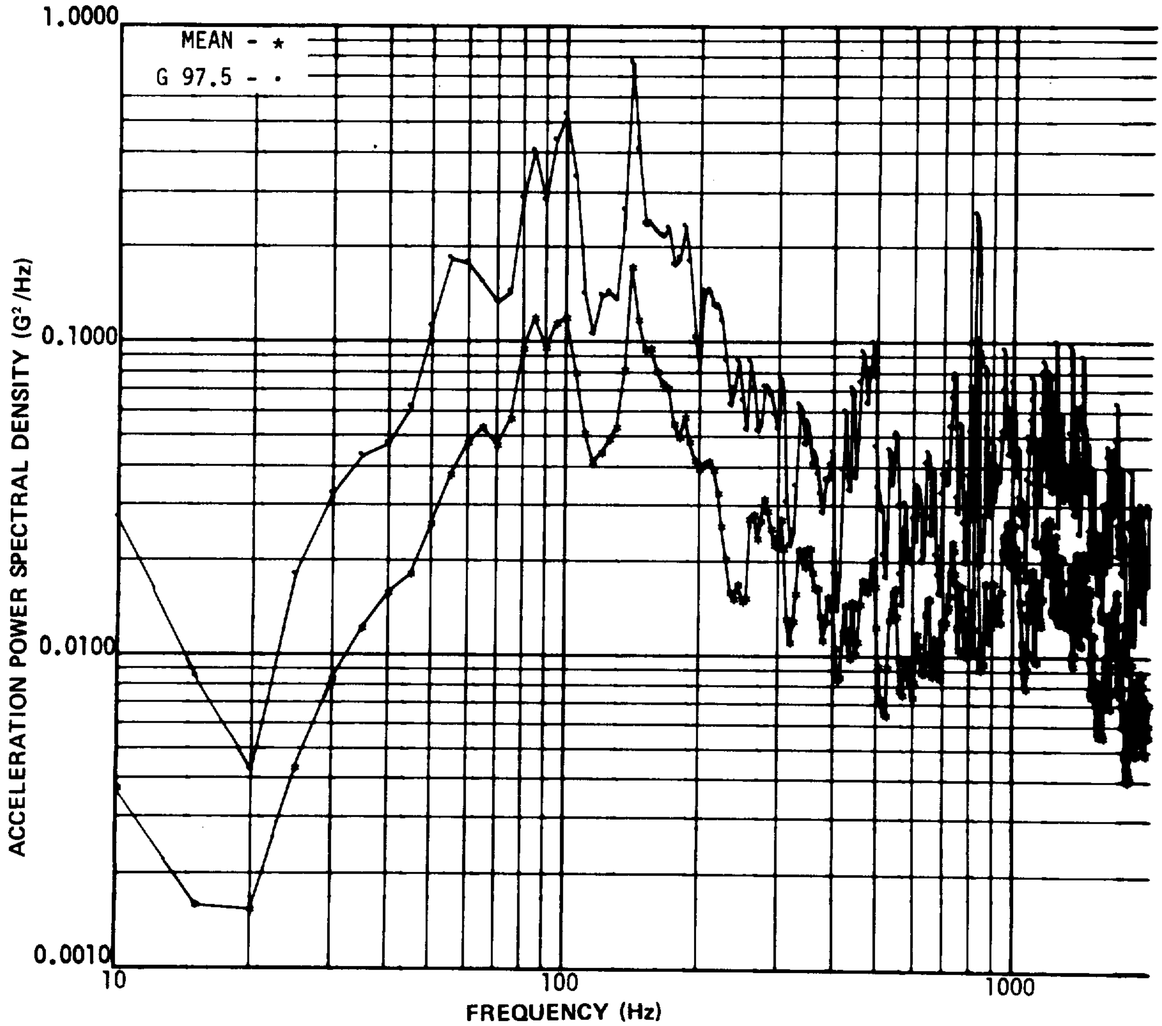
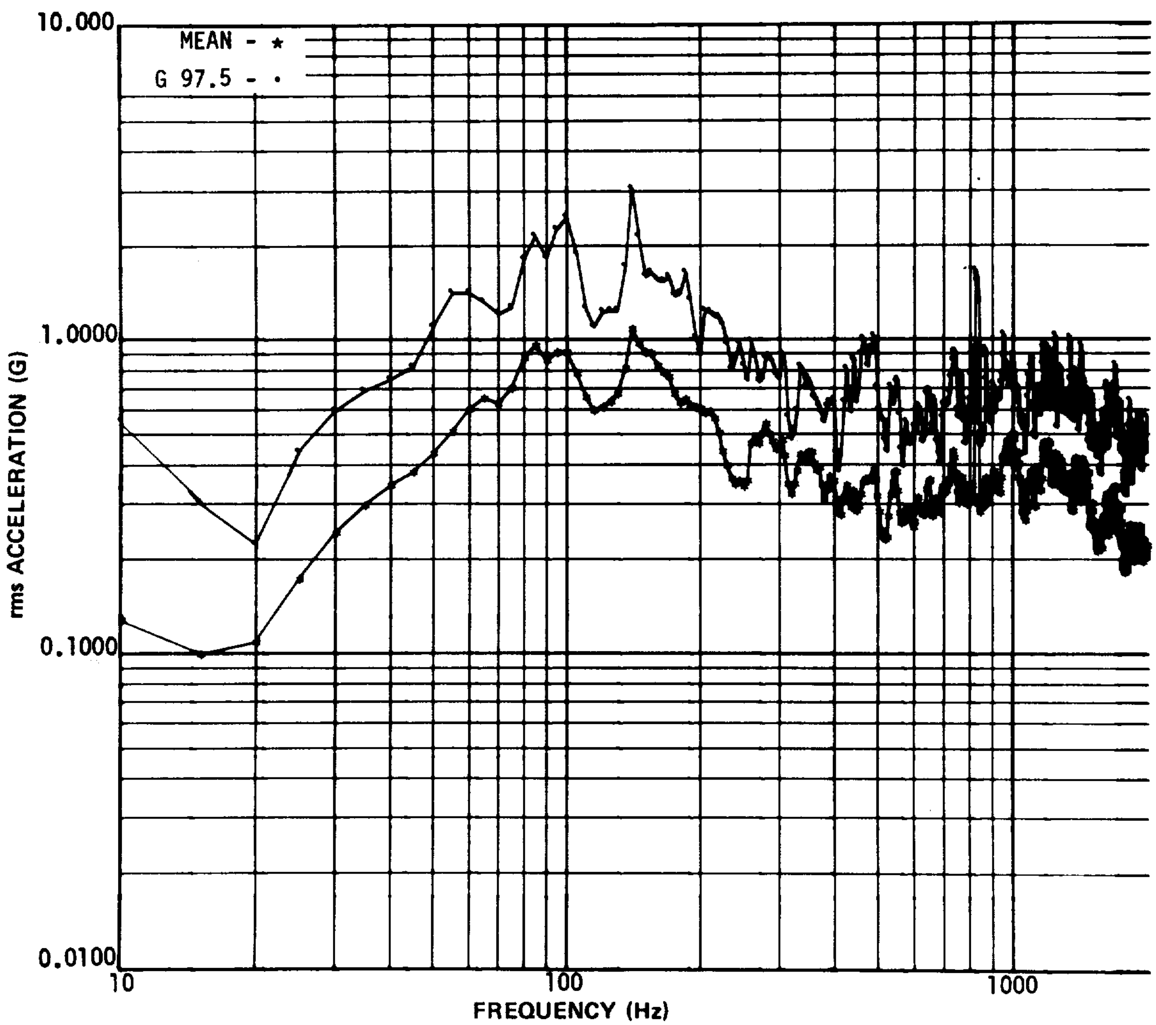


Figure A-85. Ring frame acceleration power spectral density, radial, liftoff and static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .953 cm (.375 in.)
RING SEPARATION – N/A
RING WEIGHT – 43.46 kg/m (29.06 lb/ft)
STRINGER SEPARATION – 24.69 cm (9.72 in.)
STRINGER WEIGHT – 2.9 kg/m (1.95 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF AND STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 5.86
COMPOSITE 97.5 – 8.59
VEHICLE DIAMETER – 10.06 m (33 ft)



2. Skin-Stringer Data Banks

DIRECTION – NORMAL TO INTERSTAGE
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 49.26 cm (19.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.51 cm (8.47 in.)
STRINGER WEIGHT – 2.10 kg/m (1.41 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 27.66
COMPOSITE 97.5 – 32.28
VEHICLE DIAMETER – 10.06 m (33 ft)

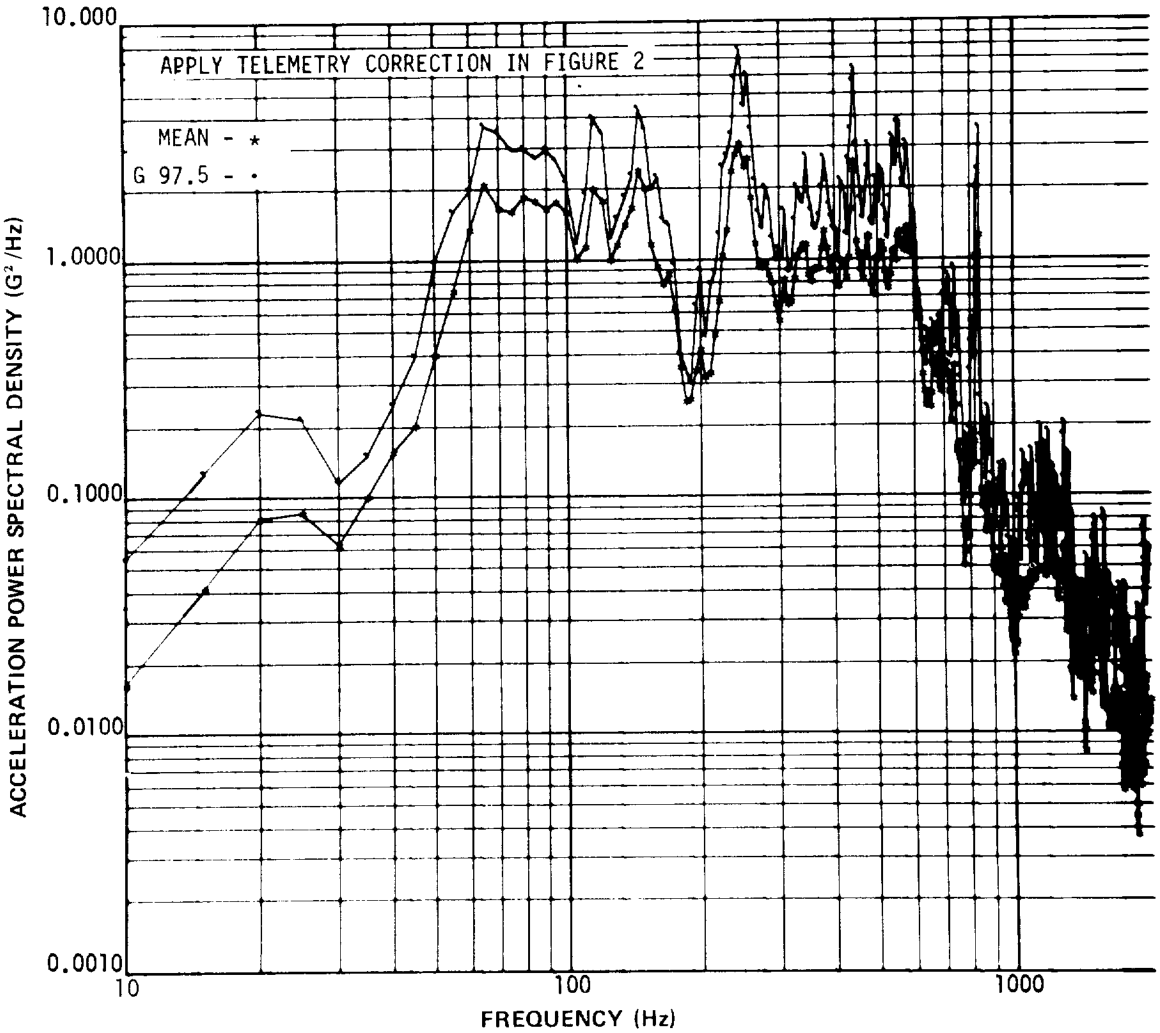


Figure A-87. Skin-stringer acceleration power spectral density, normal to interstage, liftoff.

DIRECTION – NORMAL TO INTERSTAGE
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 49.26 cm (19.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.51 cm (8.47 in.)
STRINGER WEIGHT – 2.10 kg/m (1.41 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 27.66
COMPOSITE 97.5 – 32.28
VEHICLE DIAMETER – 10.06 m (33 ft)

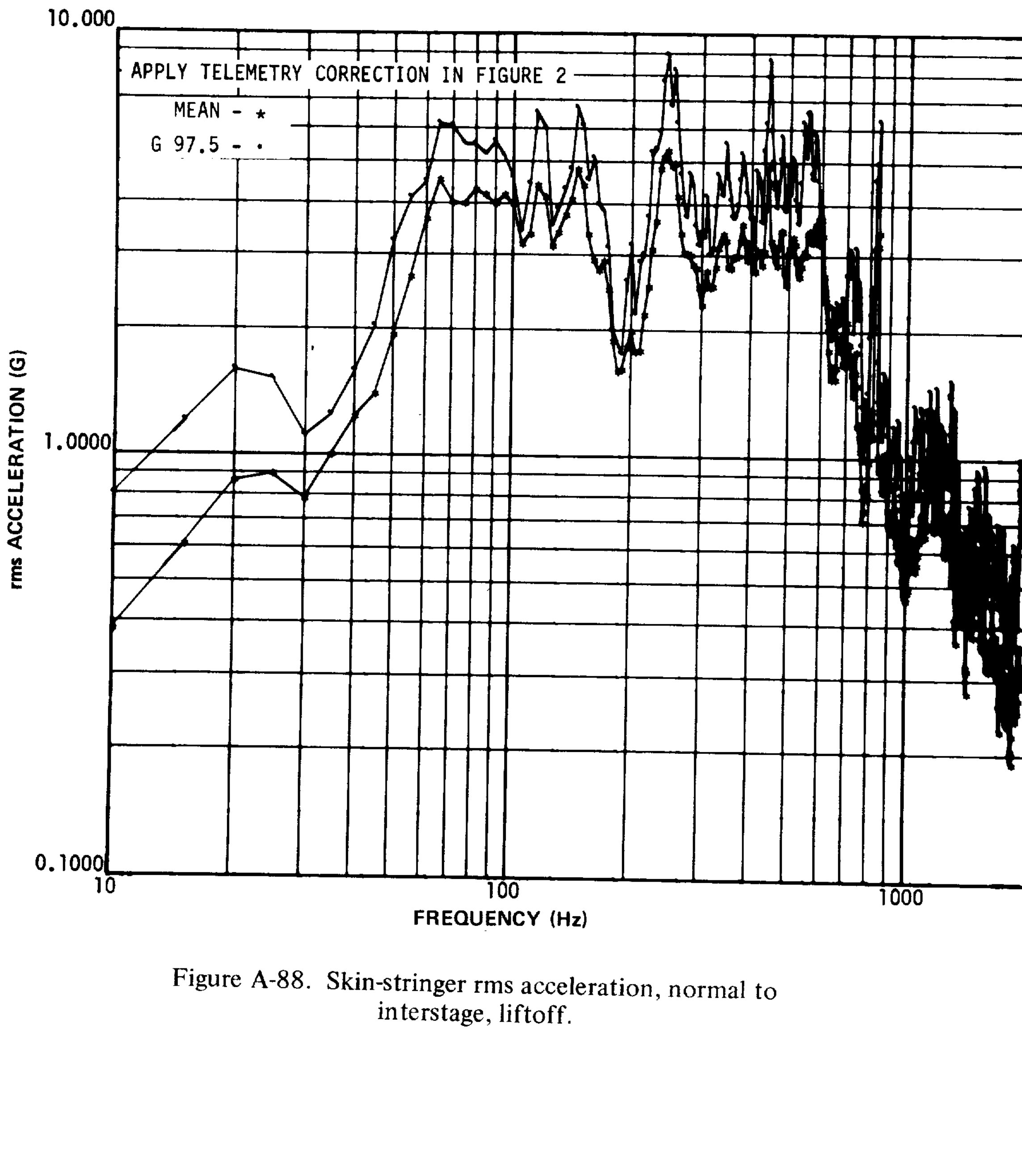


Figure A-88. Skin-stringer rms acceleration, normal to interstage, liftoff.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 2.37
COMPOSITE 97.5 – 3.65
VEHICLE DIAMETER – 10.06 m (33 ft)

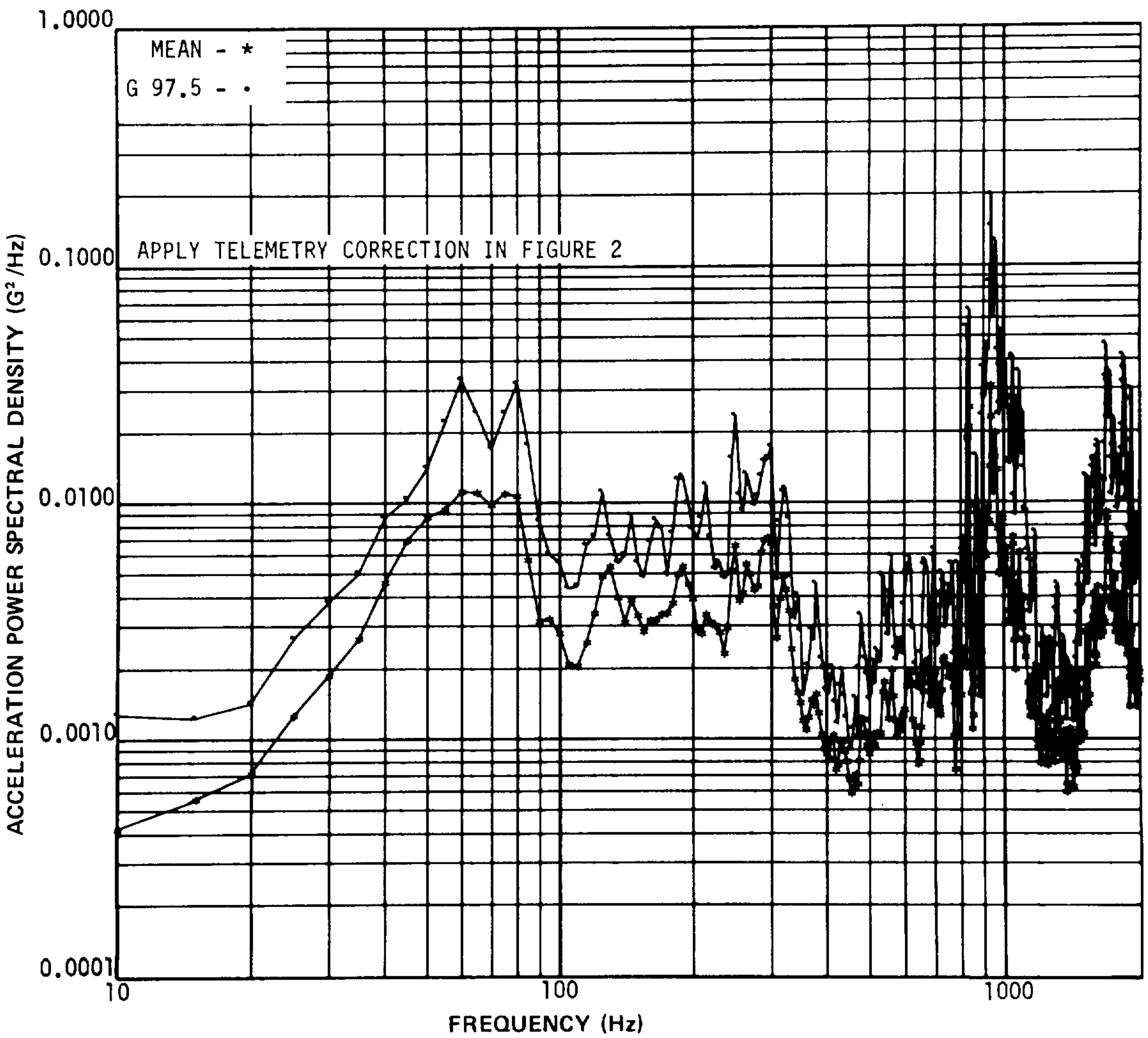


Figure A-89. Skin-stringer acceleration power spectral density, longitudinal, liftoff.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 2.37
COMPOSITE 97.5 – 3.65
VEHICLE DIAMETER – 10.06 m (33 ft)

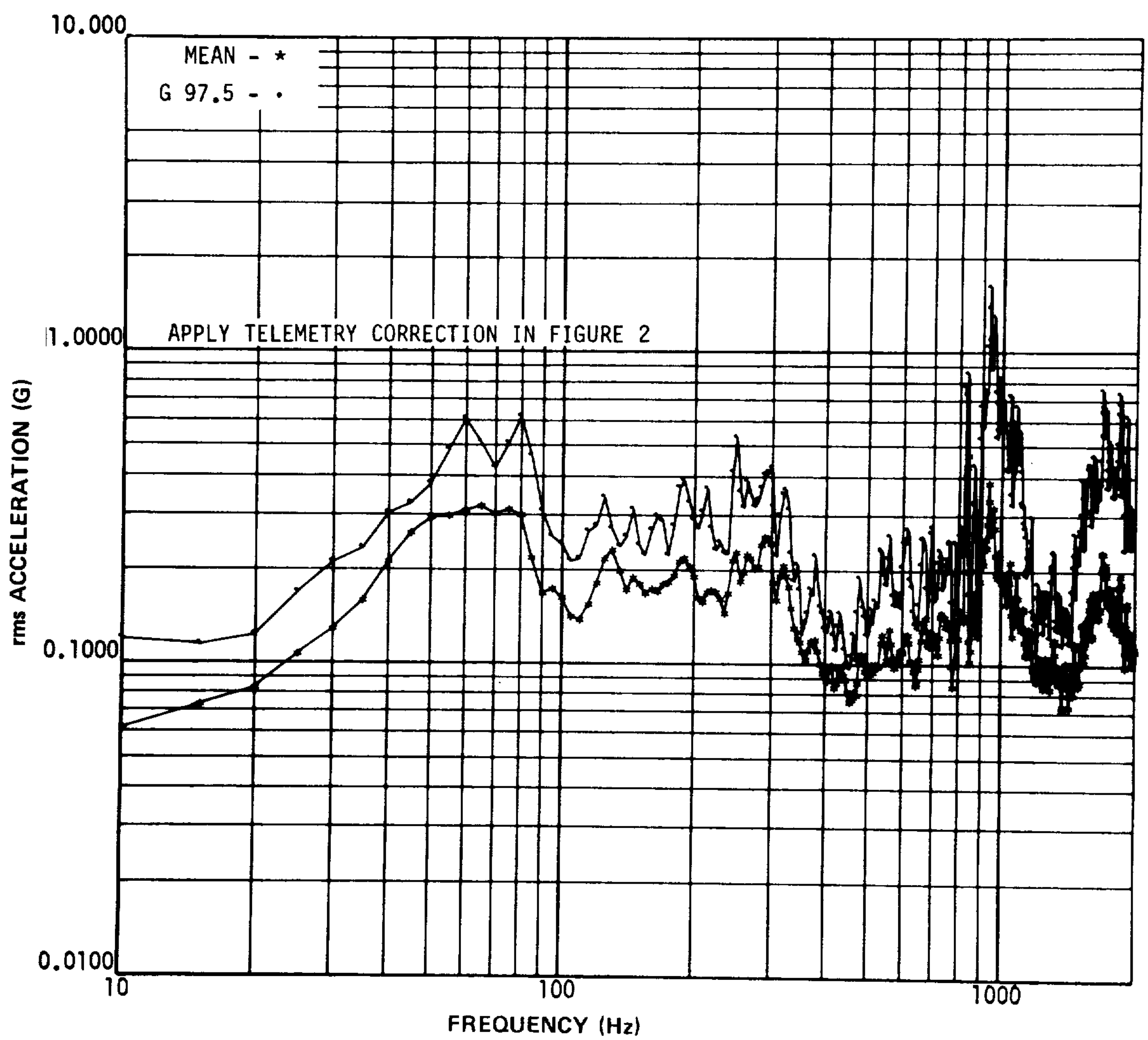


Figure A-90. Skin-stringer rms acceleration, longitudinal, liftoff.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 3.83
COMPOSITE 97.5 – 6.66
VEHICLE DIAMETER – 10.06 m (33 ft)

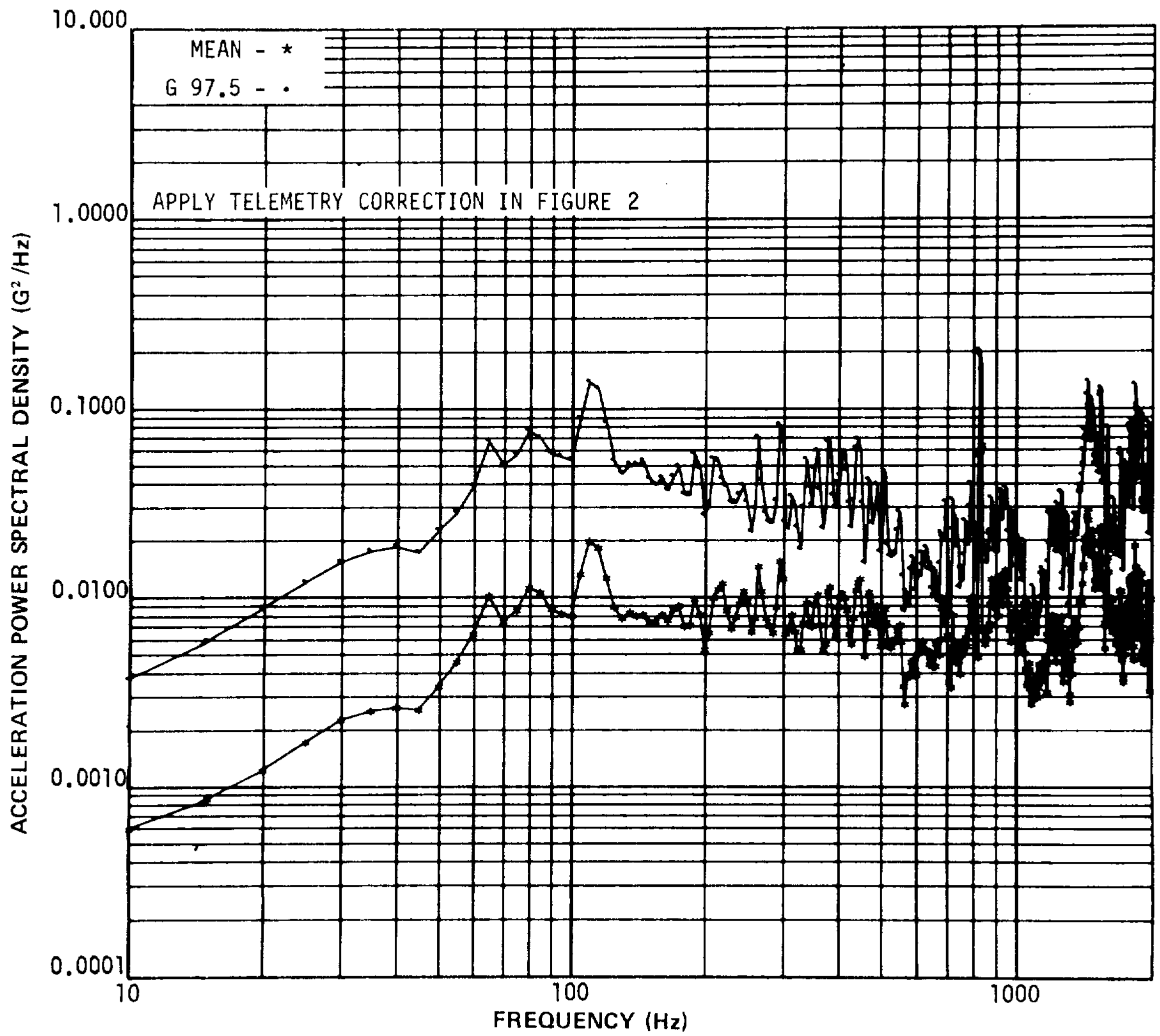


Figure A-91. Skin-stringer acceleration power spectral density, longitudinal, Mach 1.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 3.83
COMPOSITE 97.5 – 6.66
VEHICLE DIAMETER – 10.06 m (33 ft)

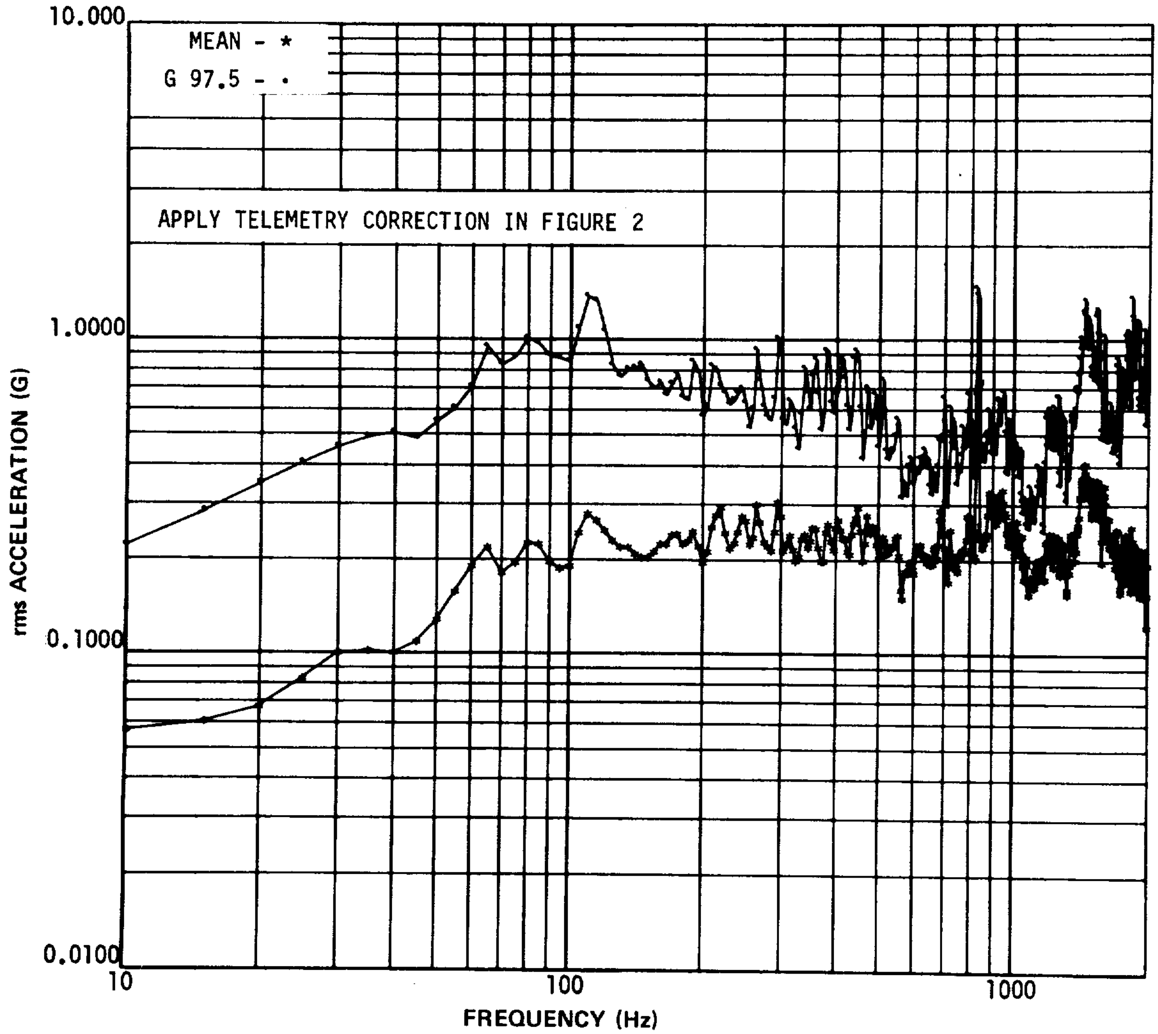


Figure A-92. Skin-stringer rms acceleration, longitudinal, Mach 1.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 3.20
COMPOSITE 97.5 – 4.33
VEHICLE DIAMETER – 10.06 m (33 ft)

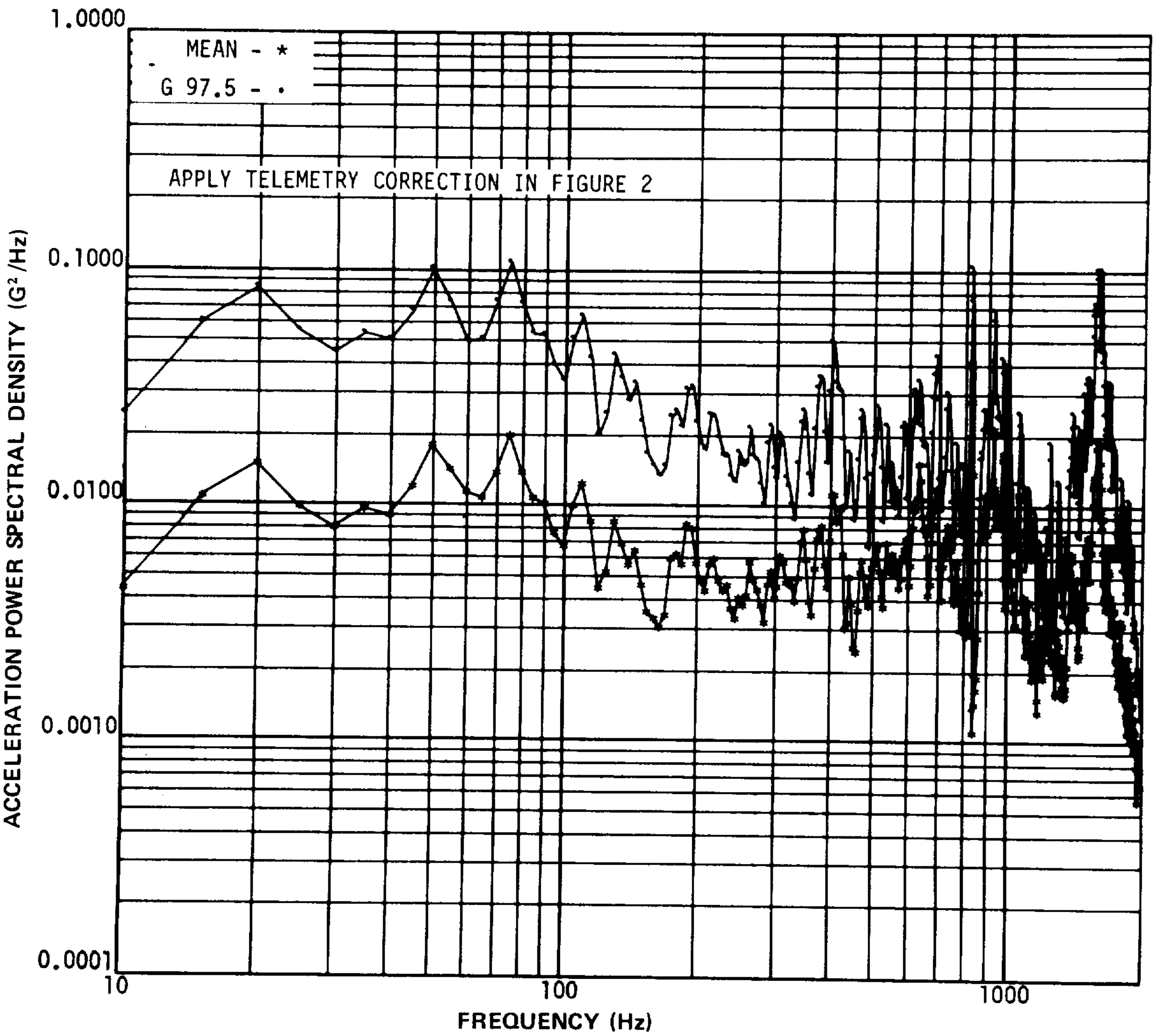


Figure A-93. Skin-stringer acceleration power spectral density, longitudinal, max Q.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 3.20
COMPOSITE 97.5 – 4.33
VEHICLE DIAMETER – 10.06 m (33 ft)

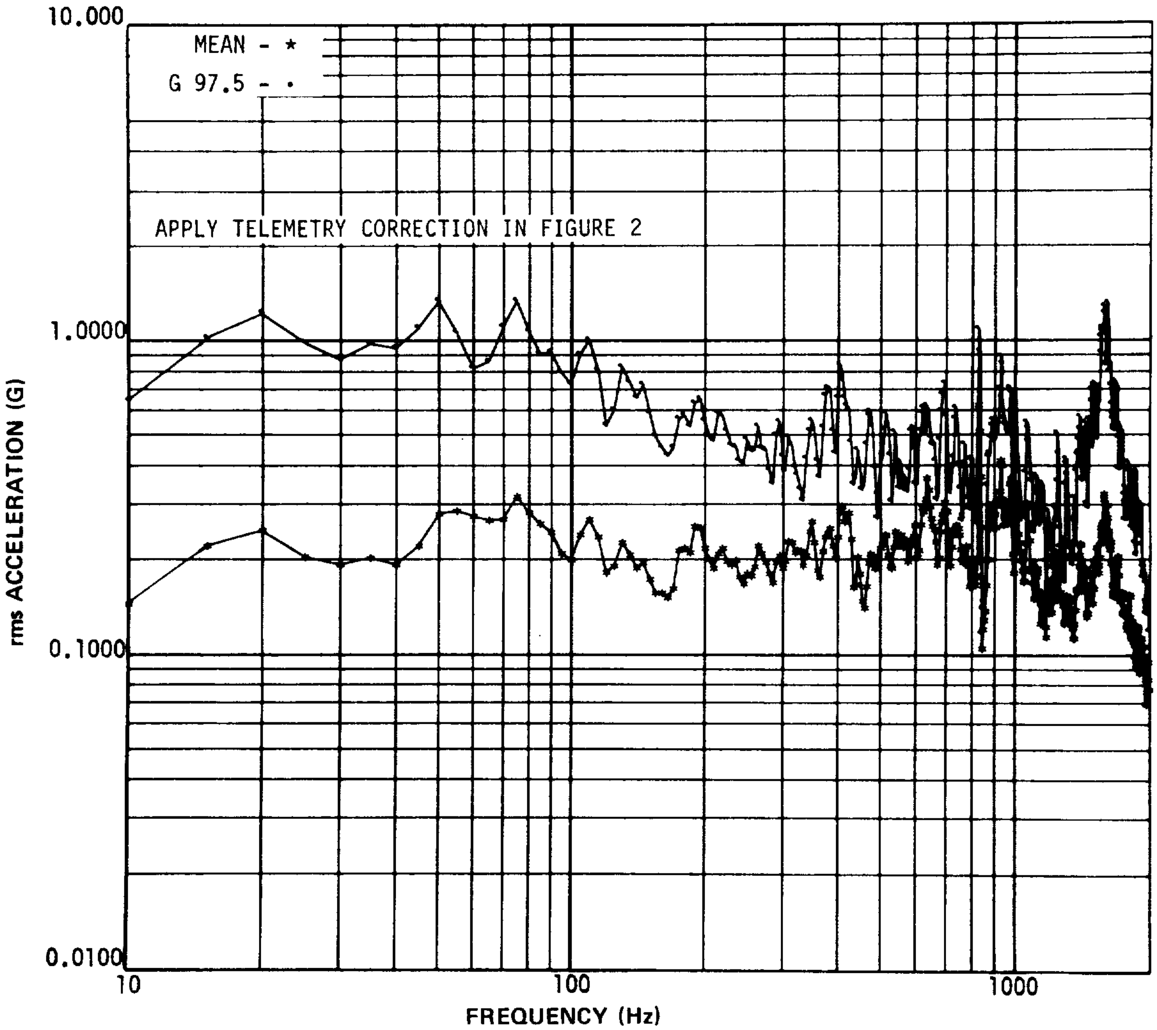


Figure A-94. Skin-stringer rms acceleration, longitudinal, max Q.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 3.68
COMPOSITE 97.5 – 6.23
VEHICLE DIAMETER – 10.06 m (33 ft)

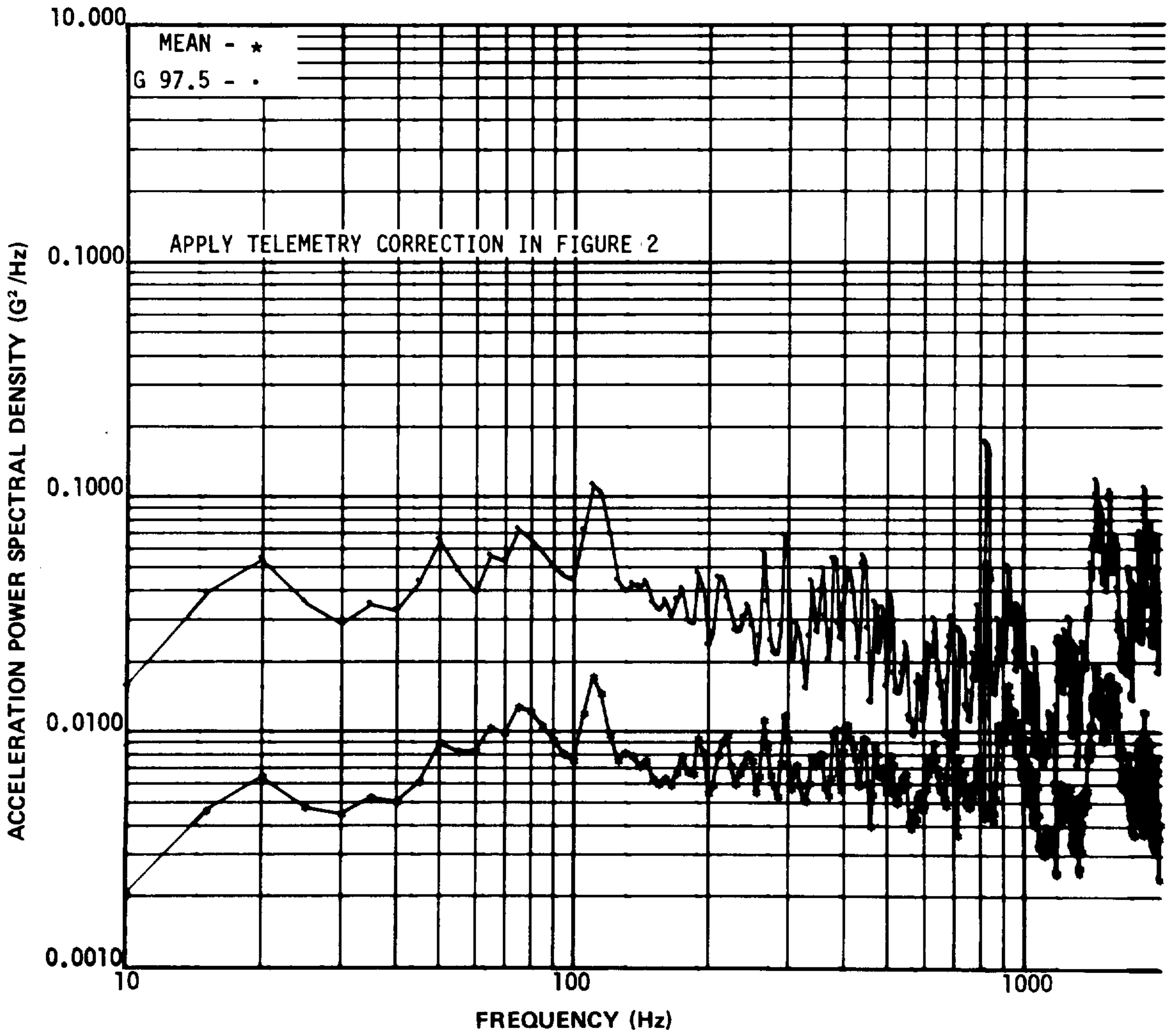


Figure A-95. Skin-stringer acceleration power spectral density, longitudinal, transonic.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 3.68
COMPOSITE 97.5 – 6.23
VEHICLE DIAMETER – 10.06 m (33 ft)

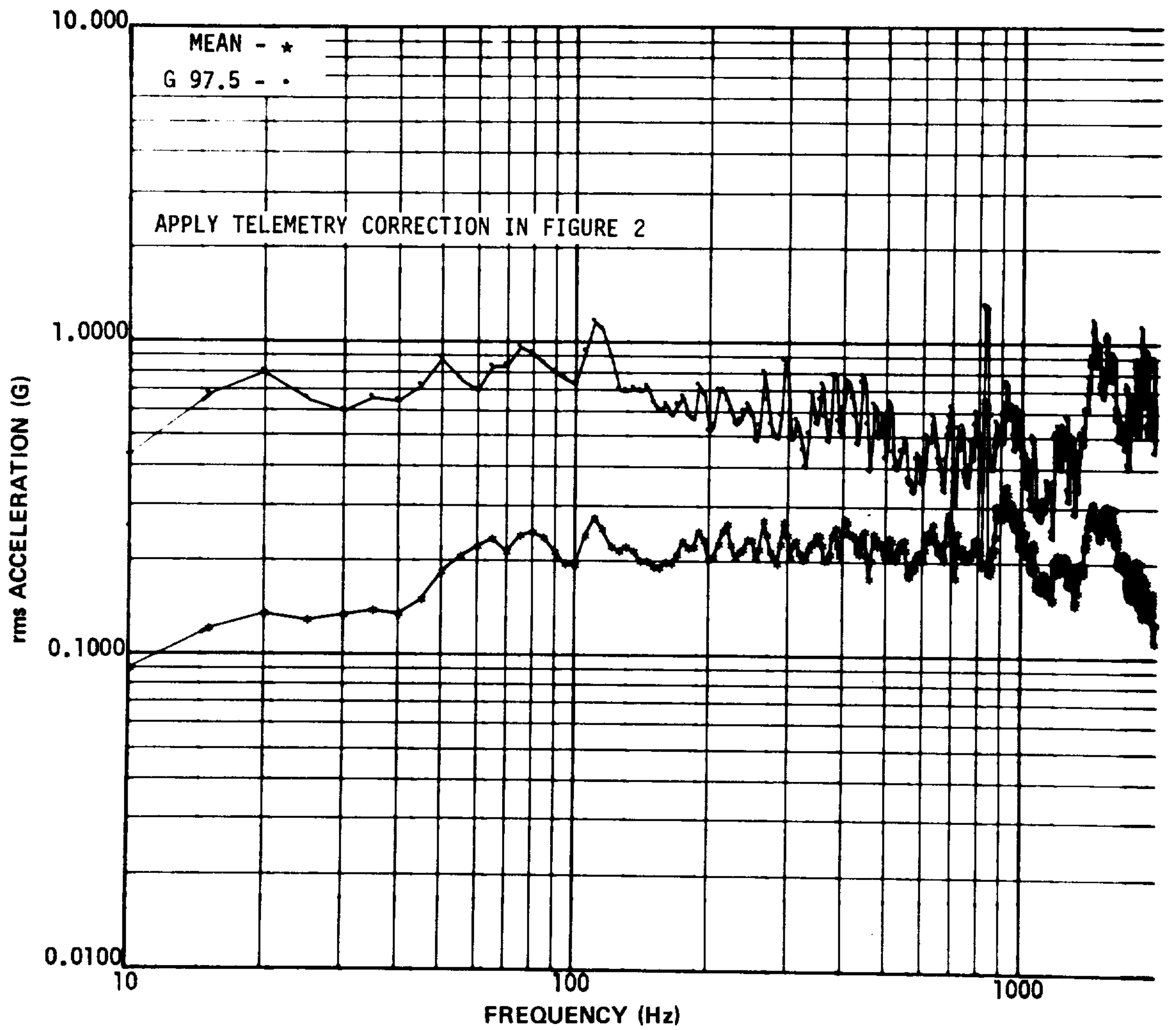


Figure A-96. Skin-stringer rms acceleration, longitudinal, transonic.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 2.91
COMPOSITE 97.5 – 4.19
VEHICLE DIAMETER – 10.06 m (33 ft)

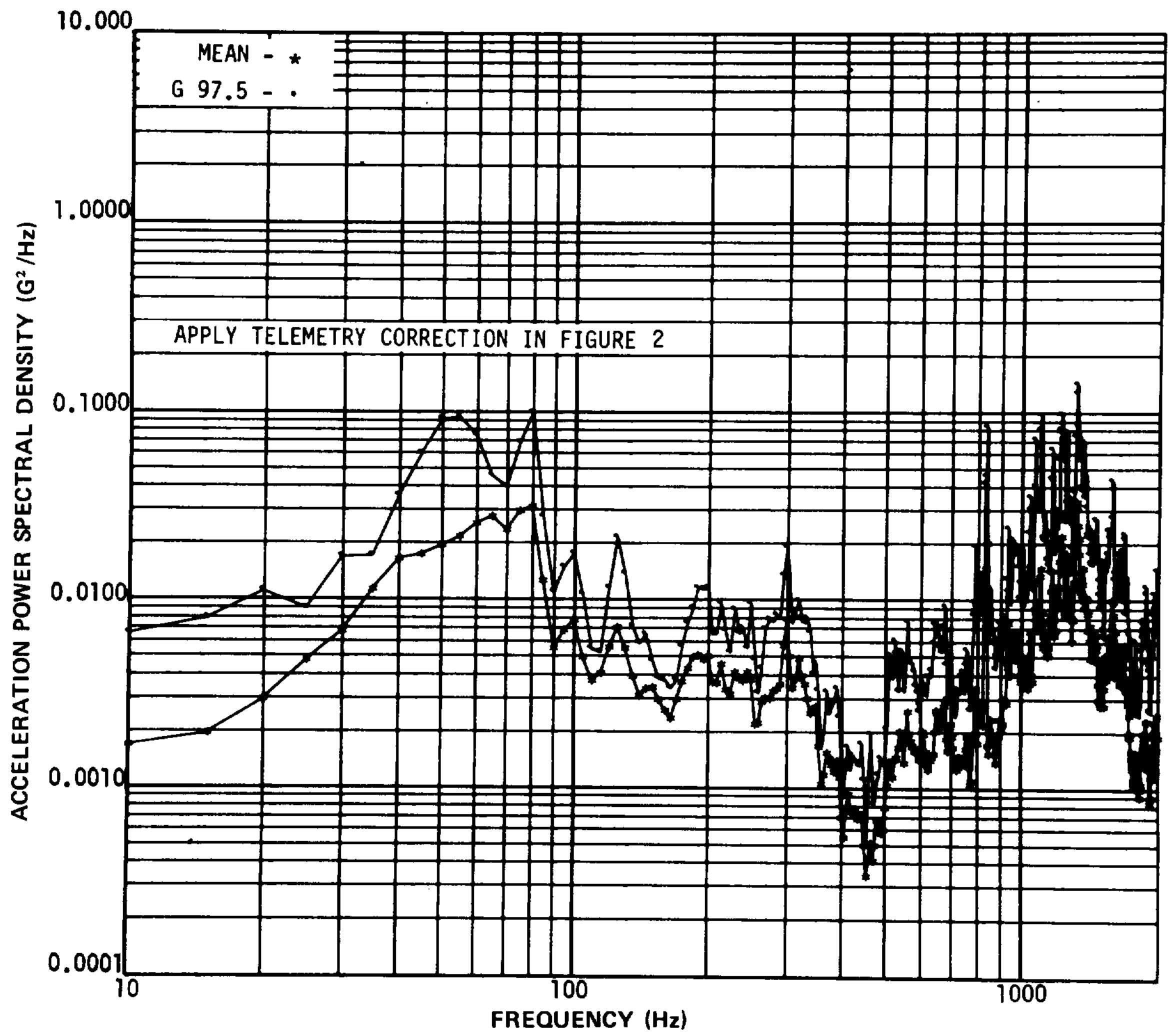


Figure A-97. Skin-stringer acceleration power spectral density, tangential, liftoff.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 2.91
COMPOSITE 97.5 – 4.19
VEHICLE DIAMETER – 10.06 m (33 ft)

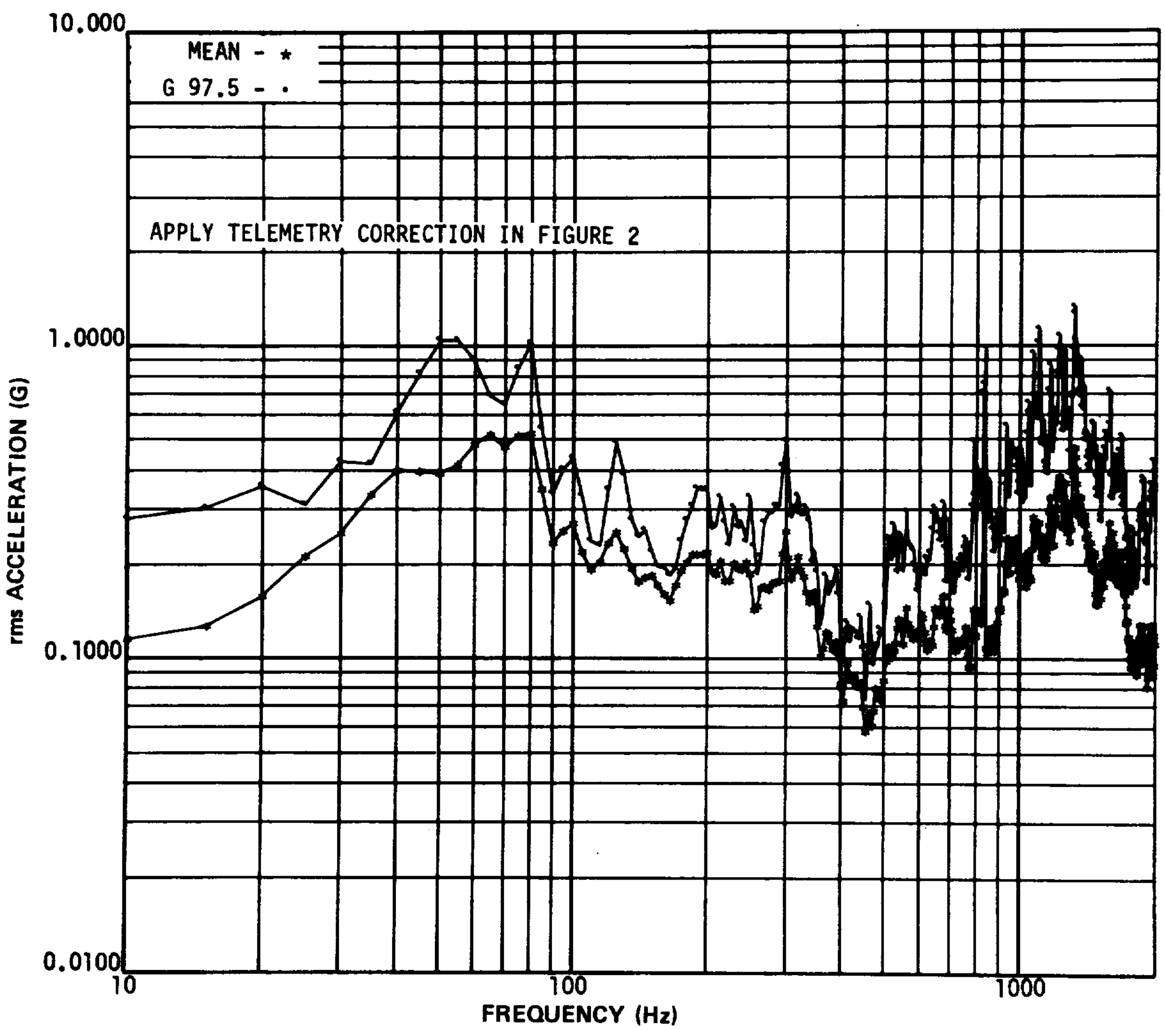


Figure A-98. Skin-stringer rms acceleration, tangential, liftoff.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 7.24
COMPOSITE 97.5 – 13.94
VEHICLE DIAMETER – 10.06 m (33 ft)

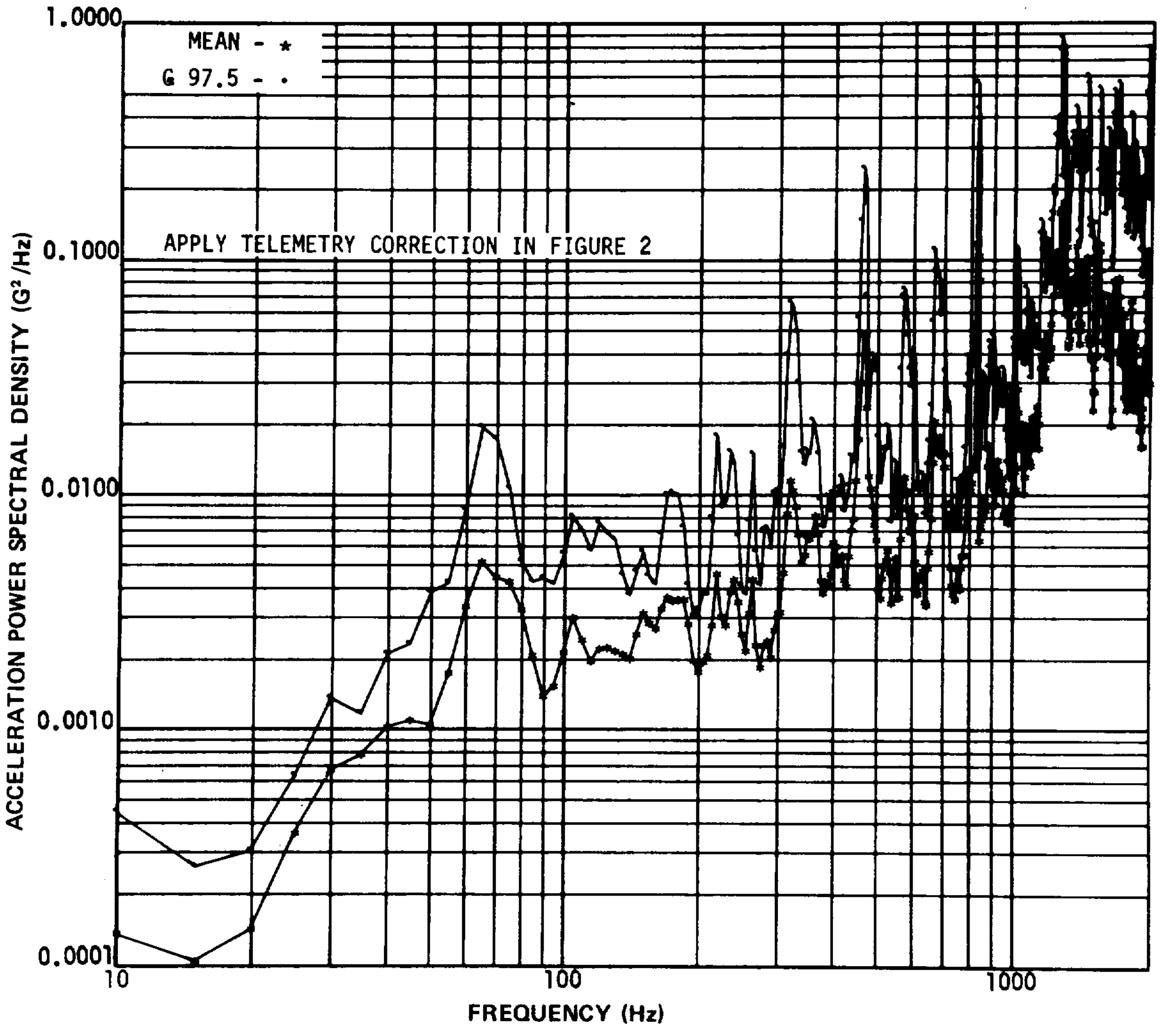


Figure A-99. Skin-stringer acceleration power spectral density, tangential, Mach 1.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 7.24
COMPOSITE 97.5 – 13.94
VEHICLE DIAMETER – 10.06 m (33 ft)

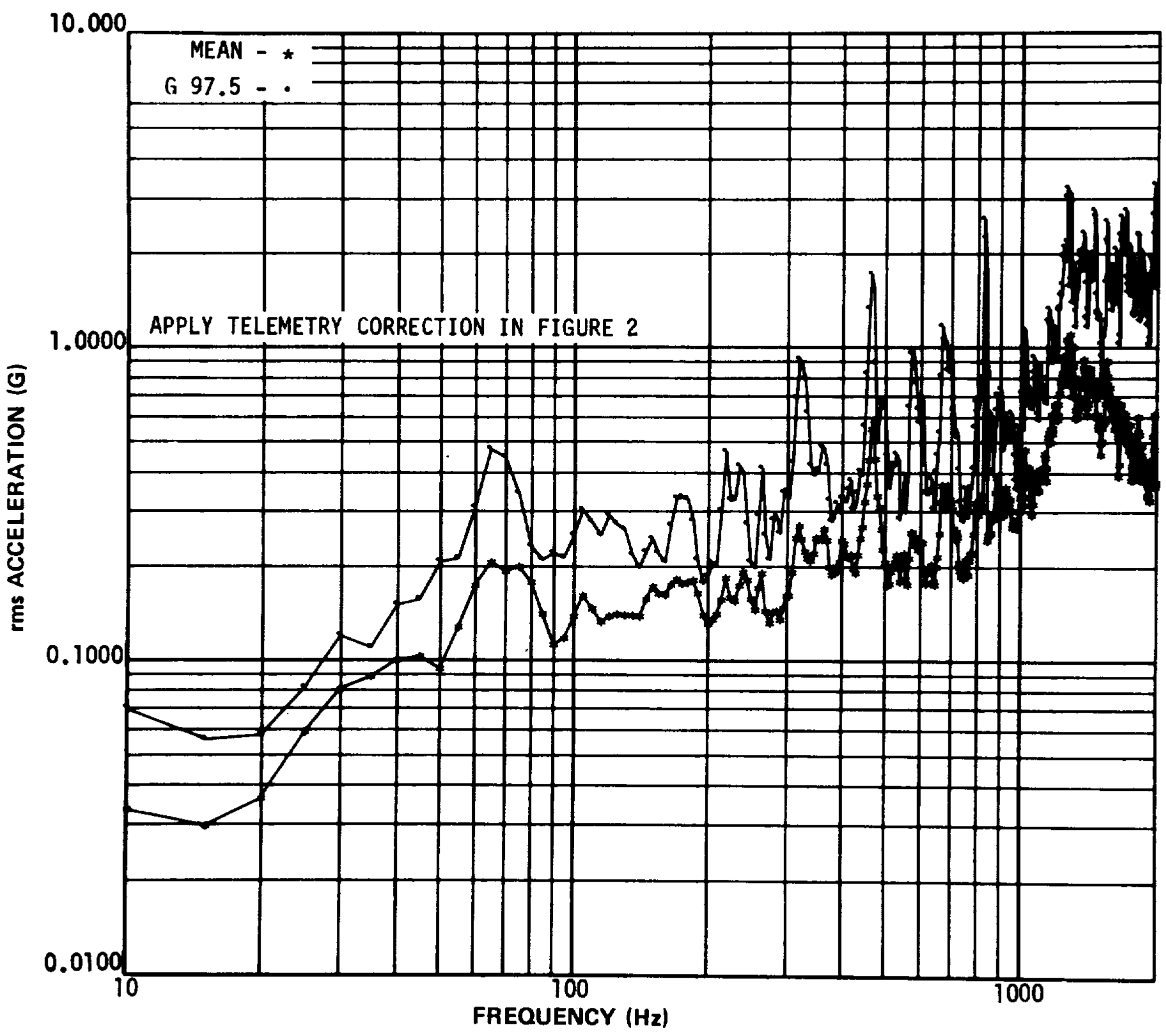


Figure A-100. Skin-stringer rms acceleration, tangential, Mach 1.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.37
COMPOSITE 97.5 – 12.63
VEHICLE DIAMETER – 10.06 m (33 ft)

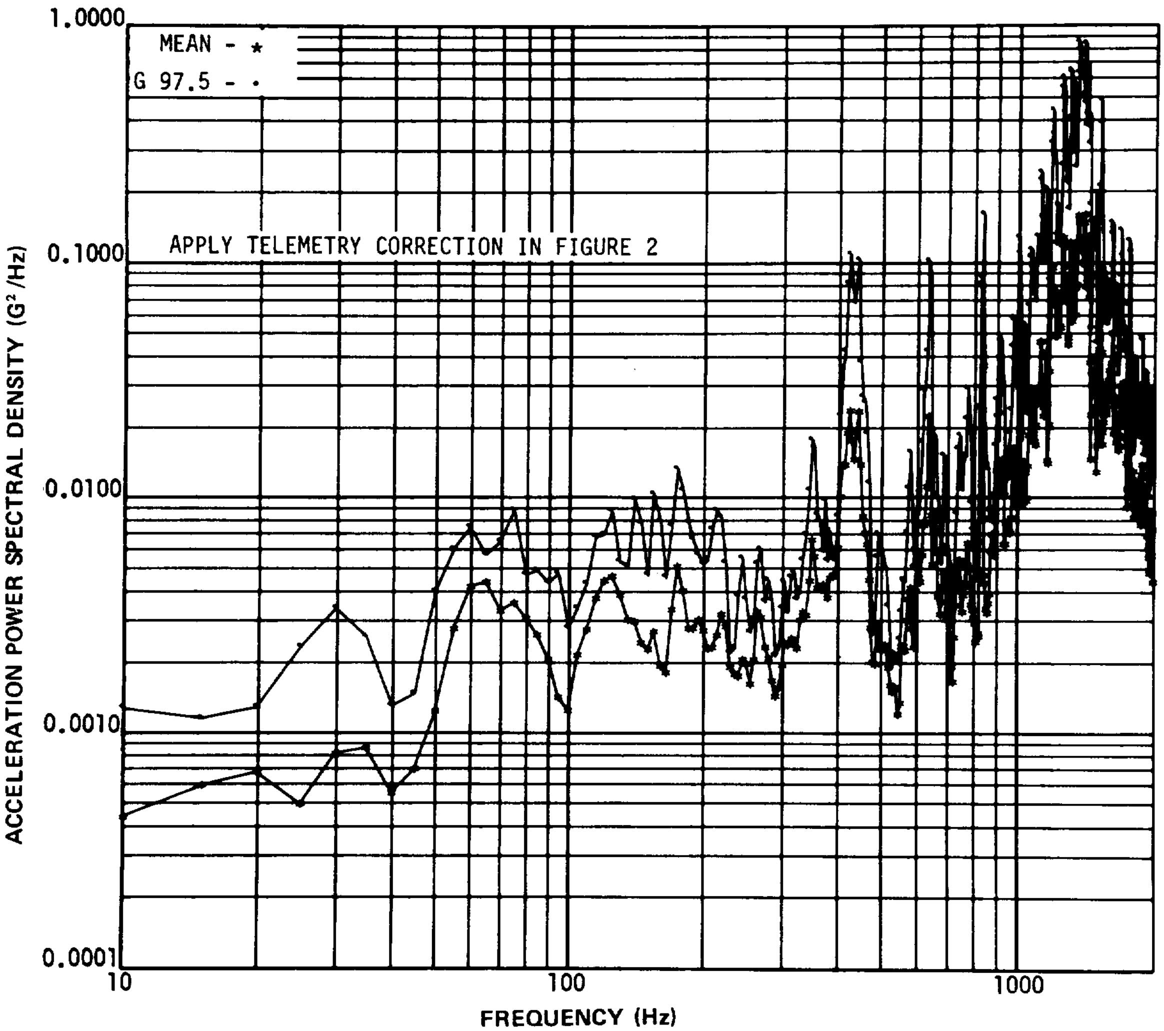


Figure A-101. Skin-stringer acceleration power spectral density, tangential, max Q.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.37
COMPOSITE 97.5 – 12.63
VEHICLE DIAMETER – 10.06 m (33 ft)

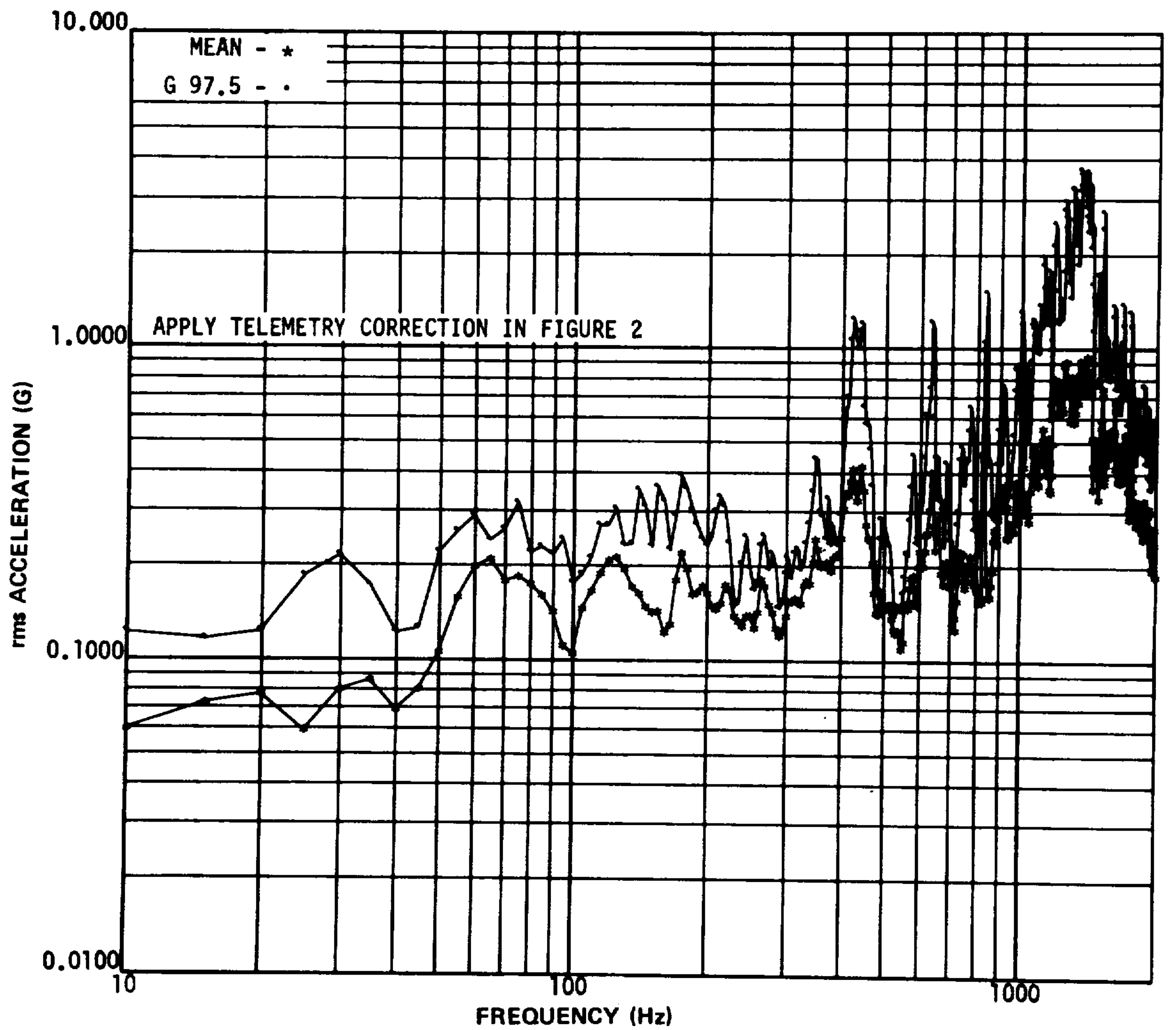


Figure A-102. Skin-stringer rms acceleration, tangential, max Q.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.92
COMPOSITE 97.5 – 12.84
VEHICLE DIAMETER – 10.06 m (33 ft)

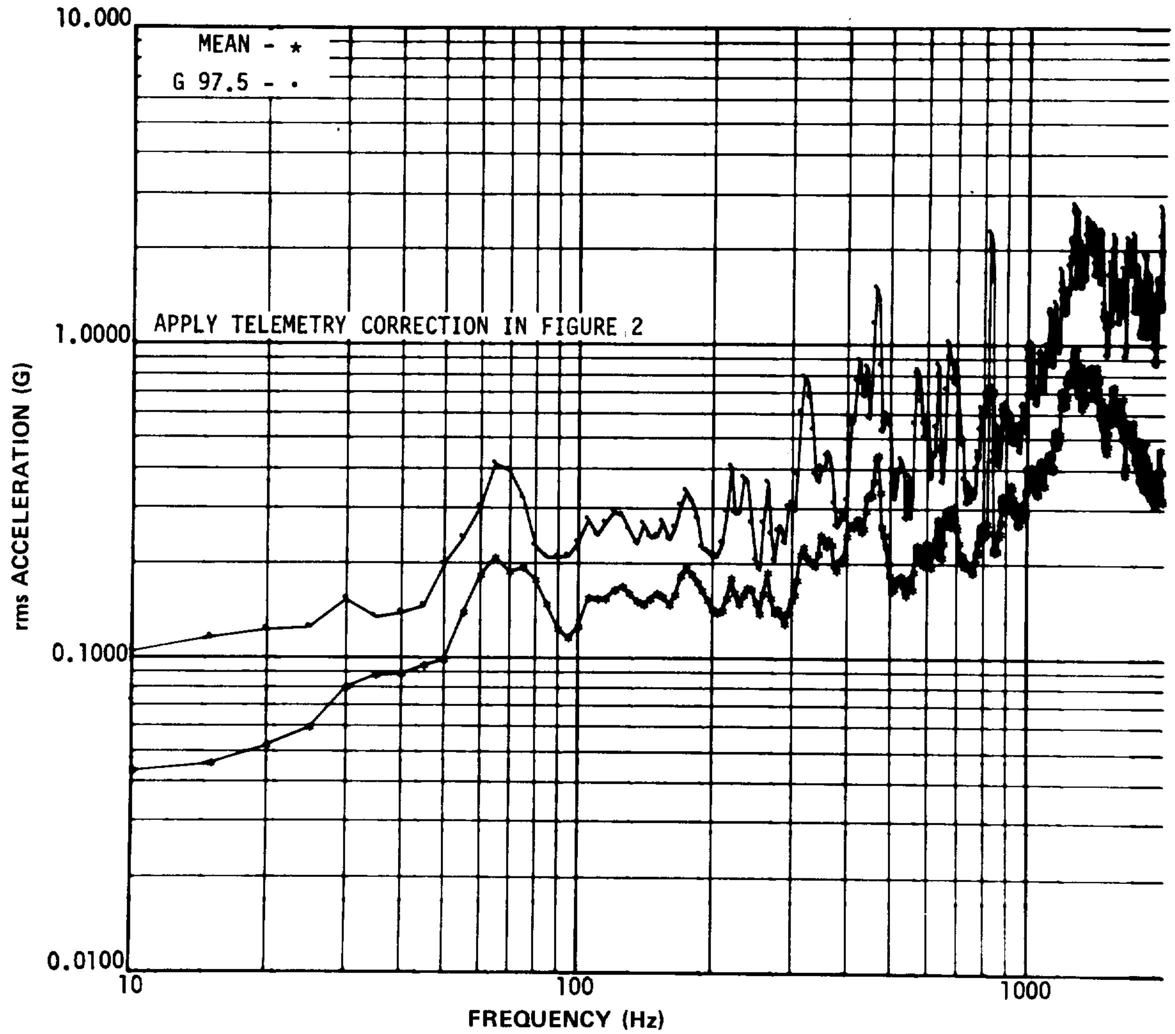


Figure A-104. Skin-stringer rms acceleration, tangential, transonic.

DIRECTION – TANGENTIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION –
TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 6.92
COMPOSITE 97.5 – 12.84
VEHICLE DIAMETER – 10.06 m (33 ft)

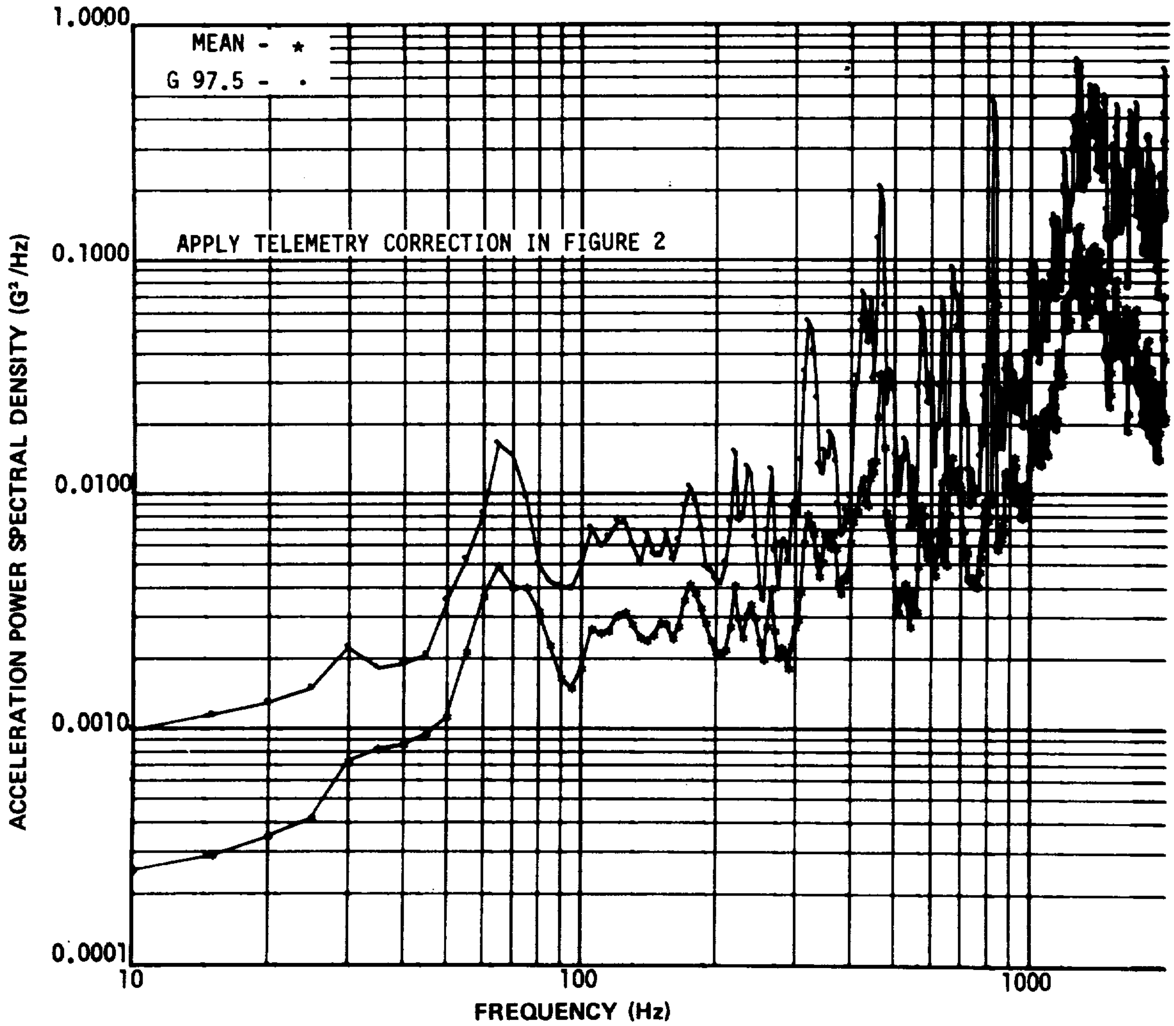


Figure A-103. Skin-stringer acceleration power spectral density, tangential, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 10.32
COMPOSITE 97.5 – 13.09
VEHICLE DIAMETER – 10.06 m (33 ft)

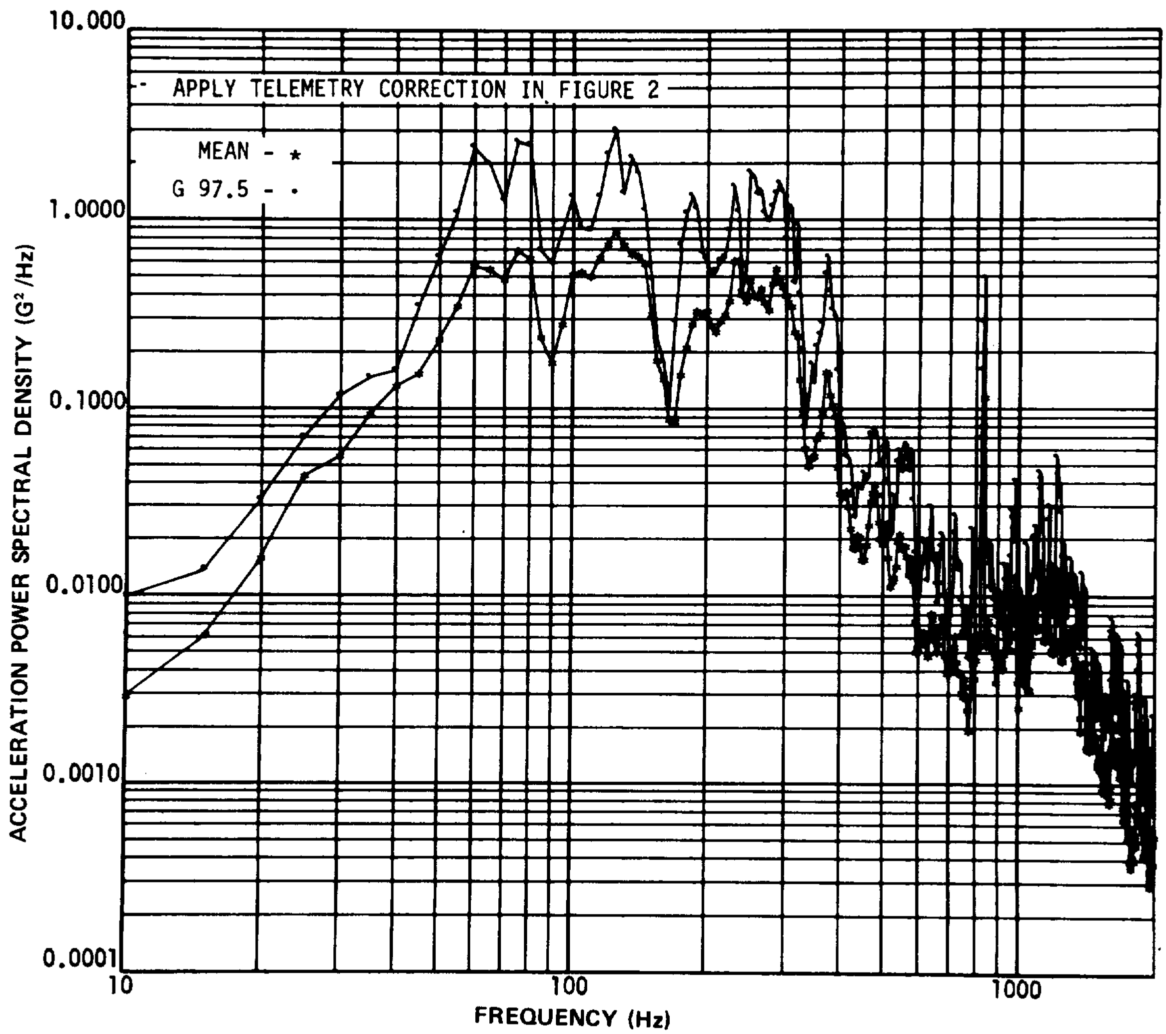


Figure A-105. Skin-stringer acceleration power spectral density, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – LIFTOFF
MATERIAL – ALUMINUM
COMPOSITE MEAN – 10.32
COMPOSITE 97.5 – 13.09
VEHICLE DIAMETER – 10.06 m (33 ft)

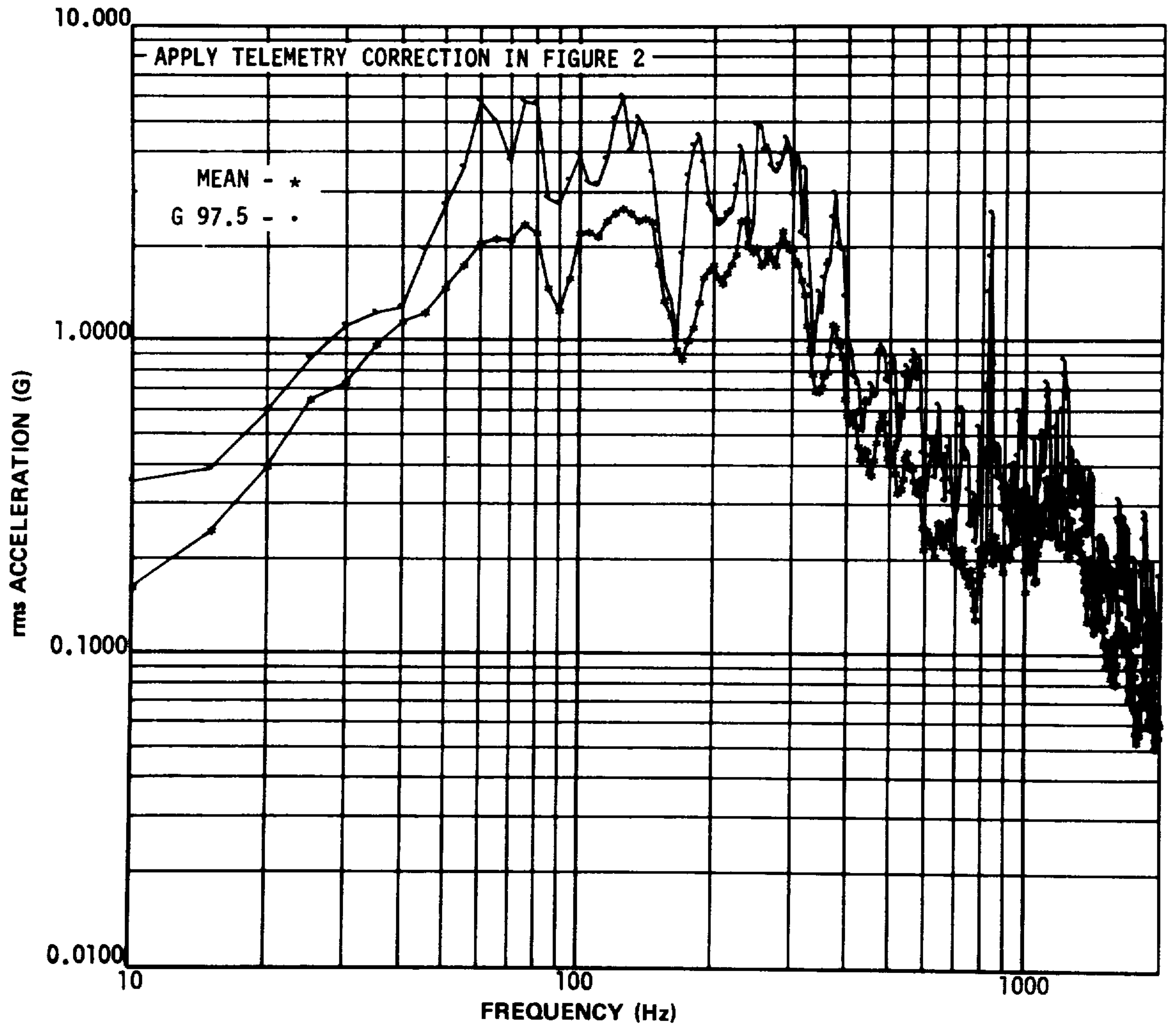


Figure ·106. Skin-stringer rms acceleration, radial, liftoff.

DIRECTION – RADIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 8.81
COMPOSITE 97.5 – 15.67
VEHICLE DIAMETER – 10.06 m (33 ft)

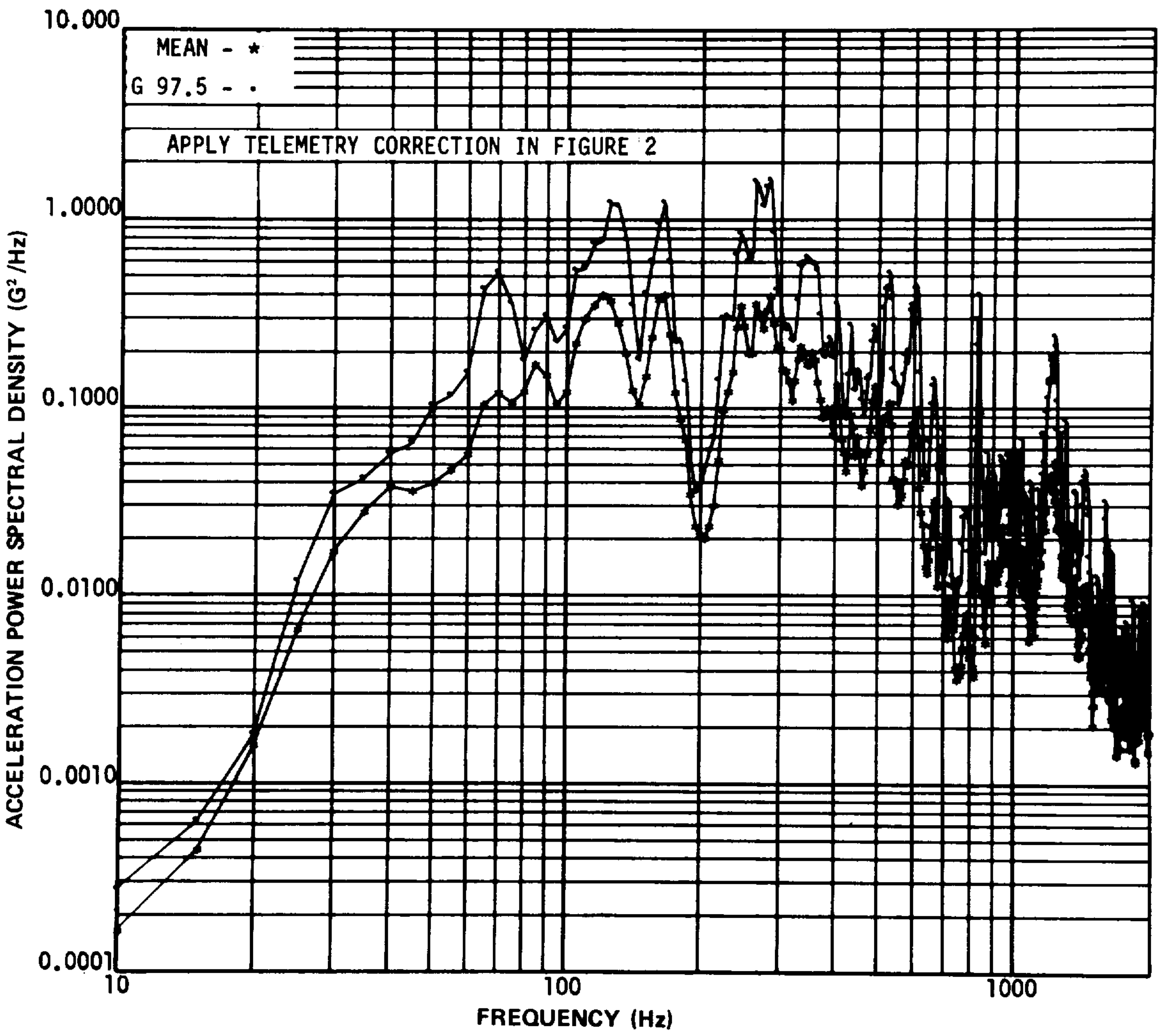


Figure A-107. Skin-stringer acceleration power spectral density, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .102 cm (.040 in.)
RING SEPARATION – 91.44 cm (36.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 21.92 cm (8.63 in.)
STRINGER WEIGHT – 1.056 kg/m (.71 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 8.81
COMPOSITE 97.5 – 15.67
VEHICLE DIAMETER – 10.06 m (33 ft)

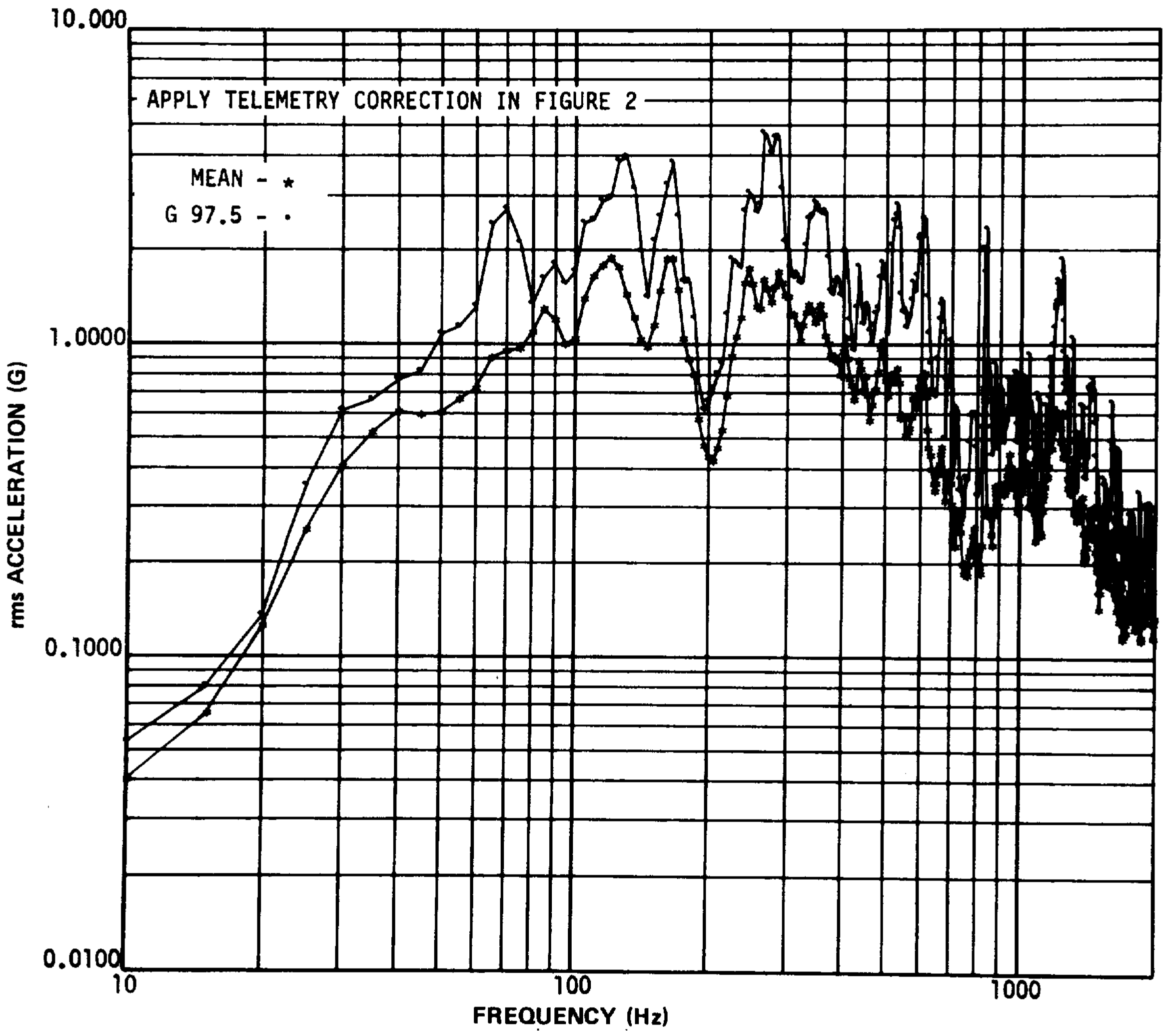


Figure A-108. Skin-stringer rms acceleration, radial, Mach 1.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 11.63
COMPOSITE 97.5 – 36.54
VEHICLE DIAMETER – 10.06 m (33 ft)

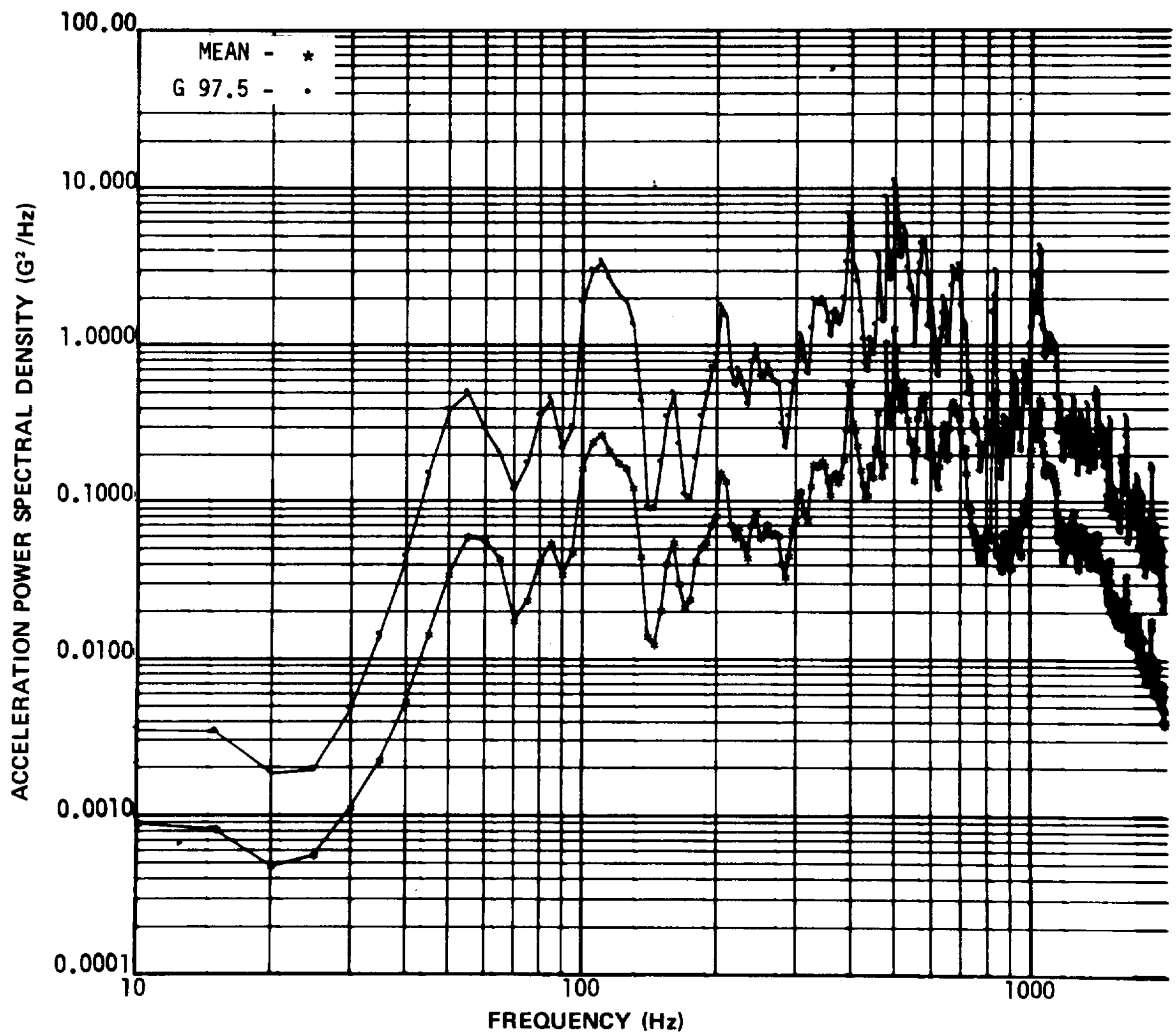


Figure A-109. Skin-stringer acceleration power spectral density, longitudinal, static firing.

DIRECTION – LONGITUDINAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 11.63
COMPOSITE 97.5 – 36.54
VEHICLE DIAMETER – 10.06 m (33 ft)

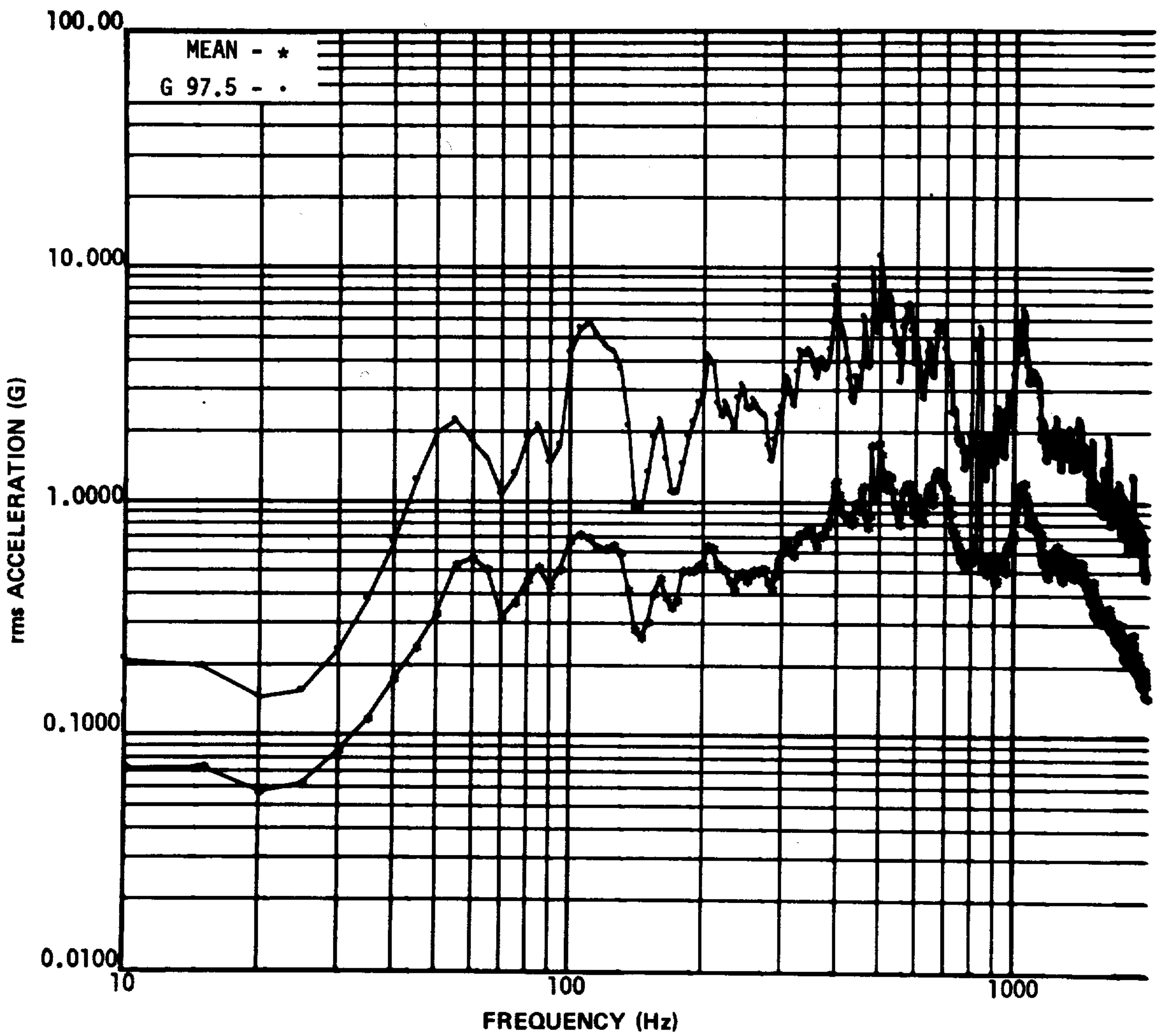


Figure A-110. Skin-stringer rms acceleration, longitudinal, static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 25.78
COMPOSITE 97.5 – 37.27
VEHICLE DIAMETER – 10.06 m (33 ft)

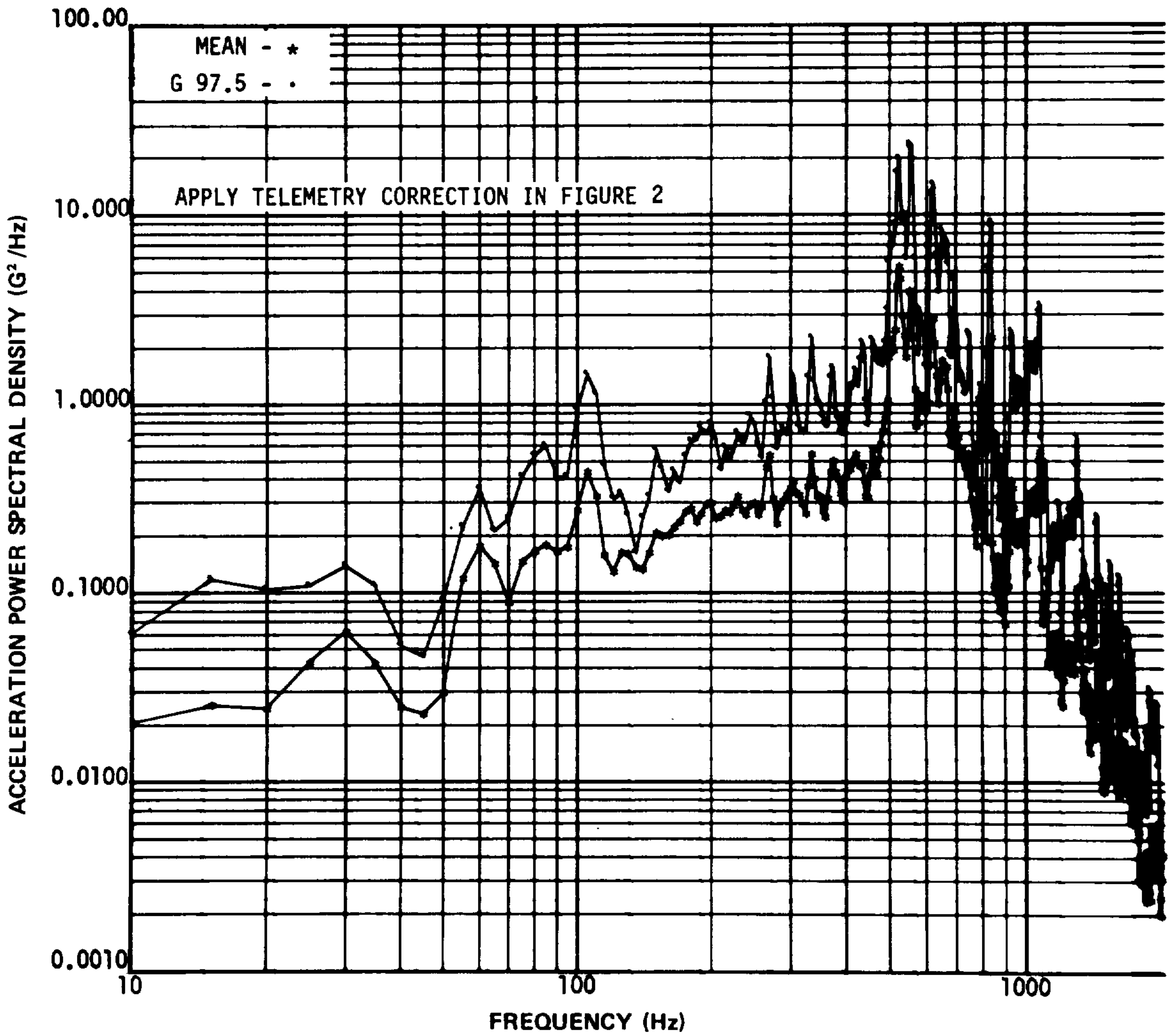


Figure A-111. Skin-stringer acceleration power spectral density, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – MACH 1
MATERIAL – ALUMINUM
COMPOSITE MEAN – 25.78
COMPOSITE 97.5 – 37.27
VEHICLE DIAMETER – 10.06 m (33 ft)

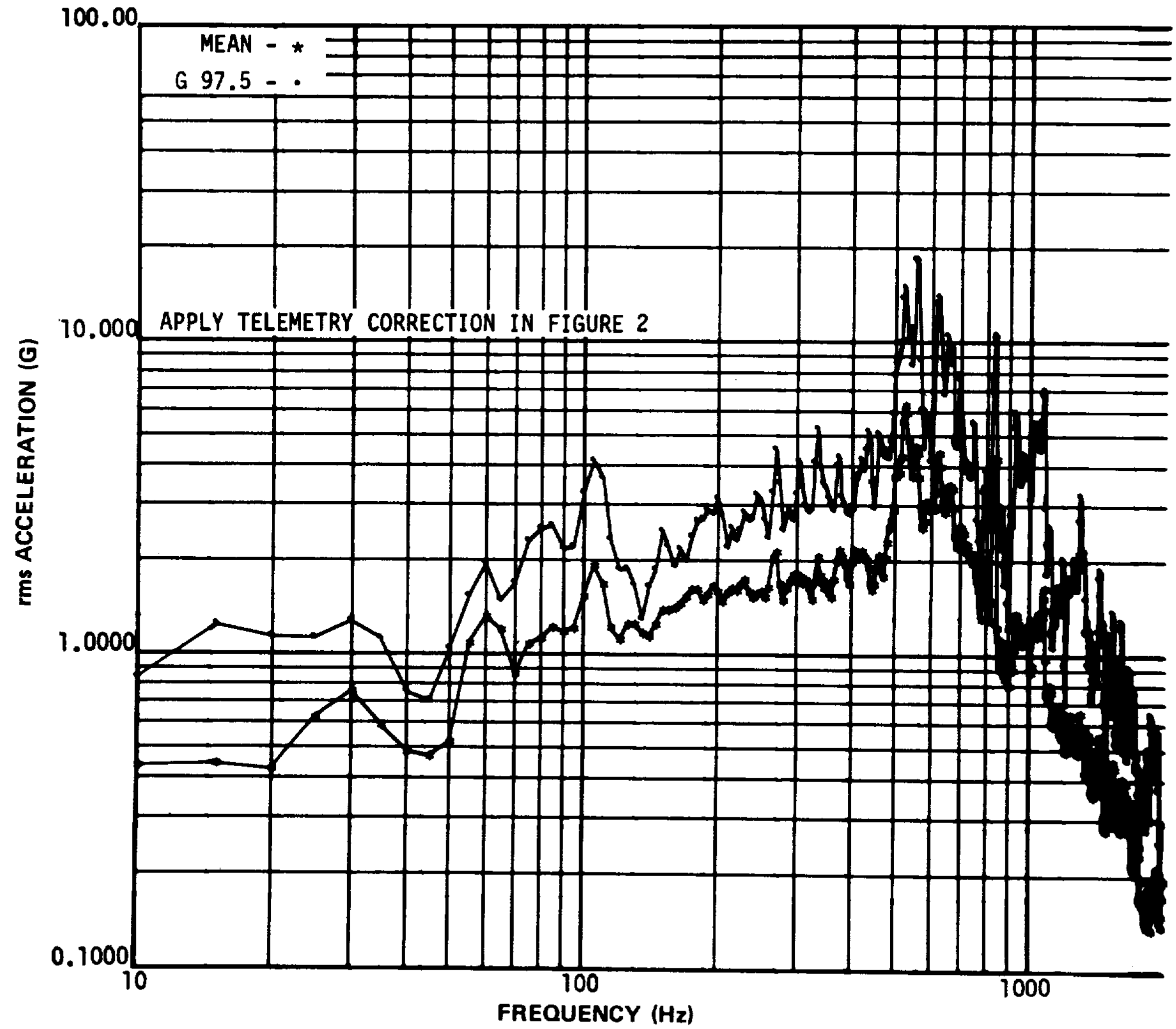


Figure A-112. Skin-stringer rms acceleration, radial, Mach 1.

DIRECTION – RADIAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 37.52
COMPOSITE 97.5 – 83.65
VEHICLE DIAMETER – 10.06 m (33 ft)

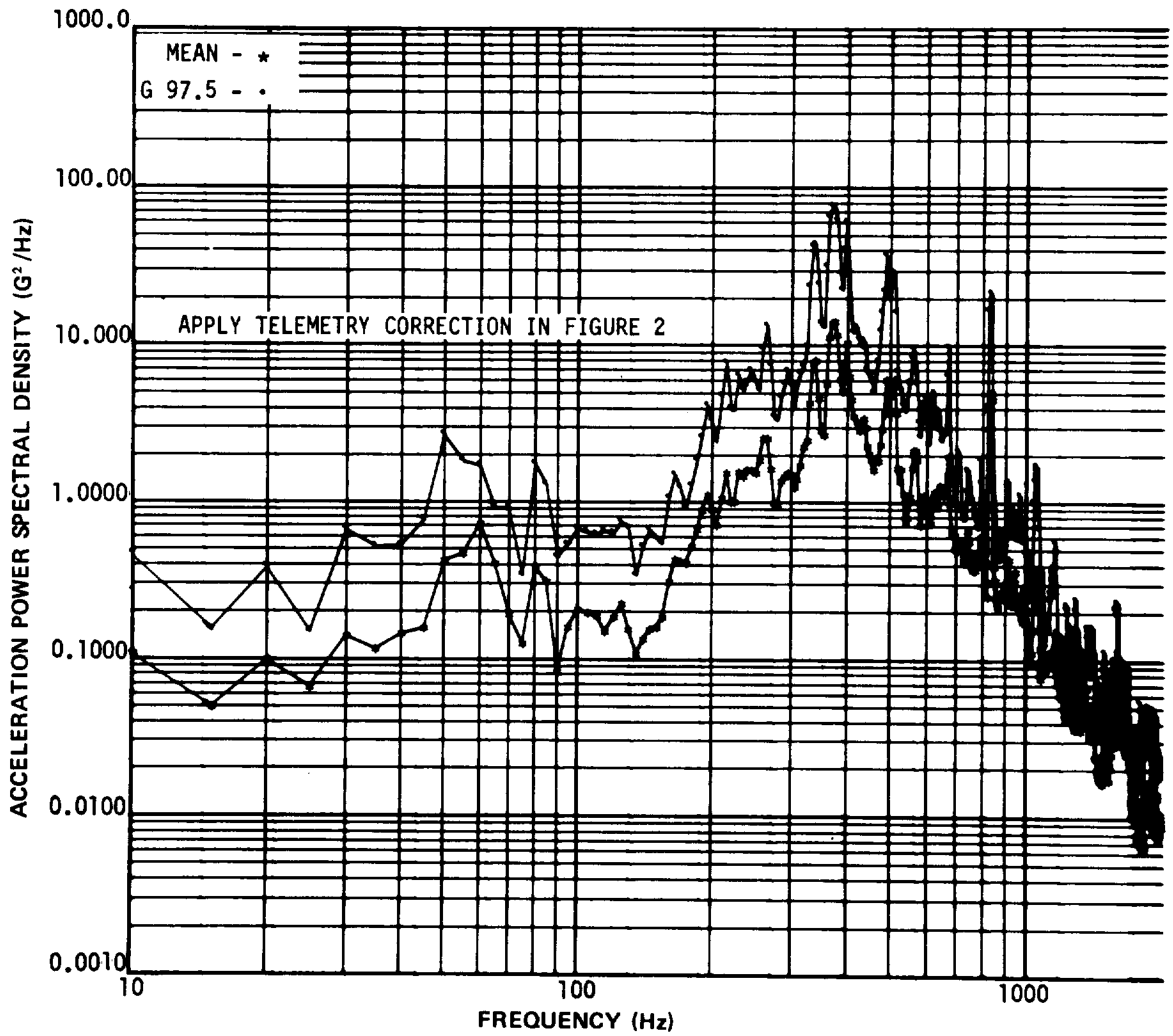


Figure A-113. Skin-stringer acceleration power spectral density, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – MAX Q
MATERIAL – ALUMINUM
COMPOSITE MEAN – 37.52
COMPOSITE 97.5 – 83.65
VEHICLE DIAMETER – 10.06 m (33 ft)

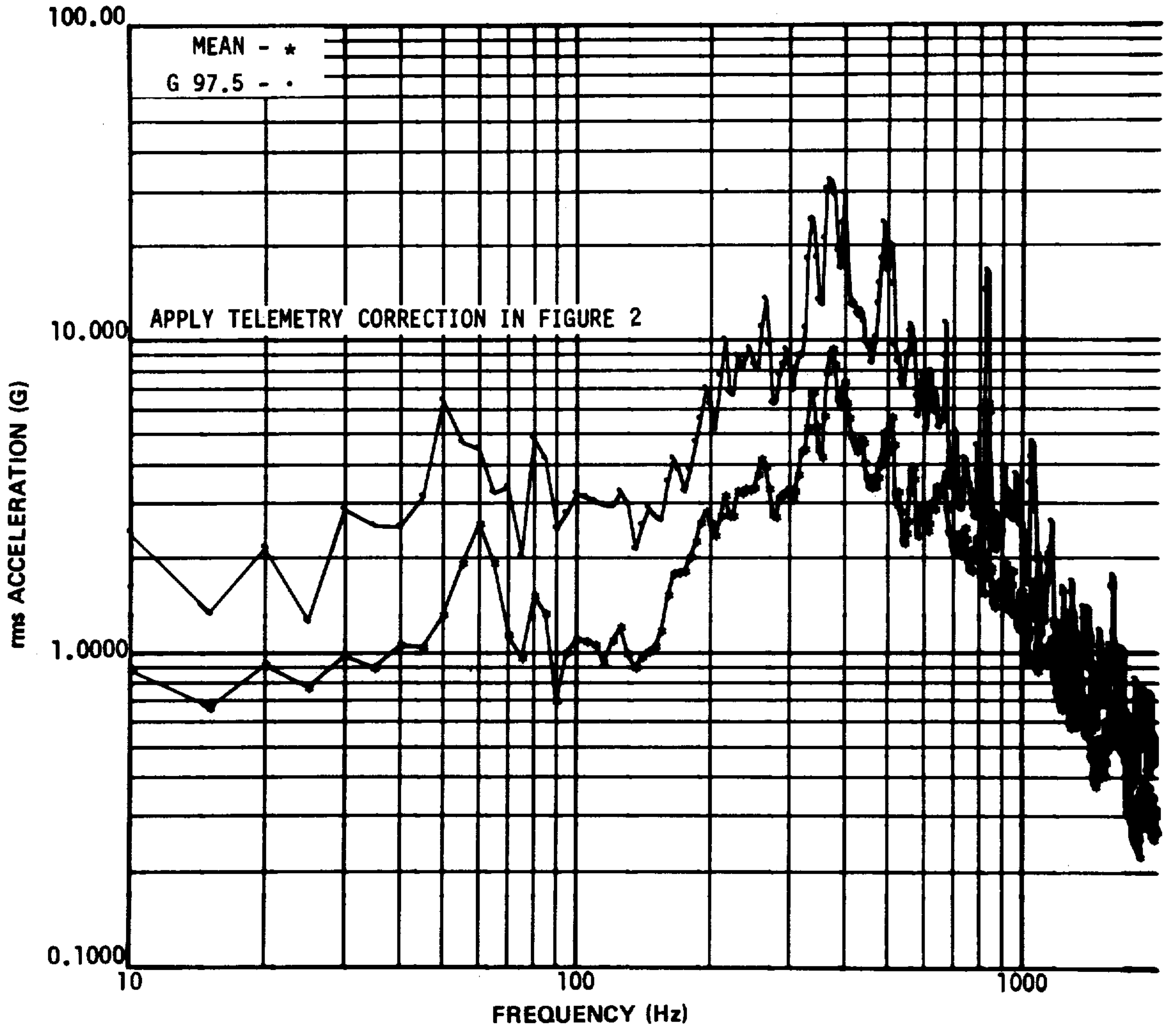
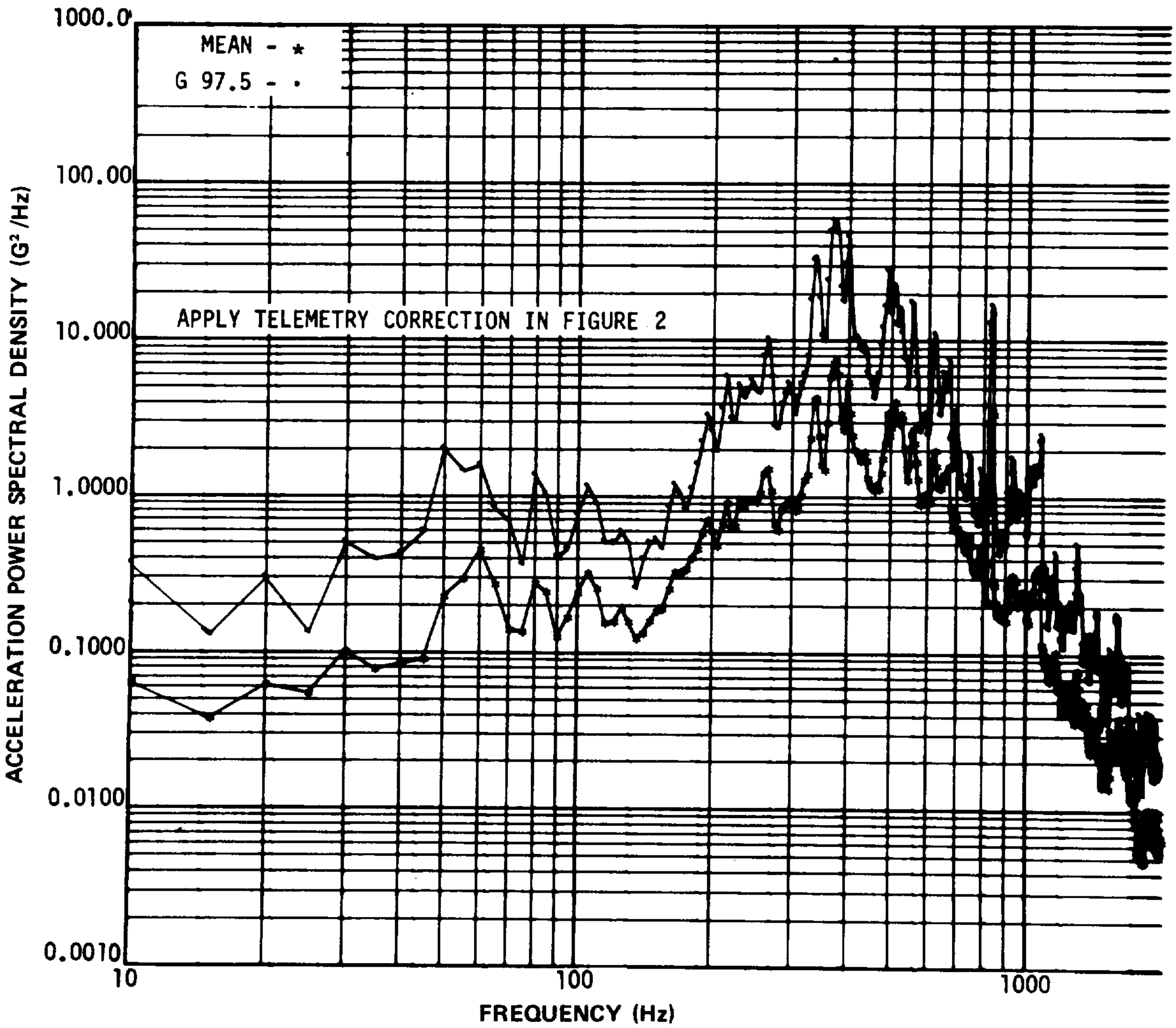


Figure A-114. Skin-stringer rms acceleration, radial, max Q.

DIRECTION – RADIAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 31.65
COMPOSITE 97.5 – 70.88
VEHICLE DIAMETER – 10.06 m (33 ft)



DIRECTION – RADIAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – TRANSONIC (MACH 1 AND MAX Q)
MATERIAL – ALUMINUM
COMPOSITE MEAN – 31.65
COMPOSITE 97.5 – 70.88
VEHICLE DIAMETER – 10.06 m (33 ft)

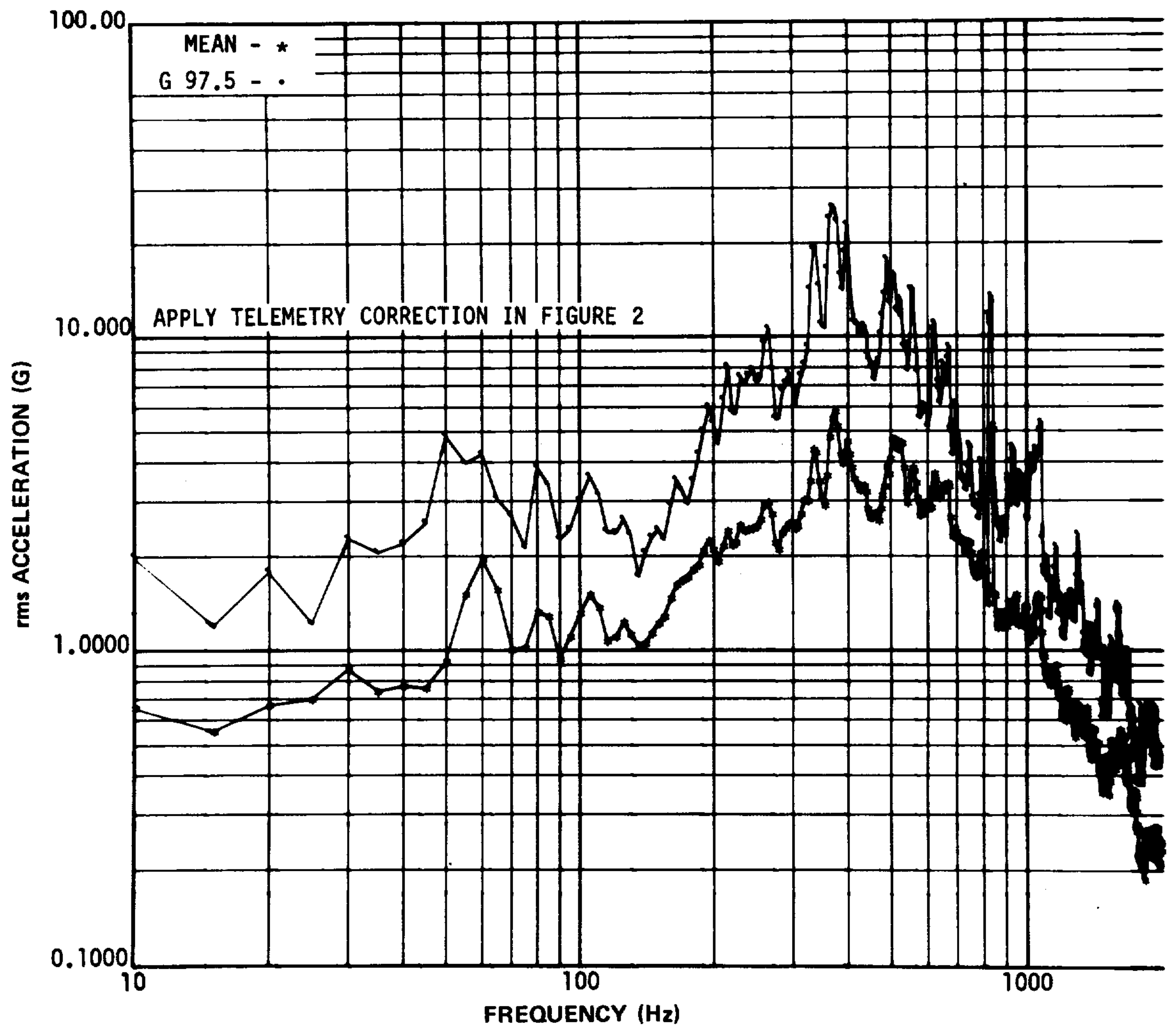


Figure A-116. Skin-stringer rms acceleration, radial, transonic.

DIRECTION – RADIAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 31.91
COMPOSITE 97.5 – 73.64
VEHICLE DIAMETER – 10.06 m (33 ft)

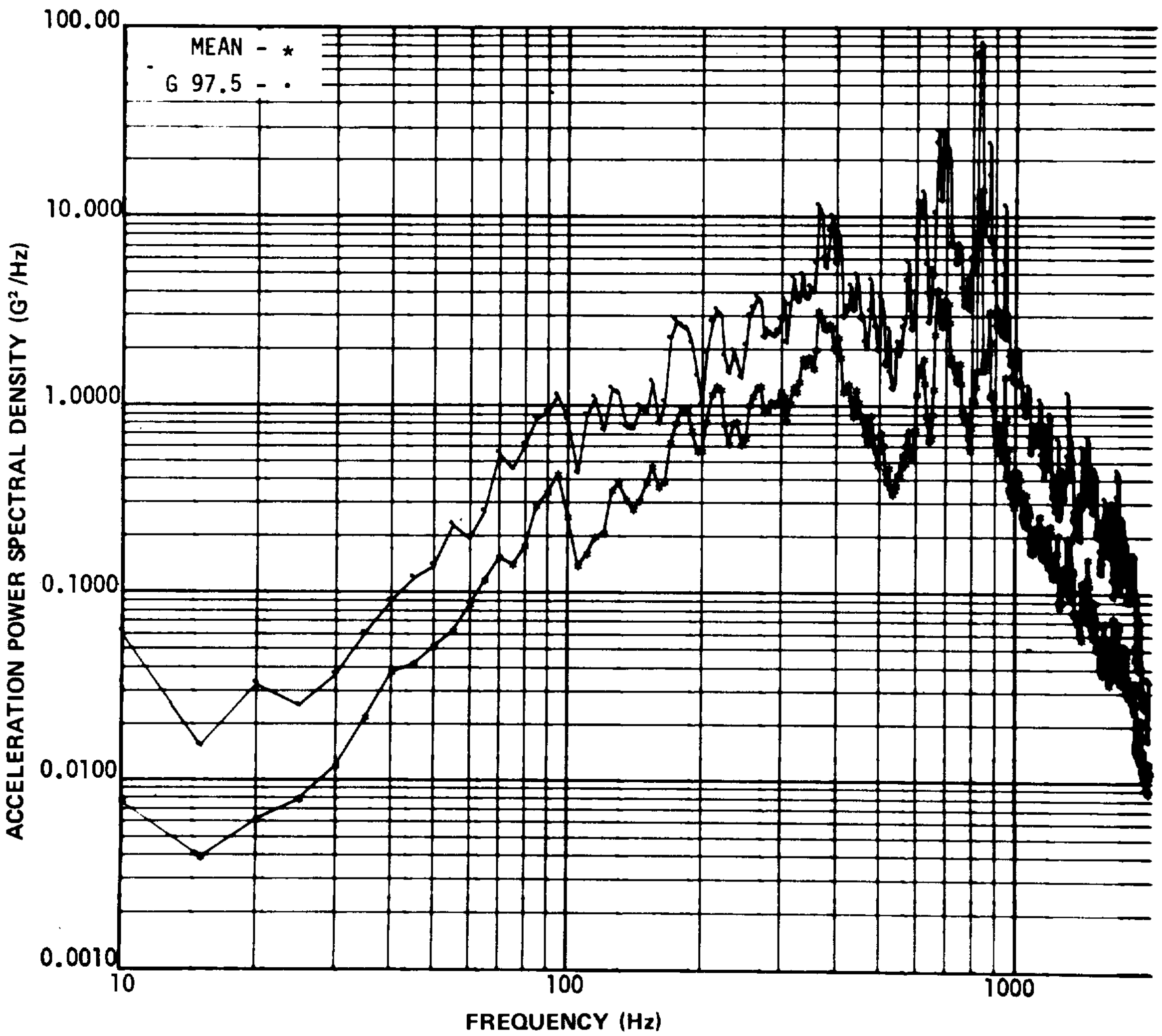


Figure A-117. Skin-stringer acceleration power spectral density, radial, static firing.

DIRECTION – RADIAL
SKIN THICKNESS – .180 cm (.071 in.)
RING SEPARATION – 68.58 cm (27.0 in.)
RING WEIGHT PER FOOT – N/A
STRINGER SEPARATION – 14.63 cm (5.76 in.)
STRINGER WEIGHT – 1.280 kg/m (.86 lb/ft)

FLIGHT OR TEST CONDITION – STATIC FIRING
MATERIAL – ALUMINUM
COMPOSITE MEAN – 31.91
COMPOSITE 97.5 – 73.64
VEHICLE DIAMETER – 10.06 m (33 ft)

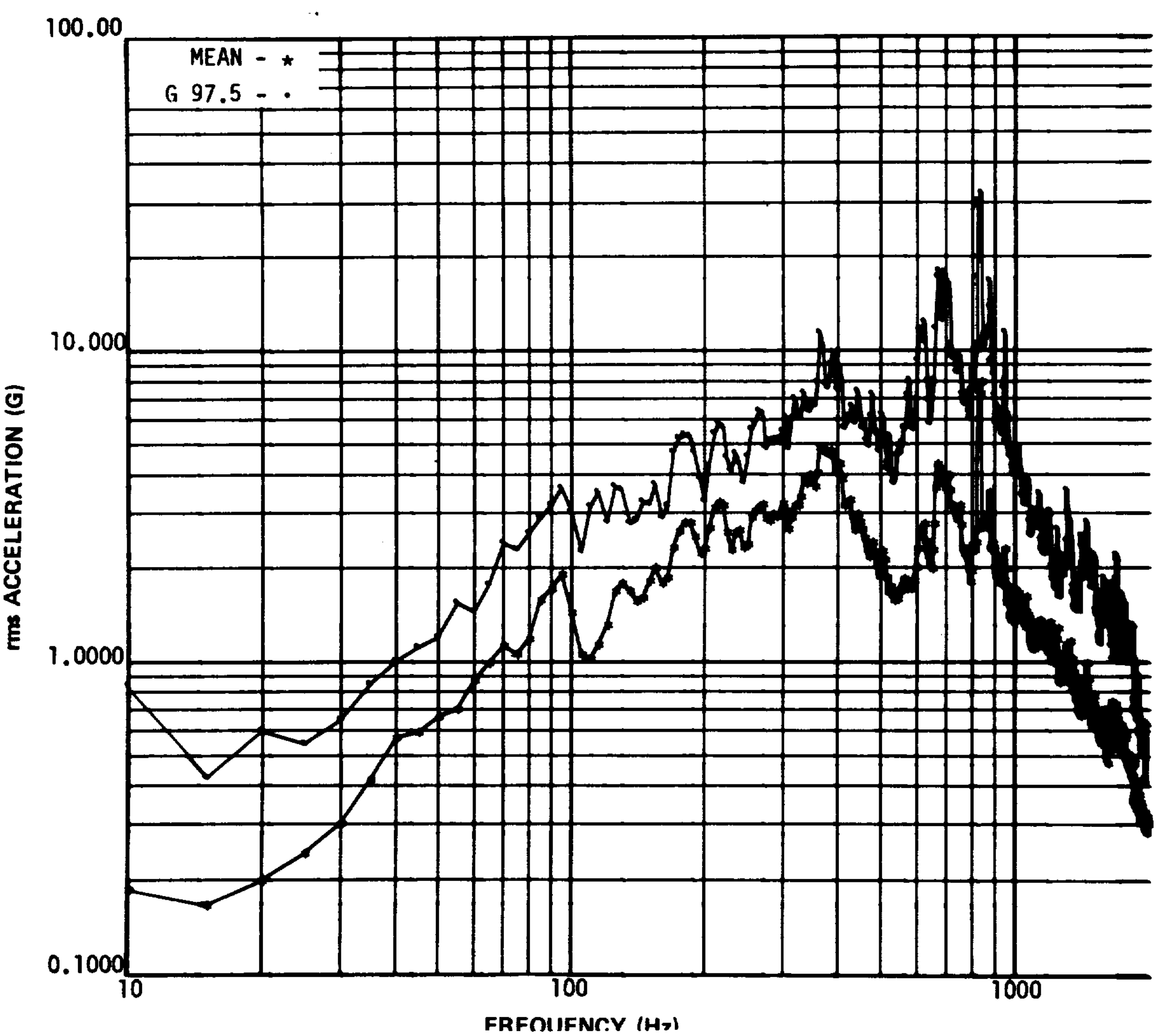


Figure A-118. Skin-stringer rms acceleration, radial, static firing.

3. Honeycomb Data Bank

DIRECTION – RADIAL
OVERALL THICKNESS – 2.54 cm (1.0 in.)
OUTER PLATE THICKNESS – .762 cm (.030 in.)
CORE DENSITY – .00498 × 10^4 kg/m^3 (.0018 lb/in.^{3})
MATERIAL – ALUMINUM

FLIGHT OR TEST CONDITION – STATIC FIRING
COMPOSITE MEAN – 33.19
COMPOSITE 97.5 – 61.74
VEHICLE DIAMETER – 6.7 m (22 ft)

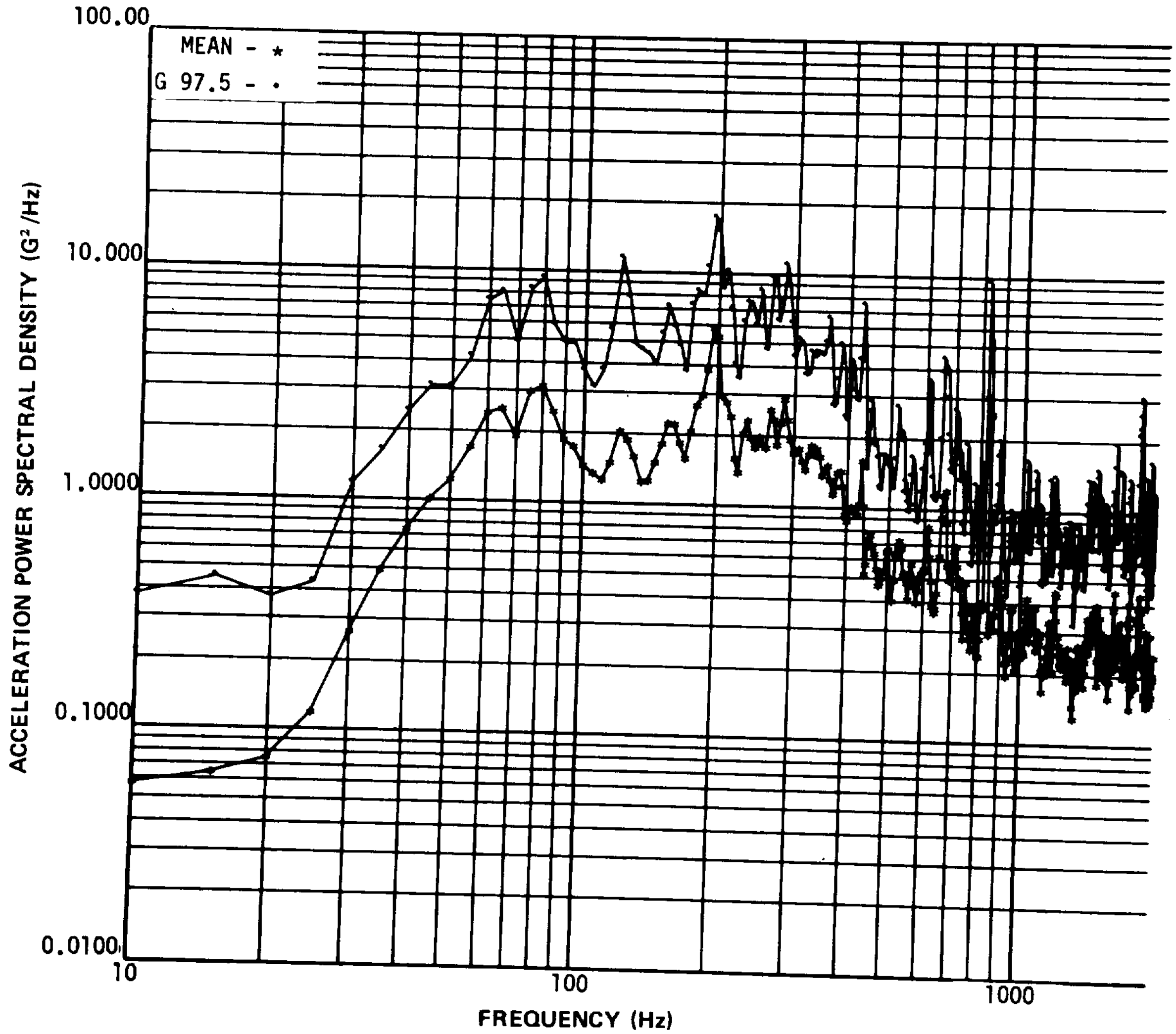


Figure A-119. Honeycomb acceleration power spectral density, radial, static firing.

DIRECTION – RADIAL
OVERALL THICKNESS – 2.54 cm (1.0 in.)
OUTER PLATE THICKNESS – 7.62 cm (.030 in.)
CORE DENSITY – .00498 X 10^4 kg/m^3 (.0018 lb/in.^{3})
MATERIAL – ALUMINUM

FLIGHT OR TEST CONDITION –
STATIC FIRING
COMPOSITE MEAN – 33.19
COMPOSITE 97.5 – 61.74
VEHICLE DIAMETER – 6.7 m (22 ft)

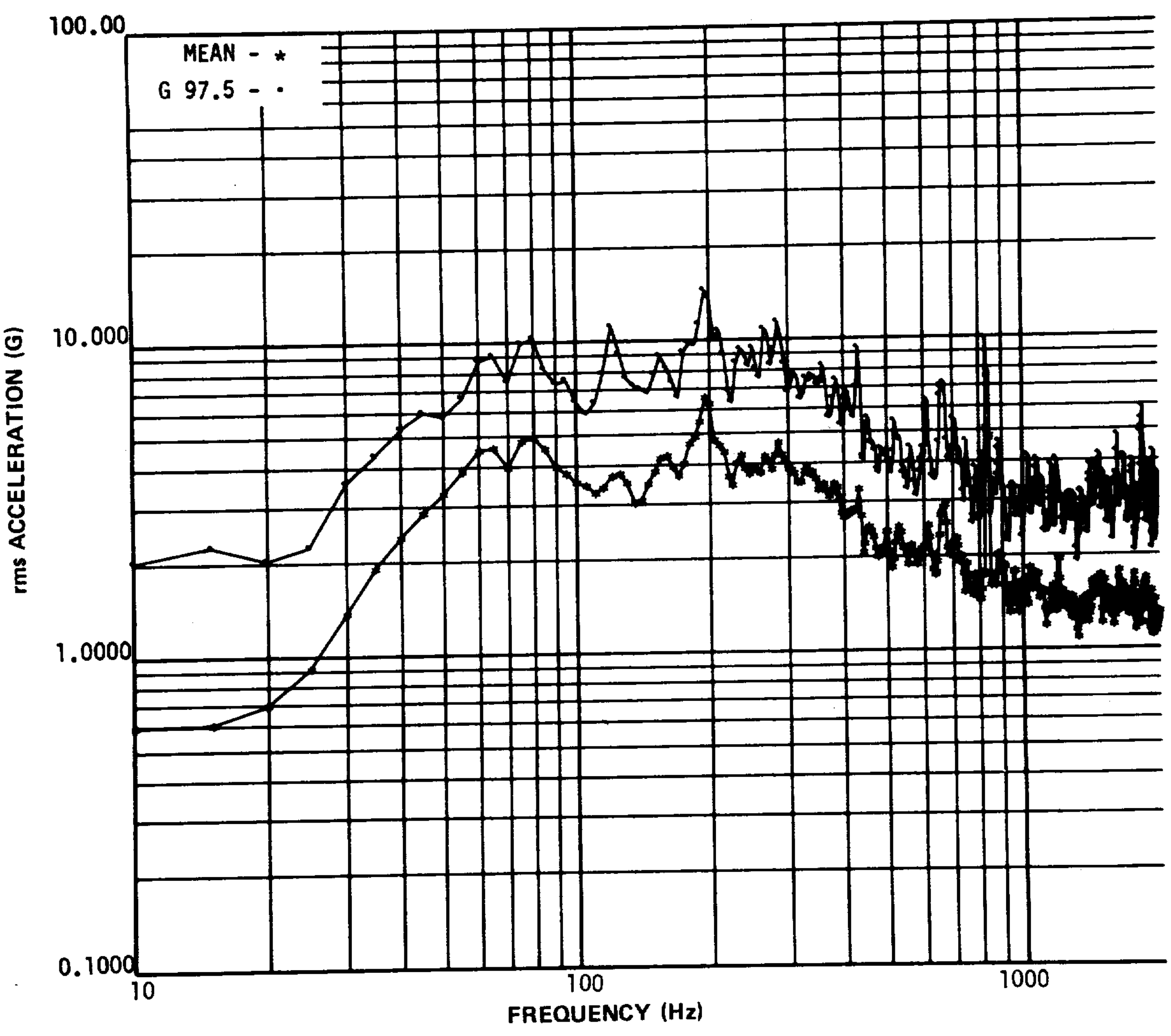


Figure A-120. Honeycomb rms acceleration, radial, static firing.

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1. Barrett, Robert E.: Statistical Techniques for Describing Localized Vibratory Environments of Rocket Vehicles. NASA TN D-2158, July 1964.

2. Saturn V Static Firing Vibration Data Zonal Statistical Analyses. Boeing Document D5-17032-1, October 3, 1969.

3. Saturn V Flight Vibration Data Zonal Statistical Analyses. Boeing Document D5-17032-2, October 10, 1969.