METHOD 214A

RANDOM VIBRATION

1. PURPOSE. This test is conducted for the purpose of determining the ability of component parts to withstand the dynamic stress exerted by random vibration applied between upper and lower frequency limits to simulate the vibration experienced in various service field environments. Random vibration is characteristic of modern field environments produced by missiles, high-thrust jets and rocket engines. In these types of environments, the random vibration provides a more realistic test. For design purposes, however, a swept frequency sinusoidal test may yield more pertinent design information.

2. APPARATUS.

2.1 Vibration system. The vibration system, consisting of the vibration machine, together with its auxiliary equipment shall be capable of generating a random vibration for which the magnitude has a gaussian (normal) amplitude distribution, except that the acceleration magnitudes of the peak values may be limited to a minimum of three times the rms (three-sigma (σ) limits). The machine shall be capable of being equalized so that the magnitude of its spectral density curve will be between specified limits (for example, see figures 214-1 and 214-2) when the test item, or a substitute equivalent mass, is appropriately secured to the vibration machine. The equalization of an electro-dynamic vibration machine system is the adjustment of the gain of the electrical amplifier and control system so that the ratio of the output vibration amplitude to the input signal amplitude is of a constant value (or given values) throughout the required frequency spectrum.

2.1.1 Control and analysis of vibration.

a. Spectral density curves. The output of the vibration machine shall be presented graphically as power spectral density versus frequency. 1/ The spectral density values shall be within +40 and -30 percent (±1.5 dB) of the specified values between a lower specified frequency and 1,000 Hz, and within +100 and -50 percent (±3 dB) of the specified values between 1,000 and 2,000 Hz. A filter bandwidth will be a maximum of 1/3 octave or a frequency of 25 Hz, whichever is greater.

b. Distribution curves. A probability density distribution curve may be obtained and compared with a gaussian distribution curve. The experimentally obtained curve should not differ from the gaussian curve by more than ±10 percent of the maximum value.

1/ Power spectral density is the mean square value of an oscillation passed by a narrow-band filter per unit filter bandwidth. For this application it is expressed as G^2/f where G^2/f is the mean square value of acceleration expressed in gravitational units per number of cycles of filter bandwidth. The spectral density curves are usually plotted either on a logarithmic scale, or in units of decibels (dB). The number of decibels is defined by the equation:

$$dB = 10 \log \frac{G^2/f}{G^2r/f} = 20 \log \frac{G/\sqrt{f}}{G_r/\sqrt{f}}$$

The rms value of acceleration within a frequency band between f_1 and f_2 is:

$$Grms = \left[\int_{f_1}^{f_2} G^2 \; f \; df \right]^{1/2}$$

Where G^2r/f is a given reference value of power spectral density, usually the maximum specified value.

2.2 Monitoring. Monitoring involves measurements of the vibration excitation and of the test item performance. When required in the individual specification, the specimen may be monitored during the test. The details of the monitoring circuit, including the method and points of connection to the specimen, shall be specified.

2.2.1 Vibration input. The vibration magnitude shall be monitored on a vibration machine, on mounting fixtures, at locations that are as near as practical to the test item mounting points. When the vibration input is measured at more than one point, the minimum input vibration shall normally be made to correspond to the specified test curve (see figures 214-1 and 214-2). For massive test items and fixtures, and for large force exciters or multiple vibration exciters, the input-control value may be an average of the average magnitudes of three or more inputs. Accelerations in the transverse direction, measured at the test item attachment points, shall be limited to 100 percent of the applied vibration. The individual specification shall specify the number and location of the test points.

3. METHOD OF MOUNTING. The specimens shall be mounted in accordance with the instructions in the individual specifications. The orientation of the specimen or direction(s) of the applied vibration motion shall be as specified. Any special test fixtures or jigs required to run the test shall be as specified in sufficient detail in the individual specification to assure reproducibility of the input motion applied to the specimen. These details shall include the dimensions, the materials, temper, etc., as applicable.

4. PROCEDURE. The specimen, or substitute equivalent mass, shall be mounted in accordance with 3 and the monitoring equipment attached, if applicable, in accordance with 2.2. The vibration machine shall then be operated and equalized or compensated to deliver the required frequencies and intensities conforming to the curves specified test condition I, figure 214-1, or test condition II, figure 214-2 (see 2.1). If the order of application of the different directions is critical, it also shall be specified in the individual specification. The specimen shall then be subjected to the vibration specified by the test condition letter (see tables 214-I and 214-II) for the duration as specified in the individual specification:

3-minutes; 15-minutes; 1-1/2 hours; or, 8-hours;

In each of three mutually perpendicular directions, and in the order specified as applicable. The measurements made before, during, and after the test shall be made in accordance with 5 and if the specimen shall be monitored during the test, the details shall be as specified in 2.2.

5. MEASUREMENTS. Measurements shall be performed before, during, and after the test as specified in the individual specification.

6. SUMMARY. The following details are to be specified in the individual specification:

a. Monitoring instrumentation, if applicable (see 2.2).

b. The number and location of test points (see 2.2.1).

c. Method of mounting and orientation (see 3).

d. Test condition (I or II); letter (A-K); and duration of test (3-minutes, 15-minutes, 1-1/2 hours, or 8-hours) (see 4).

e. Order of application of vibration direction, if applicable (see 4).

f. Measurements before, during, and after test (see 5).

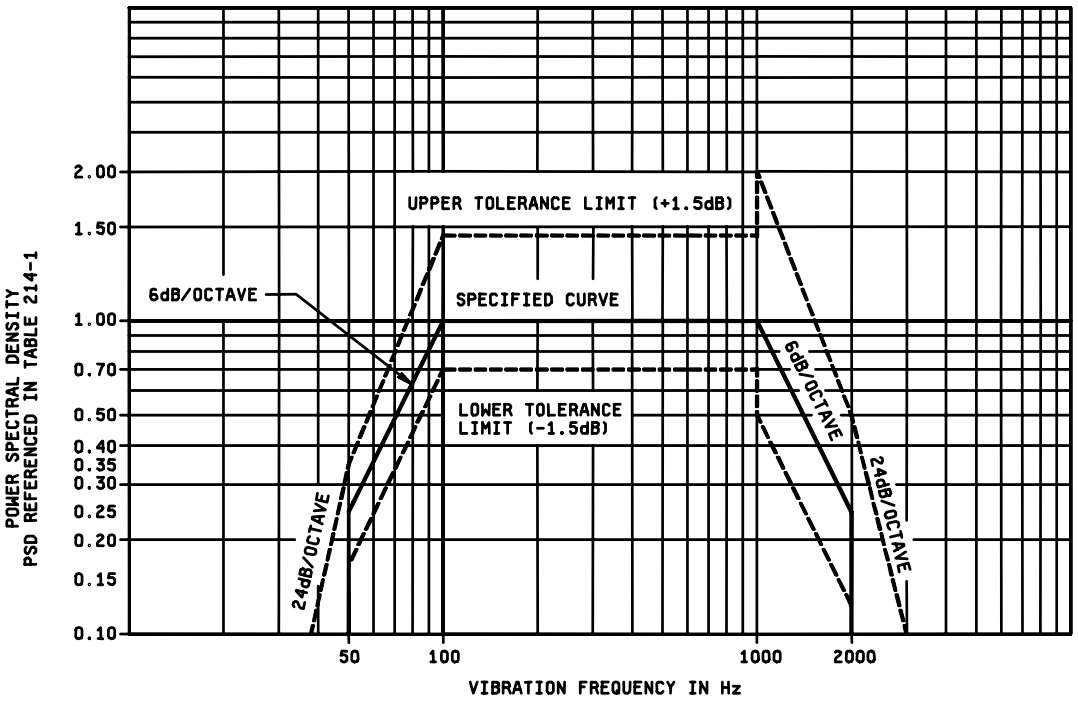

FIGURE 214-1. Test condition I, random vibration test-curve envelope (see table 214-I).

TABLE 214-I. Values for test-condition I. 1/

Characteristics		
Test condition letter	Power spectral density	Overall rms G
A	.02	5.35
B	.04	7.56
C	.06	9.26
D	.1	11.95
E	.2	16.91
F	.3	20.71
G	.4	23.91
H	.6	29.28
J	1.0	37.80
K	1.5	46.30

1/ For duration of test, see 4.

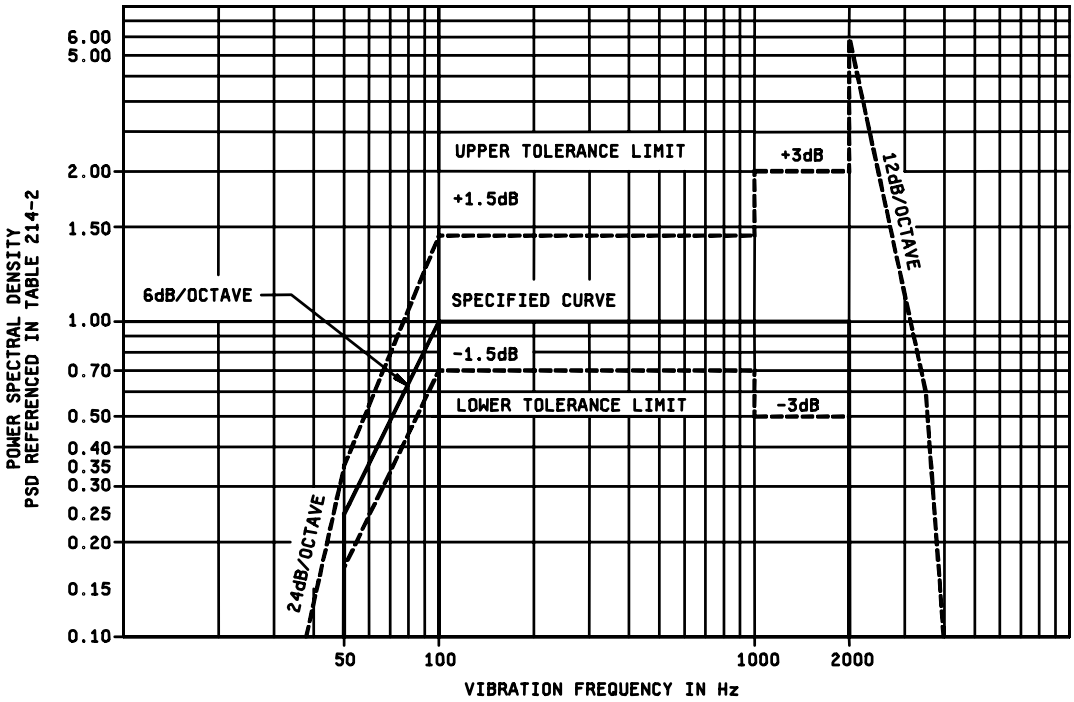

FIGURE 214-2. Test condition II, random vibration test-curve envelope (see table 214-II).

TABLE 214-II. Values for test-condition II. 1/

Characteristics		
Test condition letter	Power spectral density	Overall rms G
A	.02	6.21
B	.04	8.78
C	.06	10.76
D	.1	13.89
E	.2	19.64
F	.3	24.06
G	.4	27.78
H	.6	34.02
J	1.0	43.92
K	1.5	53.79

1/ For duration of test, see 4.