MILITARY APPLICATIONS

There are two basic types of isolators, those intended to attenuate vibration and those which can handle shock. The two types have distinctly different requirements. A vibration isolator is subjected to sinusiodal or random vibration of relatively low amplitude repeated continuously for a given period of time. Consequently, the vibration isolator requires a proportionately smaller amount of deflection capability. This means the vibration isolator can be packaged in a smaller overall space envelope

The deflection capability and natural frequency required from a vibration isolator is determined from the customers input spectrum and equipment requirements. For example, a piece of equipment might be sensitive to 60 hz vibration, therefore the isolator should be selected such that it will be in it's isolation region at 60 hz. Remember isolation theoretically begins at 1.414 times the natural frequency of the isolator, known as the cross-over point, however from experience we know various factors affect the point at which isolation occurs. Generally, these factors tend to cause the cross-over point to occur later than the 1.414 times would predict.

A shock isolator is subjected to high amplitude for very short durations. The deflections associated with attenuating these high amplitudes require the shock isolator have a larger deflection capability. This means the shock isolator would require a larger overall space envelope.

MILITARY SPECIFICATIONS

Following is a break down of the specification by category with a brief description and the basic classes of each specification.

I. SHIPBOARD

A. Mil-E-16400

Outlines the requirements for the design and construction of basic associated and auxiliary electronic equipment furnished as part of a complete system intended for Naval ship or shore use. It is noted for complete testing an individual specification in addition to this general specification must be applied.

B. Mil-M-17185

Includes design specifications which establish testing procedures, suitability requirements and quality assurance provisions for shipboard application of resilient mounts. This is basically an environmental type specification, which references Mil-STD-167 and Mil-S-901 for dynamic inputs.

C. Mil-S-901

Covers the shock testing requirements for shipboard machinery equipment and systems required to operate while resisting high impact or severe shock encountered during wartime conditions. There are three categories divided by weight. Lightweight is up to 250#, medium weight goes from 250 to 6,000 and heavy weight runs from 6,000 to 30,000#.

D. Mil-STD-167

Discusses the requirements of most naval machinery and equipment with respect to "internally excited and externally imposed vibrations." Of the five types of vibration defined, only Type 1, environmental vibration, is of concern. The remaining types refer to the degree of balancing precision necessary in the manufacture of machine parts which oscillate in a rotating, torsional, longitudinal or lateral manner. The type 1 test environmental simulates normal naval ship vibration.

E. Mil-STD-740

This standard covers acceptable instrumentation and procedures for the measurement of and acceptance criteria for, airborne and structureborne noise of Naval shipboard equipment

II. AIRCRAFT

A. MIL-C-172

Established performance requirements and other general requirements such as dimensions and space limitations in aircraft to insure interchangeability. Using a mounting system with an equipment mock-up, there are three classes of equipment;

A: Mounting base and isolators designed for a 2 to 1 load carrying capacity.

B: Mounting base and isolators designed for a +15% load carrying capacity with eccentric CG.

C: Mounting base identified with MS number.

B. Mil-E-5400

This specification covers the general requirements for the design and manufacture of airborne electronic equipment for operation primarily in piloted aircraft. The physical aspects of items such as cases, switches, terminals and mounting bases are of primary concern. The specification is divided by the type of aircraft such as propeller driven, jet driven and helicopters.

C. Mil-E-19600

This contains the general requirements for electronic modules to be used in aircraft. There are many classes of electronic modules and all are subjected to the same environmental testing. The modules are subjected environments established by both Mil-E-19600 and Mil-E-5400. The modules to be governed by this specification are intended for use in piloted aircraft.

D. Mil-T-5422

Covers procedures for testing aircraft electronic equipment under simulated environmental conditions to determine compliance with the requirements of Mil-E-5400. This specification is referred to as the "testing specification for Mil-E-5400".

E. Mil-E-5272

This specification establishes generally applicable procedures for testing aeronautical and associated equipment under simulated and accelerated climatic and environmental conditions. Procedures prescribed herein are to be utilized in subjecting equipment to simulated and accelerated environmental conditions in order to insure satisfactory operation and to reduce deterioration when the equipment operated or stored in any global locality.

F. Mil-T-21200

This is a general specification for test equipment for use with electrical and fire control systems. It promulgates the design and construction criteria for test equipments which are divided into three classifications according to operational location.

Class I is for equipment used in "air vehicles". Class II is equipment intended for use in the vicinity of aircraft being serviced or maintained in an uncontrolled. Class III is equipment protected from an uncontrolled environment.

III. Ground/Off-Road

A. Mil-T-4807

The basic requirements and tests for use in determining the ability of electronic equipment to withstand shock and vibration during transportation and handling.

IV. Shipping and Handling

A. Mil-P-116

Provides the testing requirements for packaged equipment to ensure damage-free handling, shipping and storage. The requirements are subdivided by gross weight of container and contents.

B. National Safe Transit Association

Provides vibration and various drop test for a manufacturer to predetermine the probability of the safe arrival of his "packaged product". Designed for products weighing 100# or less.

V. Miscellaneous

A. Mil-STD-202

This standard provides test methods for electronic and electrical "component parts" such as capacitors, switches, resistors, transformers, relays and jacks or small parts which do not exceed 300 pounds in weight or which do not have a root-mean-square test voltage over 50,000 volts.

B. Mil-STD-750

This standard established uniform methods for testing semiconductor devices, including basic environmental test to determine resistance to deleterious effects of natural elements and conditions surrounding military operations and physical and electrical tests. This standard is intended to apply only to semiconductor devices.

C. Mil-STD-810C

This standard established uniform environmental test methods for determining the resistance of equipment to the effects of natural and induced environments peculiar to military operations. It provides environmental test methods in order to obtain, as much as possible, reproducible test results. The test methods described herein are intended to be applied by the contractual documents. This standard is still being used as a "cookbook specification" for many projects. It contains both dynamic and environmental tests which can be specified as necessary to simulate the anticipated operational environment.

D. Mil-STD-810D

This specification replaces the fixed procedures used in Mil-STD-810C with "test tailoring", a process by which the environment expected to be experienced by the product from the time it leaves the manufacturing plant are used to determine the qualifications test procedures. If it is impossible to determine actual input levels then "standard" test levels given are to be used. The specification cautions the user to stay within standard test machines limitations.

E. Mil-STD-883

This standard establishes uniform methods, controls and procedures for designing, testing, identifying and certifying microelectronic devices suitable for use within military and aerospace electronic systems including basic environmental tests to determine resistance to deleterious effects of natural elements and conditions surrounding military and space operations.

F. Mil-S-52059/Mil-S-55286

These specifications each cover one type of lightweight field and mobile shelters designed for transport by cargo truck, fixed or rotary wing aircraft, by rail, ship, and landing craft. Specifications cover all aspects related to the shelters.

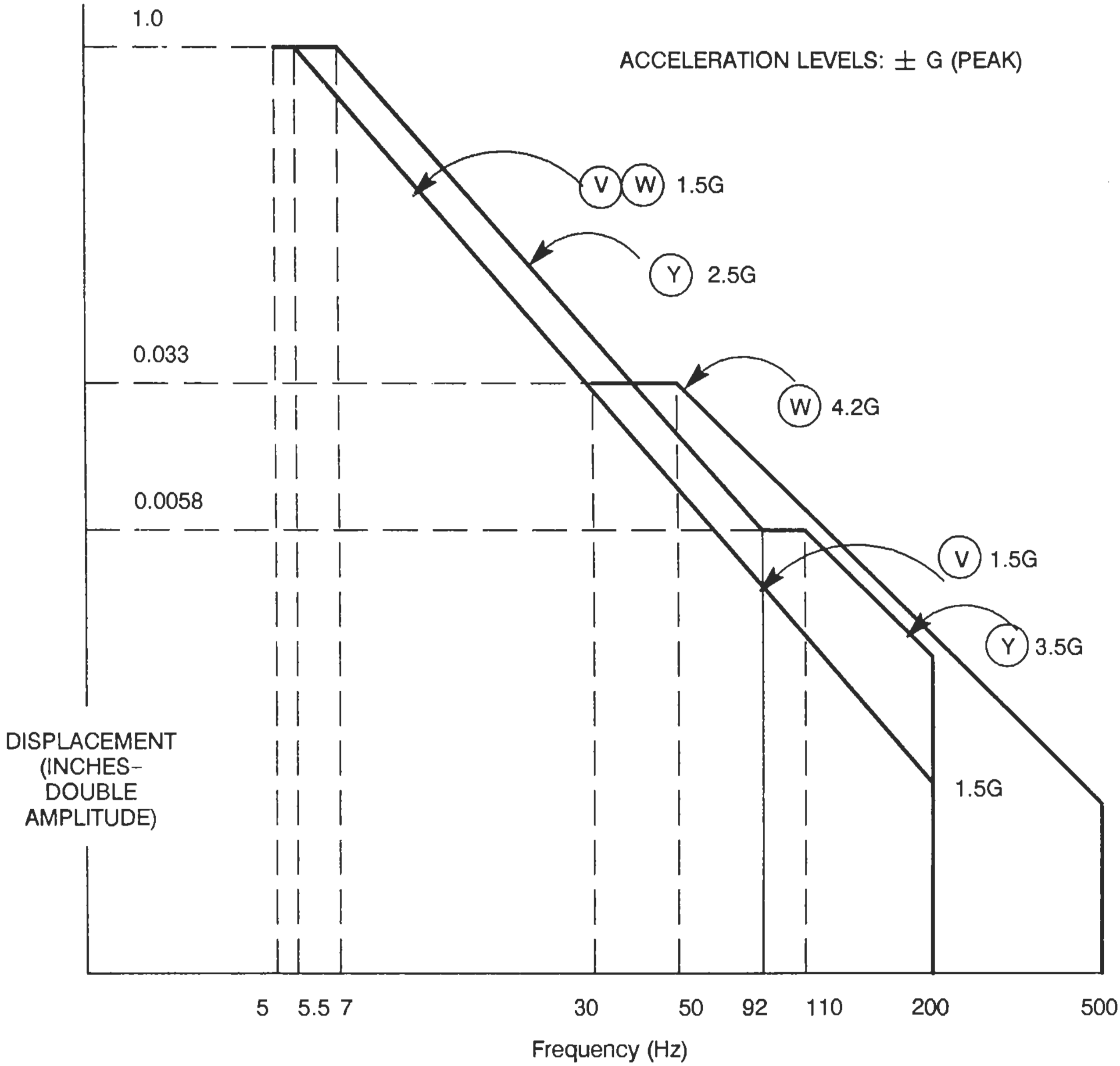
RANDOM VIBRATION

In direct contrast and as the name implies, random vibration has a different pattern. All frequencies, within the given limits, occur at the same time, However, the amplitude of any discrete frequency could be very large or very small at any given instant in time, within the capabilities of modern test equipment.

Now the problem becomes "How do we analyze this type of input to determine which isolator is the correct choice for a given application". Barry has developed the Worksheet for Random Vibration, see figure 2. This sheet, in conjunction with the Barry slide rule, will give you the required isolator displacement. This value is actually the three sigma probability, a 99.7% chance, the isolator will have to accommodate that displacement value. As you have probably already figured out, statistics is used to characterize the random process. Remember, there is a 0.3% chance you will need greater displacement during any given test.

The work sheet is fairly self explanatory but let's review it here for clarity. First the isolator's desired Resonant frequency and transmissibility are chosen. The acceleration spectral density, in the region of the isolator's resonance, is read from the input spectrum. Using these values, line up the frequency with the transmissibility on the slide rule and then read off the one sigma response which lines up with the input level of interest. Enter this value and the resonant frequency in the appropriate places in the equations and calculate the one sigma displacement required. Multiply this value by three to obtain the three sigma value. This is the required linear displacement of the isolator. Now the ultimate trick is to find an isolator that will exhibit these functional values in your customers load and size range.

Let's run through an example. Figure 3 shows a typical input spectrum. The customer has decided a 30 hz resonant frequency with a maximum transmissibility of4.0 is needed for their application. At 30 hz the input spectrum has a power spectral density of 0.04 g2/hz. Lining up 30 hz with a transmissibility of 4.0 on the Barry slide rule yields a Grms value of approximately 2.75. Using these numbers in the equation results in a one sigma displacement of .03 inches. Multiplying by 3 gives the three signma displacement requirement of 0.09 inches. In summary, an isolator would have to be selected such that when placed under the customer's loading would exhibit a resonant frequency of 30 hz, a maximum transmissibility of 4.0 and has a minimum linear deflection capability of 0.09 inches.



Note: All curves shall be extended to 2 Hz when test item resonances below 5 Hz are expected.

Figure 514. 2-6 Vibration Test curves for Equipment Installed in Ground Vehicles, Equipment Category f.

FIGURE 1