THE EQUIVALENT SINE OF AN SRS
Revision A

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The goal is to show that a sine sweep test covers a shock response spectrum (SRS) of a flight event.

Sine sweep vibration test specifications are typically base input levels.

Assume:

1. The test item is a single-degree-of-freedom system.
2. The test item's natural frequency is unknown, so it is an independent variable. But the natural frequency occurs in the frequency domain of the sine sweep test specification.
3. The test item's amplification factor is Q=10.
4. The test specification sweep rate is gradual enough that the item reaches steady state at its natural frequency.
5. The concern is only peak response. Fatigue is ignored.

The sine sweep base input acceleration spectrum can simply be multiplied by Q=10. This gives the SRS of the sine sweep. This SRS can then be compared to an SRS from flight data. Hopefully, the sine sweep SRS envelops the flight SRS across all natural frequencies, or at least at the test item's natural frequency if known.

Dr. J.N. Bricout used a variation of this approach in Reference 1. He left the sine sweep "as is." He instead divided the SRS by its Q factor. This yields an equivalent sine base input of sorts. He then compares the two SRS curves. An example is given in Figure 1, as taken from Reference 1. This approach is also used by Isam Yunis.

In summary, the equivalent sine of an SRS is the SRS divided by its Q factor. The Q value should be stated explicitly. Note that a lower Q value will yield a higher equivalent sine level for transient or random signals. Thus a lower Q value is more conservative if a sine sweep is being used to cover an SRS. A typical value is Q=10.

The two approaches outlined above are equivalent in terms of the comparison outcome. The first approach was concerned with response. The second with base input.

Each approach is conservative because the flight event is most likely a brief, transient event. The sine sweep test duration is almost certainly much longer.

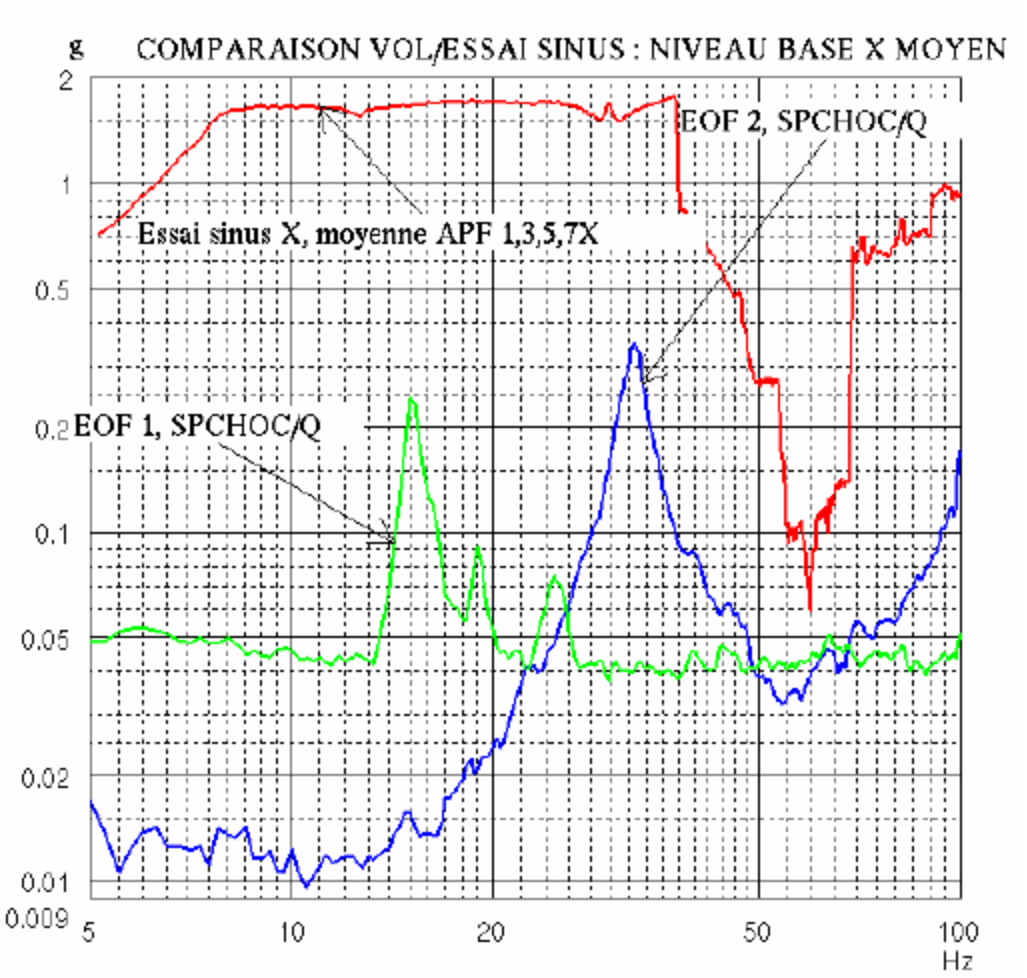

Figure 1.

Reference

1. Dr. J.N. Bricout, In Flight Measurement During SPOT 4 Satellite Launch, S/C and L/V Dynamic Enviroments Workshop, The Aerospace Corporation, El Secundo, CA, 2001. Available from: http://www.aero.org/conferences/sclv/pdfs/06-Bricout_J.pdf