Vibro-Acoustic Consultants Series on Vibration and Noise Control Issues – December 2008

High-End Vibration Criteria

Just how quiet is a "quiet" environment for vibration-sensitive research? In this article, Byron Davis and Ahmad Bayat give the low-down on high-end vibration criteria.

Since the 1980s, vibration in advanced technology facilities and research environments has been characterized and designed to a set of Generic Vibration Criterion curves.[1] Today, these curves are defined as constant-velocity vibration levels at frequencies from 1 to 80Hz, as illustrated at right. The VC curves have found wide circulation in industrial and institutional settings in the USA and around the world.

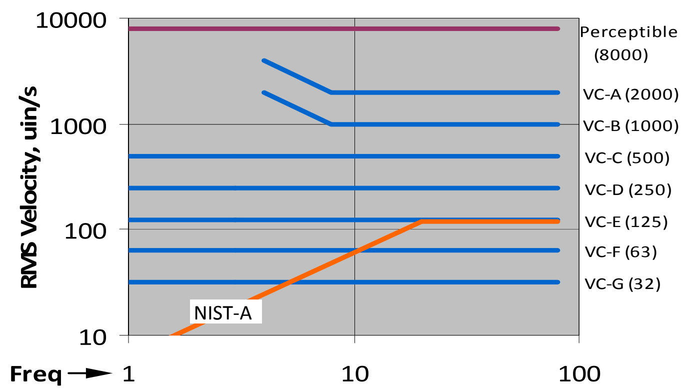
Until recently, the focus of the VC curves was industrial cleanrooms, especially for semiconductor manufacturing. Previously, the VC-E curve at 125 micro-inches/second (µin/s) was considered to be near the lower limit of practical criteria. For comparison, the threshold of human perception is often taken to be 8000µin/s as per ISO standards.

The VC-E criterion is still widely used in industry. However, research and development environments (such as at universities) are usually non-cleanroom, non-industrial spaces, and suspended structures are typically not required. Therefore, R&D spaces (at the ground level) can enjoy far quieter vibration environments than production spaces, meaning that these environments can be better than VC-E.

It's a good thing that these environments exist, because R&D work occurs at the next generation of precision. Not only is the precision greater, but experimental tools developed by researchers are often one-of-a-kind. The vendors of mature, "off-the-shelf" tools have invested considerable resources into the engineering of robustness against environmental contaminants like vibration. For R&D, this level of investment is usually unattainable.

In one unique application, the National Institute of Standards and Technology (NIST) constructed a floating slab placed on air springs to reduce the vibrations experienced by a developmental tool. The measured performance of the floating slab is the basis of a new criterion curve called "NIST-A". This curve is different from the constant-velocity VC curves. At low frequencies, the NIST-A curve demands stringent control due to the resonance amplification of the air springs; the curve relaxes to meet VC-E at high frequencies.

In addition to the challenges presented by one-of-a-kind tools, a new generation of R&D tools has appeared with capabilities at nanometer and sub-nanometer length scales.



Two new curves called VC-F (63µin/s) and VC-G (32µin/s) were adopted in 2007. In addition, the NIST-A criterion, along with a modified version called NIST-A1, is being used in national labs and university facilities. Our opinion is that VC-F and VC-G are more appropriate to non-floating slab construction such as ground/basement level slabs.

A few examples of "off-the-shelf" tools requiring VC-F and VC-G environments include electron microscopes from FEI, JEOL, and Philips. Hand-built scanning probe experiments, such as scanning tunneling microscopes, require even tighter control. Because the criteria for most of these tools become more relaxed at higher frequencies, many are also able to accommodate a NIST-A environment. These and similar tools are used across disciplines and are representative of the leading edge of technology.

Vibro-Acoustic Consultants specializes in vibration and noise design in demanding settings, serving clients around the world. Contact Byron by visiting www.va-consult.com

[1] See IEST Report IES-RP-CC-12.1, "Considerations in Clean Room Design"

VACC, Inc. dba
Vibro-Acoustic Consultants

490 Post St. #1427 • San Francisco 94102 • USA
(+1) 415-693-0424 • http://www.va-consult.com