

TWR, Multi-exciter Testing Added to New Revision MIL-STD-810G

The latest edition of the world's most widely used laboratory test document contains new test methods and revisions based on lessons learned in the field.

Keywords

MIL-STD-810, time waveform replication, TWR, multi-exciter, multi-axis, climatic testing, dynamic testing, environmental testing, vibration testing, test tailoring

Highly anticipated additions to MIL-STD-810G: *Environmental Engineering Considerations and Laboratory Tests*, issued in October 2008, include new methods for time waveform replication (TWR) and multi-exciter testing. These and other revisions to the widely used standard reflect the effectiveness and acceptance of new technologies.

"The methods presented in MIL-STD-810 have proven to provide a high degree of confidence, and we receive over half a million downloads per year," said Kenneth Thompson of the US Army Developmental Test Command (DTC). The standard is the most globally utilized laboratory test document, according to the Defense Standardization Program office. "The document has broad applicability and reaches beyond military applications. Many commercial test houses rely on it."

MIL-STD-810 is developed and maintained by a Tri-Service partnership that includes the US Air Force, the US Army, and the US Navy. Under Thompson's direction as Army Custodian for the document, DTC is responsible for Lead Standardization Activity and Preparing Activity.

Early editions of the document broke ground by treating environmental test tailoring as a systems' engineering process.¹ "Tailoring allows for outside-the-box thinking when designing test programs," Thompson explained. "We're trying to get people to think about what the test item will experience from cradle to grave."

New Test Methods

Prior to the introduction of **Method 525, Time Waveform Replication**, vibration tests typically had been presented as intensity vs. frequency graphs; i.e., in the frequency domain. Method 525 maintains field data in the time domain, which is said to result in more realistic shaker motion.² This method enables users to replicate a time trace to determine whether the test item can withstand the specified test time trace(s) to which the item is likely to be exposed in the field.

The document states, "The advent of more powerful data processing hardware/software, and the implementation of advanced control strategies, has led to exciter control system hardware and software that permit convenient replication of extended time-varying test environments on a single exciter in a single direction in the laboratory."³

A significant stride for the test industry is the introduction of **Method 527, Multi-exciter Testing (MET)**. Historically, the standard provided only for single-axis vibration testing. "We all know

things don't shake in just one direction," Thompson commented. "Multi-shaker testing has been performed by test labs, but this is the first attempt to bring a method into MIL-STD-810. Technological advances within the past five years provide a high degree of confidence. Prior to that, there were some limitations. We couldn't excite heavier payloads; multi-shaker testing was used on a small scale."

Multi-exciter testing applies vibration or shock energy to the test item in more than one axis in a controlled manner without relying on the dynamics of the item for such distribution. According to the document, MET is appropriate for items having a high slenderness ratio; large, heavy test items may require more than one exciter to provide sufficient energy.

Incorporation of MET and other new tests will encourage wider use of these methods, said Thompson. "This will also drive improvements to test facilities," he added.

Some additions to the standard were derived from other documents to give users a single reference source. "Early in the revision process, the Navy approached us with a request to incorporate MIL-STD-167-1A," Thompson recalled. **Method 528, Mechanical Vibrations of Shipboard Equipment**, incorporates the requirements of that document along with additional lessons learned. The vibration test method is designed to demonstrate the physical and functional integrity of equipment subjected to a prescribed steady-state vibration environment.

Another addition to the document is **Part Three: World Climatic Regions—Guidance**. This section was derived from other sources, including Army Regulation (AR) 70-38, "Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions"; ALBE Report 1, "Environmental Factors and Standards for Atmospheric Obscurants, Climate and Terrain"; and MIL-HDBK-310, "Global Climatic Data for Developing Military Products."

"One complaint that came up early during the review process was the time-consuming task of finding other documents for referenced information," said Thompson. "With Part Three, we made an attempt to define climatic environments found worldwide." Thompson added that the committee plans to develop Part Four as a similar resource for dynamic environments, either as a change notice or for the next revision.

Part Three provides planning guidance for developing design requirements and determining appropriate test conditions for realistic natural environments associated with:

- Climate (temperature, humidity, solar radiation, rain, snow, wind, blowing sand, dust and snow, icing phenomena, ozone, freeze-thaw occurrences, fog, cloud ceiling heights, and visibility).
- Weather-related atmospheric obscurants (rain, snow, fog, cloud cover).
- Induced climatic conditions (storage and transit).

Existing Methods Revised

Existing test methods are continually being fine-tuned to incorporate lessons learned in practice. For example, a revision to **Method 510, Sand and Dust**, arose from field failures attributed to long-term exposure to the desert environment. "We've introduced the option to include 'designer dust'," said Thompson. This revision facilitates tailoring by allowing users to replicate the chemical composition of dust in a region of interest, such as dusts containing corrosive salts.

A revision of **Method 507, Humidity Testing**, restores natural environment profiles to the procedure at the request of document users. Five natural cycles were introduced in edition 810D to supplement the aggravated cycles, but then dropped in 810F because the test durations were

found inadequate for simulating natural exposure. Revision 810F called for caution in conducting tests and interpreting results in cases where natural or induced cycles are mandated.¹ The natural cycles were brought back into the standard based on research conducted by the Army Corp of Engineers. Test durations for the B1 (constant high humidity) and B2 (cyclic high humidity) environments were based on consecutive rainy days, and the B3 (hot-humid) environment was based on consecutive days with a high dewpoint. “It should be noted that by no means can we reproduce, in a chamber, all the synergistic effects of the natural environment,” said Thompson.

Formatting changes to **Method 514, Vibration**, make the instructions more user-friendly. For example, figures and tables are placed immediately following their mention in the text. Content revisions include updated vibration profiles of composite-wheel vehicles and two-wheeled trailers, and a de-emphasis on the use of minimum integrity testing.

In Method **505, Solar Radiation**, the revision encourages the use of solar testing to obtain a closer approximation of the maximum response temperature. “Too often a requirement document will state that an item must operate at 120 °F (A-1 desert environment),” explained Thompson. “The problem with this approach is the disregard for the effect of solar radiation upon the item. Direct exposure can lead to differential heating and increased temperature in confined compartments.” The maximum response temperature, once known, can be used in Method 501 testing. In addition, modifications were made to the delineation of the solar spectrum to more accurately gauge the ability of an item to absorb energy.

A logistical change made to most test methods, according to Thompson, was the addition of a statement of the minimum data required in test reports. “The logic behind this approach change is that the test report is your final product, otherwise there’s no proof you did the test,” he noted.

Revision Process

The previous edition, MIL-STD-810F, was issued in January 2001, followed by three Change Notices. “The Defense Standardization Program office encourages 5-year updates for widely used documents,” said Thompson. An official call for input for revision 810G was issued in 2005, and some 450 comments were received during the coordination of the draft revisions. Due to the large number, the comments were divided into technical and formatting changes and tracked in a database.

The Tri-Service Working Group (WG) conducted more than 100 web conferences, separated into climatic and dynamic testing topics, to address all of the comments. Depending on the subject, technical experts and representatives from private industry were invited to attend the interactive conferences, where proposed changes were reviewed live on screen and discussed. In addition, the WG met in person at ESTECH as an IEST Working Group, as well as at Shock & Vibration Information Analysis Center (SAVIAC) events.

The Work Continues for MIL-STD-810 **Town Hall Forum**

During the ESTECH 2009 technical conference, Kenneth Thompson, US Army Custodian, will lead a review and discussion of MIL-STD-810G. Participants will have the opportunity to raise questions and provide input on problems and future testing requirements. For more information and to register, visit www.iest.org and click on the ESTECH 2009 logo.

The document grew from 500 to 800 pages, and the comment resolution file was posted for all commenters to review. Final revisions were made and MIL-STD-810G was published. The process does not end there, however. “A new method is just a start, something on paper for people to throw a dart at,” said Thompson. “In some applications, 810 is not severe enough; in others it may be too severe. We’re continually seeking feedback and reevaluating how we go about testing materiel.” A discussion of changes to each method was published in *TEST Engineering & Management*.⁴

A free copy of MIL-STD-810G is available for download at www.iest.org. Copies of all versions of the standard can be obtained at <http://www.dtc.army.mil/publications/milstd.aspx> or <http://assist.daps.dla.mil/quicksearch>.

References

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3. US Department of Defense. 2008. MIL-STD-810G: *Environmental Engineering Considerations and Laboratory Tests*.
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