The Development and Metamorphosis of MIL-STD-461D/462D

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Today, the DIESC, comprised of government and industry representatives, is working to harmonize military and commercial requirements.

FROM "C" TO "D"

Prior to 1993, the year the "D" versions of MIL-STD-461/462 were issued, the three major branches of the Department of Defense (DoD) used their own versions and interpretations of these EMC standards via notices. Each Service branch was concerned about the performance of their equipment in their unique electromagnetic operating environments and, thus, individually interpreted, tailored and applied the requirements. In early 1989, the Navy, which was the lead standardization activity for DoD EMC standards and also the preparing activity for MIL-STD-461, decided to investigate whether a coordinated effort to update and revise the standards was feasible. Since communications between the EMC organizations of the various services had been poor, contacts with key EMC representatives of the Army and Air Force were made by a "neutral" individual. As a result, a friendly dialogue began between the various military EMC branches.

Officially, a memorandum issued by the Defense Quality and Standardization Office of the Secretary of Defense, dated June 8, 1989, invited "The Services" to participate in a meeting on June 20th to review the status of the EMC standards. During this meeting, it was decided to form a working group for revising E^3 standards. The working group first officially met in Arlington, VA on August 15, 1989. Thereafter, this group met about every two months until their work was completed in 1992.

Participation at the working group meetings was limited to three individuals from each service, two representatives from industry (ANSI), an observer from the National Security Agency, and three support contractors. Uninvited guests were refused admittance, which led to an occasional awkward moment. The meetings were rotated between Pennsylvania, Florida, Ohio, Virginia, New Jersey, California, Arizona and Nevada. In addition to these bimonthly gatherings, internal service meetings were conducted. For instance, the Navy's working group representatives had to coordinate with NAVAIR on aircraft and air-launched missile requirements, with NAVSEA on ships (both metallic and nonmetallic) as well as ship-launched missiles, the submarine community, the ground facility folks, and others. Likewise, Air Force and Army representatives had to conduct internal service coordination meetings. Thus, it was a very complicated, yet well-managed, endeavor.

As work proceeded, annual briefings were made to the public at the IEEE EMCS Symposia as well as at other professional society meetings. An appendix to each of the standards was written by the Air Force. It provided a historical record and rationale of the requirements so that interpretations of the requirements would have a basis. Furthermore, the appendices would be there for reference if and when future revisions were made to the standards. This removed the handicap of not having an official record from the preparers of prior issues. Thus, the Appendix to MIL-STD-461D explained the basis for the requirements, and the Appendix to MIL-STD-462D explained and justified the test methods.

Unrecorded was all of the work that was done in researching and evaluating various other requirements and test methods which were not included in the standards, like the Ground Plane Interference (GPI) requirement and test; the use of Helmholtz coils; the control and definition of the power source impedance and load impedance; the calibration of LISNs and anechoic material; the use of a vector network analyzer in place of an EMI receiver; the application of coherent measurements; consideration of the anticipated European Union requirements, originally due in 1992; the reasons for reducing 24 requirements down to only 17 requirements; the deletion, addition and finally deletion of the antenna terminal requirements; the definitions of sweep rates and dwell times; and the rationale behind deleting the broadband measurement and fixing the minimum bandwidth of measurement receivers. The Appendices are an accurate and concise explanation of the requirements, but there was a whole lot going on which has yet to be documented. Perhaps one of the group members who kept copious notes will publish this information someday.

About a year after the D version of MIL-STD-461 and MIL-STD-462 was published, DoD acquisition reform was initiated by then Secretary of Defense, William Perry. Mr. Perry's actions resulted in the cancellation of many military specifications and standards, but

MIL-STDs-461 and 462 have survived. Along with the directive to minimize the use of military standards and specifications, Secretary Perry's memo also mandated the purchase of "commercial off-the-shelf" [COTS] equipment. Unfortunately, most commercial items cannot withstand the harsh operational electromagnetic environments of the military.

To try to resolve this conflict, the original working group was reconvened in 1995 to form the Defense/Industry E^3 Standardization Committee (DIESC) on Electromagnetic Compatibility. This group is co-chaired by representatives from the DoD and industry. Together with industry organizations (including the SAE, ANSI, EIA, IEEE and NEMA), DoD agencies and NASA, the group is striving to compare the commercial EMC requirements of the EU, FCC, RTCA DO-160, and others to the requirements of military environments. DIESC would like to consider their work as an effort to harmonize military and commercial EMC requirements, but there can't be any harmonizing with organizations that set edicts and don't want to harmonize. For instance, no one has yet to publish the basis and rationale for all of the EU EMC requirements, test methods, and limits. After conducting exhaustive comparisons and analyses, the DIESC will publish a "Guide on the Use of Civilian Standards by Military Agencies." A draft of this document should be circulated before the end of 1997. In conjunction with this guide, a computer program (EASTWin) is being prepared by the DoD to support this effort.

COST DIFFERENCES IN TESTING

Due to some of the new requirements contained in MIL-STD-462, users should see some cost increases when testing per the standard unless the test laboratory does not adhere to the new requirements. Of course, the overall application of MIL-STD-461/462 with the significantly reduced number of requirements reduces the overall cost of applying and using the standards.

Some of the requirements contributing to increased cost are discussed here.

Frequency	Minimum Absorption
80 MHz — 250 MHz	6 dB
Above 250 MHz	10 dB

Table 1. *Absorption at Normal Incidence.*

ANECHOIC MATERIAL USE

Every shielded room used for the measurement of radiated emissions must be lined with anechoic material with an absorption ratio of 6 to 10 dB in accordance with Table 1. (This is not the case for radiated susceptibility measurements.) The configuration of the anechoic material must conform with Figure 1. It should be noted that the anechoic material is on the top of the room as well as behind the measuring antenna. The RF absorbing material may be ferrite tiles. However, there is no test measurement procedure that must be followed to verify the performance characteristics of the absorbing material after it is installed in the shielded room. Whereas the EC requires a specified field uniformity over a specific volume, military equipment can be much larger than commercial equipment and, thus, is likely to exceed that volume.

TEST CONFIGURATION PARAMETERS

When the EUT is mounted on a composite structure in its final operational configuration, the MIL-STD-462D test configuration must simulate this installation. For instance, if the EUT is for a composite structure, it should be tested on a composite surface, not the usual copper ground plane or wooden test bench. The specific requirements are contained in para. 4.5.2 of the MIL-STD-462D standard.

CABLES

The arrangement of the EUT cables is significantly different in a MIL-STD-462 configuration. For instance, power cables 2 meters in length must be run parallel to the front edge of the ground plane, whereas before, only 1 meter of cable was used. Additionally, the signal line cables must be separated by 2 cm and all emission testing must be performed by an automatic scanning receiver that will produce final XY plots of the test data. This testing may not be performed manually, nor may the data be

MIL-STD-461/2 TO BE UPDATED

With the advance of technology and its effects on government and military electronic systems, plans are being made to revise MIL-STD-461/462. Consideration will be given to advanced test methodologies, new government acquisition policies, harmonization with commercial EMC requirements, and the clarification of uncertainty methodologies. Limits will be reviewed so that they continue to reflect DoD environments and needs.

As in the past, a committee of representatives from the Army, Air Force, Navy, and other government agencies, as well as from industry, will likely be convened. Generally, these review meetings will have limited participation by the designated representatives. Comments should be submitted on DD Form 1426 in accordance with Paragraph 2 of the Foreword contained in the front of either MIL-STD 461 or 462. Persons wishing to offer comments for the review committee to consider must include an in-depth rationale in support of their comments. Comments can also be sent directly to Mr. Stephen Caine, Space and Naval Warfare Systems Command, 2451 Crystal Drive, Arlington, VA 22245. Fax: (703)602-4485 or E-mail: caines@smtp-gw.spawar.navy.mil or to the Joint Spectrum Center, 120 Worthington Basin, Annapolis, MD. E-mail: Caine@jsc.mil. The SPAWAR contact information is valid only through September 30, 1997. See /www.RBitem.com/ for further updates.

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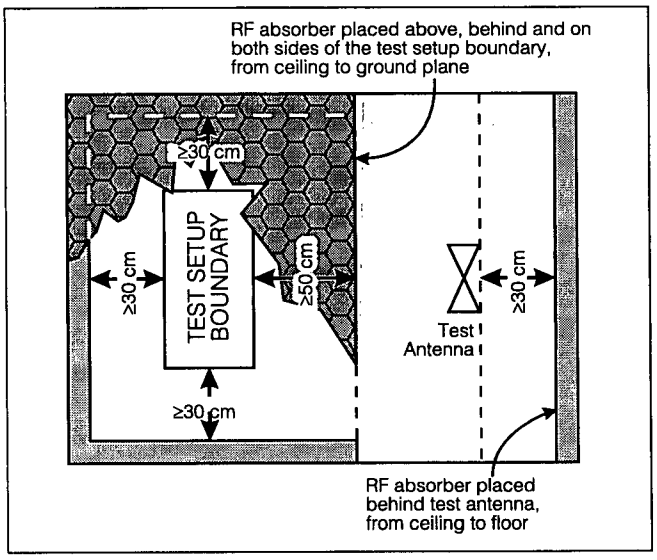

Figure 1. *RF Absorber Loading Diagram.*

separately reproduced as was allowed in previous issues of MIL-STD-462.

SCAN RATE

Previous issues of MIL-STD-462 did not control the rate at which the test receiver scans frequencies when making emission measurements. This is now corrected in MIL-STD-462D. Not only is the dwell time over each frequency range specified, but the minimum receiver bandwidth as a function of frequency is also specified. This is shown in Table 2. It is also very important to note that there are no longer broadband and narrowband emission criteria. All emissions are considered narrowband within the specified minimum receiver bandwidth. This requirement adds at least 12 to 16 hours to the old emission requirement test time.

PRECALIBRATION

At the start of each numbered test, whether emission or susceptibility, the complete test system (including measurement receivers, cables, attenuators, couplers, antennas, etc.) must be calibrated and verified by injecting a known signal at the start of each individual test method. In fact, this calibration procedure is specified with each method in the "D" version of MIL-STD-462. Many laboratories are not aware of this requirement or just omit it. However, it is a mandatory requirement and the results should be reflected in the test report. The customer should be sure that the test activity performs the precalibration prior to each test in accordance with MIL-STD-462D requirements or the test results may ultimately be rejected by the customer. This was not required in the earlier versions of MIL-STD-462.

It should be noted that the procuring activity has the duty and the right to modify and tailor the requirements of MIL-STD-461 for its particular application. This is especially true if the product being acquired is intended to be used in a defined electromagnetic environment. In such a case, the

Frequency Range	6 dB Bandwidth	Dwell Time	Minimum Measurement Time Analog Measurement Receiver
30 Hz — 1 kHz	10 Hz	0.15 sec	0.015 sec/Hz
1 kHz — 10 kHz	100 Hz	0.015 sec	0.15 sec/kHz
10 kHz — 250 kHz	1 kHz	0.015 sec	0.015 sec/kHz
250 kHz — 30 MHz	10 kHz	0.015 sec	1.5 sec/MHz
30 MHz — 1 GHz	100 kHz	0.015 sec	0.15 sec/MHz
Above 1 GHz	1 MHz	0.015 sec	15 sec/GHz

Table 2. *Bandwidth and Measurement Time.*

requirements may be more or less difficult. However, if the product is to be used in military operational electromagnetic environments which are undefined and variable, then the most severe applications of MIL-STD-461 should be imposed. In other words, the procuring activity should increase the severity requirements contained in the standard when justified.

ROBERT GOLDBLUM *is the president of R&B Enterprises and the publisher of* ITEM. *He has more than 35 years of EMC experience, which includes supporting government R&D for the development of MIL-STD-461/462 requirements. Bob has written many articles on this subject and has traveled worldwide with his related presentations and courses. (610) 825-1960.*

Comments pertaining to the status of MIL-STD-461/462 are also contained in the editorial of this issue of *ITEM*. The author will periodically update this article and the status of the standards on the R & B website: www.RBitem.com