PREPARING FOR AN EMP TEST

When MIL-STD-461C and MIL-STD-462, Notice 5 were issued on August 5, 1986, electromagnetic pulse, or EMP, testing became a primary concern among manufacturers.

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INTRODUCTION

While most program managers may be well versed in EMI/EMC testing, uncertainties may arise when they are faced with the prospect of an upcoming EMP test. What specification and test method will be used? Where will the test plan come from and will it be a valid one? Where will the testing be performed and with what equipment? How will the test results be presented?

SPECIFICATIONS

If the equipment under test, or EUT, is a U.S. Navy procurement, MIL-STD-461C and MIL-STD-462, Notice 5 are the applicable specifications. These standards cite three different test methods: CS10, CS11, and RS05. Which of these methods is used depends upon the EUT. If the EUT is to be installed in an unshielded area, such as in a non-metallic aircraft nose-cone or in an area which is exposed to the weather, or if the EUT is a mission-critical device, method RS05 is used.

If the EUT is to be installed in a shielded area, such as below decks of a ship, one of the conducted susceptibility test methods is used. The CS10 method tests individual leads of the EUT's power, signal, and control cables. CS10 is used when the EUT's installation and cabling are not wholly defined. For example the EUT might be a transmitter which could be used on an aircraft, ship, or ground facility. In each installation, the cabling would be of a different configuration. Since the cabling is not defined each lead must be subjected to the EMP threat individually. Therefore the CS10 test is not a wholly realistic test but merely a "figure of merit" stress test.

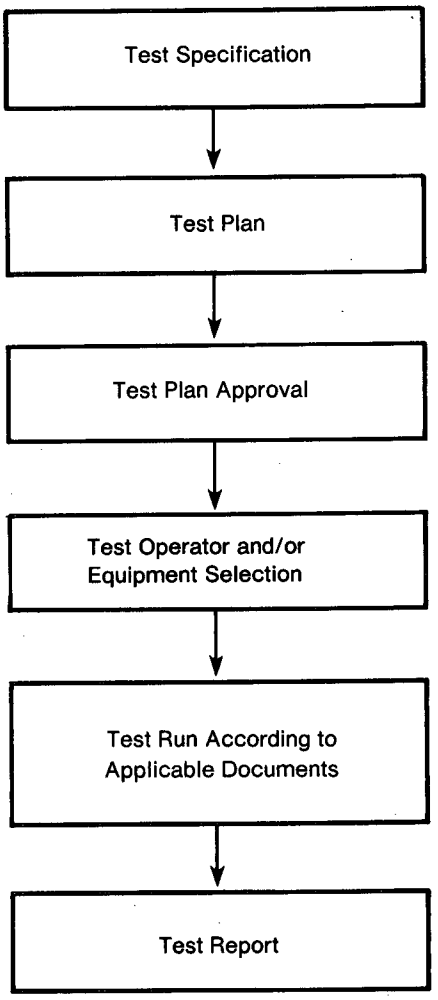
When the installation of the EUT is at least partly defined, the CS11 test method may be employed. This method subjects the entire cable to the EMP. If the type and length of the test cable is known, then it is tested in a configuration that is as similar to the actual installation as possible. If the length of the cable is not known, then the cable is tested without its overall shield.

If the EUT is a U.S. Air Force procurement, the applicable specifications are MIL-STD-461C, Notice 2 and MIL-STD-462, Notice 6. The EMP tests employ two conducted susceptibility test methods: CS12 and CS13. Like its Navy counterpart, the CS12 test method is a cable test for stressing equipment with partly or wholly defined cabling. Similarly the CS13 test method is a "figure of merit" lead test for equipment in which the installation is not defined.

Besides these military specifications, there are a number of commercial industry specifications such as those of Bell-Boeing and Grumman for products with military applications. An example is the Bell-Boeing specification for the V-22 Osprey tiltrotor aircraft. This specification details test methods for conducted susceptibility only for flight critical avionics equipment as defined in Bell-Boeing Document No. SD-572-1. Two stress levels are defined. Equipment located in the nacelle or interconnected with the nacelle is tested at a higher stress level than equipment located elsewhere. Grumman's specification is also devoted solely to conducted susceptibility but stipulates a single stress level.

TEST PLAN

The purpose of a test plan is to set forth an accurate definition of the test setup, test methodology and the equipment susceptibility criteria. If a test plan is to be written for a MIL-STD-461C/462 EMP test, it must conform to the requirements of the data item description, DI-EMCS-80201. However, any test plan should contain at least the following information: an introduction containing the scope of the document, the purpose of the test, and a description of the EUT; a list of administrative information listing applica-



EMP Test Flow Chart

ble documents and specifications, identification of the EUT (i.e., model number, serial number, etc.), the site where the test will be performed, and personnel serving as test contacts; a section outlining the test facilities and listing the equipment to be used to perform the EMP test; a section detailing the test procedure including the EUT setup and performance checks, calibration of the test pulses, and subjection of the EUT to the test pulses; a section spelling out the requirements of data to be recorded; and finally a definition of the susceptibility criteria. It should be noted that some contractors such as Bell-Boeing, request a tentative cost schedule. Even though the actual dates listed are usually nothing more than guesswork, the projected length of the test can be useful information.

Whether the test plan is prepared in-house, by an independent test lab or consultant, it must be approved by the procuring activity prior to the start of the test. An inexperienced EMP test plan writer should certainly seek expert advice. Too many test specifications contain oversights, errors, and material which may give rise to uncertainties and problems. The well-written test plan should clear up any ambiguities, not compound them. An experienced writer can aid in achieving clarity.

TESTING

When performing an EMP test, there are two major options to consider. These are either hiring an independent test laboratory to conduct the test or purchasing an EMP test system to perform the test in-house. Ultimately a decision must be made on the basis of cost-effectiveness. Hiring a test lab to perform the test is initially inexpensive; but if the test is to be a rather long one, if there are many items to be tested, or if there is much testing in the future, the test lab's bill could eventually be an expensive one. There are also the cost and inherent dangers of shipping the test sample to the lab and the travel and living expenses of potential accompanying personnel to consider.

The initial cost of purchasing EMP test equipment may be high, especially when considering the cost of operators and equipment calibration. However, the test equipment could pay for itself after only two or three months of testing time.

In purchasing EMP test equipment, or in choosing a laboratory using certain equipment, there are many important considerations. Most importantly, does the equipment test to the letter of the specification? Manufacturers' claims cannot always be regarded as reliable guidelines. Equipment should be checked out thoroughly. Customer scrutiny should include actual test demonstrations. Also there is an independent laboratory report, commissioned by NAVAIR, which supplies telling comparisons of commercially-available EMP test equipment, rated under actual test conditions.[1] Some of the key elements to consider include damping factor, output, frequency and versatility. The report mentioned previously indicated that although some test systems may be able to produce waveforms of the correct parameters, when the signals are calibrated through a coupler as called for in MIL-STD-461C/462, the testers may be unable to bring the damping factor and peak current levels within the specified limits.

For an independent test laboratory or a tester who must meet a variety of test specifications, it is vitally important that the equipment being purchased be flexible enough to meet most of the standards currently in force and those which may appear in the near future. As stated previously, it is vital that the equipment give a variable damping factor and output even through an inductive or capacitive coupler. It must be able to test at all the frequencies required. A fully variable frequency system can meet these requirements. Also the test system's output impedance must be variable if it is to meet a variety of pin injection specifications. It should contain a polarity switch for injection of both positive and negative first half-cycle damped sinusoid transients. There are systems commercially available which consist of a number of independent generators capable of covering the full frequency range. Multiple-generator systems can be especially convenient since they allow the tester the ability to run more than one test at a time. Another convenient feature, especially for independent test laboratories, is the ability of a system to provide either a sine or a cosine waveform across the frequency range. This feature allows for testing to some lightning specifications such as DO-160B.

Once the decision is made as to who should run the test and with what equipment, the actual testing process may now begin. In performing the test, if any ambiquities exist between the test plan and other documents, the test plan is followed as it is the one that is accepted and approved by the procuring activity. All relevant data taken during the test should be noted for later inclusion in the test report. If any susceptibility is noticed, testing should be halted and the contractor/procuring activity notified.

TEST REPORT

Once the EMP test has been completed, the test results must be presented to the procuring activity through a test report. If testing was performed to MIL-STD-461C/462, the report must conform to DI-EMCS-80200. Essentially the test report contains most of the information found in the test plan. However, instead of sections containing data requirements and susceptibility criteria, the report should contain test data and results, including descriptions of any noted susceptibility. The report concludes with a section describing all conclusions derived from the test results.

CONCLUSION

Although EMP testing is only a few years old, there is an abundance of resources available for those seeking information. EMP testing is not a difficult process, but the right questions must be asked and the correct answers derived in order for the testing to be carried out properly and cost-effectively. ■

NOTE

1. For a copy of this report contact Ray Hammett of Navair Systems Command at 202-692-8600. Request Report No. DTBOIR88-0964.