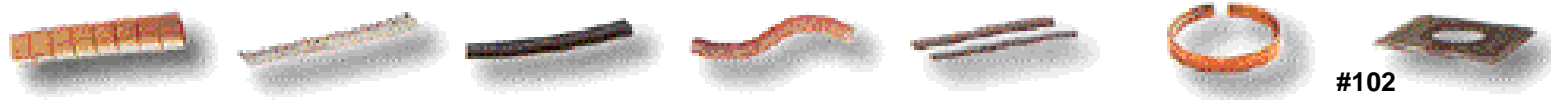




# TECH NOTES

LAIRD TECHNOLOGIES



#102

## THE STATUS AND BACKGROUND OF MIL-STD-461C/462

By Ron Brewer

Military electronic interference problems have changed dramatically since World War II, as a result of developments in and increased dependency on electronic systems. Prior to and during the early part of World War II, the major interference problem was interference to high frequency (3-30MHz) radios created by radiation from aircraft engine ignition systems. Canvas covering and wood structural members of the early aircraft provided little attenuation. Interference problems were known as "radio frequency interference"—(RFI)—and the term is still occasionally used today. Early interference specifications reflected the lack of sophistication of the early electronics systems and the completely unknown effects of electro-magnetic pulse (EMP).

Over the years, equipment and systems have changed from simple AM radio systems to complex command, control, communications, and intelligence (C<sup>3</sup>I) systems, automated information systems (AIS), and others. Operational and interference frequencies cover a range from DC to well over 40GHz with EMP susceptibility levels of up to 100,000 volts per meter. The term "RFI" is no longer meaningful and has been replaced by "EMI"—Electro-Magnetic Interference—along with an entirely new set of requirements.

Interference levels relative to modern-day military electronic equipment are controlled by MIL-STD-461ABC—the government gets to choose which letter—first issued in 1967 along with its how-to-test companion, MIL-STD-462 as mandatory DOD tri-service EMI requirements specifications.

There are several other documents in the series. MIL-STD-461A has been amended to the point that it is not one, but three different documents with a common title. At least two attempts have been made to revise MIL-STD-461A. The first occurred in 1980 with the release of the long awaited MIL-STD-461B. The B revision was primarily a re-formatting and recombination of the original 461A document with all of its old Notices into a single document. The B revision was never fully implemented, especially for airborne equipment, because of a dispute over power line filter requirements.

There were several new requirements and viewpoints, however, that stirred life into the EMC community. Notably, a requirement was established that required radiated susceptibility testing to be performed to the threshold of test sam-

ple failure or to the maximum capacity of the susceptibility test source, whichever occurs first. Additional excitement occurred when the notices for the Navy EMP requirements CS10, CS11, and RS05 were published. These requirements have been carried forward into MIL-STD-461C which was released August 4, 1986 along with MIL-STD-462, Notice 5, which tells how to perform the new tests. MIL-STD-461C retains the same format as the B revision. The new additions/modifications are summarized in Table I. Except for a few new notices, MIL-STD-462 (July 31, 1967) is still the current test procedure standard.

MIL-STD-461C/462 provide methods of measurement and limits for radiated and conducted emission and susceptibility for almost all military electrical/electronic equipment. The standard does not apply to certain non-critical items, inherently interference free devices, and some commercial off-the-shelf (COTS) equipment. Even that equipment, however, must as a minimum, meet any applicable FCC rules and regulations. The standard is mandatory for use by all Departments and Agencies of the Department of Defense and its purpose is to:

- a. provide military interference control requirements in a coordinated document.
- b. ensure that interference control is considered and incorporated into the design of equipment and subsystems.
- c. provide a basis for evaluating the electromagnetic characteristics of equipment and subsystems, as well as inputs to analysis of the electromagnetic compatibility and effectiveness of systems in a complex electromagnetic environment. This is much more realistic than the purpose of MIL-STD-461A which was "to enable compatible operation of the equipment in a complex electromagnetic environment."

MIL-STD-461C retains the quasi design orientation of its predecessors and requires the preparation of an Electro-Magnetic Compatibility (EMC) Control Plan. Its purpose is to detail how the design will ensure that an equipment item meets the requirements. This contract data item is probably the most important element of a good EMC design program; yet it receives the least amount of attention in the MIL-STD-461C. It is not nearly so obvious, now, that MIL-STD-461C stresses interference-free design and is directed toward

built-in design features that reduce the practice of after-the-fact fixes. There is also a requirement for an EMC Test Plan that details how the procedures required by MIL-STD-462 should be implemented during the test. In addition, there is a requirement for an EMC Test Report to convey the results of the tests to the customer. The report must be written in accordance with MIL-STD-831. Each of these data items must be written in accordance with their appropriate data item descriptions (DID), which were last revised and released June 30, 1986. These data items must be approved by the procuring agency before the equipment or subsystem/system is acceptable.

Because of the complexity of the electromagnetic environment systems, EMC performance can be verified only by testing. Hence, the great emphasis on testing in MIL-STD-461C. Test procedures specified by MIL-STD-461C are based upon classification by use of the equipment and heavy emphasis is placed upon the operating environment of the system/subsystem. MIL-STD-461C encourages tailoring of the limits to minimize waste, volume, and cost, providing there is no reduction in systems reliability.

**TABLE I**  
**COMPARISON OF MIL-STD-461A/B/C**

461A	461B	461C	SHORT TITLE	FREQ RANGE	COMMENT (NOTE 2)
CE01	CE01	CE01	POWER/INTER	30H-20K	30H-15K (1)
CE02	-NA-	-NA-	POWER/INTER	30H-20K	PART OF CE01
CE03	CE03	CE03	POWER/INTER	20K-50M	NOW 15K-50M
CE04	-NA-	-NA-	POWER/INTER	20K-50M	PART OF CE03
CE05	—DROPPED—		INV FILTER	30H-50M	—DROPPED—
CE06	CE06	CE06	ANTENNA COND	10K-10G	10K-26G (2)
-NA-	CF07	CE07	TIME DOMAIN	-NA-	NEW FOR B (3)
CS01	CS01	CS01	POWER LEADS	20H-50K	NOW 30H-50K
CS02	CS02	CS02	POWER LEADS	50K-400M	SAME A/B (4)
CS03	CS03	CS03	INTERMOD	15K-10G	SAME A/B/C
CS04	CS04	CS04	REJ UND SIG	15K-10G	SAME A/B/C
CS05	CS05	CS05	CROSS MODUL	15K-10G	SAME A/B/C
CS06	CS06	CS06	SPIKE ON PWR	-NA-	CHG AMP/TIME
CS07	CS07	CS07	SQUELCH	-NA-	SAME A/B/C
CS08	—DROPPED—		REJ UND SIG	30H-10G	—DROPPED—
-NA-	CS09	CS09	STRUCT (CM)		NAVY REQ
-NA-	CS10	CS10	TRANS PINS	10K-100M	EMP REQ
-NA-	CS11	CS11	TRANS CABLE	10K-100M	EMP REQ
RE01	RE01	RE01	MAG FIELD	30H-30K	SAME A/B (5)
RE02	RE02	RE02	ELEC FIELD	14K-10G	SAME A/B (6)
RE03	RE03	RE03	SPUR RAD	10K-40G	SAME A/B/C
RE04	—DROPPED—		MAG FIELD	20H-50K	—DROPPED—
RE05	—DROPPED—		VEH/ENG EQ	150K-1G	—DROPPED—
RE06	—DROPPED—		OVERHEAD PWR	14K-1G	—DROPPED—
RS01	RS01	RS01	MAG FIELD	30H-30K	SAME A/B/C
RS02	RS02	RS02	INDUCT FIELD	PWR + SPIKE	SAME A/B/C
RS03	RS03	RS03	ELEC/PLANE	14K-10G	SAME A/B/ (7)
RS04	-NA-	-NA-	PARA. PLATE	14K-30M	USED RS03
-NA-	RS05	RS05	EMP TRANS	52.5kV/m	NEW FOR B

**NOTES:**

- (1) MEASUREMENT BANDWIDTH LIMITED TO PWR FREQ + 20% FOR AC AND 75Hz for DC
- (2) HARMONIC SUPPRESSION INCREASED BY 10 dB
- (3) REQUIREMENT LIMITED TO 50uS SPIKES
- (4) NEW REQUIREMENT OF 12.25 VOLTS FOR CENTRALIZED CONTROL AND MONITORING EQUIPMENT
- (5) RELAXED 36 dB OVER 30K-50K RANGE
- (6) NOW BEING APPLIED TO ELECTRICAL EQUIPMENT IN PART 5&6 UP TO A FREQUENCY OF 400MHz
- (7) NOW PERMITTED TO USE CIRCULAR POLARIZED WAVES RATHER THAN SEPARATE HORIZONTAL AND VERTICAL — PART 2 (AIRCRAFT) FIELD INCREASED FROM 5/10V/m UP TO 20V/m, PART 5 CATEGORY ADDED FOR NON-METALLIC HULLS