

MILITARY EMC SPECIFICATIONS

HISTORY

During the early and mid 1960's, each major military agency imposed its own EMI/EMC specification in the procurement of electronic systems and equipment. For instance, the Air Force used MIL-I-6181 and MIL-I-26600, the Navy used MIL-I-16910 and the Army used MIL-I-11748 and MIL-E-55301(EL). These specifications limited the amount of conducted and radiated EMI emissions and set susceptibility levels which systems and equipment must reject. The specifications also set forth the test configurations and techniques needed to demonstrate compliance with the requirements therein.

The existence and application of different EMC specifications for each service caused quite a dilemma. They were significantly different from each other such that when a component was designed to meet one spec, it usually had to be redesigned and tested to meet another. The frequency ranges covered by each was different and the limits for overlapping frequencies varied. More significantly, each specification required the use of different test equipment making it quite expensive for an organization to be fully equipped.

The different requirements were very confusing to design engineers. Even EMI engineers had to "specialize" in EMI specifications. The problem was compounded by the generation of additional specifications for specific systems, such as Minuteman AFBSD-62-87 initiated by The Boeing Company; GSFCS-523-P-7 prepared by Genisco under contract from Goddard Space Flight Center for Aerospace Ground Equipment (AGE), and by those issued by technical centers, such as MSFC-SPEC-279 issued by the Marshall Space Flight Center. It became obvious that there was a need for the elimination of all of these different specifications and the generation of one unified standard to serve all government and military agencies.

The first attempt to issue a specification which would be acceptable to all branches of the government was the publication of MIL-STD-826 in January, 1964. This document presented a new set of limits and a complete automatic testing system originally proposed by a book published by White Electromagnetics, Inc. (now called Don White Consultants, Inc.). Unfortunately, this new standard was too advanced for its time and was soon replaced by MIL-STD-461, 462, and 463 in July 1967. The 461 document pertained to limits and requirements, 462 pertained to test techniques and configurations, and 463 contained terms and definitions.

Considerable revision was required and MIL-STD-461A was issued in August 1968. MIL-STD-461 was accepted by the joint services and used world wide, including many foreign countries. Eventually, the different military agencies (Army, Air Force, and Navy) found many items to their dissatisfaction, and, thus, six revisions were to come. The first revision was Notice 1 in February 1969 which included an addition for GSA procurements and a modification for electric hand tools. Tables showing a comparison of this standard with superceded specifications were also added to the appendix. Notice 2, dated March 1969, was even less significant, simply stating that the tables in the Appendix of Notice 1 were not applicable for Air Force Procurements.

Notice 3 contained significant changes. For example, the conducted and radiated emission limits were relaxed, radiated emission limits were increased, and the subsystem compliance concept was introduced. Among many other changes, new paragraphs to cover production testing, armament and design guidance were added. Notice 3 was applicable for Air Force procurements only and represented the first real polarization of the joint service standard by a single agency.

Not to be outdone, the Army (USAEL, Ft. Monmouth) issued Notice 4 dated 9 February 1971. (Actually, they started work on this notice in 1968.) The changes contained within Notice 4 were even more far reaching than Notice 3. In effect, this new 71 page document could stand alone without the basic standard or previous notices. Included among the changes was a new conducted transient emission requirement, subsystem definition and application, a list of equipment which are specifically exempt from the requirements, plus extensive matrix of equipment type procurements, and represented the second major deviation from the joint services standard by a single agency.

In March 1973, Notice 5 was issued. This revision was applicable only to mobile electric power (MEP) and superceded the requirements for MEP contained in Notice 3 and Notice 4. Notice 6 was released shortly after Notice 5 in July of 1973. The sole purpose of Notice 6 was to provide clear figures which had not reproduced very well in Notice 5.

MIL-STD-461B

While Notices 3 and 4 were being issued, MIL-STD-461B made its first appearance by its circulation for review by the Electronic Industry Association (EIA) in November of 1970. A great many comments were received, so many in fact, that this first preliminary issuance of 461B was completed revamped and revised and there would be little similarity between it and the new standard.

At the time of this writing (December 1975), the joint services anticipate the issuance of MIL-STD-461B in the summer of 1976. This is nearly six years after the task was undertaken to issue a B version. This date has also been rescheduled many times and the reader should note that it is possible that the summer 1976 date may also be rescheduled.

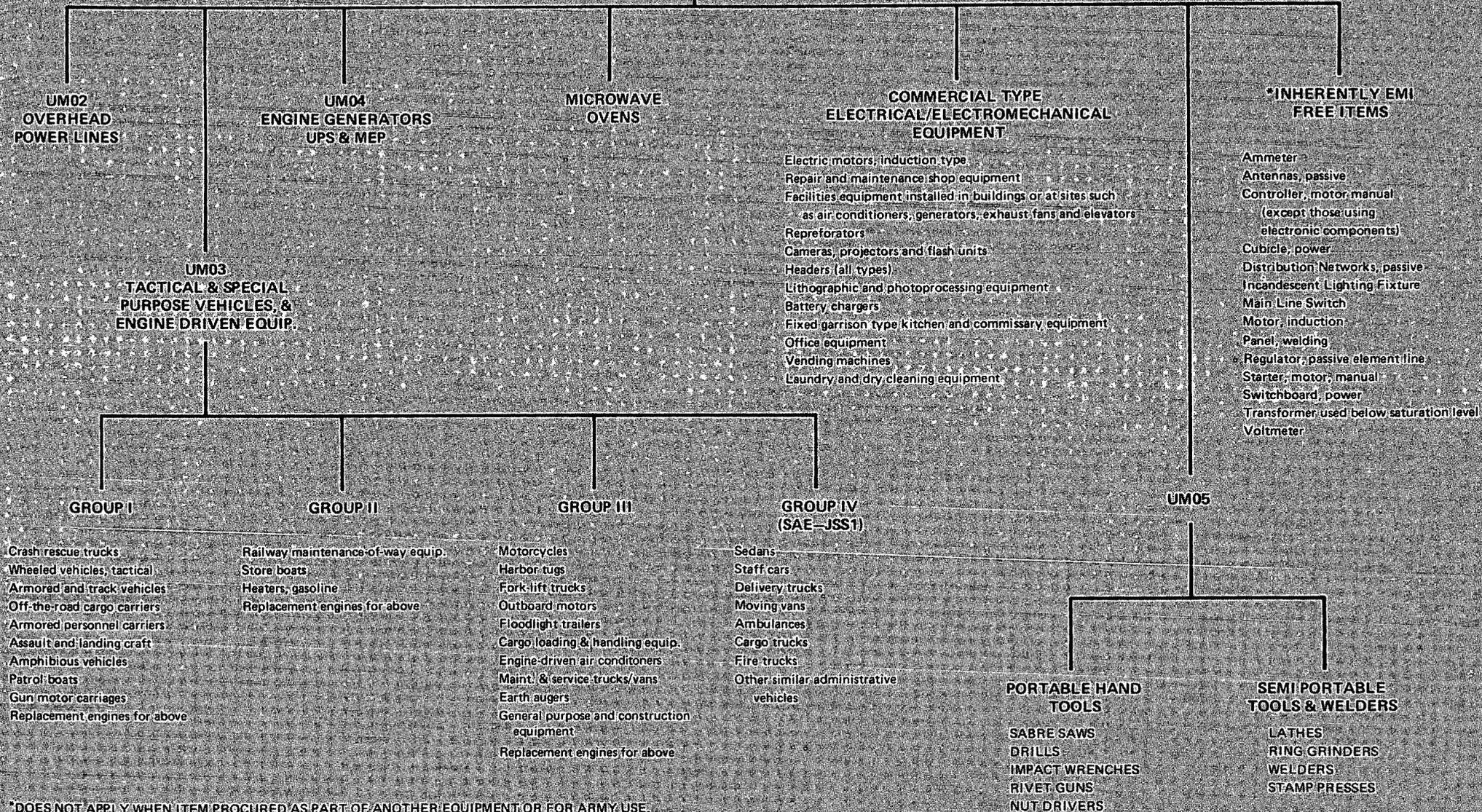
The essence of MIL-STD-461B is shown in a requirements tree format on the Electro-Metrics insert. If this insert has been removed from your copy, additional copies may be obtained directly from Electro-Metrics. Holders of the original 1970 version of MIL-STD-461B are again revised that it is in no way similar to the Standard which is to be issued this summer.

The applicability of the 461B Standard is very broad in that it is applicable for electronic, electrical and electro-mechanical equipments and systems, e.g., some test samples might be active, some passive, some cannot radiate or be susceptible, some will have antennas, etc. Thus, all equipments are not required to meet all combinations of radiated and conducted emission and susceptibility requirements. Accordingly, the equipments and subsystems are categorized into different classes, depending upon the type, function, and their intended installation. Tables have been developed defining the applicability of individual requirements and each equipment class, and are to be used according to the individual procuring agency. For instance, Table 1 on the Electro-Metrics insert shows Classes a through e of equipment by type and function. Whereas, Table 2 shows Classes A, B and C according to mission and installation. These are illustrative summary tables and to determine the actual applicable requirements, one must refer to the more definitive tables contained in the Standard. For instance, for Table 1, the Standard contains an application table for each category, Ia through Ie, with all sorts of notes, exceptions, deviations, and special conditions.

Table 2 on the insert is very similar to Table II in the Standard, except the Standard contains a table III, with four parts, ranging from IIIa to IIId, giving specific applications as did Table I.

TABLE 5

MISCELLANEOUS GENERAL PURPOSE EQUIPMENT



*DOES NOT APPLY WHEN ITEM PROCURED AS PART OF ANOTHER EQUIPMENT OR FOR ARMY USE.

TABLE 2
EQUIPMENT CLASSES – MISSION/INSTALLATION

CLASS A Equipments installed in critical areas of the following vehicles or installations	CLASS B Equipments which support Class A items used in critical areas	CLASS C Equipment not located in critical areas
A1 Aircraft (manned & unmanned) A2 Missiles A3 Ground Facilities (fixed) A4 Ground Facilities (mobile) A5 Submarines (all areas aboard submarines are considered critical areas) A6 Surface Ship, steel-hull, below deck A7 Surface Ship, steel-hull, above deck A8 Surface Ship, non-steel hull A9 Tracked & wheeled vehicles A10 Space systems including launch vehicles, space vehicles, ground systems and associated AGE	B1 AGE used on the flightline for checkout and launch of aircraft communications and other electronic support equipment such as flightlines, receiver sites and radio rooms B2 Trainers and simulators B3 Portable medical equipment for aeromedical airlift	Examples Shop maintenance and test equip. AGE Other similar equip. used in isolated areas

TABLE 3
TRANSIENT (SPIKE) SUSCEPTIBILITY REQUIREMENTS

SPIKE NUMBER	PEAK LEVEL	MAX DURATION	APPLICABLE CLASS		
			NAVY	AF	ARMY
1	100V	10 μ S	A1,2,9; B1,2,3; C	A1 \rightarrow 4,9; B1 \rightarrow 3; C	ALL
2	100V	0.15 μ S	A1 \rightarrow 4,6 \rightarrow 9; B1 \rightarrow 3; C	A1 \rightarrow 9; B1 \rightarrow 3; C	
3	400V	5.0 μ S	A3 \rightarrow 9	A5 \rightarrow 9	
NOTES: 1. For Army only, Spike 1 plus others as specified 2. Aerospace (class A10) use Mil-Std-1541 3. See Table 2 class definitions					

TABLE 4
RADIATED E-FIELD SUSCEPTIBILITY LEVELS FOR RS03

FREQUENCY RANGE	CLASS OF EQUIPMENT		
	A1 \rightarrow 4; A7 \rightarrow 10, B3	A5, A6, B2, C	B1
14 kHz – 30 MHz	10 V/M	1 V/M	5 V/M
30 MHz – 12.4 GHz	5 V/M	1 V/M	5 V/M
12.4 – 40 GHz	20 V/M	1 V/M	5 V/M
NOTES: 1. Requirements for class A5 ends at 1 GHz 2. 14 kHz – 50 kHz deleted for Army only 3. 50 kHz – 500 kHz level at 1 V/M for Army only 4. External on aircraft – 200 V/M, 14 kHz – 10 GHz 5. Navy operational environments, See MIL-HDBK-235 6. See Table 2 for class definitions			

MIL-STD-461B

REQUIREMENTS TREE

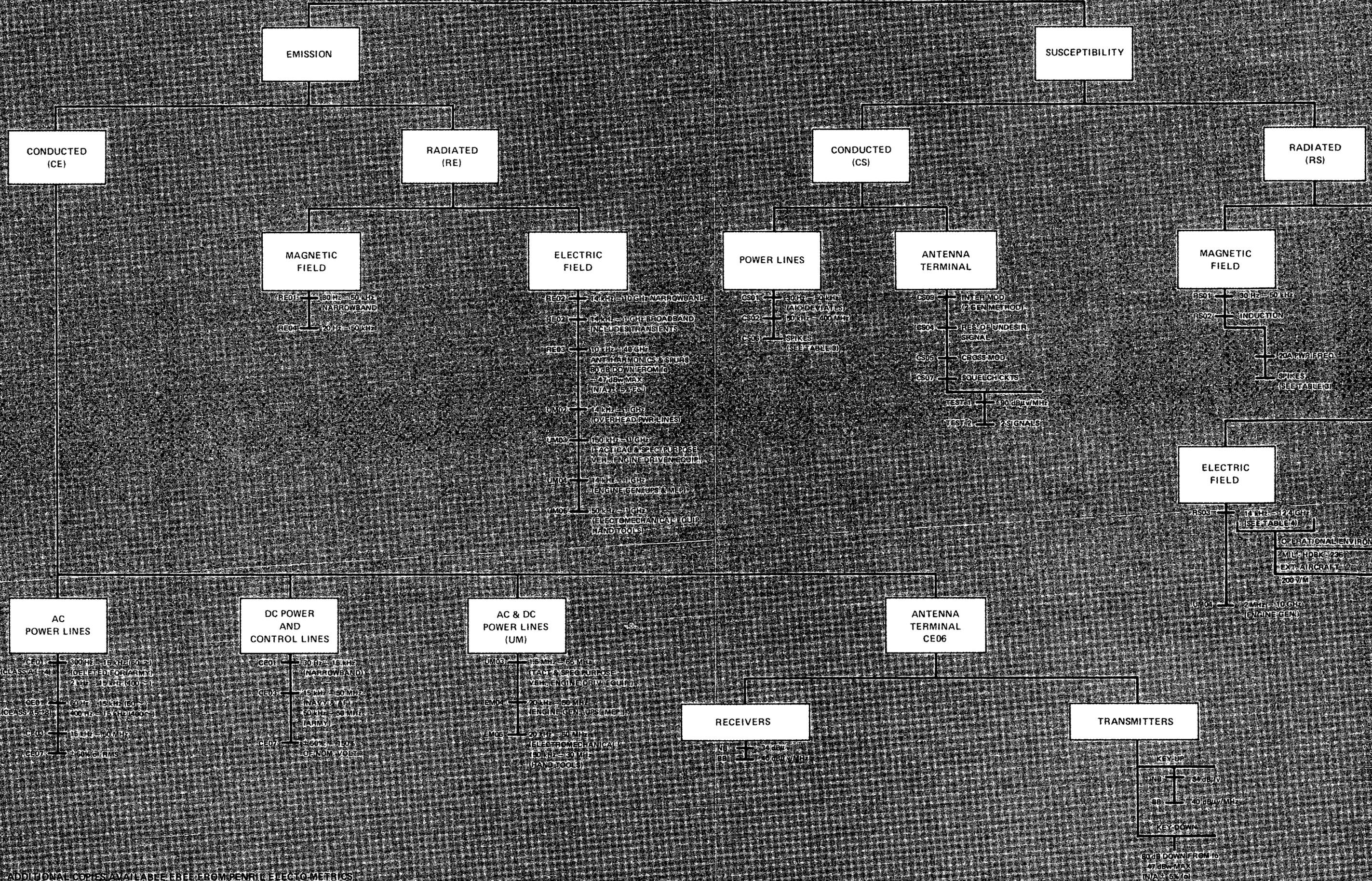
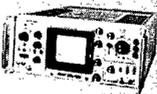


TABLE 1
EQUIPMENT TYPE/FUNCTION*

(a)	(b)	(c)	(d)	(e)
COMMUNICATIONS	SURVEILLANCE	NAV. CONTROL & STABILIZATION	DATA PROCESSING & RECORDING	ANCILLARY OR SUPPORT
Receivers Transmitters R/T Units Ant. Couplers Multicouplers Amplifiers Intercomm. Interphone Modems Repeaters Pwr. Amps Modulators Multiplexers Distributive Xmtrs Man Packs Others	Lasars IR Devices Data Cameras Radars Transponders Beacons EW Devices Interrogators Sensors Sonar Others	Receivers TACAN LORAN DOPPLER Ant. Couplers Amplifiers Radio Compasses Autopilots RMI Converters Auto Flight Control DME Inertial Guidance Flight Instruments A/C Landing & Control OMEGA Fire Control Degaussing Others	Teletypewriters Recorders Displays Computers Indicators Data Adaptors Voice Warning Sensors Tape Transports Others	Tel. Switchboards Wire Terminals Image Interpret. Perforators Sevo Drives Ant. Drives Audio Amp. Electronic Telephones Power Sources Test Equip. Ultrasonic Equip. Time/Freq. Stds. Power Supplies A/C PWR Monitors A/C PWR Regulator A/C Elect. Components Others
*PRIMARY USE BY ARMY AND NAVY. MAY BE USED BY AF FOR GUIDANCE.				

ELECTRO-METRICS BUILDING BLOCKS FOR AUTOMATED EMC TESTING

TEST REQUIREMENT	FREQUENCY RANGE		
	20 Hz — 50 kHz	10 kHz — 1000 MHz	1.0 GHz — 18.0 GHz
Basic Testing to MIL-STD's, SAE, FCC, etc.	EMC-10 	EMC-25 	EMC-50 
CISPR/VDE/ANSI	Existing requirements begin at 10 kHz: see next column.	ADD: CMM-25 	
Single-Band X-Y Plotting	ADD: EXY-125/250 		
Multi-Band X-Y Plotting—Entire Coverage On Single Sheet	ADD: ESC-125A 		ADD: MCM-50 
CRT Spectrum Display of EMI Responses	Information available on special setups.	ADD: SPD-125 	ADD: SPD-50 or Conventional Scope 
Complete System with Capabilities Above	FSS-250 AUTOMATED EMC SYSTEM		FSS-500 MICROWAVE EMC SYSTEM
Microprocessor Automation	MPS-250 MICROPROCESSOR AUTOMATED SYSTEM		
	MPS-500 MICROPROCESSOR AUTOMATED SYSTEM		
Minicomputer Coordination	CCS-250 COMPUTER-COORDINATED SYSTEM		
	CCS-500 COMPUTER-COORDINATED SYSTEM		

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Tables 1 and 2 on the chart and I, II, III in the Standard may be used independently or in combination. Specific requirements applicable for a given procurement are to be specified by the procuring activity in accordance with departmental or agency regulations, directives, instructions, etc. Unless otherwise specified, the requirements tables are to be used as indicated as follows:

For Army procurements. Tables Ia to Ie define mission and susceptible requirements based on equipments/subsystem type and intended function. To find the applicable requirement, first you must determine the table which defines function of the equipment (i.e., communication, navigation, surveillance, etc.). Then, determine the equipment heading which best describes the equipment in question. If the equipment is not listed, the requirements shown under the heading "All others not listed" are to be used. Equipments falling into one more categories must meet the most stringent requirements.

For Navy and Air Force procurements. Tables II and IIIa through IIIId define the susceptible requirements of each class. First, you must determine the appropriate installation classes of the equipment. Absence of an entry under the requirement means that the requirement is not applicable regardless of the equipment type. However, if an L entry appears under the applicable requirement, it means that it will be applicable for some equipments used in that installation and, thus, you must refer back to Table I to determine the applicability.

We must admit that this is most confusing. However, the limited space available in this publication does not allow us to go into greater detail and the reader must await receipt of the new Standard. The requirements for a number of miscellaneous general purpose equipments have been excluded from Tables 1 and 2 and are shown in Table 5 on the insert.

Multi-Agency or NATO Procurements

When an equipment or subsystem is to be used by more than one DOD agency, the procuring activity is to invoke EMI requirements that satisfy all users of the equipment. For NATO use, procuring activity is to invoke EMI activities that will enable the equipment to meet those in the Standard as well as any NATO standardization agreements, such as STANAG.

WARNINGS

If an equipment is determined to be exempt from testing and from complying with the requirements of the Standard, a warning label or sign must be affixed thereon. For these equipments, the procuring activity must include the requirements for the warning label in the individual procurement documentation.

Description of Suppression System

The procuring activity shall require a complete description and technical information, including photographs or drawings, on the operation and maintenance of any suppression system required for an equipment or subsystem to comply with its EMI requirements.

Tailoring

The requirements and limits of this Standard must be analyzed, determining the suitability for a given equipment. Tailored requirements and limits may be determined and specified by the command or agency concerned. Additional tailoring may be recommended in response to a request for a proposal (RFP), or in accordance with the terms of the contract for approval by the procuring activity. Justifications supporting analysis for the recommendation must also be submitted.

R & D Equipments

For R & D Equipments having unique characteristics, the design requirements and limits of this Standard should be used as a guide in formulation of appropriate requirements. These requirements should be described in individual equipment development, or purchase descriptions.

Transient Interference

Radiated and conducted transients resulting from automatic cycling of electronic switching circuitry and manually controlled operational mode switching functions required for normal operation must meet the Standard. However, transients produced by manually operated power on and off switches and associated functions operated before or after an operational emission, are exempt from these requirements. New transient susceptibility requirements are shown in Table 3 of the insert.

Radiated E-Field Susceptibility Limits

The electric fields to which equipments must be subjected are pretty much the same levels as originally shown in issuance of MIL-STD-461 and 826. Table 4 on the insert shows the new susceptibility levels. It is important to note for all equipments external on an aircraft, the susceptibility level is 200 volts per meter and that the various high and low levels are required in MIL-HDBK-235 to simulate Navy operational environments.

Miscellaneous Requirements

A new set of requirements has been generated for miscellaneous general purpose equipment as shown on Table 5 of the insert and the basic requirements tree. These new requirements carry identification numbers UMO2 through UMO5. Referring to Table 5, you can determine which group it falls under and then you can go the requirements tree to see which requirements for a particular UM category are applicable. You may note that office equipments used in a contractor furnished equipment or system, as a minimum, must comply with the FCC and other government and industrial regulations. Microwave ovens must meet the requirements of REO2 over the frequency range of $0.5F_0$ to $3F_0$ where F_0 is the fundamental frequency of the oven.

For additional information on the requirements in MIL-STD-461, you are referred to Mr. Stephen Caine of the Navy, Mr. Charles Seth of the Air Force and Mr. Basil DiNardi of the Army. Their addresses and phone numbers may be found in the Government Personnel locator in the back of this book.