MIL-STD-464D: A REVIEW OF RECENT CHANGES

A Long-Awaited Update to an Essential Standard for Military Procurement

MIL-STD-464D was released on December 24, 2020. This revision is in keeping with the routine five-year revision cycle applicable to many such standards, and MIL-STD-464 must keep in sync with MIL-HDBK-235, from which the electromagnetic field intensity tables are drawn. In this case, the routine five-year cycle took ten years to complete.

MIL-STD-464 is the U.S. Department of Defense (DoD) top-level E3 requirement set for the procurement of complete or modified systems. In this context, "systems" means an integrated platform of one type or another, such as a ground or air vehicle, a ship or submarine, a spacecraft, or launch vehicle. Note that some systems can be parts of other systems, such as an F-18 fighter aircraft that operates from an aircraft carrier.

The original release of MIL-STD-464 was in 1997. MIL-STD-464A (2002) and MIL-STD-464C (2010) provided minor, evolutionary changes to the original release.[1]

Compared to MIL-STD-464C, the changes in MIL-STD-464D are very minor. This article serves as a laundry list of the substantive changes, including the EME tables, and indications of what values changed in the EME tables, so that the reader may see at a glance where the changes are, rather than checking each table row-by-row and cell-by-cell.

1. MIL-STD-464C is really MIL-STD-464B, but there was a release cycle error, and MIL-STD-464B was replaced after just a few months. The content didn't change.

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By Ken Javor

The purpose of this article is to inform and save the reader the time the author spent combing through MIL-STD-464D vs. MIL-STD-464C (referenced as "D" and "C" throughout the rest of this article). Entertaining the reader was not a practical goal.

NEW DEFINITIONS

3.1 All-up-round (AUR)

"The completely assembled munition as intended for delivery to a target or configured to accomplish its intended mission. This term is identical to the term all-up-weapon."

3.2 Bare devices

"Bare electrically initiated devices (EIDs) such as electrical initiators, exploding foil initiators, detonators, etc., in an all-up round that have either one or both pins accessible on an external connector."

3.3 Below deck

Extended to include the pressure hull of a submarine.

3.7 Energetics

"A substance or mixture of substances that, through chemical reaction, is capable of rapidly releasing energy. A few examples of energetics are: liquid and solid propellants such as in rockets and air bags, gun propellants, polymer bonded explosives (PBX) for warheads, pyrotechnics for flares and ignition systems."

3.8 Flight deck

"The upper deck of an aircraft carrier that serves as a runway. The deck of an air-capable ship, amphibious aviation assault ship, or aviation ship used to launch and recover aircraft."

3.12 Helicopter-borne electrostatic discharge (HESD)

"The sudden flow of electric charge between a helicopter or rotary winged aircraft and an object of different electrical potential. A buildup of static electricity can be caused by triboelectric charging or electrostatic induction generated from operating rotary wings."

3.13 High power microwave (HPM)

Deletes the frequency range.

3.18 Maximum no-fire stimulus

MIL-STD-464D	MIL-STD-464C
"The greatest firing stimulus that will not cause initiation or degrade an EID of more than 0.1 % of all electric initiators of a given design at a confidence level of 95%. Stimulus refers to electrical parameters such as current, rate of change of current (di/dt), power, voltage, or energy, which are most critical in defining the no-fire performance of the EID."	*"The greatest firing stimulus which does not cause initiation within five minutes of more than 0.1% of all electric initiators of a given design at a confidence level of 95%. When determining maximum no-fire stimulus for electric initiators with a delay element or with a response time of more than five minutes, the firing stimulus will be applied for the time normally required for actuation."*

3.22 Ordnance (fewer words than "C")

"Explosives, chemicals, pyrotechnics, and similar stores (e.g., bombs, guns, and ammunition, flares, smoke, or napalm)."

3.23 Personnel-borne electrostatic discharge (PESD)

"The sudden flow of electric charge between personnel and an object of different electrical potential. A buildup of static electricity can be caused by triboelectric charging or electrostatic induction generated by the movement of the person's body."

3.27 Spectrum-dependent systems

Adds this statement at the end:

> *"This includes transmitters, transceivers, and receive-only systems."*

3.34 Vertical replenishment (VERTREP)

> *"The transfer of ordnance and cargo using rotary winged aircraft."*

3.35 Weather deck

> *"The topside of the ship that is exposed to the weather. The weather deck does not include the flight deck, hangar, well deck, man-aloft areas, or the ship's mast."*

MAIN BODY REQUIREMENTS

5.1 Margins (MIL-STD-464D)[2]

> *"Margins shall be established for safety and mission critical subsystems/equipment within the system. Margins shall be no less than 6 dB for safety critical subsystems/equipment, unless otherwise stated in the detailed requirements of this standard. Compliance shall be verified by test, analysis, or a combination thereof."*

Compare this with the text in "C," as follows:

> *"Margins shall be provided based on system operational performance requirements, tolerances in system hardware, and uncertainties involved in verification of system-level design requirements. Safety critical and mission critical system functions shall have a margin of at least 6 dB. EIDs shall have a margin of at least 16.5 dB of maximum no-fire stimulus (MNFS) for safety assurances and 6 dB of MNFS for other applications. Compliance shall be verified by test, analysis, or a combination thereof. Instrumentation installed in system components during testing for margins shall capture the maximum system response and shall not adversely affect the normal response characteristics of the component. When environment simulations below specified levels are used, instrumentation responses may be extrapolated to the full environment for components with linear responses (such as hot bridgewire EIDs). When the response is below instrumentation sensitivity, the instrumentation sensitivity shall be used as the basis for extrapolation. For components with non-linear responses (such as semiconductor bridge EIDs), no extrapolation is permitted."*

5.2 Intra-system electromagnetic compatibility (EMC)

MIL-STD-464D	MIL-STD-464C
"The system shall be electromagnetically compatible within itself such that system operational performance requirements are met. Compliance shall be verified by system-level test, analysis, or a combination thereof. This includes permanent, temporary, and portable electronic equipment."	*"The system shall be electromagnetically compatible within itself such that system operational performance requirements are met. Compliance shall be verified by system-level test, analysis, or a combination thereof. For surface ships, MIL-STD-1605(SH) provides test methods used to verify compliance with the requirements of this standard for intra- and inter-system EMC, hull generated intermodulation interference, and electrical bonding."*

5.2.2 Shipboard internal electromagnetic environment (EME)

The very last sentence in "C" section 5.2.2.b after the listing of the individual device and total EIRP is not found in "D." This sentence in "C" that is not in "D" reads:

> *"Additionally, no device shall be permanently installed within 1 meter of safety or mission critical electronic equipment."*

Also, whereas verification in "C" is by test in all cases, in "D," for submarines an analysis consisting of a summation of all individual device EIRP into total radiated power (TRP) is allowed.

(See Tables I – VI, pages 27, 28, and 30)

5.5 Lightning

Has some expanded wording about near strikes and slightly different wording describing Figure 2 and Table VII.

2. Author's note: The significant truncation is due to moving ordnance-related margins to their own separate section. The ordnance margins haven't changed – this just represents a reorganization of the standard.

Frequency Range		Shipboard Flight Decks Electric Field (V/m-rms)		Shipboard Weather Decks Electric Field (V/m-rms)	
(MHz)	(MHz)	Peak	Avg	Peak	Avg
0.01	2	*	*	*	*
2	30	164	164	189/169	189/169
30	150	61	61	61	61
150	225	61	61	61	61
225	400	61	61	61	61
400	700	196	71	445	71
700	790	94	94	94	94
790	1000	491/246	100	744/1307	141/244
1000	2000	212	112	212/112	112
2000	2700	159	159	159	159
2700	3600	4700/2027	595/200	4700/897	595/200
3600	4000	1225/298	200	1859	200
4000	5400	200	200	200	200
5400	5900	361	213	711	235
5900	6000	213	213	235	235
6000	7900	213	213	235	235
7900	8000	200	200	200	200
8000	8400	200	200	200	200
8400	8500	200	200	200	200
8500	11000	913/200	200	913	200
11000	14000	745/744	200	833	200
14000	18000	745/744	200	833	200
18000	50000	200	200	267	200

TABLE I: Maximum external EME for deck operations on Navy ships vs. -464C Table 1. Maximum external EME for deck operations on Navy ships

Frequency Range (MHz)		Main Beam (distances vary with ship class and antenna configuration) Electric Field (V/m –rms)	
		Peak	Avg
0.01	2	*	*
2	30	200	200
30	150	15/10	15/10
150	225	17/10	17/10
225	400	43	43
400	700	2036	268
700	790	20/10	20/10
790	1000	2615/2528	489/485
1000	2000	930	156
2000	2700	21/10	21/10
2700	3600	27460	7500/2620
3600	4000	8553	272
4000	5400	1357/139	198/139
5400	5900	3234	637/267
5900	6000	637/267	637/267
6000	7900	667/400	667/400
7900	8000	667/400	667/400
8000	8400	449/400	449/400
8400	8500	400	400
8500	11000	6900/4173	6900/907
11000	14000	3329	642
14000	18000	3329/3529	642/680
18000	50000	2862	576

‡ The EME levels in the table apply to shipboard operations in the main beam of systems in the 2700 to 3600 MHz frequency range on surface combatants. For all other operations, the unrestricted peak EME level is 12667 V/m and the unrestricted average level is 1533 V/m.

TABLE II: Maximum external EME for ship operations in the main beam of transmitters vs. -464C TABLE 2. External EME for shipboard operations in the main beam of transmitters

-464D values first, -464C values second, where different. Red fill means level has increased. Yellow fill means change is less than 3 dB, either higher or lower, and blue fill means -464D level is lower than for -464C. * means no emitters in that frequency range.

5.7 Subsystems and equipment electromagnetic interference (EMI)

Now includes new wording (in non-italicized in the excerpt that follows):

> *"Individual subsystems and equipment shall meet interference control requirements (such as the conducted emissions, radiated emissions, conducted susceptibility, and radiated susceptibility requirements of MIL-STD-461) so that the overall system complies with all applicable requirements of this standard.* This includes permanent, temporary, and portable electronic equipment. *Compliance shall be verified by tests that are consistent with the individual requirement (such as testing in accordance with MIL-STD-461)."*

Frequency Range (MHz)		Electric Field (V/m-rms)	
		Peak	Avg
0.01	2	1	1
2	30	73	73
30	150	17	17
150	225	4	1
225	400	*	*
400	700	47	6
700	790	1	1
790	1000	7	7
1000	2000	63	63
2000	2700	187	187
2700	3600	23	8
3600	4000	2	2
4000	5400	3	3
5400	5900	164	164
5900	6000	164	164
6000	7900	6	6
7900	8000	3	1
8000	8400	1	1
8400	8500	3	1
8500	11000	140	116
11000	14000	114	114
14000	18000	16	9
18000	50000	23	23

NOTE: *denotes no emitters in that frequency range.

TABLE III: Maximum external EME for space and launch vehicle systems vs. -464C TABLE 3. External EME for space and launch vehicle systems

Frequency Range (MHz)		Electric Field (V/m-rms)	
		Peak	Avg
0.01	2	54/73	54/73
2	30	103	103
30	150	74	74
150	225	41	41
225	400	92	92
400	700	98	98
700	790	58/267	58/267
790	1000	58/284	58/267
1000	2000	232/2452	94/155
2000	2700	638/489	42/155
2700	3600	1148/2450	219
3600	4000	320/489	25/49
4000	5400	645	173/183
5400	5900	5183/6146	129/155
5900	6000	40/549	40/55
6000	7900	3190/4081	292/119
7900	8000	2471/549	296/97
8000	8400	2471/1095	296/110
8400	8500	82/1095	82/110
8500	11000	810/1943	139
11000	14000	3454	102/110
14000	18000	7897/8671	243
18000	50000	2793	48/76

TABLE IV Maximum external EME for ground systems vs. -464c TABLE 4. External EME for ground systems

-464D values first, -464C values second, where different. Red fill means level has increased. Yellow fill means change is less than 3 dB, either higher or lower, and blue fill means -464D level is lower than for -464C. * means no emitters in that frequency range.

5.7.1 Portable electronic devices and carry-on equipment requirements

Newly added in "D," as follows:

> *"Portable electronic devices and carry-on equipment containing electronics which are not permanently installed or integrated into platforms and require airworthiness certification shall meet, as a minimum, the following EMI interface control requirements:*
>
> - *Safety Critical: All platform emissions and susceptibility requirements (such as those defined in MIL-STD-461) that are defined for safety critical equipment.*
> - *Non-Safety Critical: All platform emissions requirements (such as those defined in MIL-STD-461).*
>
> *"If any part of the portable electronic device/carry-on equipment contains radio frequency transmission capability, then transmitter emissions characteristics shall be measured (such as in MIL-STD-461 Test Method CE106), in addition to the applicable requirements stated above. An aircraft EMC evaluation per 5.2 shall also be required to demonstrate platform compatibility of the portable electronic devices/carry-on equipment which have radio frequency transmitting capability.*
>
> *"If any part of the portable electronic device/carry-on equipment contains ordnance or is integrated into an ordnance system, then the HERO requirements stated within this standard shall also be met. Compliance shall be verified by test per the applicable requirements."*

5.7.3 Shipboard DC magnetic field environment. (5.7.2 in "C")

In the "C" revision, this requirement could only be verified by test. In the "D" revision, the ubiquitous phrase, "Compliance shall be verified by test, analysis, or a combination thereof," is used.

5.8.1 Vertical lift and in-flight refueling

Slightly reworded, but the same overall requirement with one significant deletion. The "C" applicability to "any man portable items that are carried internal to the aircraft" has been deleted.

5.8.3 Ordnance subsystems

Rewritten with two brand new sub-paragraphs that break out separately the pre-existing "C" requirement to withstand a 25 kV personnel ESD and adds a separate new requirement to withstand helicopter ESD (300 kV).

Frequency Range (MHz)		Electric Field (V/m – rms)	
		Peak	Avg
0.01	2	200	200
2	30	200	200
30	150	200	200
150	225	200	200
225	400	200	200
400	700	1311	402
700	790	700	183/402
790	1000	700	215/402
1000	2000	6057	232
2000	2700	3351	200
2700	3600	4220	455
3600	4000	3351	657/200
4000	5400	9179	657
5400	5900	9179	657
5900	6000	9179	200
6000	7900	400	200
7900	8000	400	200
8000	8400	7430	266
8400	8500	7430	266
8500	11000	7430	266
11000	14000	7430	558
14000	18000	730	558
18000	50000	1008	200

TABLE V: Maximum external EME for rotary-wing aircraft, excluding shipboard operations vs. -464C Maximum external EME for rotary-wing aircraft, including UAVs, excluding shipboard operations

Frequency Range (MHz)		Electric Field (V/m-rms)	
		Peak	Avg
0.01	2	88	27
2	30	64	64
30	150	67	13
150	225	67	36
225	400	58	3
400	700	2143	159
700	790	554/80	81/80
790	1000	289	105
1000	2000	3363	420
2000	2700	957	209
2700	3600	4220	455
3600	4000	148	11
4000	5400	3551	657
5400	5900	3551	657
5900	6000	148	4
6000	7900	344	14
7900	8000	148	4
8000	8400	187	70
8400	8500	187	70
8500	11000	6299	238
11000	14000	2211	94
14000	18000	1796	655
18000	50000	533	38

TABLE VI: Maximum external EME for fixed-wing aircraft, excluding shipboard operations vs. -464C TABLE 6. External EME for fixed wing aircraft, including UAVs, excluding shipboard operations

-464D values first, -464C values second, where different. Red fill means level has increased. Yellow fill means change is less than 3 dB, either higher or lower, and blue fill means -464D level is lower than for -464C. * means no emitters in that frequency range.

5.8.4 Electrical and electronic subsystems

Rewritten to refer to MIL-STD-461G (CS118) for test, whereas previously they had to point elsewhere.

5.9.3 Hazards of electromagnetic radiation to ordnance (HERO)

Rewritten to include ordnance safety margins that were struck from general margin paragraph 5.1.

5.14.2 Platform radiated emissions

Renamed from the same paragraph in "C" labeled *5.14.2 Inter-system EMC*. The requirement has both greater generality and is more specific about what parameters need to be controlled. New sub-paragraph in "D."

6.2 Acquisition requirements

Acquisition documents should specify the following: a. Title, number, and date of this standard.

6.3 DIDs

Not updated.

6.5 Key Words

Adds two new terms, electrostatic and HESD.

6.6 International standardization agreement implementation.

Rewritten slightly in "D" from the previous similar section 6.5 in "C."

6.7 Acronyms

Replaces "EMRADHAZ" with "RADHAZ." Also, PESD and HESD are added.

6.8 Technical points of contact

Air Force and Army points-of-contact have been updated.

Frequency Range		Field Intensity (V/m – rms)			
		Unrestricted*		Restricted **	
(MHz)	(MHz)	Peak	Avg	Peak	Avg
0.01	2	200	200	80	80
2	30	200	200	100	100
30	150	200	200	80	80
150	225	200	200	70	70
225	400	200	200	100	100
400	700	2200	410	450	100
700	790	700	190	270	270
790	1000	2600	490	1400	270
1000	2000	6100	420	2500	160
2000	2700	6000	500	490	160
2700	3600	27460	5350/2620	2500	220
3600	4000	8600	280	1900	200
4000	5400	9200	660	650	200
5400	5900	9200	660	6200	240
5900	6000	9200	640/270	550	240
6000	7900	3190/4100	670/400	3190/4100	240
7900	8000	2500/550	670/400	550	240/200
8000	8400	7500	450/400	1100	200
8400	8500	7500	400	1100	200
8500	11000	7500	3450/910	2000	300
11000	14000	7500	650/680	3500	220
14000	18000	7900/8700	650/680	7900/8700	250
18000	50000	2900	580	2800	200

NOTES:

*It must be noted that on certain naval platforms, there are radar systems (and unique modes of operation) that may produce fields in excess of those in Table IX, and MIL-HDBK-235 must be consulted to identify specific EME test requirements.

** In some of the frequency ranges for the "Restricted Average" column, limiting the exposure of personnel through time averaging will be required to meet the requirements of 5.9.1 for personnel safety.

TABLE IX: Maximum external EME levels for ordnance vs. -464C TABLE 9. Maximum external EME levels for ordnance.

-464D values first, -464C values second, where different. Red fill means level has increased. Yellow fill means change is less than 3 dB, either higher or lower, and blue fill means -464D level is lower than for -464C. * means no emitters in that frequency range.

APPENDICES AND GUIDANCES

A.1.1 Scope

Includes extra language emphasizing that appendix is guidance only, not mandatory.

A.2.1.1 Specifications, standards, and handbooks

Slightly different wording. Also, the following additions, changes, and deletions:

- MIL-STD-1576, Electroexplosive Subsystem Safety Requirements and Test Methods for Space Systems—removed from applicable documents
- MIL-STD-3023 HEMP Protection for Military Aircraft—added
- MIL-STD-4023 HEMP Protection for Maritime Assets—added
- MIL-HDBK-83578 Criteria for Explosive Systems and Devices Used on Space Vehicles—deleted

A.2.1.2 Other Government documents, drawings, and publications

- Army, ATPD-2407 Electromagnetic Environmental Effects (E3) for U.S. Army Tank and Automotive Vehicle Systems Tailored from MIL-STD-464C—added
- TOP 01-2-511A US Army Test and Evaluation Command Test Operations Procedure—added

A.2.2 Non-Government Publications

- Institute of Electrical and Electronics (IEEE) Transactions on Electromagnetic Compatibility
- DOI:10.1109/TEMC.2016.2575842 Effect of Human Activities and Environmental Conditions on Electrostatic Charging—added
- Franklin Applied Physics
- F-C2560 RF Evaluation of the Single Bridgewire Apollo Standard Initiator—deleted

A.3 Acronyms

- AMITS air management information tracking system—deleted
- EMRADHAZ—deleted
- HESD helicopter-borne electrostatic discharge—added
- PESD personnel-borne electrostatic discharge—added
- RADHAZ Radiation hazards—added

A.4.1 Requirement Guidance

Adds Army ATPD-2407 and TOP 01-2-511A is EMC guidance and test procedures.

A.4.1.e Requirement Guidance

Includes additional guidance and a slightly different approach than "C." Margin Requirement Guidance A.5.1 adds the non-italicized statement in the following excerpt:

> *"Margins need to be viewed from the proper perspective. The use of margins simply recognizes that there is variability in manufacturing and that requirement verification has uncertainties. The margin ensures that every produced system will meet requirements, not just the particular one undergoing a selected verification technique. Smaller margins are appropriate for situations where production processes are under tighter controls or more accurate and thorough verification techniques are used. Smaller margins are also appropriate if many production systems undergo the same verification process, since the production variability issue is being addressed. Margins are not an increase in the basic defined levels for the various electromagnetic environments. The most common technique is to verify that electromagnetic and electrical stresses induced internal to the system by external environments are below equipment strength by at least the margin.* This approach is similar to the test methodology described in A.4.1 (e). *While margins can sometimes be demonstrated by performing verification at a level in excess of the defined requirement, the intent of the margin is not to increase the requirement."*

This paragraph is deleted from this section in "D" (look for it in the EID section):

> *"MNFS values for EIDs are normally specified by manufacturers in terms such as DC currents or energy. Margins are often demonstrated by observing an effect during the application of an electromagnetic environment that is the same effect observed when applying a stimulus level in the form under which the MNFS is defined. For example, the temperature rise of a bridgewire can be monitored in the presence of an EME*

relative to the temperature rise produced by a DC current level that is 16.5 dB below MNFS. The space community has elected to use MNFS levels determined using RF rather than DC. This approach is based on Franklin Institute studies, such as report F-C2560. Outside of the space community, the use of DC levels has provided successful results."

A.5.2 Intra-system EMC

Under *Requirements Rationale*, the final sentence in "C":

"To ensure EMC is achieved in Navy ships, a MIL-STD-1605(SH) survey should be performed."

is replaced by a more descriptive version in "D":

"For surface ships, MIL-STD-1605(SH) provides test methods used to verify compliance with the requirements of this standard for intra- and inter-system EMC, hull generated intermodulation interference, and electrical bonding."

A.5.2 Verification Guidance

The following and final line item is modified in "D" to read:

"For portable electronic devices and carry-on equipment, EMI requirements are defined in 5.7.1."

In "C," line item h reads:

"TABLE A- 1 identifies what kind of EMI/EMC testing is required when new, modified, or carry-on equipment will be used on military aircraft."

Table A-1 Type of EMI/EMC testing doesn't exist in "D."

A.5.3 Requirement Guidance

These words added to the very end of this section:

"A platform design, while descriptively fitting the title of an external EME table (e.g., Fixed Wing or Rotary Wing), may not coincide with the platform's operational EME definition. Strict attention must be paid to the assumptions used in deriving the tables to ensure appropriate EMC compliance."

A.5.4 Requirement Guidance (HPM)

Eliminates Tables A-4 – A-10 from "C" and also calculation of some example problems using these tables.

A.5.4 Requirement Rationale (HPM)

Eliminates some wording questioning the effectiveness of HPM.

A.5.4 Verification Guidance (HPM)

Eliminates reference to these deleted examples in "D."

A.5.6 Requirement Guidance (EMP)

Contains some extra description of HEMP composite environment. It also adds descriptions of EMP-related military standards for dealing with EMP, including effects on spacecraft.

A.5.6 Requirement Lessons Learned

Has this sentence in common with "C":

> *"Hardening against ground-burst nuclear radiation environments is often not cost effective because a burst near enough to produce a radiation and electromagnetic threat is also close enough for the blast to disable the facility."*

But "D" adds this last sentence not in "C":

> *"Buried facilities such as ICBM launch sites are an exception."*

A.5.6 Verification Rationale (EMP)

"D" replaces this "C" paragraph:

> *"For many systems, the cost of EMP verification is a major driver. Therefore, the procuring activity should decide what level of verification is consistent with the risk that they are willing to take."*

with this paragraph:

> *"High-altitude EMP protection standards have been developed for fixed ground-based facilities, transportable ground-based systems, aircraft and ships. Each of these standards contains detailed verification testing protocols and pass/fail criteria. Use of these standards is mandatory for DoD military system procurements that have a HEMP requirement."*

Note the emphasis on the cost of EMP design has been replaced with wording more conducive to getting EMP designs installed.

In the same section, this new "D" wording:

> *"MIL-STD-3023 and MIL-STD-4023 for HEMP protection of military aircraft and ships, respectively provide a similar verification test approach except that these standards require illuminating the aircraft and ships with a simulated plane wave HEMP threat environment and measuring the induced stresses at each MCS equipment interface. Each MCS must be tested to MIL-STD-461 CS116 to establish its immunity before being installed into the platform. A user selectable margin is then applied to the measured current stress which is then pulse current injected (PCI) at the same interface used in the MIL-STD-461 CS116 testing. This enables direct stress to immunity comparisons at common interfaces for each mission critical equipment throughout the system. Monitoring for upset and damage is also performed at this time."*

has been appended to this existing "C" wording:

> *"MIL-STD-188-125-1 and MIL-STD-188-125-2 contain verification test methods for demonstrating that C^4I fixed ground-based facilities and transportable ground-based systems meet HEMP requirements. The test methods describe coupling of threat-relatable transients using pulse current injection to penetrating conductors at injection points outside of the facility shield."*

A.5.7 Requirement Guidance (Subsystem & Equipment EMI)

Eliminates wording about DO-160 section 22 now that CS117 is available.

A.5.7.1 Portable Electronic Devices and Carry-On Equipment Requirements

All new appendix material. Basically refers to A.5.2. Intra-system EMC.

A.5.8.1 Vertical lift and in-flight refueling

Slightly rewritten, no changes.

A.5.8.3 Ordnance Subsystems

Greatly expanded and also includes the following new sections:

- A.5.8.3.1 Personnel-borne ESD (PESD) for ordnance and ordnance systems

- A.5.8.3.2 Helicopter-borne ESD (HESD) for ordnance and ordnance systems

A.5.9.3 Requirement Rationale (Ordnance RADHAZ (HERO)).

This section is rewritten with substantive changes.

A.5.9.3 Requirement Guidance (Ordnance RADHAZ (HERO))

This section is rewritten with substantive changes. MIL-STD-464C was:

> *"OD 30393 provides design principles and practices for controlling electromagnetic hazards to ordnance. MIL-STD-1576 and MIL-HDBK-83578 (USAF) provide guidance on the use of ordnance devices in space and launch vehicles. For space applications using ordnance devices, an analysis of margins based on the RF threshold determination of the MNFS should be performed."*

The last sentence refers to measuring the rf TOS of bridgewires, and that has been completely debunked. This section now reads:

> *"NASA document TP2361 provides design guidelines for space and launch vehicle charging issues. Subsystems and equipment installed aboard space systems should be able to meet operational performance requirements during and/or after being subjected to representative discharges simulating those due to spacecraft charging."*

A.5.14.2 Requirement Rationale (Platform Radiated Emission)

Rewritten with added information.

A.5.15 Requirement Guidance (EM Spectrum Compatibility)

Completely rewritten.

A.5.15 Verification Rationale (EM Spectrum Compatibility)

Completely rewritten.

A.5.15 Verification Guidance (EM Spectrum Compatibility)

Added information.