



TECHNICAL REPORT

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Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility Characteristics of Equipment Intended to Operate in Severe Electromagnetic Environments

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EIA/IS-647

EIA INTERIM STANDARD

**Requirements for the Control of
Electromagnetic Interference Emissions
and Susceptibility Characteristics of
Equipment Intended to Operate in
Severe Electromagnetic Environments**

EIA/IS-647

MAY 1996

**ELECTRONIC INDUSTRIES ASSOCIATION
ENGINEERING DEPARTMENT**



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FOREWORD

1. The stated requirements represent the minimum considered necessary to provide reasonable confidence that a particular subsystem or equipment complying with these requirements will function within their designated design tolerances when operating in their intended electromagnetic environment. Test methods to be used to demonstrate compliance to this document are contained in EIA/IS-648.
2. An annex has been included which provides the rationale and background for each requirement.
3. The requirements contained in this document may be tailored by the procuring activity for each application based on the intended operational Electromagnetic Environment (EME).
4. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Electronic Industries Association, 2500 Wilson Boulevard, Arlington, VA 22201-3834



1. SCOPE

1.1 Purpose

This standard establishes the performance requirements for the control of the electromagnetic emission and susceptibility characteristics of electronic, electrical, and electromechanical equipment and subsystems designed or procured for use in severe electromagnetic environments such as ships, aircraft, spacecraft, armored vehicles, etc. Such equipment and subsystems may be used independently or as an integral part of other subsystems or systems.

1.2 Application

1.2.1 General applicability

The applicability of the emission and susceptibility requirements is dependent upon the types of equipment or subsystems and their intended installations as specified herein.

1.2.2 Tailoring of requirements

Application-specific environmental criteria may be derived from operational and engineering analyses on equipment or subsystems being procured for use in specific systems or platforms. When analyses reveal that the requirements in this standard are not appropriate for that procurement, the requirements may be tailored and incorporated into the request-for-proposal, specification, contract, order, and so forth.

1.3 Emission and susceptibility designations

The emissions and susceptibility requirements in this standard and corresponding test methods of EIA/IS-648 are designated in accordance with an alpha-numeric coding system. Each method is identified by a two letter combination followed by a three digit number. The number is for reference purposes only. The meaning of the individual letters are as follows:

C = Conducted
R = Radiated
E = Emission
S = Susceptibility

- (1) Conducted emissions tests are designated by "CE---."
- (2) Radiated emissions tests are designated by "RE---."
- (3) Conducted susceptibility tests are designated by "CS---."
- (4) Radiated susceptibility test are designated by "RS---."
- (5) "---" = numerical order of test from 101 to 199.

2. APPLICABLE DOCUMENTS

2.1 Electronic Industries Association documents

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation.

STANDARD

EIA/IS-648	Measurement of Electromagnetic Interference Characteristics of Equipment Intended to Operate in Severe Electromagnetic Environments
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(Application for copies should be addressed to Electronic Industries Association, 2500 Wilson Boulevard, Arlington, VA 22201-3834, Phone: 703/907-7500, Fax: 703/907-7501)

2.2 Non-EIA publications

The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents adopted are cited in the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C63.14	Standard Dictionary for Technologies of Electromagnetic Compatibility (EMC), Electromagnetic Pulse (EMP), and Electrostatic Discharge (ESD).
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ANSI/IEEE 268	Metric Practice (DOD adopted)
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(Application for copies should be addressed to the IEEE Service Center, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 380	Standard for Metric Practice. (DOD adopted)
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(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

2.3 Order of precedence

In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 General

The terms used in this standard are defined in ANSI C63.14. In addition, the following definitions are applicable for the purpose of this standard.

3.2 Acronyms used in this standard

a.	ASW	Anti-submarine Warfare
b.	EMC	Electromagnetic Compatibility
c.	EME	Electromagnetic Environment
d.	EMI	Electromagnetic Interference
e.	EMICP	Electromagnetic Interference Control Procedures
f.	EMITP	Electromagnetic Interference Test Procedures
g.	EMITR	Electromagnetic Interference Test Report
h.	EUT	Equipment Under Test
i.	GFE	Government Furnished Equipment
j.	ISM	Industrial, Scientific and Medical
k.	NDI	Non-Developmental Item
l.	RMS	Root Mean Square

3.3 Above deck

An area on ships which is generally in the open air.

3.4 Below deck

An area on ships which is surrounded by a metallic structure, or an area which provides significant attenuation to electromagnetic radiation, such as the metal hull or superstructure of a surface ship, the hull of a submarine and the screened rooms in non-metallic ships.

3.5 External installation

An equipment location on a platform which is exposed to the external electromagnetic environment, such as an aircraft cockpit which does not use electrically conductive treatments on the canopy or windscreen.

3.6 Flight-line equipment

Any support equipment that is attached to or used next to an aircraft during pre-flight or post-flight operations, such as uploading or downloading data, maintenance diagnostics, or equipment functional testing.

3.7 Internal installation

An equipment location on a platform which is totally inside an electrically conductive structure, such as a typical avionics bay in an aluminum skin aircraft.

3.8 Metric units

Metric units are a system of basic measures which are defined by the International System of Units based on "Le System International d'Unites (SI)", of the International Bureau of Weights and Measures. These units are described in ASTM E 380 and ANSI/IEEE 268.

3.9 Non-developmental item

Non-developmental item is a broad, generic term that covers material available from a wide variety of sources with little or no development effort required by the Customer.

3.10 Safety critical

A category of subsystems and equipment whose degraded performance could result in loss of life or loss of vehicle or platform.

4. GENERAL REQUIREMENTS

4.1 General

Electronic, electrical, and electromechanical equipment and subsystems shall comply with the applicable requirements in 4.2 through 4.8. The requirements are in addition to the applicable emission and susceptibility requirements defined in other portions of this standard.

4.2 Joint procurement

Equipment or subsystems procured by one activity for multi-agency use shall comply with the requirements of all the user agencies.

4.3 Filtering (Navy only)

The use of line-to-ground filters for EMI control should be minimized. Such filters establish low impedance paths for structure (common-mode) currents through the ground plane and can be a major cause of interference in systems, platforms, or installations because the currents can couple into other equipment using the same ground plane. If such a filter must be employed, the line-to-ground capacitance for each line shall not exceed 0.1 microfarads (μF) for 60 Hertz (Hz) equipment or 0.02 μF for 400 Hz equipment. For submarine DC-powered equipment and aircraft DC-powered equipment, the filter capacitance from each line-to-ground at the user interface shall not exceed 0.075 $\mu\text{F}/\text{kW}$ of connected load. For loads less than 0.5 kW, the filter capacitance shall not exceed 0.03 μF . The filtering employed shall be fully described in the equipment or subsystem technical manual and the Electromagnetic Interference Control Procedures (EMICP) (See 6.3).

4.4 Self-compatibility

The operational performance of an equipment or subsystem shall not be degraded, nor shall it malfunction when all of the units or devices in the equipment or subsystem are operating together at their designed levels of efficiency or their design capability.

4.5 Non-Developmental Items (NDI)

In accordance with accepted good engineering practice, the requirements of this standard shall be met when applicable and warranted by the intended installation and platform requirements.

4.5.1 Commercial off-the-shelf equipment

4.5.1.1 Selected by contractor

When it is demonstrated that a commercial item selected by the contractor is responsible for equipment or subsystems failing to meet the contractual EMI requirements, either the commercial item shall be modified or replaced or interference suppression measures shall be employed, so that the equipment or subsystems meet the contractual EMI requirements.

4.5.1.2 Specified by procuring activity

When it is demonstrated by the contractor that a commercial item specified by the procuring activity for use in an equipment or subsystem is responsible for failure of the equipment or subsystem to meet its contractual EMI requirements, the data indicating such failure shall be included in the Electromagnetic Interference Test Report (EMITR) (See 6.3). No modification or replacement shall be made unless authorized by the procuring activity.

4.5.2 Procurement of equipment or subsystems having met other EMI requirements

Procurement of equipment and subsystems electrically and mechanically identical to those previously procured by activities of DOD or other Federal agencies, or their contractors, shall meet the EMI requirements and associated limits, as applicable in the earlier procurement, unless otherwise specified by the Command or agency concerned.

4.6 Customer Furnished Equipment (CFE)

When it is demonstrated by the contractor that a CFE is responsible for failure of an equipment or subsystem to meet its contractual EMI requirements, the data indicating such failure shall be included in the EMITR (See 6.3). No modification shall be made unless authorized by the procuring activity.

4.7 Testing requirements

The testing requirements and procedures of EIA/IS-648 shall be used to determine compliance with the applicable emission and susceptibility requirements of this standard. Data gathered as a result of performing tests in one electromagnetic discipline may be sufficient to satisfy requirements in another. Therefore, to avoid unnecessary duplication, a single test program should be established with tests for similar requirements conducted concurrently whenever possible. Equipment that are intended to be operated as a subsystem shall be tested as such to the applicable emission and susceptibility requirements whenever practical. Formal testing is not to commence without approval of the Electromagnetic Interference Test Procedures (EMITP) (See 6.3) by the Customer.

4.8 Switching transients

Switching transient emissions that result at the moment of operation of manually actuated switching functions are exempt from the requirements of this standard. Other transient type conditions, such as automatic sequencing following initiation by a manual switching function, shall meet the emissions requirements of this standard.

5. DETAILED REQUIREMENTS

5.1 General

Table 1 is a list of emissions and susceptibility requirements established by this standard. General test methods for these requirements are contained in EIA/IS-648 as implemented by the approved EMITP (See 6.3). All test results performed to demonstrate compliance with the requirements should be documented in the EMITR (See 6.3) and forwarded to the Customer concerned for evaluation prior to acceptance of the equipment or subsystem. Design procedures and techniques for the control of EMI should be described in the EMICP (See 6.3). Approval of design procedures and techniques described in the EMICP does not relieve the supplier of the responsibility of meeting the contractual emission, susceptibility, and design requirements.

5.1.1 Units of frequency domain measurements.

All frequency domain limits are expressed in terms of equivalent Root Mean Square (RMS) value of a sine wave as would be indicated by the output of a measurement receiver using peak envelope detection.

Table 1. Emission and susceptibility requirements

Requirement	Description
CE101	Conducted Emissions, Power Leads, 30 Hz to 10 kHz
CE102	Conducted Emissions, Power Leads, 10 kHz to 10 MHz
CE106	Conducted Emissions, Antenna Terminal, 10 kHz to 40 GHz
CS101	Conducted Susceptibility, Power Leads, 30 Hz to 50 kHz
CS103	Conducted Susceptibility, Antenna Port, Intermodulation, 15 kHz to 10 GHz
CS104	Conducted Susceptibility, Antenna Port, Rejection of Undesired Signals, 30 Hz to 20 GHz
CS105	Conducted Susceptibility, Antenna Port, Cross-Modulation, 30 Hz to 20 GHz
CS109	Conducted Susceptibility, Structure Current, 60 Hz to 100 kHz
CS114	Conducted Susceptibility, Bulk Cable Injection, 10 kHz to 400 MHz
CS115	Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation
CS116	Conducted Susceptibility, Damped Sinusoidal Transients, Cables and Power Leads, 10 kHz to 100 MHz
RE101	Radiated Emissions, Magnetic Field, 30 Hz to 100 kHz
RE102	Radiated Emissions, Electric Field, 10 kHz to 18 GHz
RE103	Radiated Emissions, Antenna Spurious and Harmonic Outputs, 10 kHz to 40 GHz
RS101	Radiated Susceptibility, Magnetic Field, 30 Hz to 100 kHz
RS103	Radiated Susceptibility, Electric Field, 10 kHz to 40 GHz
RS105	Radiated Susceptibility, Transient Electromagnetic Field

5.2 EMI control requirements versus intended installations

Table 2 summarizes the requirements for equipment and subsystems intended to be installed in, on, or launched from various military platforms or installations. When an equipment or subsystem is to be installed in more than one type of platform or installation, it shall comply with the most stringent of the applicable requirements and limits. An "A" entry in the table means the requirement is applicable. An "L" entry means the applicability of the requirement is limited as specified in the appropriate requirement paragraphs of this standard; the limits are contained herein. An "S" entry means the procuring activity must specify the applicability and limit requirements in the procurement specification. Absence of an entry means the requirement is not applicable.

Table 2. Requirements Matrix

Equipment and Subsystems Installed In, On, or Launched From the Following Platforms or Installations	Requirement Applicability															
	C	C	C	C	C	C	C	C	C	C	C	R	R	R	R	R
	E	E	E	S	S	S	S	S	S	S	S	E	E	E	S	S
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
	1	2	6	1	3	4	5	9	4	5	6	1	2	3	1	3
Surface Ships	A	A	L	A	S	S	S		A		A	A	A	L	A	A
Submarines	A	A	L	A	S	S	S	L	A		A	A	A	L	A	A
Aircraft, Army, Including Flight Line	A	A	L	A	S	S	S		A	A	L	A	A	L	A	A
Aircraft, Navy	L	A	L	A	S	S	S		A	A	A	L	A	L	L	A
Aircraft, Air Force		A	L	A	S	S	S		A	A	A		A	L		A
Space Systems, Including Launch Vehicles		A	L	A	S	S	S		A	A	A		A	L		A
Ground, Army		A	L	A	S	S	S		A	L	L		A	L	L	A
Ground, Navy		A	L	A	S	S	S		A		A		A	L	L	A
Ground, Air Force		A	L	A	S	S	S		A	L	A		A	L		A

5.3 Emission and susceptibility requirements and limits

5.3.1 CE101 (Conducted emissions, power leads, 30 Hz to 10 kHz)

5.3.1.1 CE101 applicability

This requirement is applicable as follows for power leads, including returns, that obtain power from other sources not part of the EUT.

- | | | |
|----|-----------------|--|
| a. | Not applicable | Air Force |
| b. | AC leads only | Ships |
| c. | AC and DC leads | Submarines, Army Aircraft [†] (including flight line) and Navy Aircraft ^{*†} |

^{*}For equipment intended to be installed on Navy aircraft, this requirement is applicable only for aircraft with Anti-Submarine Warfare (ASW) capability.

[†]For AC applications, this requirement is applicable starting at the second harmonic of the EUT power frequency.

5.3.1.2 CE101 limits

Conducted emissions on power leads shall not exceed the applicable values shown on Figures 1 through 3, as appropriate, for ships and submarines and Figure 4 for Army aircraft (including flight line) and Navy ASW aircraft.

5.3.2 CE102 (Conducted emissions, power leads, 10 kHz to 10 MHz)

5.3.2.1 CE102 applicability

This requirement is applicable from 10 kHz to 10 MHz for all power leads, including returns, that obtain power from other sources not part of the EUT.

5.3.2.2 CE102 limits

Conducted emissions on power leads shall not exceed the applicable values shown on Figure 5.

5.3.3 CE106 (Conducted emissions, antenna terminal, 10 kHz to 40 GHz)

5.3.3.1 CE106 applicability

This requirement is applicable to the antenna terminals of transmitters and receivers. The requirement is not applicable to equipment designed to operate into a non-removable antenna. The transmitter (transmit mode) portion of this requirement is not applicable within either the EUT necessary bandwidth or ± 5 percent of the fundamental frequency. Depending on the operating frequency range of the EUT, the start frequency of the test is as follows:

<u>Operating Frequency Range (EUT)</u>	<u>Start Frequency of Test</u>
10 kHz to 3 MHz	10 kHz
3 MHz to 300 MHz	100 kHz
300 MHz to 3 GHz	1 MHz
3 GHz to 40 GHz	10 MHz

The end frequency of the test is 40 GHz or twenty times the highest generated or received frequency within the EUT, whichever is less. For equipment using waveguide, the requirement does not apply below eight-tenths of the waveguide's cutoff frequency. Requirement RE103 may be used as an alternative for CE106 for testing transmitters with their operational antennas.

5.3.3.2 CE106 limits

Conducted emissions at the EUT antenna terminal shall not exceed the values given below.

- Receivers: 34 dB μ V
- Transmitters (standby mode): 34 dB μ V
- Transmitters (transmit mode): Harmonics, except the second and third, and all other spurious emissions shall be at least 80 dB down from the level at the fundamental. The second and third harmonics shall be suppressed $50 + 10 \log p$ (where p = peak power output in watts, at the fundamental) or 80 dB, whichever requires less suppression.

5.3.4 CS101 (Conducted susceptibility, power leads, 30 Hz to 50 kHz)

5.3.4.1 CS101 applicability

This requirement is applicable to equipment and subsystem AC and DC input power leads, not including returns. If the EUT is DC operated, this requirement is applicable over the frequency range of 30 Hz to 50 kHz. If the EUT is AC operated, this requirement is applicable starting from the second harmonic of the EUT power frequency and extending to 50 kHz.

5.3.4.2 CS101 limit

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to a test

signal with levels as specified in Figure 6. The requirement is also met under the following condition: when the power source specified in EIA/IS-648, adjusted to dissipate 80 watts in a 0.5 ohm load, cannot develop the required voltage at the EUT power input terminals, and the EUT is not susceptible to the output of the signal source.

5.3.5 CS103 (Conducted susceptibility, antenna port, intermodulation, 15 kHz to 10 GHz)

5.3.5.1 CS103 applicability

This receiver front-end susceptibility requirement is applicable to equipment and subsystems, such as communications receivers, RF amplifiers, transceivers, radar receivers, acoustic receivers, and electronic warfare receivers as specified in the individual procurement specification.

5.3.5.2 CS103 limit

The EUT shall not exhibit any intermodulation products beyond specified tolerances when subjected to the limit requirement provided in the individual procurement specification.

5.3.6 CS104 (Conducted susceptibility, antenna port, rejection of undesired signals, 30 Hz to 20 GHz)

5.3.6.1 CS104 applicability

This receiver front-end susceptibility requirement is applicable to equipment and subsystems, such as communications receivers, RF amplifiers, transceivers, radar receivers, acoustic receivers, and electronic warfare receivers as specified in the individual procurement specification.

5.3.6.2 CS104 limit

The EUT shall not exhibit any undesired response beyond specified tolerances when subjected to the limit requirement provided in the individual procurement specification.

5.3.7 CS105 (Conducted susceptibility, antenna port, cross modulation, 30 Hz to 20 GHz)

5.3.7.1 CS105 applicability

This receiver front-end susceptibility requirement is applicable only to receivers that normally process amplitude-modulated RF signals, as specified in the individual procurement specification.

5.3.7.2 CS105 limit

The EUT shall not exhibit any undesired response, due to cross modulation, beyond specified tolerances when subjected to the limit requirement provided in the individual procurement specification.

5.3.8 CS109 (Conducted susceptibility, structure current, 60 Hz to 100 kHz)

5.3.8.1 CS109 applicability

This requirement is applicable to equipment and subsystems that have an operating frequency range of 100 kHz or less and an operating sensitivity of 1 μV or less (such as 0.5 μV). Handheld equipment is exempt from this requirement.

5.3.8.2 CS109 limit

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the values shown on Figure 7.

5.3.9 CS114 (Conducted susceptibility, bulk cable injection, 10 kHz to 400 MHz)

5.3.9.1 CS114 applicability

This requirement is applicable to all interconnecting cables, including power cables. The requirement is applicable to equipment and subsystems, based on the intended installation as follows:

- | | | |
|----|--------------------|--|
| a. | 10 kHz to 2 MHz | all |
| b. | 2 MHz to 30 MHz | all |
| c. | 30 MHz to 200 MHz | aircraft (Air Force and Army); space systems; and optional* for all others |
| d. | 200 MHz to 400 MHz | optional* for all |

*Required only if specified in the procurement specification

5.3.9.2 CS114 limit

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to a test signal with calibration levels as shown in Figure 8. The appropriate limit curve in Figure 8 shall be selected from Table 3. The requirements are also met if the following currents are induced in the cable under test and the EUT is not susceptible:

Curve 5: 115 dB μA
Curve 4: 103 dB μA
Curve 3: 95 dB μA
Curve 2: 89 dB μA
Curve 1: 83 dB μA

Table 3. CS114 Limit Curves

PLATFORM FREQ RANGE		LIMIT CURVE # FROM FIGURE 8 (CS114)							
		AIRCRAFT (EXTERNAL OR SAFETY CRITICAL)	AIRCRAFT (INTERNAL)	ALL SHIPS (ABOVE DECKS)	SHIPS (METALLIC) (BELOW DECKS)	SHIPS (NON- METALLIC) (BELOW DECKS)	SUBMARINES	GROUND	SPACE
10 kHz to 2 MHz	A	5	5	2	2	2	1	3	3
	N	5	3	2	2	2	1	2	3
	AF	5	3					2	3
2 MHz to 30 MHz	A	5	5	5	2	4	1	4	3
	N	5	5	5	2	4	1	2	3
	AF	5	3					2	3
30 MHz to 200 MHz	A	5	5	5	2	2	1	4	3
	N			5	2	2	1	2	3
	AF	5	3					2	3
200 MHz to 400 MHz	A	5	5	5	2	2	1	4	3
	N			5	2	2	1	2	3
	AF	5	3					2	3

KEY: A = Army N = Navy AF = Air Force

5.3.10 CS115 (Conducted susceptibility, bulk cable injection, impulse excitation)

5.3.10.1 CS115 applicability

This requirement is applicable to all aircraft and space system interconnecting cables, including power cables. The requirement is also applicable for Army and Air Force ground subsystems and equipment when specified by the procuring activity.

5.3.10.2 CS115 limit

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystems specification, when subjected to a calibrated test signal as specified in Figure 9 at a 30 Hz rate for one minute.

5.3.11 CS116 (Conducted susceptibility, damped sinusoidal transients, cables and power leads, 10 kHz to 100 MHz)

5.3.11.1 CS116 applicability

This requirement is applicable to all interconnecting cables, including power cables, and individual power leads. Power returns need not be tested individually. For Air Force ground subsystems and equipment, this requirement is applicable only for power cables and individual power leads. The requirement is also applicable for Army ground subsystems and equipment, including flight line, when specified by the procuring activity.

5.3.11.2 CS116 limit

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to a signal having the waveform shown in Figure 9 and having a maximum current as specified in Figure 10. As a minimum, compliance shall be demonstrated at the following frequencies: 0.01, 0.1, 1, 10, 30, 100 MHz, and resonant frequencies as determined in accordance with EIA/IS-648. The test signal repetition rate shall be no greater than one pulse per second and no less than one pulse every two seconds. The pulses shall be applied for a period of five minutes.

5.3.12 RE101 (Radiated emissions, magnetic field, 30 Hz to 100 kHz)

5.3.12.1 RE101 applicability

This requirement is applicable for radiated emissions from equipment and subsystem enclosures, and all interconnecting cables. The requirement does not apply at telecommunication transmitter fundamental frequencies, but does apply to the operating frequencies of sonar and industrial, scientific, and medical (ISM) subsystems and equipment. The requirement does not apply to radiation from antennas. For Navy aircraft, this requirement is applicable only for aircraft with an ASW capability.

5.3.12.2 RE101 limit

Magnetic field emissions shall not be radiated in excess of the levels shown in Figures 12 and 13 at the specified distances of 7 centimeters and 50 centimeters.

5.3.13 RE102 (Radiated emissions, electric field, 10 kHz to 18 GHz)

5.3.13.1 RE102 applicability

This requirement is applicable for radiated emissions from equipment and subsystem enclosures, and all interconnecting cables. The requirement does not apply at the transmitter fundamental frequencies or to radiation from antennas. The requirement is applicable as follows:

- | | | |
|----|-------------------------------|-------------------|
| a. | Ground | 2 MHz to 18 GHz* |
| b. | Ships, surface | 10 kHz to 18 GHz* |
| c. | Submarines | 10 kHz to 1 GHz |
| d. | Aircraft (Army) | 10 kHz to 18 GHz |
| e. | Aircraft (Air Force and Navy) | 2 MHz to 18 GHz* |

*Testing is required up to 1 GHz or 10 times the highest intentionally generated frequency within the EUT, whichever is greater. Measurements beyond 18 GHz are not required.

5.3.13.2 RE102 limits

Electric field emissions shall not be radiated in excess of those shown in Figures 14 through 16. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized fields.

5.3.14 RE103 (Radiated emissions, antenna spurious and harmonic outputs, 10 kHz to 40 GHz)

5.3.14.1 RE103 applicability

This requirement may be used as an alternative for CE106 when testing transmitters with their intended antennas. CE106 is the preferred requirement unless the equipment or subsystem design characteristics preclude its use. The requirement is not applicable within either the EUT necessary bandwidth or ± 5 percent of the fundamental frequency. Depending on the operating frequency range of the EUT, the start frequency of the test is as follows:

Operating Frequency Range (EUT) Start Frequency of Test

10 kHz to 3 MHz	10 kHz
3 MHz to 300 MHz	100 kHz
300 MHz to 3 GHz	1 MHz
3 GHz to 40 GHz	10 MHz

The end frequency of the test is 40 GHz or twenty times the highest generated frequency within the EUT, whichever is less. For equipment using waveguide, the requirement does not apply below eight-tenths of the waveguide's cutoff frequency.