DEMC Korea 2025

PREPARING FOR MIL-STD-461H: AN OVERVIEW OF THE UPCOMING MILITARY STANDARD FOR ELECTROMAGNETIC COMPATIBILITY

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CONTENTS

DEFINITIONS

- 3.1.4 Cable bundle.

  All wires and shields associated with a single connector of the equipment under test (EUT).

- 3.1.8 Input (primary) power leads.

  Input (primary) power leads and returns are those wires and cable bundles that connect the EUT directly to the platform’s primary source(s) of power.

- 3.1.12 Primary power.

  Primary power is the source of electric power provided by the platform. The source may be electromechanical (alternator, generator), chemical (e.g., fuel cell), energy storage device (e.g., battery, supercapacitor), photovoltaic (solar) cells, or a combination thereof. The voltage provided by the source may be direct current (DC), alternating current (AC), or a combination thereof. Converters, inverters, and rectifiers are considered part of primary power if present in the platform’s power system prior to the point of power distribution. Primary power to the platform's electrical/electronic equipment is protected by a fuse, circuit breaker, solid-state power distribution unit, etc.

GENERAL REQUIREMENTS

- 4.3.5.1 Metallic ground plane.

  When the EUT is installed on a metallic ground plane, the ground plane shall have a surface resistance no greater than 0.1 milliohms per square. The DC resistance between metallic ground planes and the shielded enclosure shall be 2.5 milliohms or less. The metallic ground planes shown on Figures 2 through 4 shall be electrically bonded to the floor or wall of the basic shielded room structure at least once every 1 meter. The metallic bond straps shall be solid and maintain a five-to-one ratio or less in length to width. Metallic ground planes used outside a shielded enclosure shall extend at least 2.5 meters beyond the test setup boundary in each direction as shown on Figure 5.

FIGURE 5. General test setup for free standing EUT.

FIGURE 5. General test setup for free standing EUT outside shielded enclosure.

GENERAL REQUIREMENTS

- 4.3.7.3 Overload precautions.

  Measurement receivers and transducers are subject to overload, especially receivers without pre-selectors and active transducers. Checks shall be performed and documented for each measurement setup to assure that an overload condition does not exist. Instrumentation changes shall be implemented to correct any overload condition.

- 4.3.10.3.3 Frequency scanning.

  For emission measurements, the entire frequency range for each applicable test shall be scanned. Synthesized, or step-tuned, measurement receivers shall step in one-half bandwidth increments or less, and the measurement dwell time shall be as specified in Table II. For equipment that operates such that potential emissions are produced at only infrequent intervals, times for frequency scanning shall be increased as necessary to capture any emissions.

GENERAL REQUIREMENTS

- 4.3.8.6 Construction and arrangement of EUT cables.

  The EUT shall meet the requirements of this standard when connected to cables built and configured as described in this section. Cables used for testing shall match the platform-installed subsystem cables in design, material selection, and construction. The cables attached to the EUT during testing shall become a part of the EUT configuration.

- 4.3.8.6.1 Construction of input (primary) power leads, returns, and wire grounds.

- 4.3.8.6.2 Construction of interconnecting leads and cables.

- 4.3.8.6.3 Arrangement of EUT cables and leads.

GENERAL REQUIREMENTS

TABLE II. Bandwidth and measurement time.

Frequency Range	6 dB Resolution Bandwidth	Minimum Dwell Time		Minimum Measurement Time Analog-Tuned Measurement Receiver 1/
		Stepped-Tuned Receiver 1/ (Seconds)	FFT Receiver 2/ (Seconds/ Measurement Bandwidth)	
30 Hz - 1 kHz	10 Hz	0.15	1	0.015 sec/Hz
1 kHz - 10 kHz	100 Hz	0.015	1	0.15 sec/kHz
10 kHz - 150 kHz	1 kHz	0.015	1	0.015 sec/kHz
150 kHz - 10 MHz	10 kHz	0.015	1	1.5 sec/MHz
10 MHz - 30 MHz	10 kHz	0.015	0.15	1.5 sec/MHz
30 MHz - 1 GHz	100 kHz	0.015	0.15	0.15 sec/MHz
Above 1 GHz	1 MHz	0.015	0.015	15 sec/GHz

CE101

- 5.4.1 CE101 applicability.

  This requirement is applicable from 30 Hz to 20 kHz for power leads, including returns, that obtain power from other sources not part of the EUT. This requirement applies to surface ships, submarines, Navy aircraft[1)] with Anti-Submarine Warfare (ASW) equipment operating between 30 Hz and 10 kHz (such as Acoustic Receivers, Sonobuoy, or Magnetic Anomaly Detectors), and Army aircraft[1)] (including flight line). This requirement is not applicable to power leads that do not directly interface with the platform power bus.

  1) For aircraft AC applications, this requirement is only applicable from the second harmonic of the EUT power frequency to 10 kHz. For aircraft DC applications, this requirement is only applicable from 30 Hz to 10 kHz.

CE101

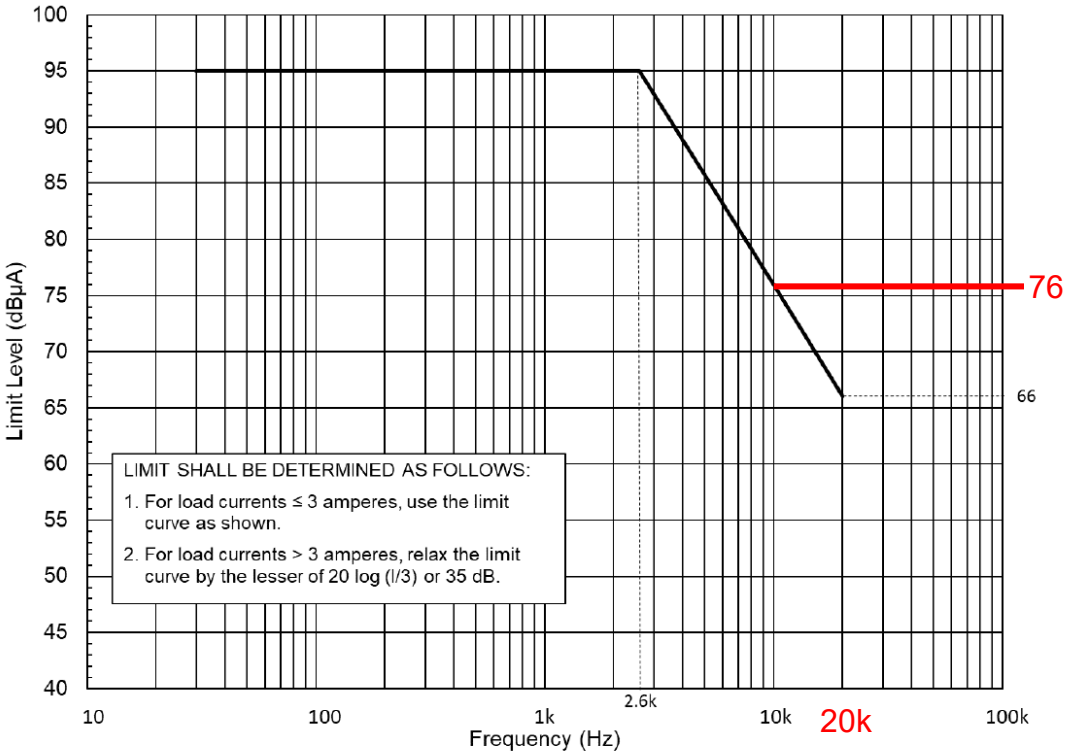

FIGURE CE101- 1. CE101 limit for surface ships and submarine applications, DC.

CS101

► 5.7.3.2 Test equipment.

f. Isolation transformer for oscilloscope use or transducer for measurement receiver use

f. Two oscilloscope probes, or one differential probe with appropriate voltage rating (for oscilloscope use), or ripple detection transducer (for measurement receiver use)

CS101

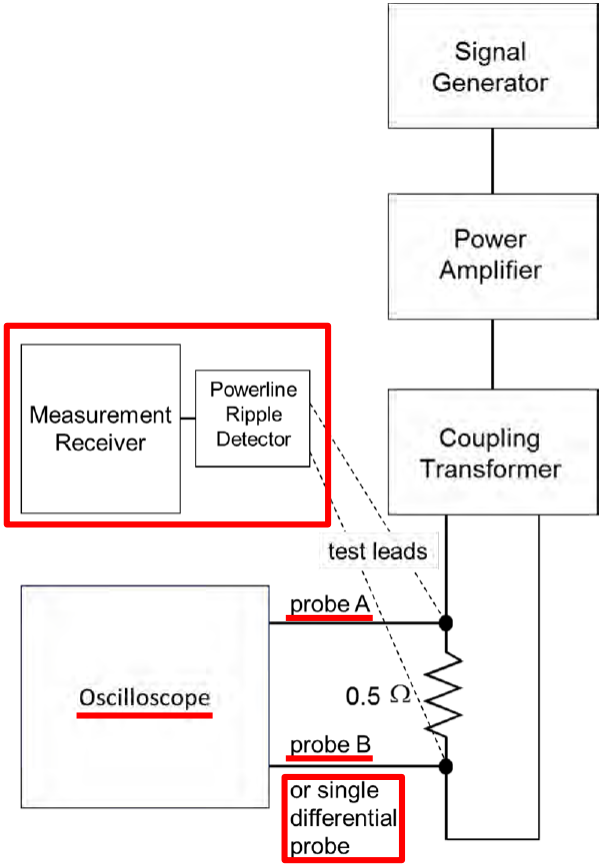

FIGURE CS101- 3. Calibration.

CS101

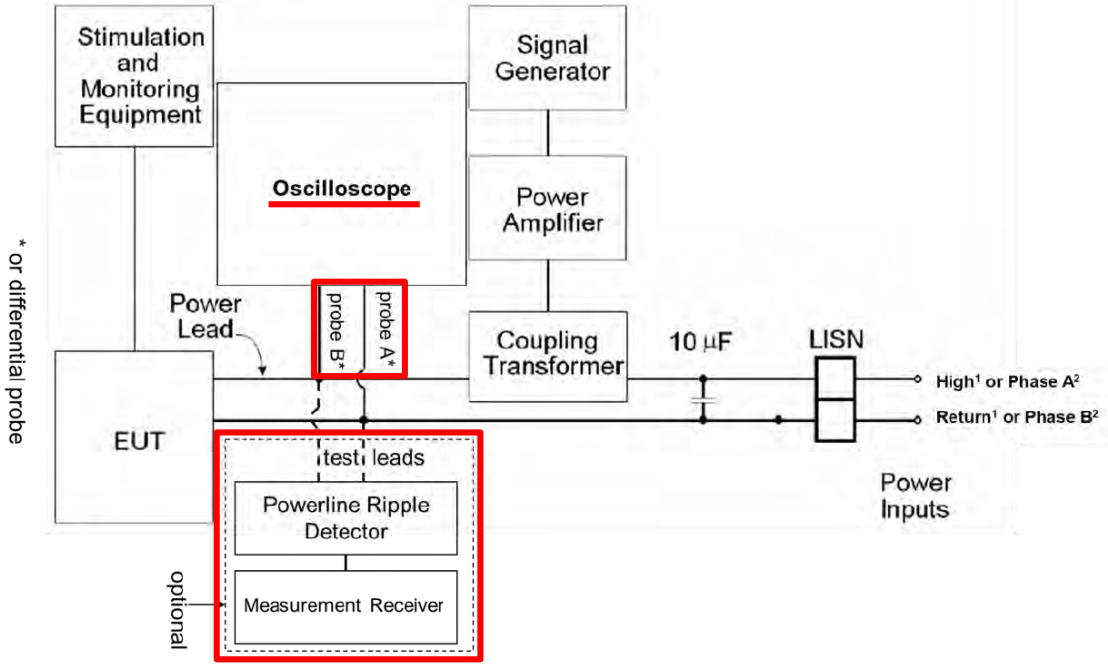

FIGURE CS101- 4. Signal injection, DC[1] or single-phase AC (Wye connected EUT[1] and Delta connected EUT[2]).

CS101

- 5.7.3.5 Data presentation.

  Data presentation shall be as follows:

  a. Provide graphical or tabular data showing the frequencies and amplitudes at which the test was conducted for each lead.

  b. Provide data on any susceptibility thresholds and the associated frequencies that were determined for each power lead.

  c. Provide indications of compliance with the applicable requirements for the susceptibility evaluation specified in 5.7.3.4c for each lead.

  d. Provide photographs showing actual equipment test setup, including equipment grounding and the associated dimensions. The following dimensions shall be clearly shown in the respective photographs:

    (1) Position of the 10 µF capacitor(s) with respect to the LISN(s) in 5.7.3.3c(1), 5.7.3.3c(2), or 5.7.3.3c(3) as applicable.

CS114

- 5.12.1 CS114 applicability.

This requirement is applicable from 10 kHz to 200 MHz for all interconnecting electrical cables, including power cables. For EUTs intended to be installed on ships or submarines, an additional common mode requirement is applicable from 4 kHz to 1 MHz on complete power cables.

The requirement is not applicable for coaxial cables to antenna ports of antenna-connected receivers except for surface ships and submarines.

CS114

- 5.12.2 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 an injection probe drive level which has been pre-calibrated to the appropriate current limit shown on Figure CS114-1 and is modulated as specified below. The appropriate limit curve on Figure CS114-1 shall be selected from Table VI. A common mode limit of 77 dBµA is applicable from 4 kHz to 1 MHz. Requirements are also met if the EUT is not susceptible at forward power levels sensed by the directional coupler that are below those determined during calibration provided that the actual current induced in the cable under test is 115 dBµA for Curve 5, 103dBµA for Curve 4, 95 dBµA for Curve 3, 89 dBµA for Curve 2, 83 dBµA for Curve 1 across the frequency range. For EUTs intended for installation in surface ships and submarines, the 4kHz to 1 MHz requirement for complete power cables is also met if the actual current induced in the cable under test is 83 dBµA across the applicable frequency range.

CS114

- 5.12.3.5 Data presentation.

  Data presentation shall be as follows:

  a. Provide amplitude versus frequency plots for the monitoring probe system integrity check in 5.12.3.4c(3).

  c. Provide photographs showing actual equipment test setup, including equipment grounding and the associated dimensions. The following dimensions shall be shown in the respective photographs for each interconnecting cable and power cable tested:

     (1) Position of the monitor probe with respect to the connector in 5.12.3.3c(3).

     (2) Position of the injection probe with respect to the monitor probe in 5.12.3.3c(4).

  d. Provide amplitude versus frequency plots for the forward power and measured current levels as determined in 5.12.3.4d(2)(c).

CS114

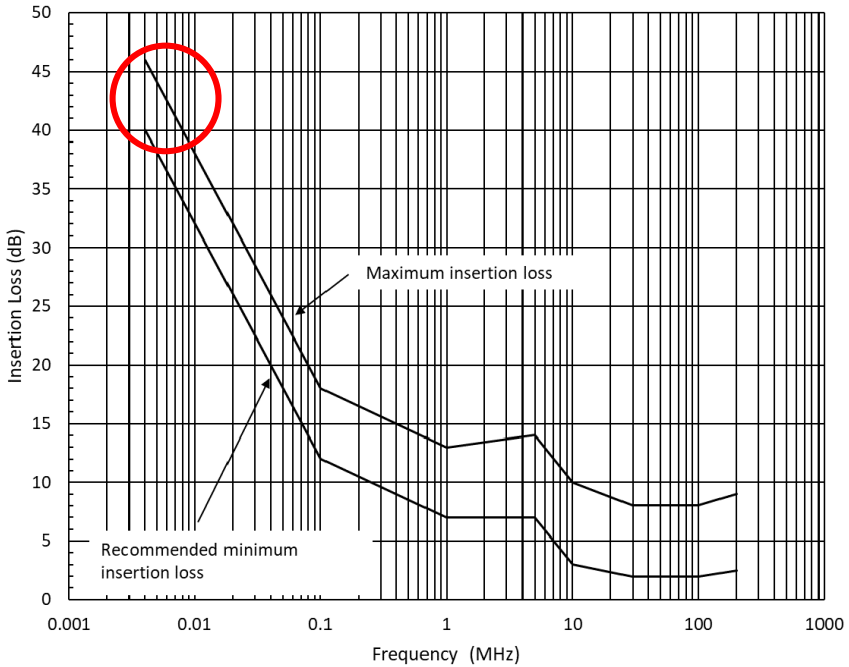

FIGURE CS114- 2. Insertion loss for injection probes.

RE101

- 5.17.3.4 Procedures. > c. EUT testing.

  (3) Optimize the measurement receiver settings to ensure adequate frequency resolution is used to detect elevated signal levels across the applicable spectrum.

  NOTE: Division of the frequency spectrum into multiple bands may be required to ensure adequate frequency resolution is used to identify individual signals across the spectrum (ex. 30 Hz to 1kHz, 1kHz to10 kHz, 10 kHz to 100 kHz).

  (4) Monitor the output of the measurement receiver while moving the loop sensor (maintaining the 7 cm spacing) over the surface of the EUT to identify locations of maximum radiation. Note the location of maximum radiation for each elevated signal level observed.

  NOTE: At least one test location should be included for each individual signal of interest observed.

  (5) Repeat 5.17.3.4c(2) through 5.17.3.4c(4) for each face of the EUT and for each EUT electrical connector.

RE101 (CONT.)

(6) Position the loop sensor at 7cm from one of the test locations identified in 5.17.3.4c(4). Orient the plane of the loop sensor to give a maximum reading on the measurement receiver while maintaining the 7 cm spacing from the center of the loop sensor. Scan the measurement receiver over the test band using the bandwidths and minimum measurement times listed in Table II and record the reading.

(7) If the measured emissions exceed the limit at the 7 cm distance, increase the measurement distance until the emissions level falls within the specified limit. Reorient the plane of the loop sensor to ensure the maximum reading remains below the specified limit. Record the emissions and the measurement distance for assessment by the procuring activity.

NOTE: The EUT shall comply with the applicable RE101 limit at 7 cm.

(8) Repeat 5.17.3.4c(6) for each test location identified in 5.17.3.4c(4) and 5.17.3.4c(5).

RE101

- 5.17.3.5 Data presentation.

  Data presentation shall be as follows:

  a. Provide graphs of scans and tabular listings of each of the following: measurement frequency, test locations, mode of operation, measured magnetic field, and magnetic field limit level.

  b. Provide photographs showing actual equipment test setup, including equipment grounding and the associated dimensions. The following dimensions shall be clearly shown in the respective photographs:

  (1) Distance between the plane of the loop sensor and face of the EUT or electrical interface connector being measured in 5.17.3.4c(2).

  (2) Actual measurement distance between the plane of the loop sensor and the face of the EUT or electrical interface connector when the measured emission exceeds the limit at the 7 cm distance in 5.17.3.4c(6).

RE101

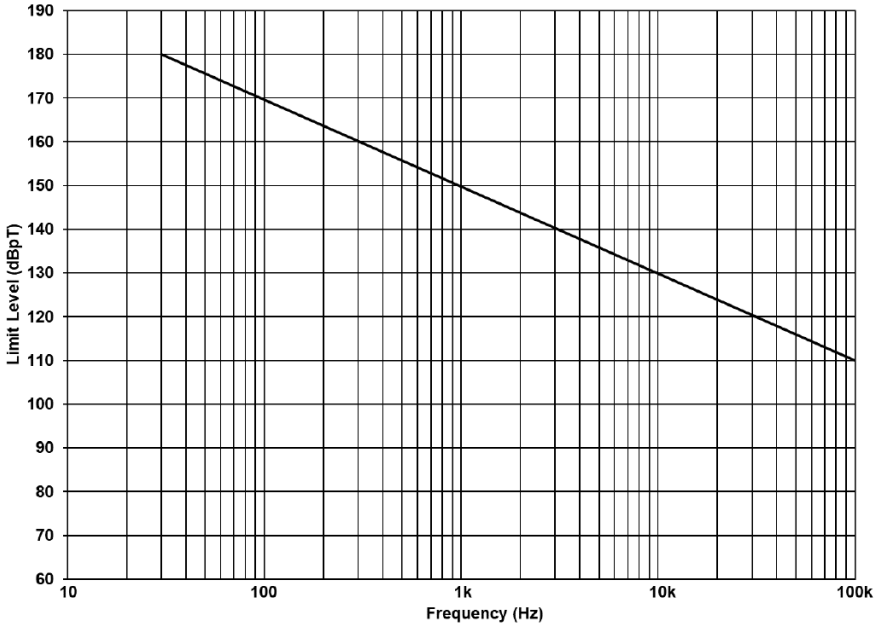

FIGURE RE101- 1. RE101 limit for all Army applications.

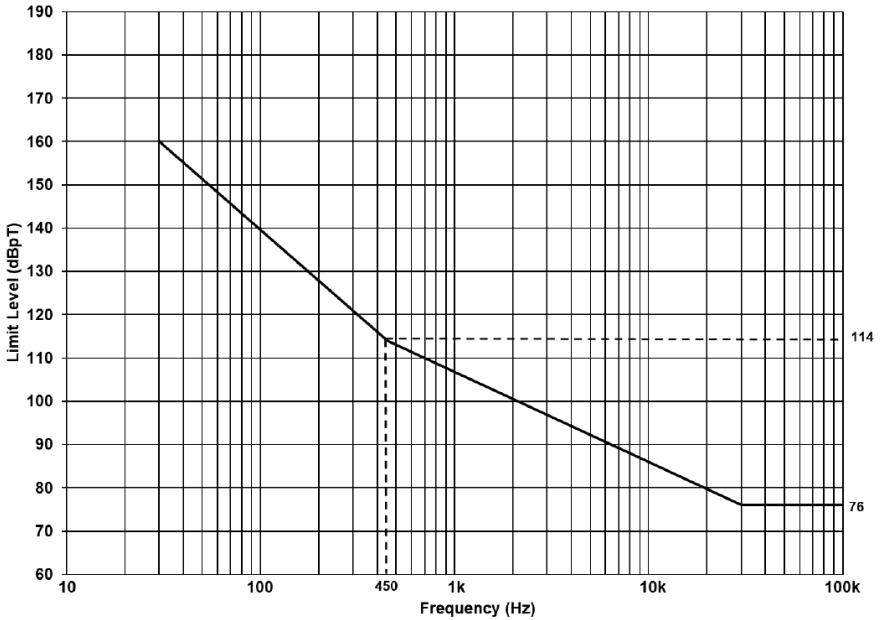

FIGURE RE101- 2. RE101 limit for all Navy applications.

RE102

- 5.18.3.3 Setup. > c. EUT testing. > (2) Antenna positioning.

  (2) For testing from 200 MHz up to 1 GHz, place the antenna in a sufficient number of positions such that the entire area of each EUT enclosure and the first 35 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna. The front surface of the antenna shall remain parallel to the EUT test boundary. The elevation of the antenna's boresight shall be maintained parallel to the floor of the EMI chamber. The azimuth of the antenna's boresight shall be perpendicular to the test setup boundary.

  (3) For testing at 1 GHz and above, place the antenna in a sufficient number of positions such that the entire area of each EUT enclosure and the first 7 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna. The front surface of the antenna shall remain parallel to the EUT test boundary. The elevation of the antenna's boresight shall be maintained parallel to the floor of the EMI chamber. The azimuth of the antenna's boresight shall be perpendicular to the test setup boundary.

RE102

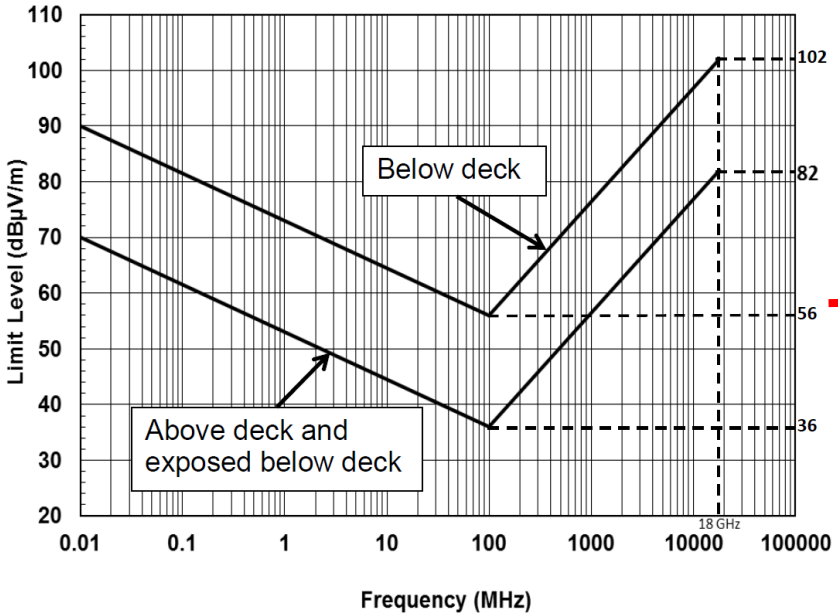

FIGURE RE102-1. RE102 limit for surface ship applications.

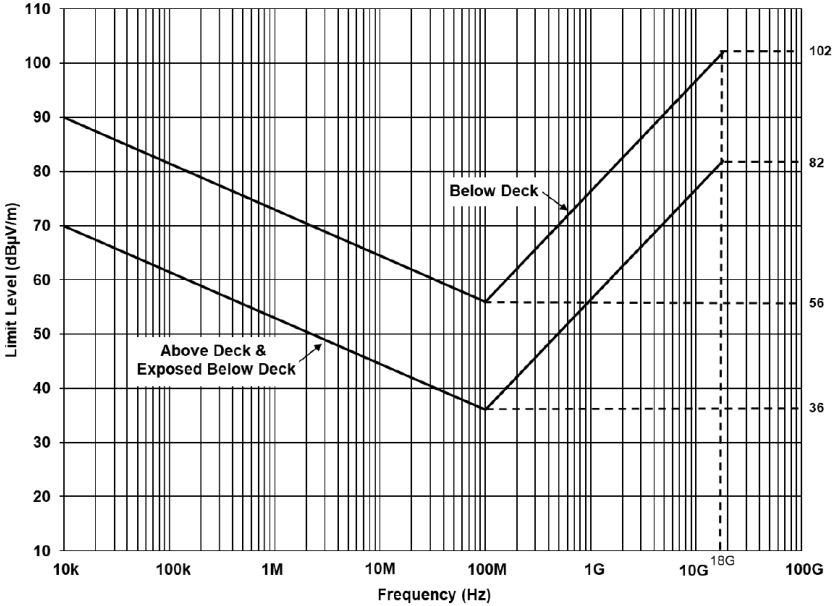

FIGURE RE102- 1. RE102 limit for surface ship applications.

RS103

- 5.21.3.5 Data presentation.

  d. Provide photographs showing actual equipment test setup, including equipment grounding and the associated dimensions.

  e. Provide photographs showing actual equipment setup and the associated dimensions. The following dimensions shall be clearly shown in the respective photographs:

  (1) Dimensions of the EUT, as well as dimensions of the basic test setup shown on Figures 2 through 5 and 4.3.8 as applicable in 5.21.3.3a.

  (2) 3dB beamwidth coverage for each transmit antenna used.

  (3) Distance of the physical reference point of each antenna to the test setup boundary for all antenna positions required in 5.21.3.3c(1).

  (4) Placement of the electric field sensor(s) with respect to the EUT and distance above the ground plane in 5.21.3.3d.

RS103

TABLE XI. RS103 limits.

PLATFORM / FREQUENCY RANGE	LIMIT LEVELS (VOLTS/METER)											
	ALL AIRCRAFT (EXTERNAL OR SAFETY CRITICAL) ALL SERVICES	AIRCRAFT INTERNAL - ARMY	AIRCRAFT INTERNAL - NAVY	AIRCRAFT INTERNAL - AIR FORCE	SHIPS - ABOVE DECK & EXPOSED BELOW DECK **	SUBMARINES (EXTERNAL)*	METALLIC SHIPS - BELOW DECK	NON-METALLIC SHIPS - BELOW DECK	SUBMARINE (INTERNAL)	GROUND - ARMY	GROUND - NAVY AND AIR FORCE	SPACE
2 MHz to 30 MHz	200	200	200	20	200	200	10	50	5	50	10	20
30 MHz to 1 GHz	200	200	200	20	200	200	10	10	10	50	10	20
1 GHz to 18 GHz	200	200	200	60	200	200	10	10	10	50	50	20
18 GHz to 40 GHz	200	200	60	60	200	200	10	10	10	50	50	20

* For equipment located external to the pressure hull of a submarine but within the superstructure, use METALLIC SHIPS - BELOW DECK

** For equipment located in the hangar deck of Aircraft Carriers, use NON-METALLIC SHIPS - BELOW DECK

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THANK YOU