

EMC Standards  
Update and Review  
Mil STD 461 E

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# Mil STD 461 E

Establishes The Requirements for the  
Control of Electromagnetic Interference  
(EMI) Characteristics of Subsystems and  
Equipment for Applicable Military and  
Aerospace Requirements

# Mil STD 461E

- Conducted Emissions
- Conducted Susceptibility
- Radiated Emissions
- Radiated Susceptibility

# MIL-STD-461E

TABLE IV. 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 150 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 200 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, 2 MHz to 40 GHz
RS105	Radiated Susceptibility, Transient Electromagnetic Field

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TABLE V. Requirement matrix

Equipment and Subsystems Installed In, On, or Launched From the Following Platforms or Installations	Requirement Applicability																
	CE101	CE102	CE106	CS101	CS103	CS104	CS105	CS109	CS114	CS115	CS116	RE101	RE102	RE103	RS101	RS103	RS105
Surface Ships		A	L	A	S	S	S		A	L	A	A	A	L	A	A	L
Submarines	A	A	L	A	S	S	S	L	A	L	A	A	A	L	A	A	L
Aircraft, Army, Including Flight Line	A	A	L	A	S	S	S		A	A	A	A	A	L	A	A	L
Aircraft, Navy	L	A	L	A	S	S	S		A	A	A	L	A	L	L	A	L
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	A	A		A	L	L	A	
Ground, Navy		A	L	A	S	S	S		A	A	A		A	L	A	A	L
Ground, Air Force		A	L	A	S	S	S		A	A	A		A	L		A	

Legend:

- A: Applicable
- L: Limited as specified in the individual sections of this standard
- S: Procuring activity must specify in procurement documentation

# Specifications

- Mil STD 461 E includes Mil STD 462
- Testing Methods and Requirements
- Mil STD 462 Still Applicable for A-D
- NAVAIR Requires NVLAP ISO 17025 Accreditation- NATRE Certified Engineers

# CE 101      Power Leads

## 30 Hz to 10 KHz

- Required for:
  - Submarines
  - Army Aircraft (Including Flight Line)
  - Navy Aircraft with Anti Submarine Warfare
  - No Longer Applicable for Surface Ships

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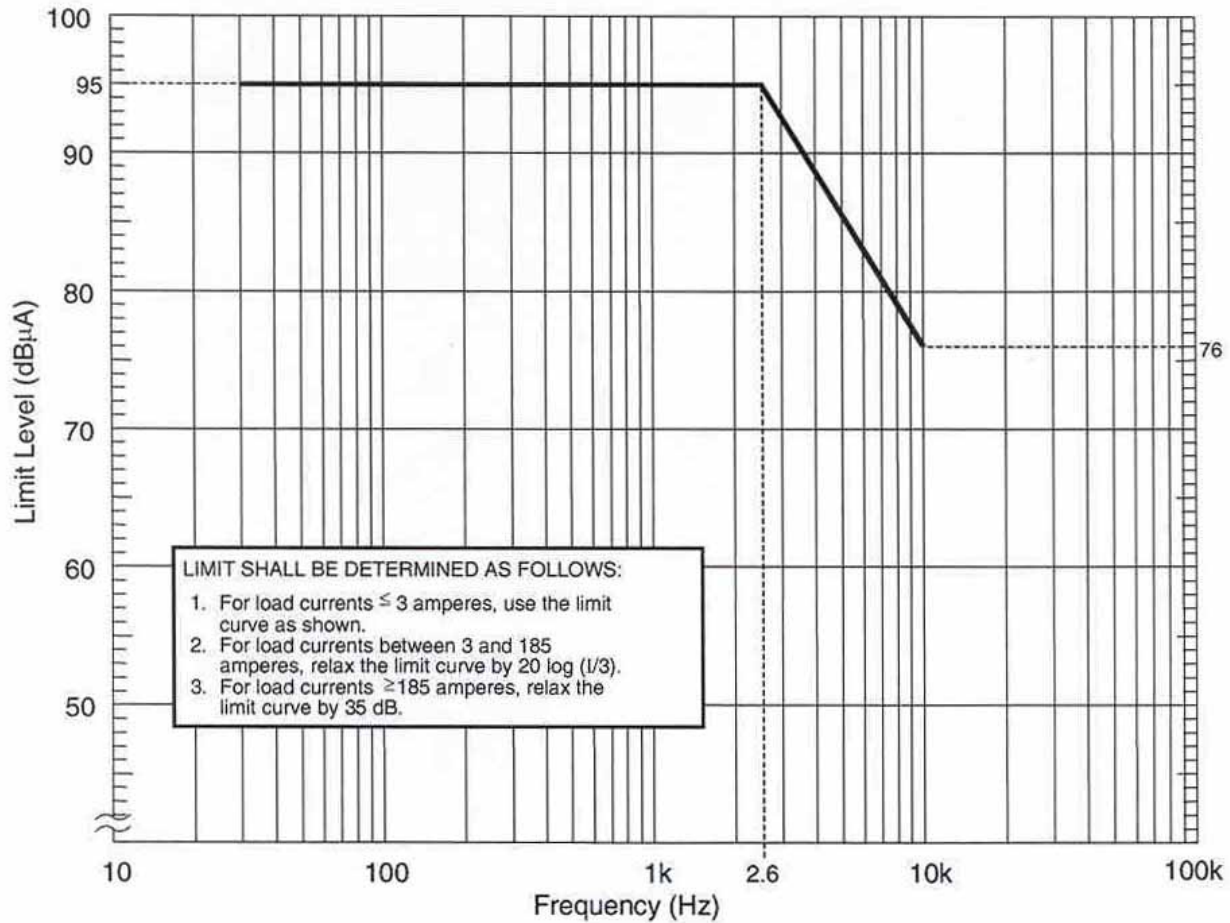


FIGURE CE101-1. CE101 limit for submarine applications, DC

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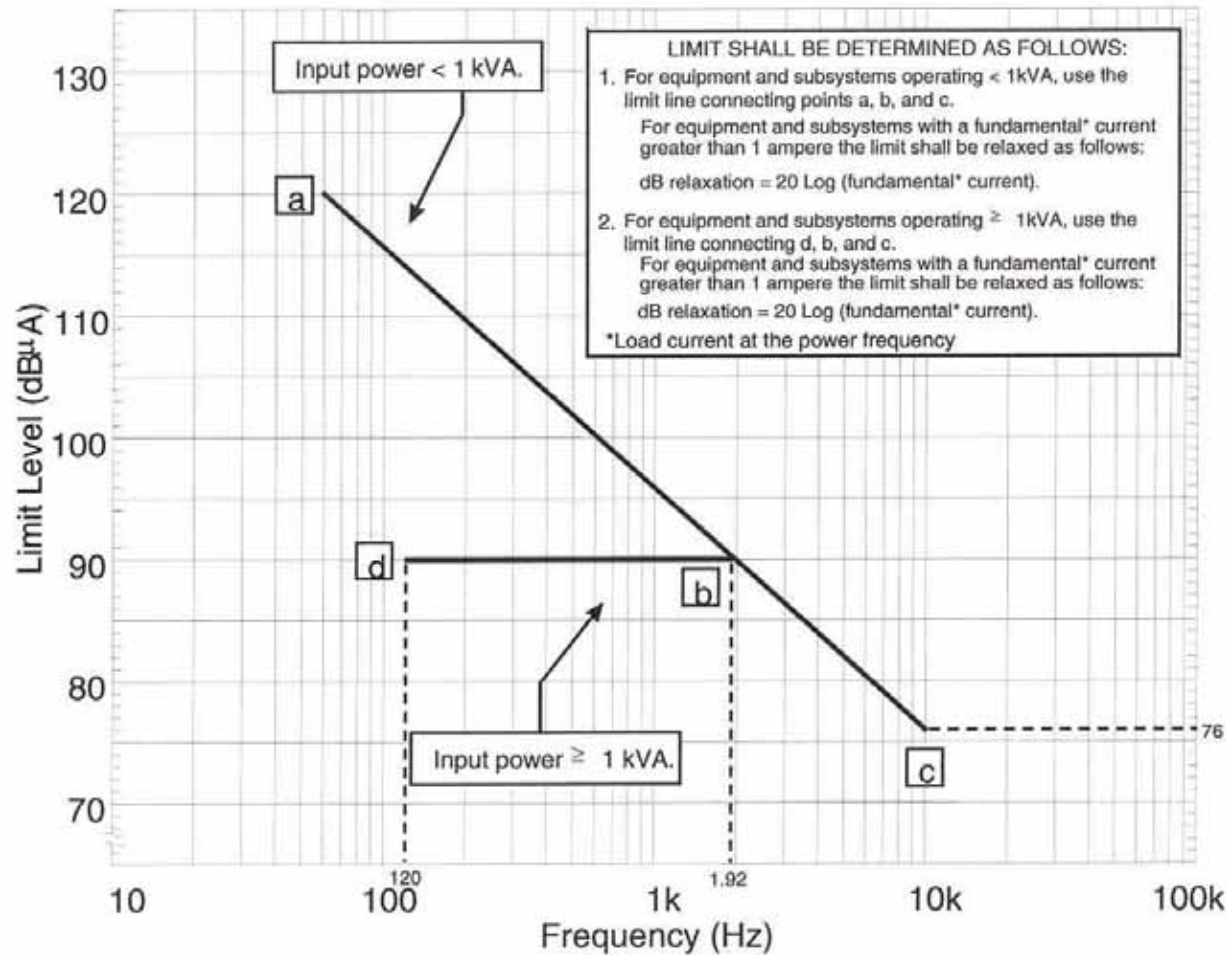


FIGURE CE101-2. CE101 limit for submarine applications, 60 Hz

# MIL-STD-461E

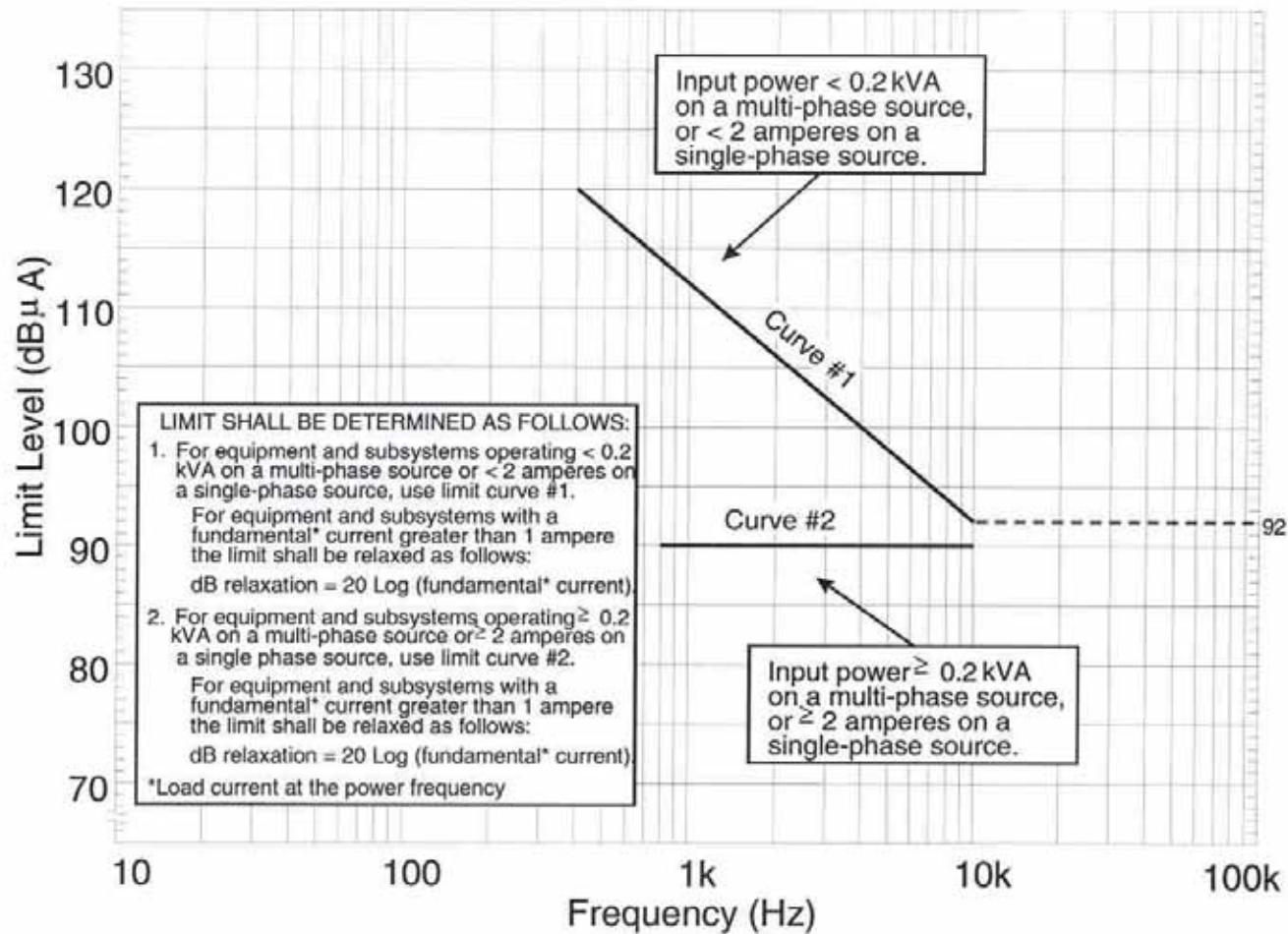


FIGURE CE101-3. CE101 limit for submarine applications, 400 Hz

# CE 102      Power Leads

## 10 KHz to 10 MHz

- No Major Changes
- Required for:
  - Submarines
  - Army Aircraft (Including Flight Line)
  - Navy Aircraft
  - Air Force Aircraft
  - Space Systems
  - Ground Army
  - Ground Navy
  - Ground Air Force
  - Surface Ships

# CE 106

- Applicable to the antenna terminals of transmitters, receivers, and amplifiers, but not applicable to equipment designed with antenna permanently mounted to equipment under test.
- Modified to Include Amplifiers

# CS 101 Power Leads

## 30 Hz to 150 kHz

- Applicable to ALL Equipment and subsystems AC and DC Input Power Leads
- If DC Applicable from 30 Hz to 150 kHz
- If AC Applicable starting at 2 nd harmonic of the power frequency of EUT, and extends to 150 kHz- from 50 kHz
- Applicable to ALL Ships, Aircraft, Vehicles, Systems

# MIL-STD-461E

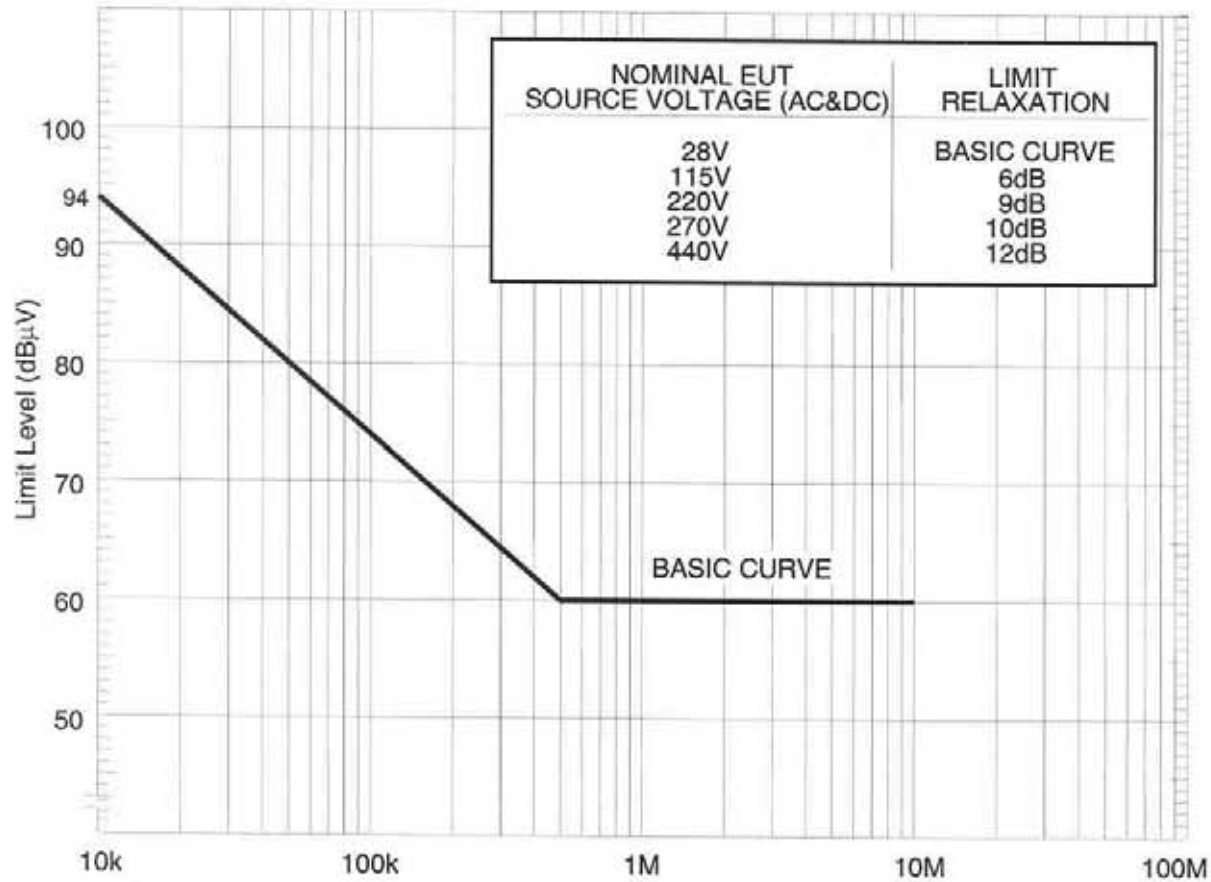


FIGURE CE102-1. CE102 limit (EUT power leads, AC and DC) for all applications.

# MIL-STD-461E

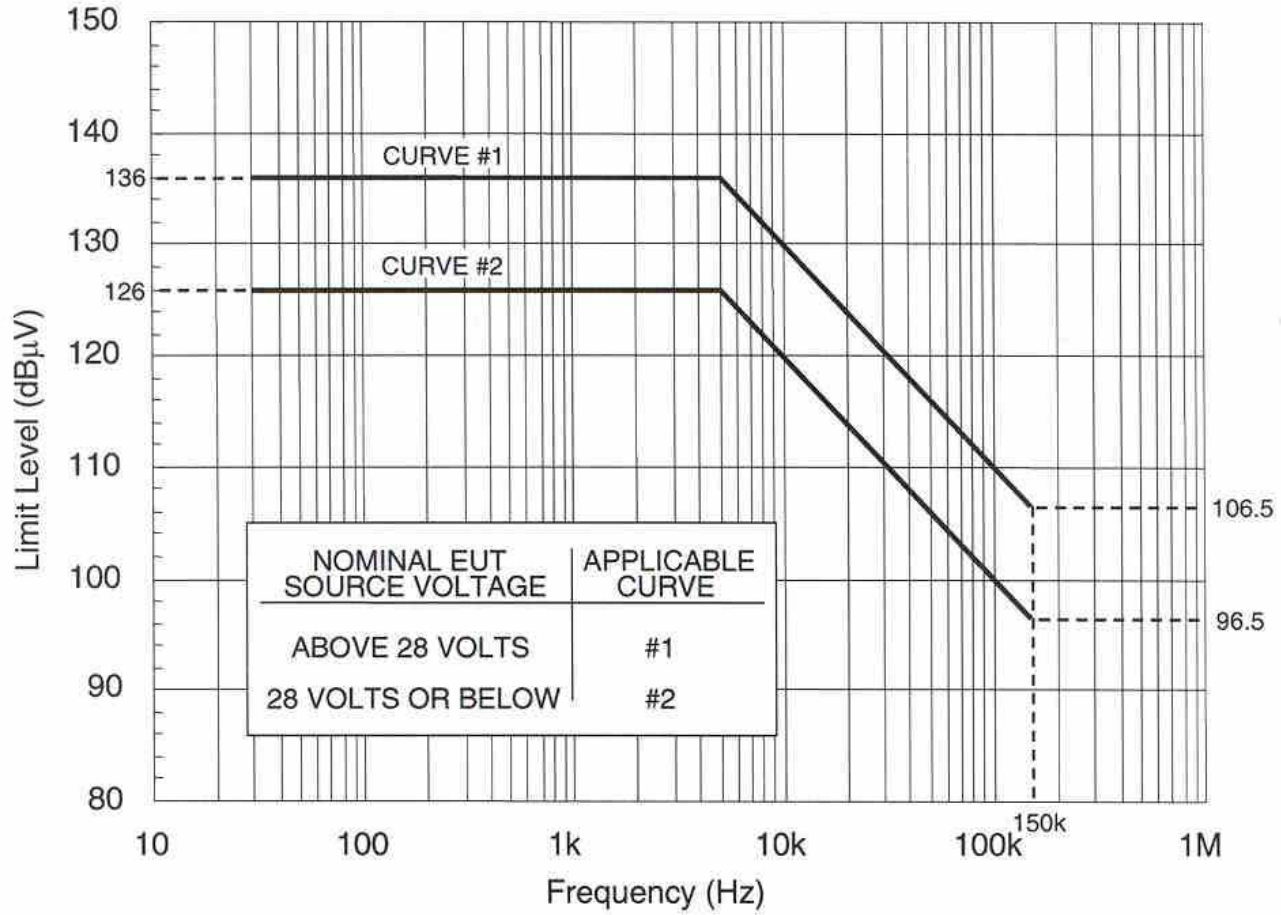


FIGURE CS101-1. CS101 voltage limit for all applications.

# MIL-STD-461E

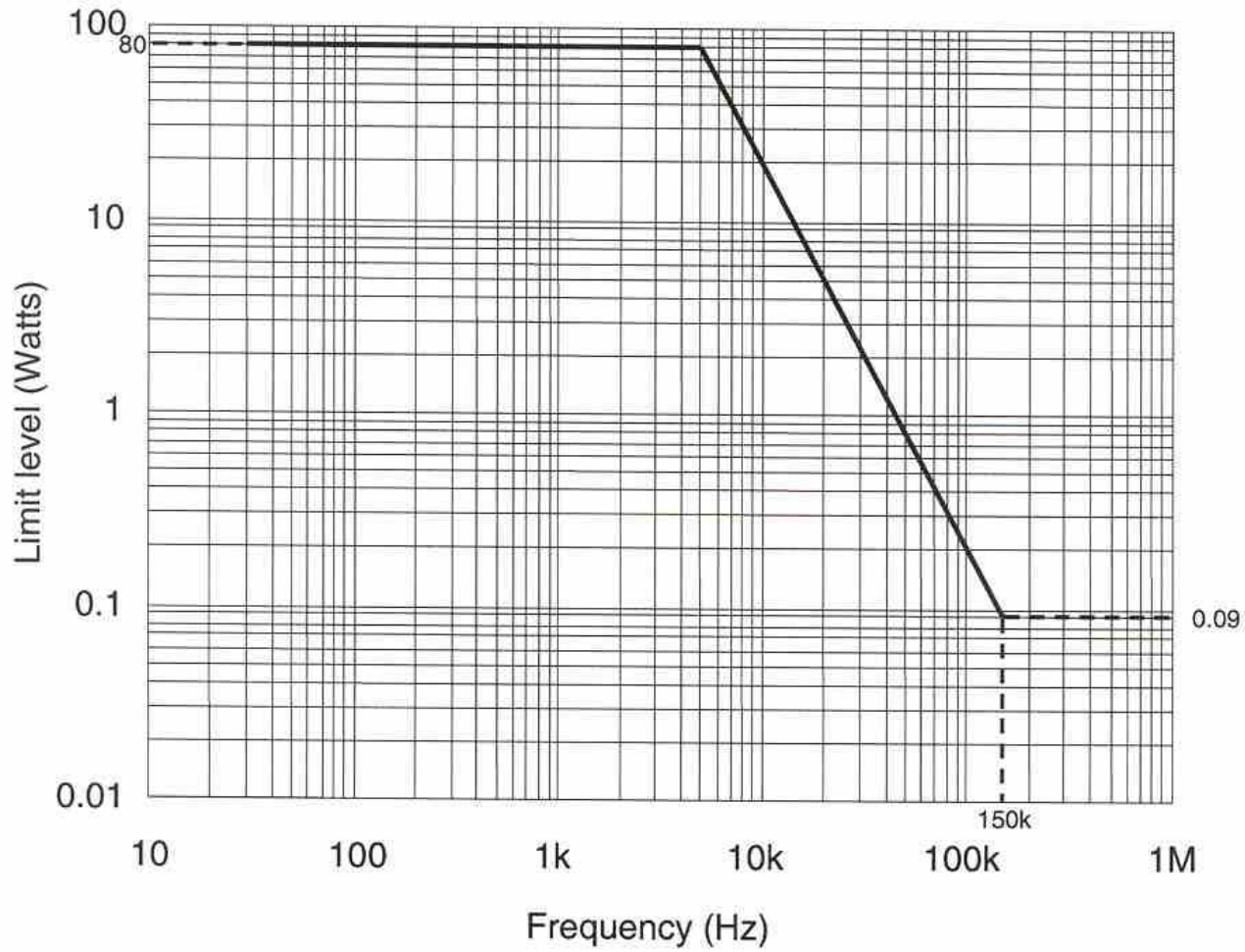


FIGURE CS101-2. New CS101 power limit for all applications.

CS101  
20 August 1999

# CS 114 Bulk Cable Injection

## 10 kHz to 200 MHz

- Applicable to ALL Interconnecting Cables
- Applicable to Vehicles, Ships, Aircraft, Systems
- Removed Loop Circuit Impedance Measurement Requirements
- Alternative Limit Now Set at 6 dB above Calibration Level
- New Levels for Maximum Insertion Loss

# MIL-STD-461E

TABLE VI. CS114 limit curves

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

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

\* For equipment located external to the pressure hull of a submarine but within the superstructure, use SHIPS (METALLIC)(BELOW DECKS)

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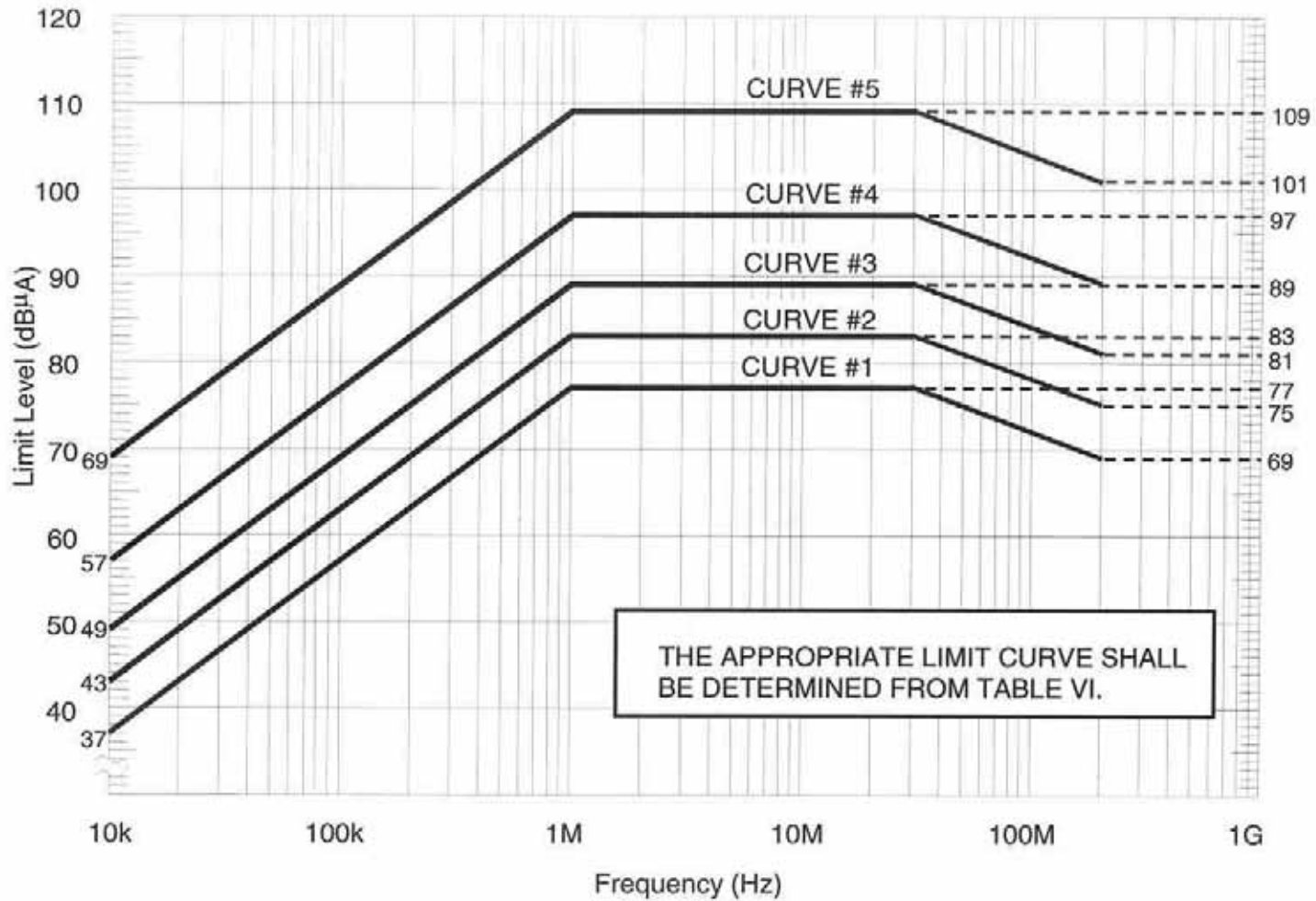


FIGURE CS114-1. New CS114 calibration limit for all applications.

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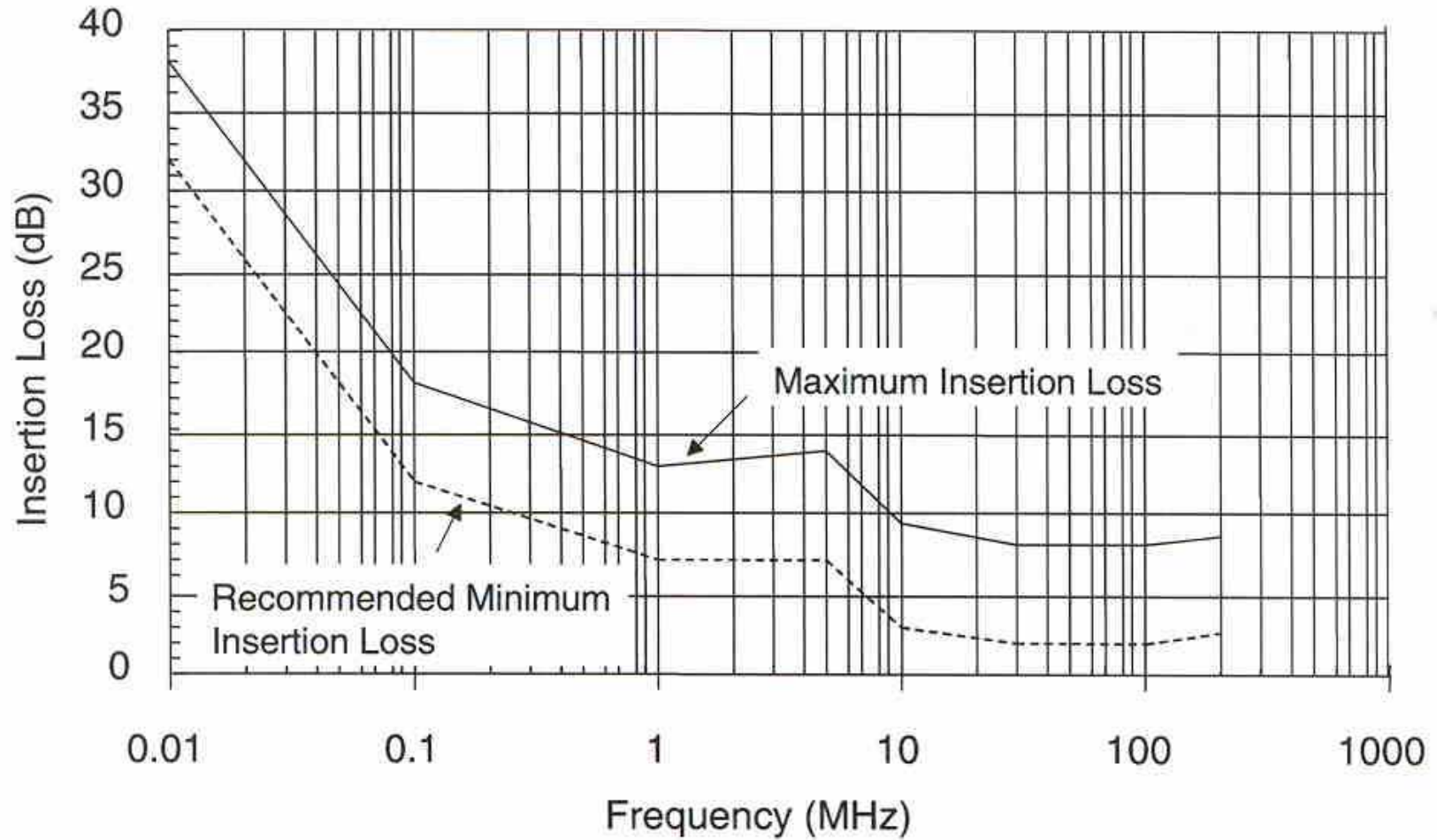


FIGURE CS114-2. New Maximum insertion loss for injection probes.

# CS 116

## Damped Sinusoidal Transients for Cables and Power Leads

### 10 kHz to 100 MHz

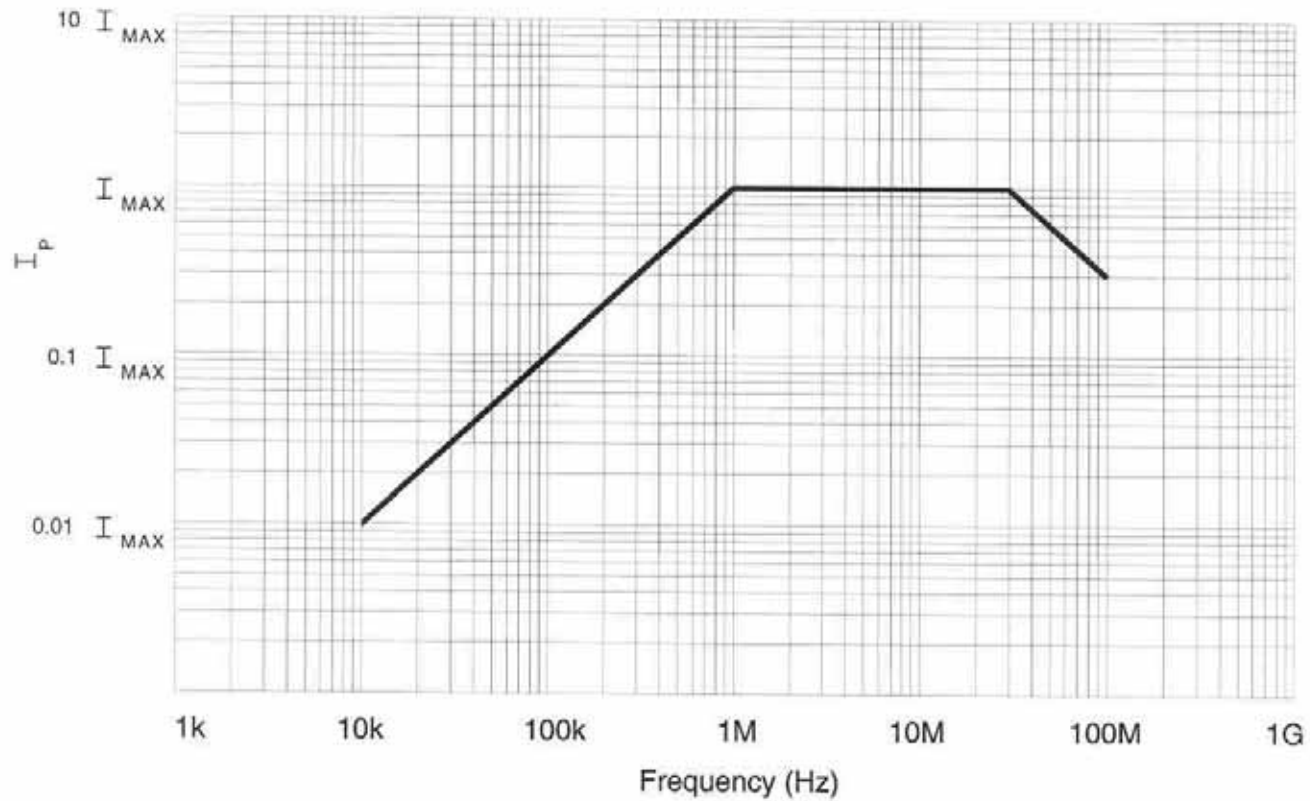
- Basic concept is to simulate electrical current and voltage waveforms occurring in platforms from excitation of natural resonance's.
- The requirements are applicable to all electrical cables interfacing with each EUT and individually on each power lead.
- Testing should verify the the EUT's ability to withstand damped sinusoidal transients coupled onto the EUT associated cables and power leads

# CS 116

## Damped Sinusoidal Transients for Cables and Power Leads 10 kHz to 100 MHz

- Removed Loop Circuit Impedance Measurement Requirements and Testing at Resonant Frequencies
- Applicable to ALL Interconnecting Cables
- Including Power Cables
- Including High Side Power Leads
- Power Returns and Neutrals Do Not Need to be Tested Individually.

# MIL-STD-461E



NOTES:

1. For Army and Navy procurements,  $I_{MAX} = 10$  amperes
2. For Air Force procurements,  $I_{MAX} = 5$  amperes

FIGURE CS116-2. CS116 limit for all applications.

# RE 102 Electric Field

## 10 kHz to 18 GHz

- Basic intent is to protect sensitive receivers from interference coupled through the antennas associated with the receiver.
- The testing will verify that the electric field emissions from the EUT and its associated cabling do not exceed specified limits.

# RE 102 Electric Field

## 10 kHz to 18 GHz

- Applicable to ALL Ships, Aircraft, Vehicles, Space, Ground Systems, and Submarines
- Applicable to equipment, sub system enclosures, interconnecting cables, antennas designed to be permanently mounted to EUT's.
- Not Applicable at Transmitter Fundamental Frequencies

# RE 102 Electric Field Specific Requirements

- Ground 2 MHz to 18 GHz
- Surface Ships 10 kHz to 18 GHz
- Submarines 10 kHz to 18 GHz
- Aircraft Army 10 kHz to 18 GHz
- Aircraft Navy and Air Force 2 MHz to 18 GHz
- Space 10 kHz to 18 GHz

# MIL-STD-461E

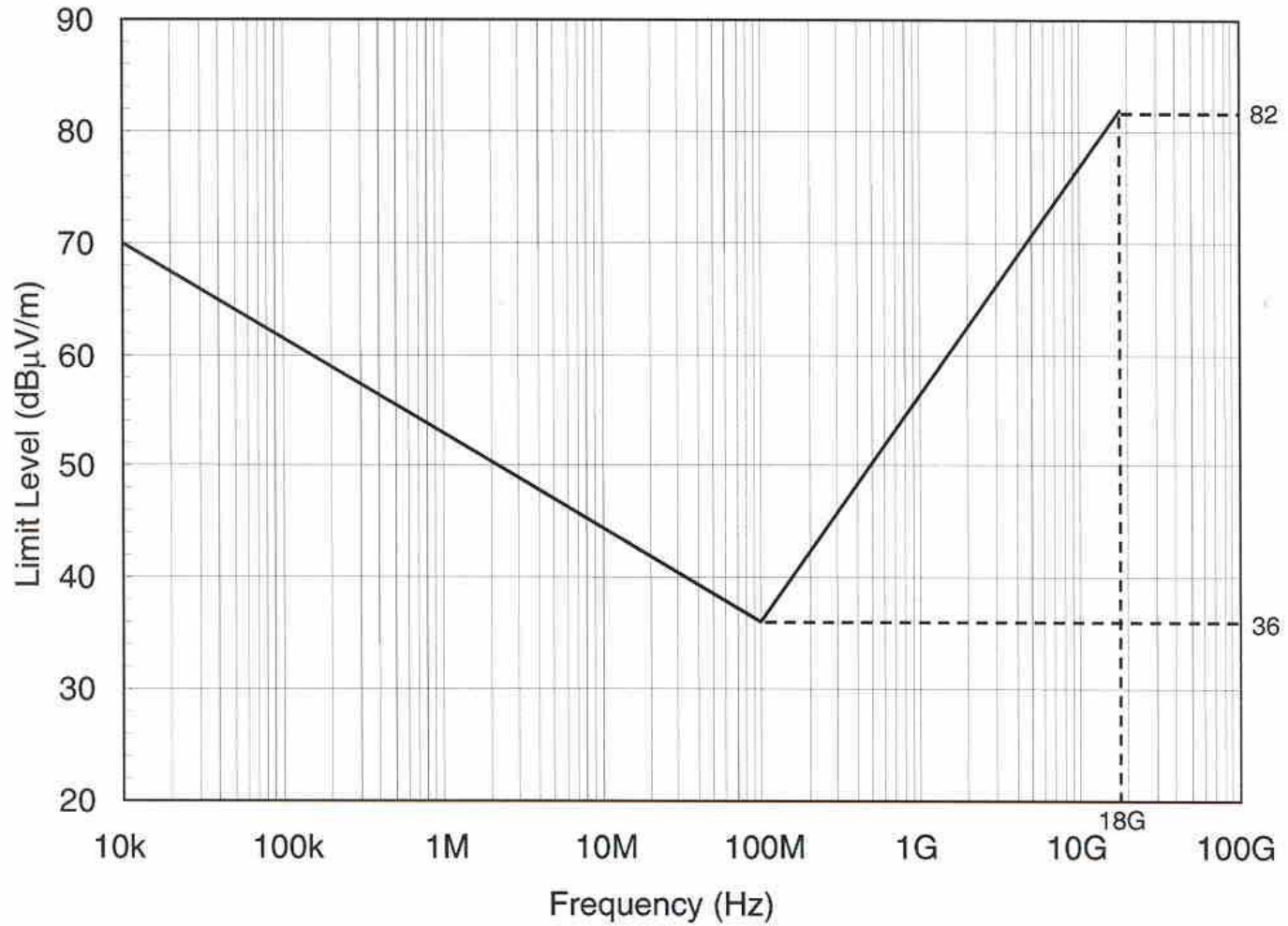


FIGURE RE102-1. RE102 limit for surface ship applications.

RE102  
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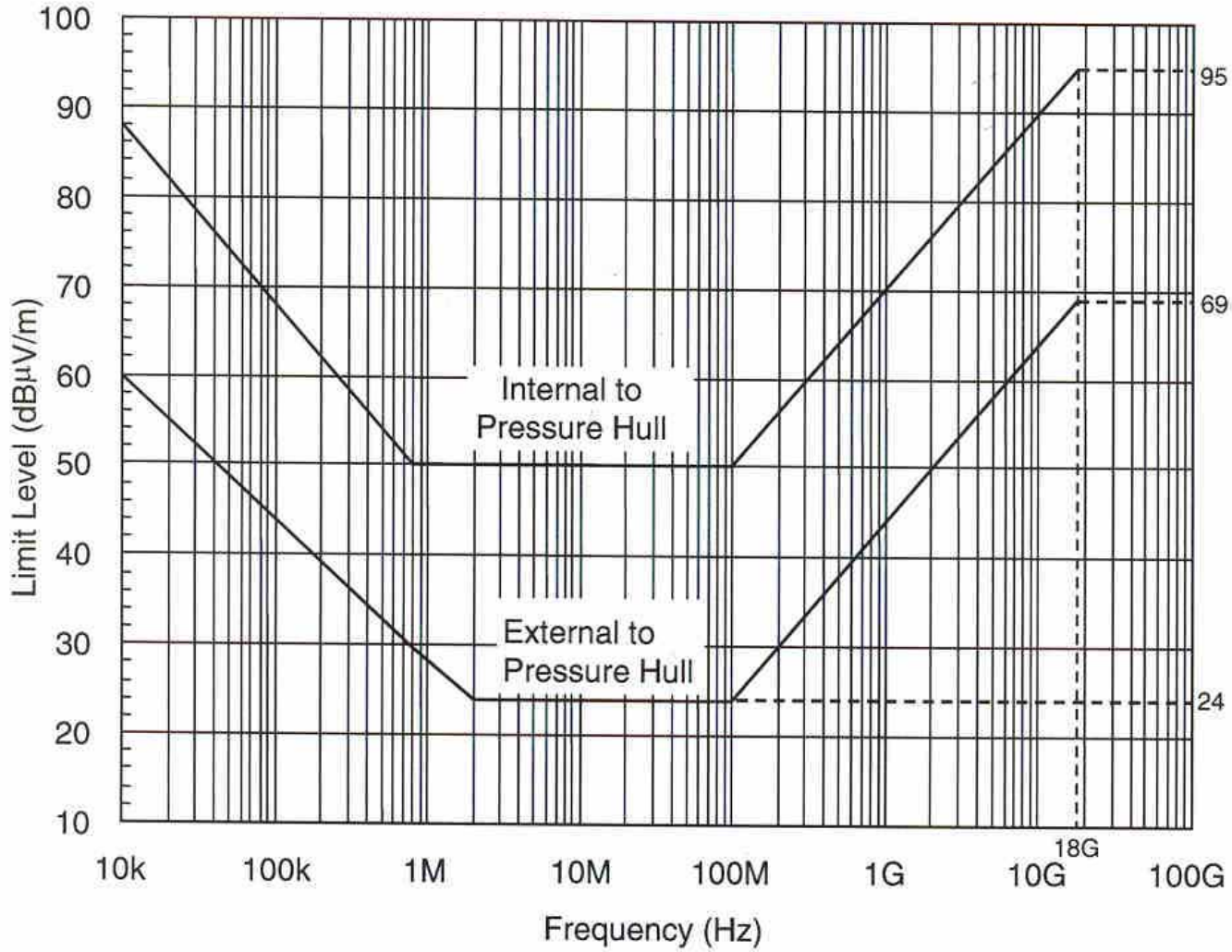


FIGURE RE102-2. New RE102 limit for submarine applications.

RE102  
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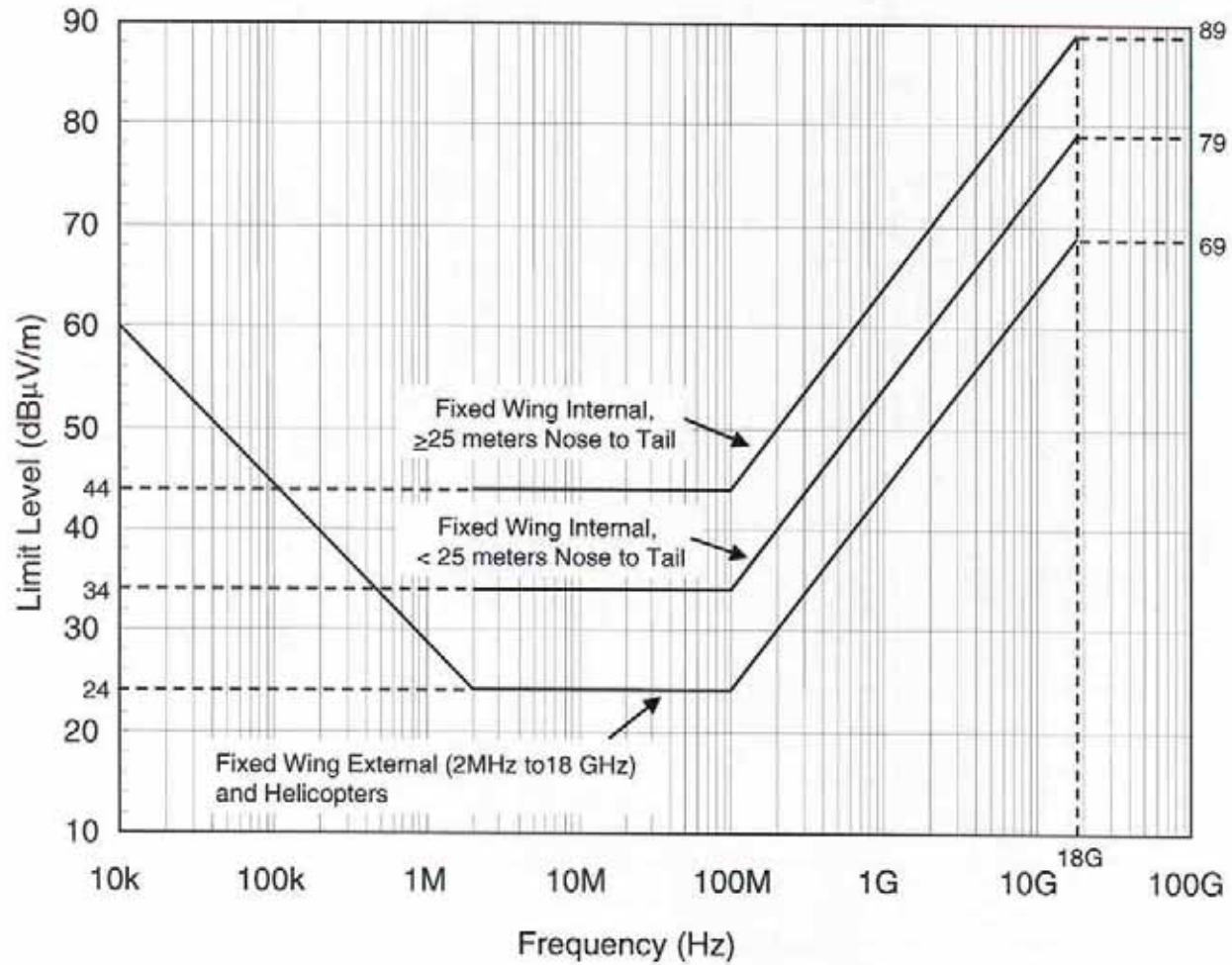


FIGURE RE102-3. RE102 limit for aircraft and space system applications.

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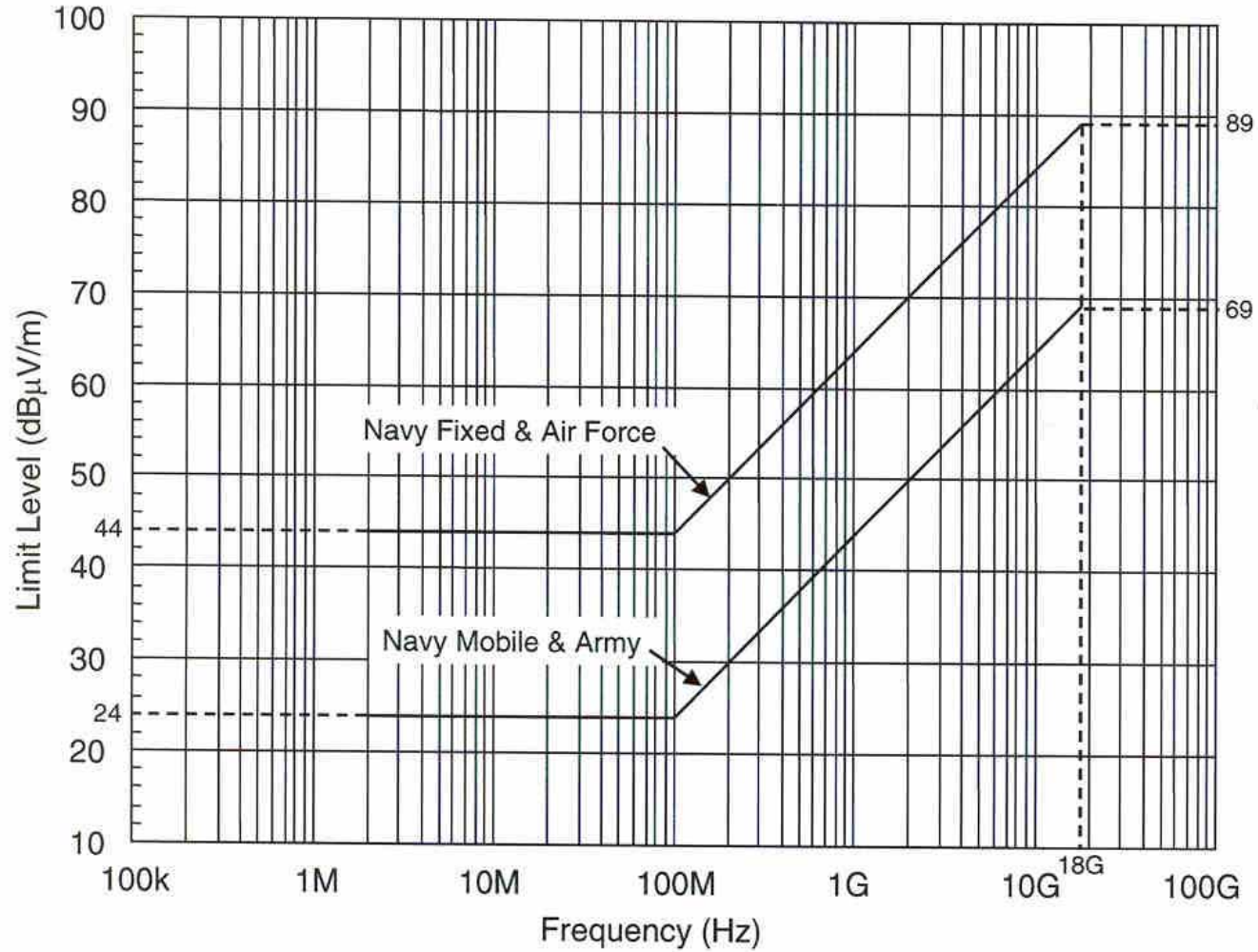


FIGURE RE102-4. RE102 limit for ground applications.

# RS 101 Requirements

- Specialized requirement and is intended primarily to ensure the performance of equipment potentially sensitive to low frequency magnetic fields is not degraded.
- Applicable to equipment and sub system enclosures, including electrical cable interfaces
- Not applicable for electromagnetic coupling via antennas

# RS 101 Requirements

- Navy Aircraft
  - Only with Anti Submarine Warfare Capability
- Army Ground Equipment
  - Only if Mine Sweeping or Mine Detection

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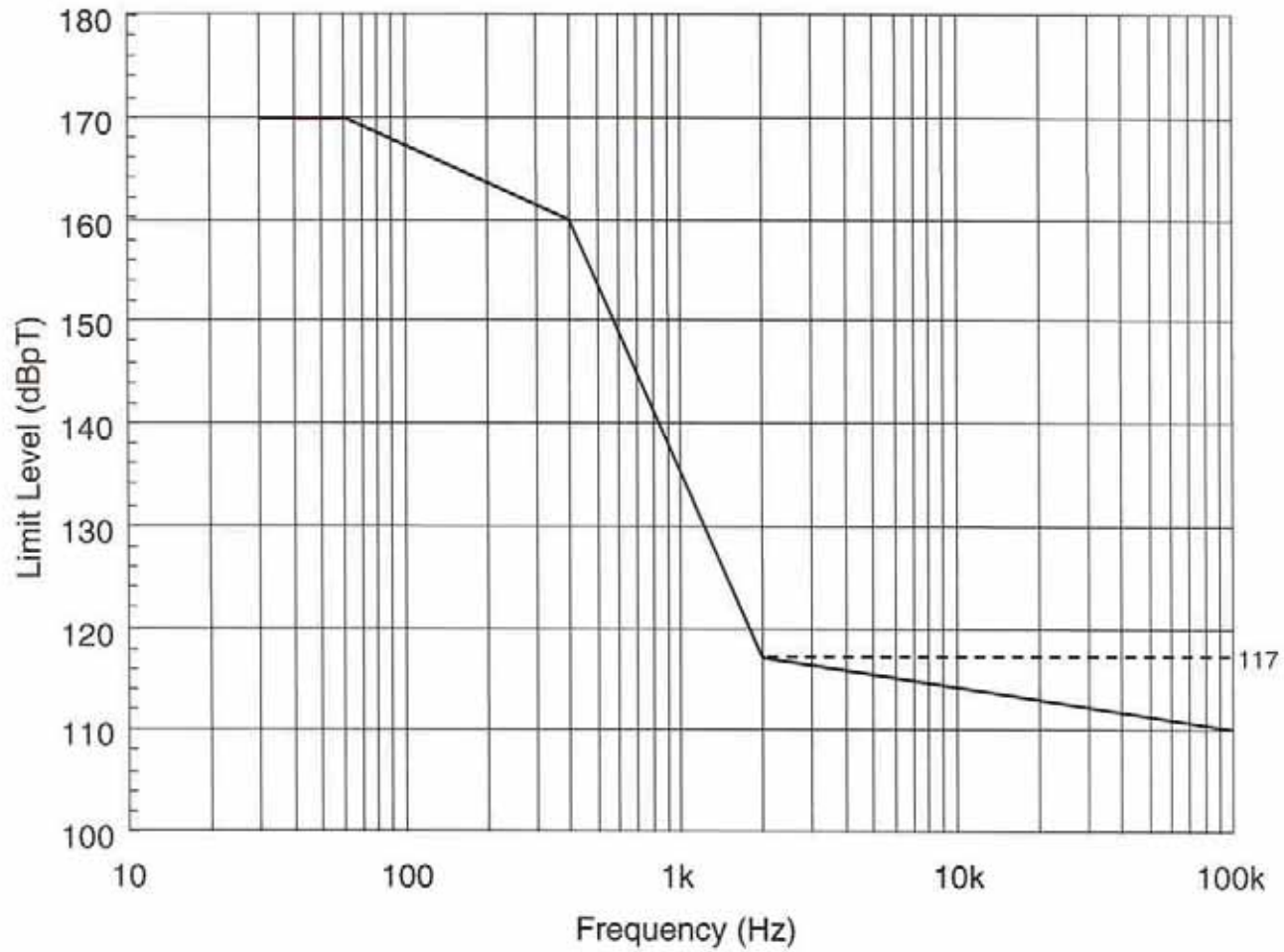


FIGURE RS101-1. RS101 limit for all Navy applications.

RS101  
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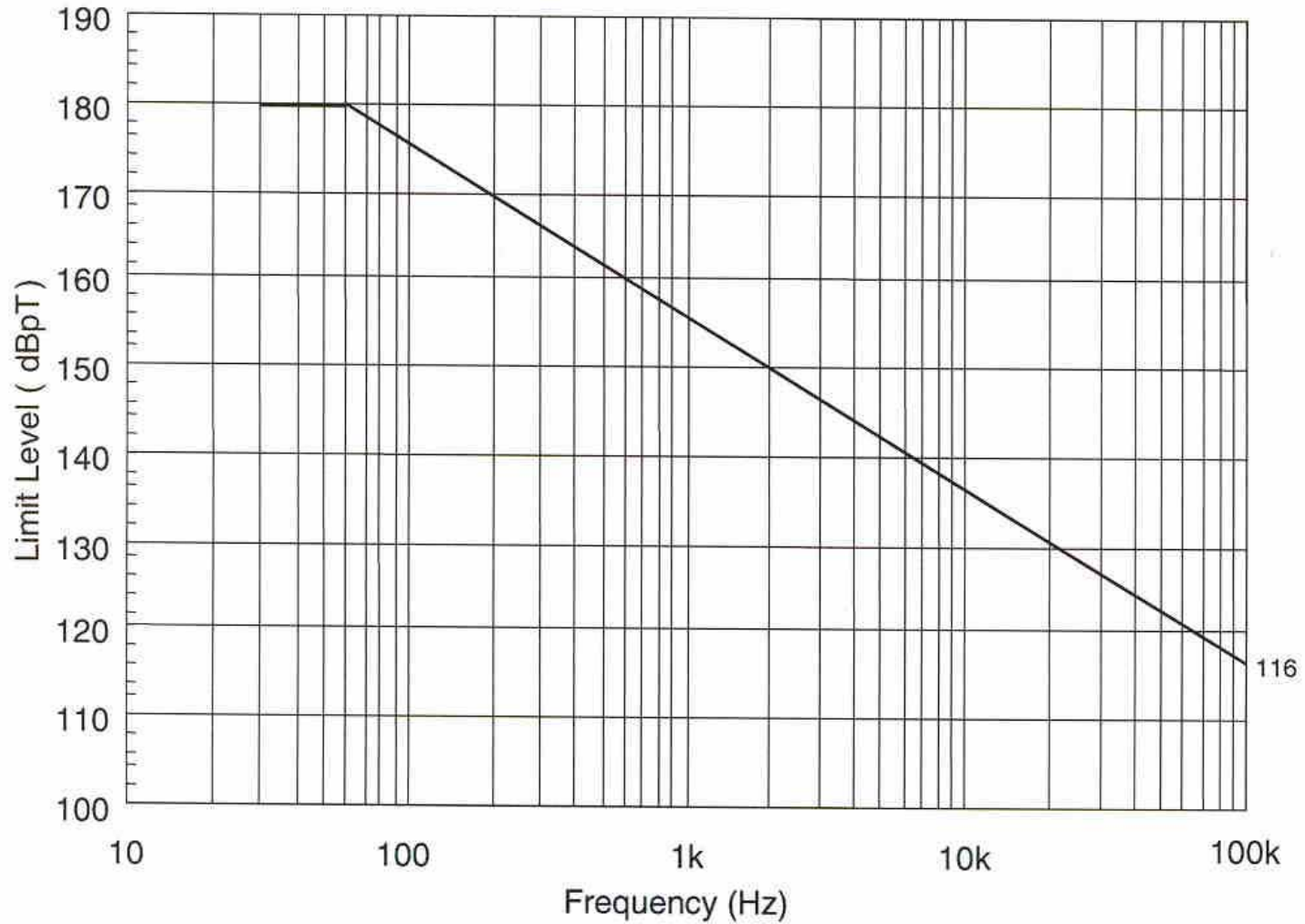


FIGURE RS101-2. RS101 limit for all Army applications.

RS101  
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# RS 103 Electric Field

- Basic concern is to insure EUT will operate without degradation in the presence of electromagnetic fields generated by antenna transmissions both on board and external to the tested platform
- The EUT shall not exhibit any malfunction, degradation of performance or deviation from the specified indications
- Applicable to equipment and sub systems enclosures and all interconnecting cables

# RS 103 Electric Field

## 2 MHz to 40 GHz

- Applicable to ALL Equipment, Ships, Space, Aircraft, Submarines, and Vehicles
- Applicable to equipment and sub systems enclosures and all interconnecting cables
- Starting Frequency 2 MHz-from 10 kHz
- 18 to 40 GHz is Required on Many Applications

# RS 103 Electric Field Submarine Applications

- Distinguished between equipment located internal versus external to the pressure hull
  - Internal requirements are now 10 Volts per meter for above 30 MHz
  - External identifies fully operation when above the waterline 200 volts per meter

# RS 103 Electric Field Army Aircraft

- 200 Volts Per meter
- Regardless of Location
- Rotary Aircraft- Highest Levels of Exposure

# MIL-STD-461E

TABLE VII. RS103 limits.

PLATFORM FREQ. RANGE		LIMIT LEVEL (VOLTS/METER)							
		AIRCRAFT (EXTERNAL OR SAFETY CRITICAL)	AIRCRAFT INTERNAL	ALL SHIPS (ABOVE DECKS) AND SUBMARINES (EXTERNAL)*	SHIPS (METALLIC) (BELOW DECKS)	SHIPS (NON- METALLIC) (BELOW DECKS)	SUBMARINES (INTERNAL)	GROUND	SPACE
2 MHz ↓	A	200	200	200	10	50	5	50	20
	N	200	200	200	10	50	5	10	20
30 MHz	AF	200	20	-	-	-	-	10	20
30 MHz ↓	A	200	200	200	10	10	10	50	20
	N	200	200	200	10	10	10	10	20
1 GHz	AF	200	20	-	-	-	-	10	20
1 GHz ↓	A	200	200	200	10	10	10	50	20
	N	200	200	200	10	10	10	50	20
18 GHz	AF	200	60	-	-	-	-	50	20
18 GHz ↓	A	200	200	200	10	10	10	50	20
	N	200	60	200	10	10	10	50	20
40 GHz	AF	200	60	-	-	-	-	50	20

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

\* For equipment located external to the pressure hull of a submarine but within the superstructure, use SHIPS (METALLIC)(BELOW DECKS)

# RS 105 Transient Electromagnetic Field

- Applicable to equipment and subsystem enclosures is located on a hardened or shielded platform or facility
- Applicable to Army Aircraft for Safety Critical Equipment located in an external installation
- Applicable for equipment of non metallic platforms when specified as such

# RS 105 Transient Fields

- Established for EUT to withstand the fast rise time, free field, transient environment of an electromagnetic pulse
- For enclosures only
- Electrical Interface cabling should be protected in shielded conduit

# Summary

- Mil STD 461 E Includes Mil STD 462
- Radiated Emissions and Susceptibility
- Conducted Emissions and Susceptibility
- Required on Military and Space Electronic Equipment, Ships, Weapons, Devices, Aircraft, Ground Equipment, and Vehicles
- Accredited Testing Facility through NVLAP
- Staffed with Certified NARTE Engineers

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