

NOTICE OF
CHANGE

METRIC

MIL-STD-454M
NOTICE 3
22 September 1994

MILITARY STANDARD
STANDARD GENERAL REQUIREMENTS FOR ELECTRONIC EQUIPMENT

TO ALL HOLDERS OF MIL-STD-454M:

1. THE FOLLOWING REQUIREMENTS OF MIL-STD-454M HAVE BEEN REVISED AND SUPERSEDE THE REQUIREMENTS LISTED:

NEW REQUIREMENTS	DATE	SUPERSEDED REQUIREMENTS	DATE
25	22 September 1994	25	15 December 1989
64	22 September 1994	64	30 October 1991
71	22 September 1994	71	30 June 1992
78-1/78-2	22 September 1994	NEW REQUIREMENT	---

2. MAKE THE FOLLOWING PEN AND INK CHANGES:

- a. Page vi, contents, tables: In table 71-ii, delete "Indexes" from title.
- b. Requirement 2, page 2-1, paragraph 4.2: Delete "MIL-C39006/22" and substitute "MIL-C-39006/22".
- c. Requirement 5, page 5-1, paragraph 2: Delete "Document" and substitute "Documents".
- d. Requirement 5, page 5-1: Delete the heading "Information for guidance only." and substitute "5. Information for guidance only.".
- e. Requirement 7, page 7-1, paragraph 4.1: In line six, insert "departure" between "without" and "from".
- f. Requirement 11, page 11-3, paragraph 4.5: Delete "MIL-P-79, MIL-P-997, MIL-P-15037, MIL-P-15047" from the second line.
- g. Requirement 20, page 20-2, table 20-1, spec type or class M16878/2: Delete the value for max rms volts of "10000" and substitute "1000".
- h. Requirement 39, page 39-2, paragraphs 5, 6, and 7: Renumber as "4.1, 4.2, and 4.3"; paragraphs 8, 9, 10, and 11: Renumber as "5, 5.1, 5.2, and 5.3", respectively.
- i. Requirement 41, pages 41-1 and 41-3, paragraph 2: Delete "-88" from ASTM A29/A29M-88; delete "-83" from ASTM A228/A228M-83; delete "-87" from ASTM A313-87; delete "-79" from ASTM A682-79; delete "-86" from ASTM A684/A684M-86; delete "-86" from ASTM B122-86; delete "-90" from ASTM B139/B139M-90; delete "-88" from ASTM B194-88; delete "-88" from ASTM B196/B196M-88; delete "-89" from ASTM B197/B197M-89; delete "-86A" from ASTM B206-86A; Delete "-87" from ASTM B206M-87; and delete "-80" from ASTM B522-80.
- j. Requirement 46, page 46-1, paragraph 2: Delete "MIL-F-9397" and substitute "MIL-M-9397" and on page 46-2, paragraph 4.3: Delete "MIL-F-9397" and substitute "MIL-M-9397".
- k. Requirement 50, page 50-2, table 50-1: Delete the listing for "Fluorescent lamps".

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- l. Requirement 52, notice 2, page 52-1, paragraph 2: Delete "F-F-300" and substitute "ASTM F872" and on page 52-2, paragraph 4.1, sixth line: Delete "F-F-300" and substitute "ASTM F872".
- m. Requirement 55, page 55-1, paragraph 2: Delete "EIA RS-310-C-77" and substitute "EIA 277" and on page 55-1, paragraph 4.4, second line: Delete "EIA RS-310-C" and substitute "EIA 277".
- n. Requirement 66, page 66-1, paragraph 2: Delete title for MIL-W-22759 and substitute "Wire Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy."
- (1) Title for MIL-W-25038 should read "Wire, Electrical, High Temperature and Fire Resistant, Aircraft and Flight Critical, General Specification for".
- (2) Title for MIL-C-27072 should read "Cable, Power, Electrical and Special Purpose, Electrical, Multiconductor".
- (3) Change title for ASTM A580 to "Standard Specification for Stainless and Heat Resisting Steel Wire".
- (4) Change title for ASTM B33 to read "Standard Specification for Tinned soft or Annealed Copper Wire for Electric Purposes".
- o. Requirement 76, page 76-4, paragraph 4.2: Delete "IEC-693-80" and substitute "IEC-693" and on page 76-3, paragraph 3.1: Delete "IEEE-STD-812" and substitute "MIL-STD-2196".
3. INDEX OF APPLICATION DOCUMENTS II-1. MAKE THE FOLLOWING PEN AND INK CHANGES:
- Page 11-2, Document: Delete "MIL-F-9397" and substitute "MIL-M-9397".
- Page 11-8, Document: Delete "ASTM D3295-81" and substitute "ASTM D3295".
- Page 11-8, Document: Delete "IEC-693-80" and substitute "IEC-693".
- Page 11-8, Document: Delete "IEEE 200-1975:" and substitute "IEEE 200".
- Page 11-1 through 11-8, Index 1: Insert the following documents in number sequence:

<u>Military standards</u>	<u>Requirement</u>
MIL-STD-11991	FWD
MIL-I-24768	11, 26
<u>Handbooks</u>	
MIL-HDBK-179(ER)	64
MIL-HDBK-411	25
MIL-HDBK-727	78
<u>Non Government documents</u>	
EIA 277	55
IEEE 1029	64
ASTM F1166	77
JEDEC-STD-17	64

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NAVSO P-3679	78
NAVSO P-6071	78
DoD 4245.7M	78
DI-EGDS-80811	64

Page 11-1 through 11-8, Index 1: Delete the following documents:

<u>Military standards</u>	<u>Requirement</u>
MIL-P-79	11, 26
MIL-P-997	11, 26
MIL-P-15037	11, 26
MIL-P-15047	11
MIL-P-19161	11, 26
MIL-E-81512	56
MIL-STD-480	72

Non Government documents

ASTM A580-90	71
EIA-310-C	55
IEEE 812-84	76

4. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

5. Holders of MIL-STD-454N will verify that page changes and additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the Military Standard is completely revised or canceled.

CONCLUDING MATERIAL

Custodians:

Army - ER
Navy - AS
Air Force - 11

Review activities:

Army - AR, AV, CR, ME, MI, PT, TE
Navy - EC, OS, SH
Air Force - 17, 19, 85, 99

Other:

DLA - ES
FAA

Preparing activity:

Air Force - 10

Agent:

DLA - ES

(Project GDRO-0152)

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REQUIREMENT 25

ELECTRICAL POWER

1. Purpose. This requirement establishes criteria for electrical power.

2. Documents applicable to Requirement 25:

MIL-STD-205	Frequencies for Electric Power.
MIL-STD-255	Electric Voltages, Alternating and Direct Current.
MIL-STD-704	Aircraft Electric Power Characteristics.
MIL-STD-1275	Characteristics of 28 Volt DC Electrical Systems in Military Vehicles.
MIL-STD-1399	Interface Standard for Shipboard Systems.
MIL-STD-1539	Electrical Power, Direct Current, Space Vehicle Design Requirements.
MIL-HDBK-411	Power and the Environment for Sensitive DoD Electronic Equipment.

3. Definitions. Not applicable.

4. Requirements.

4.1 General. Except as specified below, the electrical power source required for electronic equipment and associated equipment and for portions of systems employing electronic equipment shall be in accordance with MIL-STD-205 and MIL-STD-255.

4.2 Airborne. The electrical power requirements for airborne and associated equipment shall be in accordance with MIL-STD-704.

4.3 Shipboard. The electrical power requirements for shipboard and associated equipment shall be in accordance with type I or type II of section 300 of MIL-STD-1399.

4.4 Space. The electrical power requirements for space equipment shall be in accordance with MIL-STD-1539.

4.5 Ground vehicles. The electrical power requirements for military ground vehicles shall be in accordance with MIL-STD-1275.

5. Information for guidance only.

5.1 Critical fixed communications and related automatic data processing facilities. The electrical power requirements for critical communications and related automatic data processing equipment should be for a nominal -48 V dc uninterruptible power supply in accordance with MIL-HDBK-411.

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REQUIREMENT 64

MICROELECTRONIC DEVICES

1. Purpose. This requirement establishes criteria for the selection and application of microelectronic devices. These criteria are based on the objectives of achieving technological superiority, quality, reliability, and maintainability in military systems.

2. Documents applicable to Requirement 64:

MIL-H-38534	Hybrid Microcircuits, General Specification For.
MIL-I-38535	Integrated Circuits (Microcircuits) Manufacturing, General Specification For.
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production.
MIL-STD-883	Test Methods and Procedures for Microelectronics.
MIL-STD-975	NASA Standard Electrical, Electronic and Electromechanical Parts List.
MIL-STD-1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles, Technical Requirements For.
MIL-STD-1562	List of Standard Microcircuits.
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices).
MIL-BUL-103	List of Standardized Military Drawings (SMDs).
MIL-HDBK-217	Reliability Prediction of Electronic Equipment.
ANSI/IEEE 1076	VHSIC Hardware Description Language (VHDL) VHSIC Interoperability Standards. Includes Specifications for the IM-bus, ETM bus, PI bus, and VHSIC Electrical Specification. (Copies available from Naval Research Laboratory, Code 5305, Wash DC 20375-5000).
ANSI/IEEE 1029	Waveform and Vector Exchange Specification.
MIL-HDBK-179(ER)	Microcircuit Application Handbook.
JEDEC-STD-17	Latch-Up in CMOS Integrated Circuits.
DI-EGDS-80811	VHSIC Hardware Description Language (VHDL) Documentation.

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3. Definitions.

3.1 Microelectronic devices. Monolithic, hybrid, rf and microwave (hybrid/integrated circuits, multichip microcircuits, and microcircuit modules).

3.2 Advanced microcircuit module technology. Microcircuit module fabrication and design technology which is newly available for prototype designs and will be available for production in the near future (2 to 5 years). For digital microcircuits, the performance capability can be approximately characterized by the minimum feature size, the clocking frequency, and the functional throughput rate.

3.3 VHSIC hardware description language (VHDL). A high level computer language developed under the VHSIC program for describing the signal structure of electronic hardware (chips, modules, and subsystems). The language describes the signal flow and the structure of the device in terms of the basic circuit models, fundamental logic blocks, and higher level functional assemblies of logic blocks.

3.4 Qualified device (microcircuit). Any device or microcircuit which has met the requirements of MIL-H-38534, or MIL-I-38535 and is listed on the associated QML/QPL listings.

3.5 Waveform and vector exchange specification (WAVES). A high level computer language for describing test vector and waveform stimuli for electronic hardware (chips, modules, and subsystems). The WAVES is compatible with the VHDL simulation language and simulation environments.

3.6 Application specific integrated circuit (ASIC). Any microcircuit that is custom designed or any programmable microcircuit (e.g. EPROM, EEPROM, UVEEPROM, PLA, PLD, gate array, sea of gates, standard cell library, etc.) that is programmed or personalized to perform a specific equipment or custom function.

3.7 VHSIC. Very high speed integrated circuit.

4. Requirements.

4.1 Selection.

4.1.1 Technology. At each stage in new and re-engineered system designs, i.e., concept studies, demonstration and validation, and engineering and manufacturing development, the advanced microcircuit module technologies which meet reliability, performance, and cost requirements of the application shall be evaluated for use in the production phase.

4.1.2 Reliability. Microelectronic devices in military systems which are in engineering and manufacturing development and production shall, as a minimum, conform to the applicable product assurance level of MIL-H-38534 or MIL-I-38535.

4.1.3 Order of precedence. Unless otherwise specified, the order of precedence shall be as follows: This requirement shall be superseded upon publication and DoD/Industry fully coordinated acceptance of the proposed DoD Microcircuit Application Handbook or Standard. This document will provide guidance on how the DoD and its contractors can select devices based on cost effective performance, designed in high quality, and reliability for a given application.

- a. Microcircuits listed in table I of MIL-STD-1562. Microcircuits with dated military specifications, fully compliant to the QML (MIL-H-38535 and MIL-H-38534).
- b. Microcircuits listed in table II of MIL-STD-1562. Microcircuits compliant to the Standard Military Drawing Program, and other MIL-H-38534 compliant microcircuits not listed in tables I and II of MIL-STD-1562.
- c. Other microcircuits (see 4.1.5), subject to acquiring activity approval.

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4.1.4 Qualified devices. When the contract or purchase order for new designs, or redesign, or part level, or qualified part upgrade of military hardware specifies the use of a MIL-STD-883 class B or S microcircuit, and there is a qualified device of the required generic chip and package type or case outline, the qualified device shall be the preferred device authorized in that design.

4.1.4.1 Space applications. When qualified devices are not available or cannot be qualified by the manufacturer, the requirement of MIL-STD-975 or MIL-STD-1547 shall apply.

4.1.4.2 Other applications. When a qualified device does not exist and a SMD device of the required generic chip and package type or case outline does exist, the SMD device shall be the preferred device authorized for that design.

4.1.5 Other microcircuits. For other than qualified devices, the following information shall be included in the nonstandard part approval request (except where identification of a military detail specification or SMD number satisfies this requirement or other direction is given):

- a. Device nomenclature, marking, configuration, functional requirements, parameters and limits sufficient to insure the required form functions and interchangeability.
- b. Required environmental, endurance (life) and other design capability tests.
- c. Quality assurance requirements, including screening and lot quality conformance (acceptance) tests. As a minimum, devices shall be procured to all the requirements of MIL-STD-883 paragraph 1.2.1. The applicable detail specification, SMD or vendor/contractor document shall be specified for electrical performance, mechanical, and final electrical test requirements.
- d. An evaluation of the projected availability and product assurance status of the device at the time of production and through the projected life of the system.
- e. Device design and test documentation in the VHDL and WAVES format (see 4.5.3 and 4.5.4).

4.1.6 Electrostatic sensitive parts. Microcircuits are susceptible to electrostatic discharge (ESD) damage. Microcircuit susceptibility is classified in MIL-STD-1686 and test method 3015 of MIL-STD-883. When device susceptibility is not available, it can be determined using test method 3015 or appendix B of MIL-STD-1686. Microcircuits from the ESDS Class necessary to meet ESD requirements shall be selected. ESD susceptibility of microcircuits are listed in the associated QML/QPL listings of MIL-H-38534 or MIL-I-38535 for the individual devices.

4.1.7 Latchup test. Latchup testing shall be performed on applicable technologies (i.e., CMOS) per JEDEC-STD-17 as a minimum.

4.2 Programmable devices. Use of programmable devices, regardless of type, requires approval of the procuring activity.

4.3 Fusible link devices. When fusible link devices (PROMs, PALs, PLDs, etc.) are programmed by the user, parametric and functional electrical tests in accordance with MIL-STD-883, method 5005, group A, subgroups 7 and 9 as a minimum, shall be performed after programming to verify the specific program configuration and effectiveness of link fusing.

4.4 Packages. Microcircuit devices used in equipment shall be hermetically sealed in glass, metal or ceramic (or combinations of these) packages. No organic or polymeric materials such as lacquers, varnishes, coatings, or greases shall be used inside the microcircuit package, unless otherwise specified. No desiccants shall be contained in the microcircuit package, unless otherwise specified. Organic or polymeric materials (e.g. adhesives) compliant to MIL-STD-883, test method 5011, are permitted inside the microcircuit package when specified in the appropriate military specification or SMD.

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4.4.1 Use of plastic encapsulated microcircuits. Upon specific request and approval by the procuring activity to waive the requirements of 4.1, plastic encapsulated microcircuits may be considered for use in ground fixed (GF) or ground benign (GB) environments as defined in MIL-HDBK-217. They should meet all the requirements of the equipment specification. Temperature and humidity shall be completely controlled in transit, storage, and application. This requirement shall be superseded upon publication and DoD/Industry fully coordinated acceptance of the proposed DoD Microcircuit Application Handbook or standard. For Army applications, use of MIL-HDBK-179(ER) is recommended.

4.5 Device design and test documentation.

4.5.1 ASIC documentation in VHDL. Digital Application-specific integrated circuits (ASICs) shall be documented by means of structural and behavioral VHSIC hardware description language (VHDL) descriptions in accordance with ANSI/IEEE 1076, (see 5.6). Behavioral VHDL descriptions shall include function and timing at the ports accurate enough to enable the performance of test generation and determination of fault detection/fault isolation levels at the integrated circuits pins when performing board or subsystem simulations.

4.5.2 Fault coverage. For all digital microcircuits, fault coverage shall be documented in accordance with MIL-STD-883 test method 5012 for all manufacturing-level logic tests.

4.5.3 Qualified device documentation in VHDL. Digital qualified devices used in board level applications shall be documented by means of behavioral VHDL descriptions in accordance with ANSI-IEEE 1076, (see 5.6). Behavioral VHDL descriptions shall include function and timing at the port accurate enough to perform test generation and determine fault detection/fault isolation levels at the integrated circuit pins.

4.5.4 ASIC test stimuli documentation in WAVES. Digital ASICs shall have all test vectors and test waveforms documented and delivered to the Government in the WAVES format.

4.6 Cost considerations. Microelectronic devices shall be selected on the basis of overall life cycle cost.

5. Information for guidance only.

5.1 Technology progression. The use of advanced microcircuit technology should be considered and evaluated in the design of all systems/equipment. For critical weapon systems applications, and for system development schedules projected to be longer than four years, the performance advantages provided by advanced technologies should be evaluated early in the system development phases for use in the procurement stage.

5.2 Reliability.

5.2.1 Reliability prediction. When required, microcircuit reliability predictions should be prepared in accordance with MIL-HDBK-217, or with procuring activity approval by using specific test and/or field rate data.

5.2.2 Reliability assurance. A plan should be in place to assure that microelectronic devices meet the reliability requirement of paragraph 4.1.2 at the time of engineering and manufacturing development. This plan should provide for resubmission of parts list, if so invoked by contract, through DESC/MPCAG prior to procurement of parts to be used in actual production to assure that all evaluations are based on the most recent standardization status.

5.3 Microcircuit obsolescence. Due to rapid technology advances, many military and commercial microcircuits listed in specifications and catalogs are either obsolete or are nearing obsolescence. The use of these devices will affect the mission objectives of the using equipment. For Navy equipment, current information on microcircuits that may be nearing obsolescence may be obtained from the Naval Air Warfare Center, Code 435, Indianapolis, IN 46219-2189, telephone (317) 353-3767.

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5.4 Testability. New and upgraded systems should exploit chip level built-in-test features to enhance the testability and operational availability of the module or system. When advanced digital modules or boards are developed, microcircuits incorporating the ETM-BUS or TM-BUS should be used.

5.5 Life cycle cost evaluation. The following factors should be considered in estimating life cycle costs associated with selection of microcircuit devices or technologies:

- a. Effect of built-in-test on repair, maintainability, operational availability, and reconfigurability.
- b. Value of VHDL descriptions of chips, modules, and boards in resupply, multiple source development, and design upgrade.

5.6 ASIC documentation reference. Data item description, DI-EGDS-80811 provides the documentation preparation and delivery instructions for ASIC documentation.

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REQUIREMENT 71

CABLE AND WIRE, INTERCONNECTION

1. Purpose. This requirement establishes criteria for the selection and application of electric cable and wire used for interconnection between units.

2. Documents applicable to Requirement 71:

00-W-343	Wire, Electrical, Copper (Uninsulated).
MIL-C-17	Cables, Radio Frequency, Flexible and Semi-Rigid, General Specification For.
MIL-W-76	Wire and Cable, Hookup, Electrical, Insulated, General Specification For.
MIL-C-442	Cable, Wire, Two Conductor, Parallel.
MIL-C-3432	Cables, (Power and Special Purpose) and Wire, Electrical (300 and 600 Volts).
MIL-W-5086	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy.
MIL-W-5846	Wire, Electrical, Chromel and Alumel, Thermocouple.
MIL-C-7078	Cable, Electric, Aerospace Vehicle, General Specification for.
MIL-W-8777	Wire, Electrical, Silicone-Insulated, Copper, 600 Volt, 200°C.
MIL-C-13777	Cable, Special Purpose, Electrical, Conductors, General Specification For.
MIL-W-16878	Wire, Electrical, Insulated, General Specification For.
MIL-W-19150	Wire, Insulated, Hard Drawn Copper.
MIL-C-19547	Cable, Electrical, Special Purpose, Shore Use.
MIL-W-22759	Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy.
MIL-C-23437	Cable, Special Purpose, Electrical.
MIL-C-24640	Cable, Electrical, Lightweight for Shipboard Use, General Specification for.
MIL-W-25038	Wire, Electrical, High Temperature and Fire Resistant, General Specification for.
MIL-C-27072	Cable, Power, Electrical and Cable, Special Purpose, Electrical, Multiconductor and Single Shielded, General Specification for.
MIL-C-27500	Cable, Power, Electrical and Cable Special Purpose, Electrical, Shielded and Unshielded, General Specification for.
MIL-C-55021	Cable, Electrical, Shielded Singles, Shielded and Jacketed Singles, Twisted Pairs and Triples, Internal Hookup, General Specification for.

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MIL-W-81044	Wire, Electric, Crosslinked Polyalkene, Crosslinked Alkane-imide Polymer, or Polyarylene Insulated, Copper or Copper Alloy
MIL-W-81381	Wire, Electric, Polyimide-Insulated, Copper or Copper Alloy.
MS25471	Wire, Electrical, Silicone Insulated, Copper, 600 Volt, 200°C, Polyester Jacket.
MS27110	Wire, Electrical, Silicone Insulated, Copper, 600 Volt, 200°C, FEP Jacket.
ASTM A580	Standard Specification for Stainless and Heat Resistant Steel Wire.
ASTM-B33	Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

3. Definitions.

3.1 Interconnecting wire. Insulated, single-conductor wire used to carry electric current between units.

3.2 Interconnecting cable. Two or more insulated conductors contained in a common covering or one or more insulated conductors with a gross metallic shield outer conductor used to carry electrical current between units.

4. Requirements.

4.1 Wire selection. Selection of wire for interconnection between units shall be in accordance with table 71-I.

4.2 Multiconductor cable selection. Selection of multiconductor cable for interconnection between units shall be in accordance with table 71-II.

4.3 Application restrictions.

- a. MIL-W-76 shall be used for Army application only (see 4.3.3).
- b. MIL-W-16878 shall not be used for Air Force or Navy aerospace applications.
- c. Cable or wire with polyvinyl chloride insulation shall not be used in aerospace applications. Use of these wires or cables in any other application requires prior approval of the procuring activity.
- d. MIL-W-22759 wire with only single polytetrafluoroethylene insulation used in Air Force space and missile applications shall require the approval of the procuring activity.
- e. Use of aluminum wire requires specific approval by the procuring activity.
- f. Silver plated copper wire shall not be used in applications involving Army missile systems.

5. Information for guidance only.

5.1 Rf signals. All interconnecting cables carrying rf signals should be coaxial cables or waveguides and should be terminated, when possible, in the characteristic impedance of the transmitting media.

TABLE 71-1. Wire, electrical, interconnection.

Spec no.	Title	Spec type or class	Construction						Max cond temp °C	Max rms volts	Remarks
			Conductor 1/		Insulation 2/		Jacket/topcoat				
			Material	Coating	Type	Primary cover		Primary			
MIL-V-76	Wire and cable, hookup, electrical insulated	LV	Cu/A or CCU	Sn	S, Str	1	8, 10, 13A 3/	8, 10, 13A 3/	300	See notes 4 and 5. For Army use only	
		MH							1000		
		HV							2500		
		HF							1000		
MIL-V-5086	Wire, electric, PVC insulated, copper or copper alloy	MS086/1	Cu/A	Sn	Str	1	13A	8	600	Medium weight	
		MS086/2							105		
		MS086/3							8, 11		
		MS086/4							8		
		MS086/5							110		
		MS086/6							9A		
		MS086/7							8		
MIL-V-8777	Wire, electrical, silicone insulated, copper, 600 V 200°C	MS25471	Cu/A	Ag	Str	6	13A	12	600	See note 4	
		MS27110							4A		

See footnotes at end of table.

TABLE 71-1. Wire, electrical, interconnection - Continued.

Spec no.	Title	Spec type or class	Construction						Max cond temp °C	Max rms volts	Remarks
			Conductor 1/		Insulation 2/						
			Material	Coating	Type	Primary	Primary cover	Jacket/topcoat			
MIL-W-16878	Wire, electrical, insulated, high temperature	M16878/1	Cu/A,	Ag, Sn	1	8, 10, 11	1, 8, 10, 11	105	600	See note 4	
		M16878/2									
		M16878/3									
		M16878/4	HSA,	3A	3A, 3B, 4A	200	600				
		M16878/5									
		M16878/6									
		M16878/7	Cu/A	Ag	6	4A, 8, 10, 11	600				
		M16878/8									
		M16878/10									
		M16878/11	Cu/A	Sn	S, Str	2A	8, 10, 11	75	1000		
		M16878/12									
		M16878/13									
		M16878/14	CCW	Ag	4A	4A	200	250	600		
		M16878/15									
		M16878/16									
		M16878/17	Cu/A, RSA, CCW	Ag, Sn	2C		125	600	3000		
		M16878/18									
					Ag, Sn	1	8	105	1000		

See footnotes at end of table.

TABLE 71-1. Wire, electrical, interconnection - Continued.

Spec no.	Title	Spec type or class	Conductor 1/						Insulation 2/				Max cond temp °C	Max rms volts	Remarks
			Material	Coating	Type	Primary cover	Primary	Jacket/topcoat	Max cond temp °C	Max rms volts					
											Material	Coating			
MIL-W-16878 (contd)	Wire, electrical, insulated, high temperature	M16878/19		Ag, Sn			1					3000	See note 4		
		M16878/20										250			
		M16878/21		Ag			3B				200	600			
		M16878/22	Cu/A,				3A				1000				
		M16878/23	RSA,				3B				250				
		M16878/24	CCV				3A		3A, 3B, 4A		260	600			
		M16878/25		Ni			3B		13B, 3/			1000			
		M16878/26					3A								
		M16878/27					3B								
		M16878/28					3A								
		M16878/29					3B								
		M16878/30		Cu/A	Sn	Str		6			150	600			
		M16878/31										1000			
		M16878/32			Ag						200				
		M16878/33		Cu/A, CCV	Sn	S, Str		2A			75	600			
M16878/34		Cu/A	Ag	Str		3B			200	1000					
M16878/35			Ni						260						
MIL-W-19150	Wire, insulated, hard-drawn copper		Cu/H			2A		8							

See footnotes at end of table.

TABLE 71-1. Wire, electrical, interconnection - Continued.

Spec no.	Title	Spec type or class	Conductor 1/				Insulation 2/			Max cond temp °C	Max rms volts	Remarks
			Material	Coating	Type	Primary	Primary cover	Jacket/topcoat				
MIL-W-22759	Wire, electrical, fluoropolymer -insulated, copper or copper alloy	M22759/1		Ag	Str	3A,3B,3D	13B	4A	200	600		
		M22759/2		Ni		3D			260			
		M22759/3				3B,3D			200			
		M22759/4		Ag					260			
		M22759/5				3C			200			
		M22759/6		Ni					200			
		M22759/7	CuA	Ag					260			
		M22759/8		Ni					200			
		M22759/9		Ag					260			
		M22759/10		Ni		3A			1000			
		M22759/11		Ag					200			
		M22759/12		Ni					260			
		M22759/13		Sn					600			
		M22759/14				4A			135			
		M22759/15	HSA	Ag								

See footnotes at end of table.

TABLE 71-i. Wire, electrical, interconnection - Continued.

Spec no.	Title	Spec type or class	Conductor 1/				Construction			Insulation 2/	Max cond temp °C	Max rms volts	Remarks
			Material	Coating	Type	Primary	Primary cover	Jacket/topcoat					
MIL-W-22759 (contd)	Wire, electrical, fluoropolymer-insulated, copper or copper alloy	M22759/16	Cu/A	Sn	18	3A	7B	20	150	600	Light weight Medium weight Light weight Light weight		
		M22759/17	HSA	Ag									
		M22759/18	Cu/A	Sn									
		M22759/19		Ag									
		M22759/20											
		M22759/21	HSA	Ni									
		M22759/22		Ag									
		M22759/23		Ni									
		M22759/28	Cu/A	Ag								Str	
		M22759/29		Ni									
		M22759/30	HSA	Ag									
		M22759/31		Ni									
		M22759/32	Cu/A	Sn									
		M22759/33	HSA	Ag									
		M22759/34	Cu/A	Sn									
M22759/35	HSA	Ag											
M22759/41	Cu/A	Ni											
M22759/42	HSA												
M22759/43	Cu/A	Ag	20	150	600								
								200					

See footnotes at end of table.

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TABLE 71-1. Wire, electrical, interconnection - Continued.

Spec no.	Title	Spec type or class	Construction								Max cond temp °C	Max rms volts	Remarks
			Conductor 1/			Insulation 2/							
			Material	Coating	Type	Primary	Primary cover	Jacket/topcoat					
MIL-W-25038	Wire, electrical, high temperature and fire resistant	M25038/1	Cu/A	Ni clad	Str	15	38	138		288	600	Critical circuits where electrical integrity must be maintained during fire (1093°C flame/5 min)	
MIL-W-81044	Wire, electrical, cross-linked, polyalkene, cross-linked alkaneimide polymer, etc insulated, copper or copper alloy	M81044/6	Cu/A	Sn	Str	28				150	600	Sheets /12 and /13 lt wt. See note 4 Sheets /9 and /10 med wt. See application temp stipulated on detail specification sheet	
			HSA	Ag									
			Cu/A	Sn									
			HSA	Ag									
			Cu/A	Sn									
		M81044/12	Cu/A	Sn									
		M81044/13	HSA	Ag									

See footnotes at end of table.

TABLE 71-1. Wire, electrical, interconnection - Continued.

Spec no.	Title	Spec type or class	Conductor Y/						Insulation Z/			Max cond temp °C	Max rms volts	Remarks
			Material	Coating	Type	Primary	Primary cover	Jacket/topcoat	Material	Coating	Type			
MIL-W-81381	Wire, Electric, Polyimide Insulated, Copper or Copper Alloy	M81381/7	Cu/A	Ag	Str	7A				17		200	600	Sheets /7 thru /10 lt wt. Sheets /11 thru /14 med wt. Sheets /17 thru /20 lt wt, single wrap primary interconnect wiring where wt, space, and high temp capability are critical sheets /7 thru /10 & /17 thru /20 - see note 4
		M81381/8		Ni										
		M81381/9	HSA	Ag										
		M81381/10		Ni										
		M81381/11	Cu/A	Ag										
		M81381/12		Ni										
		M81381/13	HSA	Ag										
		M81381/14		Ni										
		M81381/17	Cu/A	Ag										
		M81381/18		Ni										
		M81381/19	HSA	Ag										
		M81381/20		Ni										
M81381/21	Cu/A	Sn												
M81381/22														

See footnotes at end of table.

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NOTES:

1/	<u>Conductor Code</u>	<u>Description</u>
Material	Cu/A	Copper, annealed
	Cu/H	Copper, hard-drawn
	CCW	Copper covered steel
	HSA	High strength copper alloy
	Al	Aluminum
Coating	Sn	Tin
	Ag	Silver
	Ni	Nickel
Type	S	Solid
	Str	Stranded
2/	<u>Insulation Code</u>	<u>Description</u>
	1	Polyvinyl chloride/extruded
	2A	Polyethylene/extruded
	2B	Polyalkene/cross-linked extruded
	2C	Polyethylene/cross-linked/modified/extruded
	3A	Polytetrafluoroethylene/extruded (TFE Teflon)
	3B	Polytetrafluoroethylene/tape
	3C	Polytetrafluoroethylene/mineral filled/extruded
	3D	Polytetrafluoroethylene impregnated glass type
	4A	Fluorinated-ethylene propylene/extruded (FEP Teflon)
	4B	Fluorinated-ethylene propylene/dispersion
	5	Monochlorotrifluoroethylene/extruded (Kel-F)
	6	Silicone rubber/extruded
	7A	FEP/polyimide film (Kapton)
	7B	Polymide lacquer (Pure ML)
	8	Polymide/extruder (Nylon)
	9A	Polyvinylidene fluoride/extruded (Kynar)
	9B	Polyvinylidene fluoride/extruded/cross-linked
	10	Braid/synthetic yarn/lacquer impregnated
	11	Braid/nylon/impregnated
	12	Braid/polyester/impregnated
	13A	Braid/glass fiber/impregnated
	13B	Braid/TFE coated glass fiber/TFE finish
	14	Braid/asbestos/TFE impregnated
	15	Braid, weave or warp/inorganic fiber
	16	Alkane-imide polymer/extruded/cross-linked
	17	Modified aromatic polyimide
	18	Ethylene-tetrafluoroethylene/extruded (Tefzel)
	19	Polyarylene/extruded
	20	Cross-linked, extruded, modified ethylene-tetrafluoroethylene

3/ When specified on purchase order.

4/ Wire intended for use in electronic equipment hook-up applications. It may also be used as an interconnecting wire when an additional jacket or other mechanical protection is provided.

5/ Various combinations of primary, primary cover, and jacket insulations and unshielded, shielded, etc, constructions are available to meet application requirements. See detail wire specification.

TABLE 71-11. Cable, multiconductor, interconnection.

Spec. no.	Title	Basic wire specs	Conductor		Shield braid 1/			Jacket 1/		Remarks	
			No. of cond.	Volts rms	Temp 2/	Strand material	Strand coating	% Coverage	Material 3/		Type
MIL-C-442	Cable, two (wire), two conductor, parallel	OO-V-343 & insulation	2	300	Flexibility at -40°C or -55°C				Vinyl-polymer or synthetic (styrene butadiene) rubber or natural rubber	Lead wire for firing explosive charges	
MIL-C-3432	Cables (power and special purpose) & wire, electrical (300 & 600 V)	OO-V-343 & insulation	Unlimited & mixed sizes	300 & 600	-40°C to +65°C or -55°C to +75°C	None or copper	Tin	85	Styrene butadiene Rubber, chloroprene rubber, ethylene-propylene rubber, ethylene-propylene-diene rubber, polyurethane thermoplastic elastomer, or natural rubber	Extruded & vulcanized	
			5/ 3/								
MIL-C-7078	Cable, electric aerospace vehicle	MS086/1 MS086/2 MS086/3	2-7	600	105°C	Copper Copper	Tin Tin		None	Extruded or impregnated	(a) Fluorinated ethylene propylene (b) Poly-tetrafluoroethylene
			1-7		260°C 260°C	Copper Copper	Nickel Nickel	85 85	(a) (b)	Extruded or tape	
			1-7		100°C	Copper	Tin	85	Polyvinylidene fluoride	Extruded	
		MB1044/9	200°C 200°C	Copper	Nickel	85	FEP/polyimide	Film tape			
		MB1381/11	200°C	Copper	Nickel	85	FEP/polyimide	Film tape			
MB1381/12 MB1381/13	150°C 200°C	Copper Copper	Tin Nickel	85 85	FEP/polyimide	Film tape					

See footnotes at end of table.

TABLE 71-II. Cable, multiconductor, interconnection - Continued.

Spec. no.	Title	Basic wire specs	Conductor			Shield braid 1/			Jacket 1/		Remarks
			No. of cond.	Volts rms	Temp 2/	Strand material	Strand coating	% Coverage	Material 3/	Type	
MIL-C-13777	Cable, special purpose electrical	MIL-C-17 QQ-W-343 ASTM 580A & insulation	2-78 6/	600	-53°C to +71°C	Copper	Tin	80	Sheath poly-chloroprene primary insulation polyethylene	Extruded & vulcanized extruded	See note 7
MIL-C-19547	Cable, electrical, special purpose shore use	ASTM B33 & insulation	Multiple twisted pairs, 6-100 pairs	600	75°C	Corrugated aluminum		100	Polyethylene	Extruded	For use as telephone & telegraph signal cables in shore communications
MIL-C-23437	Cable, special purpose electrical	MIL-W-16878/1	Shielded & Jacketed twisted pairs 1 pair - 104 pairs	600	105°C	Copper	Tin	90	PVC	Extruded	For use within shore communications stations, not to be used on board ship
MIL-C-24640	Cable, electrical, light weight for shipboard use	MIL-W-81044	2-77 pair	600	150°C	Copper tape	Tinned	85	Crosslinked polyalkene, crosslinked alkanamide polymer, or polyarylene	Extruded	

See footnotes at end of table.

TABLE 71-11. Cable, multi-conductor, intersconnection - Continued.

Spec. no.	Title	Basic wire specs	Conductor			Shield braid 1/			Jacket 1/		Remarks	
			No. of cond.	Volts rms	Temp 2/	Strand material	Strand coating	% Coverage	Material 3/	Type		
MIL-C-27072	Cable, special purpose, electrical, multi-conductor	MIL-C-17	2-36	Various	Temp 2/	Copper	Tin, Silver	85	Sheath of PVC, polyethylene, polychloroprene, polyamide, TFK-teslon, or FEP-teslon		Flexible multi-conductor cable for use in protected, wire ways, instrument racks, and conduit, polyethylene jacketed cable suitable for underwater or direct burial applications only. M16878/6 and /13 not for aerospace applications only. M16878/6 and /13 not for aerospace applications.	
		MIL-V-5846	Various	Not Spec								
		M16878/1	600	105°C								
		M16878/2	1000	105°C								
		M16878/3	3000	105°C								
		M16878/4	600	200°C								
		M16878/5	1000	200°C								
		M16878/6	250	200°C								
		M16878/10	600	75°C								
		M16878/13	250	200°C								
		Note: MIL-C-27072 applicable detail specification sheets control materials for each specific cable configuration.										

See footnotes at end of table.

TABLE 71-II. Cable, multiconductor, interconnection - Continued.

Spec. no.	Title	Basic wire specs	Conductor			Shield braid 1/			Jacket 1/		Remarks
			No. of cond.	Volts rms	Temp 2/	Strand material	Strand coating	% Coverage	Material 3/	Type	
MIL-C-27500	Cable, power, electrical and cable and special purpose, electrical, shielded and unshielded	MIL-W-8777	1-7	600	200°C	Various	Various	85	Various	Braided	For general aerospace flight vehicle applications
		MIL-W-22759	1-7	Various	Various	Various	Various	85	Various	Extruded or braided	
		MIL-W-25038	1-7	600	260°C	Various	Various	85	TFE coated glass fiber	Braided	
		MIL-W-81064	1-7	600	150°C	Various	Various	85	Various	Extruded	
		MIL-W-81381	1-7	600	Various	Various	Various	85	Various	Tape	
MIL-C-55021	Cable, twisted pairs & triples, internal hookup	MIL-W-16878	2-3	600 to 1000	-40°C to +105°C or -65 °C to +200°C	None or Copper	Tin, Silver or Nickel	90	None PVC, Nylon TFE-Teflon	Extruded extruded or tape	

See footnotes at end of table.

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NOTES:

- 1/ See applicable detail specification sheet for materials control of specific cable configurations.
- 2/ See applicable detail specification sheet for temperature limitations.
- 3/ Polyester: Polyethylene terephthalate
TFE-teflon: Polytetrafluoroethylene
PVC: Polyvinyl chloride (not to be used in airborne applications)
KEL-F: Polymonochlorotribluoroethylene
FEP-teflon: Fluorinated ethylene propylene
PVF: Polyvinylidene fluoride
- 4/ Although the specification does not limit the number of conductors in a cable, the size, weight, and flexibility are determining factors.
- 5/ Available in three classifications:
 - Class L: Light duty: To withstand severe flexing and frequent manipulation.
 - Class M: Medium duty: To withstand severe flexing and mechanical abuse.
 - Class H: Heavy duty: To withstand severe flexing and mechanical abuse and ability to withstand severe service impacts such as to be run over by tanks or trucks.
- 6/ See applicable detail specification sheet for mechanical test requirements for cold bend, cold bend torque, impact bend, and twist.
- 7/ For use under abuse mechanical conditions and where resistance to wether, oil and ozone are requirements.

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REQUIREMENT 78

PRODUCIBILITY

1. Purpose. This requirement offers guidance as to producibility requirements which should be considered when preparing contractual documents. It does not establish requirements, and must not be referenced in contractual documents. Producibility program tasks, quantitative requirements, and verification or demonstration requirements must be directly specified in the contract or the system and/or equipment specification, as appropriate.

2. Documents applicable to Requirement 78:

DoD 4245.7M	Transition from Development to Production.
NAVSO P-3679	Producibility Measurement Guidelines.
NAVSO P-6071	Best Practices.
MIL-HDBK-727	Design Guidance for Producibility.

3. Definitions. Not applicable.

4. Requirements. Not applicable.

5. Information for guidance only.

5.1 Producibility program. Producibility engineering and planning tasks aimed at preventing, detecting, and correcting manufacturability design deficiencies and providing producibility related information essential to acquisition, operation, and support management should be included in contract requirements with the objective of establishing and maintaining an efficient producibility program according to program phase. NAVSO P-3679 is the overall program document for the subject. The successful creation and management of a producibility program is detailed in Section 2.

5.2 Producibility measurement. Producibility measurement and assessment tools are a critical part of insuring a product is ready for production. Sections 3 and 4 of NAVSO P-3679 give two industry examples of measurement and assessment tools.

5.3 Quantitative requirements. Quantitative producibility requirements and verification or demonstration requirements should be established as appropriate to program phase. Producibility measurement is an essential part of the design process which can determine the probability of successful production. Minimal tailoring should be required when NAVSO P-3679 is applied to a program. Other producibility documents which may be cited directly as a basis for contract requirements include DoD 4245.7M, NAVSO P-6071, and MIL-HDBK-727.