MILITARY STANDARD

STANDARD GENERAL REQUIREMENTS FOR ELECTRONIC EQUIPMENT

TO ALL HOLDERS OF MIL-STD-454K:

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

NEW PAGES	DATE	SUPERSEDED PAGES	DATE
4-1 thru 4-2	29 Aug 86	4-1 thru 4-2	26 Sep 77
7-1	29 Aug 86	7-1	1 Mar 73
8-1 thru 8-3	29 Aug 86	8-1 thru 8-3	30 Aug 84
9-1 thru 9-3	29 Aug 86	9-1 thru 9-3	1 Sep 78
14-1 thru 14-2	29 Aug 86	14-1 thru 14-2	10 Jan 83
20-1 thru 20-5	29 Aug 86	20-1 thru 20-5	1 Mar 85
30-1 thru 30-2	29 Aug 86	30-1	1 Sep 82
36-1 thru 36-2	29 Aug 86	36-1 thru 36-2	15 Mar 80
52-1 thru 52-2	29 Aug 86	52-1 thru 52-2	14 Feb 86
59-1	29 Aug 86	59-1	10 Jun 68
69-1 thru 69-7	29 Aug 86	69-1 thru 69-7	10 Sep 81
72-1	29 Aug 86	72-1	15 Mar 78
I1-1 thru I1-6	29 Aug 86	I1-1 thru I1-6	14 Feb 86
I2-1 thru I2-4	29 Aug 86	I2-1 thru I2-4	14 Feb 86

2. MAKE THE FOLLOWING PEN AND INK CHANGES:

a. Requirement 1, paragraph 10.3, line 2 - Delete "runless" and substitute "unless".

b. Requirement 64, paragraph 4.d, line 2 - Delete "proposal" and substitute "approval".

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

4. Holders of MIL-STD-454K 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 cancelled.

Custodians:
Army - ER
Navy - AS
Air Force - 11

Review activities:
Army - AR, AV, CR, ME, MI
Navy - EC, OS, SH
Air Force - 17, 19, 85
DLA - ES, IS
FAA

Preparing activity:
Air Force - 10

Agent:
Air Force - 11

Project GDRQ-0037

FSC GDRQ

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REQUIREMENT 4

FUNGUS-INERT MATERIALS

1. Purpose. This requirement identifies those materials which are acceptable nonnutrients of fungus and establishes the conditions or treatments under which fungus nutrients are acceptable.

2. Documents applicable to Requirement 4:

* MIL-STD-810 Environmental Test Methods and Engineering Guidelines
Code of Federal Regulations, Title 29, Chapter XVII, Part 1910

3. Materials

* a. For new designs, only inherently fungus-inert materials shall be used; however, other materials may be used in hermetically sealed assemblies or other applications specifically approved by the procuring activity.

* b. If it is necessary to use materials which are not inherently fungus-inert in other than the above approved applications, they shall be treated by a method that will render the exposed surface fungus-resistant so that they will pass the test of 3.2. When materials are compounded with a permanently effective fungicide in order to pass the fungus test, there shall be no loss of the original electronic or physical properties required by the basic materials specification.

* 3.1 Fungus susceptibility. Group I in table 4-I lists those materials which are considered to be fungus-inert in all modified states and grades. Group II lists materials which are not fungus-inert in all grades and therefore the fungus resistance of the materials selected shall be confirmed by testing in accordance with 3.2. The appearance of a particular material in table 4-I does not constitute approval for its use except from the viewpoint of the resistance of the material to fungus.

* 3.2 Fungus testing. Group II and treated materials selected for other than approved applications (see para 3) shall be subjected to the fungus test specified in MIL-STD-810, Method 508, for a period of 28 days. The pass/fail criteria shall be determined by the procuring activity using the data of table 508-1 and paragraph I-4.1. Certification by a qualified laboratory or by the material producer, based upon test data on record that the selected material meets Grade 0 or Grade I requirements, will be sufficient evidence of acceptability.

3.2.1 Nonplastic materials. All nonplastic materials to be tested for fungus-susceptibility in accordance with 3.2, such as paint, ink, coatings, adhesives, lubricants, rubber, viscous damping fluids, silicone grease, etc, shall be prepared in the form of 2-inch squares or circles no more than 1/16-inch thick for testing. Liquid or paste materials shall be prepared by impregnating to saturation a sterile sample of glass fabric.

3.3 Carcinogens. Certain chemicals have been identified in the Occupational Safety and Health Act (OSHA) as cancer-producing substances (carcinogens). Before using any materials which might contain these chemicals, they should be evaluated in accordance with the Code of Federal Regulations, Title 29, Chapter XVII, Part 1910. Consideration of the toxicity of a substance shall be given prior to material selection.

Table 4-I. Fungi Susceptibility of Materials

GROUP I (Fungus-inert in all modified states and grades)	
Acrylics	1/ Polyamide
Acrylonitrile-styrene	Polycarbonate
Acrylonitrile-vinyl-chloride copolymer	Polyester-glass fiber laminates
Asbestos	Polyethylene, high density (above 0.940)
Ceramics	Polyethylene terephthalate
Chlorinated polyether	Polyimide
Fluorinated ethylenepropylene copolymer (FEP)	Polymonochlorotrifluoroethylene
Glass	Polypropylene
Metals	Polystyrene
Mica	Polysulfone
Plastic laminates:	Polytetrafluoroethylene
Silicone-glass fiber	Polyvinylidene chloride
Phenolic-nylon fiber	Silicone resin
Diallyl phthalate	Siloxane-polyolefin polymer
Polyacrylonitrile	Siloxane-polystyrene

GROUP II (Not fungus-resistant in all grades; fungus-resistance shall be established by test)	
ABS (acrylonitrile-butadiene-styrene)	Polyethylene, low and medium density (0.940 and below)
Acetal resins	Polymethyl methacrylate
Cellulose acetate	Polyurethane (the ester types are particularly susceptible)
Cellulose acetate butyrate	Polyricinoleates
Epoxy-glass fiber laminates	Polyvinyl chloride
Epoxy-resin	Polyvinyl chloride-acetate
Lubricants	Polyvinyl fluoride
Melamine-formaldehyde	Rubbers, natural and synthetic
Organic polysulphides	Urea-formaldehyde
Phenol-formaldehyde	
Polydichlorostyrene	

1/ Literature shows that under certain conditions polyamides may be attacked by selective micro-organisms. However, for military applications they are considered group I.

REQUIREMENT 7

INTERCHANGEABILITY

1. Purpose. This requirement establishes criteria for the selection and application of interchangeable items.

2. Documents applicable to Requirement 7:

MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models, and Related Terms

3. Interchangeable items. Interchangeable items shall be as defined in MIL-STD-280 to permit their installation as interchangeable assemblies, subassemblies and parts without regard to the source of manufacture or supply.

4. Standard items. Standard items are defined in the applicable general specification.

4.1 Design tolerances. Provisions shall be made for design tolerances such that items having the dimensions and characteristics permitted by the item specification may be used as replacements without selection or departure from the specified equipment performance.

4.2 Use of standard items. Standard items shall be used when such items are available. When existing standard items are not available and permission is granted by the procuring activity for use of a nonstandard item only because the existing standard item is not available, the equipment shall be so designed that the nonstandard item can be replaced by the standard item. Appropriate space, mounting holes, and other necessary provisions shall be provided for this purpose unless they conflict with the specified equipment size requirement. When provision is made for substitute or replacement items, the standard item to be used for replacement shall be identified in the applicable documentation.

* 4.3 Choice of parts and materials. When the item specification provides more than one characteristic or tolerance, the item having the broadest characteristics and tolerances that will fulfill the equipment performance requirements shall be used.

REQUIREMENT 8

ELECTRICAL OVERLOAD PROTECTION

1. Purpose. This requirement establishes the criteria and philosophy for electrical overload protection.

1.1 Classification. The requirements for electrical overload protection apply to electrical and electronic equipment intended for use in the following classes. The protection philosophy differs for each classification.

a. Class 1 equipment: Ground and shipboard, including test and checkout ground equipment.

b. Class 2 equipment: Manned aerospace

c. Class 3 equipment: Unmanned aerospace

2. Documents applicable to Requirement 8:

MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models, and Related Terms
MIL-STD-1539	Electrical Power, Direct Current, Space Vehicle Design Requirements
* NFPA 70-1984	National Electrical Code

3. Application. The requirements specified herein shall apply only to equipment and systems as defined in MIL-STD-280 for class 1 and class 2 equipment and MIL-STD-1539 for class 3 equipment.

4. Protection for class 1 equipment

4.1 Current overload protection. Current overload protection for the equipment shall be provided by fuses, circuit breakers, or other protective devices for primary circuits. All multiphase power shall contain multiple breakers and shall disconnect all phases when an overload occurs in any one phase.

* 4.2 Protective devices. Devices such as fuses, circuit breakers, time-delays, cutouts, or solid-state current-interruption devices shall be used to open a circuit whenever an overload condition occurs. No overcurrent protective device shall be connected in series with any conductor which is grounded at the power source unless the device simultaneously opens all load conductor in the circuit and no pole operates independently, or as otherwise allowed by the National Electrical Code, NFPA 70. Protective devices for wired-in equipment shall be connected to the load side of the equipment power switch (main circuit power disconnect). For portable equipment a separable connector or the attachment plug and receptacle shall serve as the main circuit power disconnect and the protective device may be on either the line side or the load side of the equipment on-off switch.

4.3 Network protection. Protection of individual parts from failure of associated parts should generally not be provided; however, protection of networks, such as pulse forming networks, from the failure of a single circuit by disconnecting this circuit from the network may be required.

4.4 Fuses. All fuses providing protection to the equipment shall be so located that they are readily replaceable and located in a convenient, serviceable location. Requirement for blown fuse indicators shall be as indicated in the detail equipment specification. Where fuses are used, at least one extra fuse of each type and rating used shall be supplied and attached to the applicable units of the equipment. Panel-mounted fuse posts shall be such as to permit renewal of fuses without use of tools.

4.5 Circuit breakers. When circuit breakers are used, the restoring or switching device shall be readily accessible to the operator. The circuit breaker shall give a visual indication when the breaker is tripped. Holding the switching device closed on an overload shall not prevent tripping of the breaker. Multipole circuit breakers shall be used for three-phase equipment and shall disconnect all phases if an overload occurs in any one phase. Circuit breakers shall not be used as switches unless such breakers have been specifically designed and tested for that type service.

4.6 Normal performance. The use of overload or other protective devices shall not alter the normal performance characteristics of the source or load.

4.7 Secondary circuit. The use of protective devices in secondary circuits shall be held to a minimum. Cost and ease of replacement of the affected part or unit shall be included in the data used in determining the need for such protective devices.

5. Protection for class 2 equipment

5.1 Current overload protection. Current overload protection for the equipment shall be provided by fuses or circuit breakers to avoid hazards of fire, smoke, explosion and arc-over. Circuit breakers shall not be used as switches unless such breakers have been specifically designed and tested for that type service. In addition, overload protection of the primary power wiring to the equipment and internal wiring cable harnesses shall be provided. (Protection of the primary power wiring shall be provided by the vehicle contractor.)

5.2 Location. Overload protection for the equipment shall be provided therein. This protection shall be provided in the most advantageous portions of the circuits. All protective devices employed in the equipment shall be in a readily accessible, safe location therein.

5.3 Spare fuses. When fuses are used, a minimum of one spare fuse for each size and rating but a quantity of not less than 10 percent of the total shall be incorporated in the equipment and shall be contained in the same compartment as the used fuse.

5.4 Resettable circuit protectors. Circuit breakers or other resettable devices shall be used to protect critical circuits, or where predictable overloads or surges occur because of peculiar equipment functions or operator effects which are unavoidable. The reset controls of such devices shall be readily accessible to the operator.

5.5 Gap clearance. Fuses or circuit breakers shall have sufficient gap clearance, after breaking or clearing, to prevent arcing at any altitude at which the equipment will be required to operate.

6. Protection for class 3 equipment. Unless otherwise specified by the procuring activity, electrical overload protection shall not be provided in individual boxes or systems receiving power. Overload protection, when required, shall be part of the missile, space booster, or spacecraft electrical power control subsystems and conform to the failure protection requirement of MIL-STD-1539.

REQUIREMENT 9

WORKMANSHIP

1. Purpose. This requirement establishes the acceptable workmanship criteria for electronic equipment intended for use by the Department of Defense. This requirement will define those workmanship requirements not normally covered in subsidiary specifications or drawings. It is not intended to supersede any of the provisions of the contract or applicable specifications and drawings considered a part of the contract. Where actual conflict exists, the provisions of the contract or application specification or drawing shall take precedence over the requirement herein.

2. General. Workmanship shall be in accordance with the requirements herein and any requirements of the detail equipment specification applicable to soldering, marking of parts and assemblies, wiring, welding and brazing, plating, riveting, finishes, machine operations, screw assemblies, and freedom of parts from burrs, sharp edges, or any other damage or defect that could make the part (or equipment) unsatisfactory for the purpose intended.

3. Mounting of parts. Parts or hardware shall be assembled and secured or mounted in the specified manner to satisfactorily accomplish the purpose for which intended. Electronic equipment having missing, inoperative, defective, bent, broken, or otherwise damaged parts will not be acceptable.

3.1 Mounted hardware installation. The installation of hardware parts, such as hinges, catches, handles, or knobs, shall be accomplished in such manner as to avoid damaging the hardware or the mounting surface. Hardware or mounting surfaces damaged in this way shall be touched up to provide a continuous protective coating. A color match between the surface touched up and the original finish shall be provided.

4. Cleaning. After fabrication, parts and assembled equipment shall be cleaned of smudges; loose, spattered, or excess solder; weld metal; metal chips and mold release agents or any other foreign material which might detract from the intended operation, function, or appearance of the equipment. (This would include any particles that could loosen or become dislodged during the normal expected life of the equipment.) All corrosive material shall be removed. Whenever possible, this cleaning shall take place before the parts are assembled into the equipment. All assembled equipment shall be cleaned of contaminants such as lubricating oils, mold release agents, waxes, sand, corrosion products, solder fluxes, finger prints, dust, etc. The nature of the contaminant must be determined to the extent that a suitable cleaning solvent can be selected for item removal. The inertness of the materials of construction to the solvent must be determined to prevent damage to electrical and mechanical properties. After cleaning, moving parts should be relubricated and the assembly allowed to dry to remove trapped or soaked cleaning fluid. Cleaning processes shall have no deleterious effect on the equipment or parts.

5. Threaded parts or devices. Screws, nuts and bolts shall show no evidence of cross threading, mutilation, or detrimental or hazardous burrs.

5.1 Tightness. All screw-type fasteners shall be tight. The word tight means the screw shall be firmly secured and that there shall be no relative movement possible between the attached parts.

6. Riveting. The riveting operation shall be carefully performed in order to assure that rivets are tight and satisfactorily headed with the rivet heads tightly seated against their bearing surface.

7. Gear assemblies. Gear assemblies shall be aligned and meshed and shall be operable without interference, tight spots, loose spots, excessive backlash, or other irregularities that could cause unsatisfactory operation.

8. Bearing assemblies. Bearing assemblies shall be free of rust, discoloration, and imperfections of ground, honed, or lapped surfaces. Contacting surfaces shall be free of tool marks, gouge marks, nicks, or other surface-type defects. There shall be no detrimental interference, binding, or galling.

9. Wiring. Insulated wire running between equipments or subassemblies within an equipment, such as between drawers or chassis and module subassemblies, shall be formed into cables or ducted wherever practicable. Wires and cables shall be positioned or protected to avoid contact with rough or irregular surfaces and sharp edges.

9.1 Wire dress. Wire dress or cabling of wires shall not result in improper electrical operation or interference with mechanical operation that will lead to subsequent damage of the wire or cable. Wires and cables subject to flexing shall be protected to prevent abrasion.

* 9.2 Containment. The harness and cable form containment means shall be neat in appearance, uniformly applied, and positioned to retain critical form factors and breakout locations. The containment means (lacing, ties, tiedown straps, etc) shall not be applied so as to exert excessive pressure on the harness bundle or cable causing the wire or cable insulation to deform to the extent that their individual performance characteristics are adversely affected.

9.3 Harnesses. Cabling or wiring harnesses shall be anchored to avoid damage to conductors or adjacent parts.

9.4 Insulation. There shall be no evidence of burns, abrading, or pinch marks in the insulation that could cause short circuits or leakage.

9.5 Splicing. Wires in a continuous run between two terminals shall not be spliced during the assembly of the equipment, except where a stranded conductor is spliced to a solid conductor and the two are supported at the splice.

9.6 Clearance. The clearance between wires or cables and heat generating parts, such as electron tubes and resistors, shall be such as to avoid deterioration of the wires or cables from the heat dissipated by these parts under the specified service conditions of the equipment.

9.7 Shielding. Shielding on wires and cables shall be secured in a manner that will prevent it from contacting or shorting exposed current-carrying parts. The shielding shall terminate at sufficient distance from the exposed conductors of the cable to prevent shorting or arcing between the cable conductor and the shielding. The ends of the shielding or braid shall be secured against fraying.

10. Welding and brazing. All welds and brazes shall be free of harmful defects such as cracks, porosity, undercuts, voids, and gaps. There shall be no burn-through. Fillets shall be uniform and smooth. Angular or thickness misalignment, warpage, or dimensional change due to heat from the operation shall be within permitted tolerances. There shall be no damage to adjacent parts resulting from the welding or brazing.

REQUIREMENT 14

TRANSFORMERS, INDUCTORS, AND COILS

1. Purpose. This requirement establishes the requirements for transformers, inductors, and coils.

2. Documents applicable to Requirement 14:

	MIL-T-27	Transformers and Inductors (Audio, Power, and High Power Pulse), General Specification for
	MIL-C-15305	Coils, Fixed and Variable, Radio Frequency, General Specification for
	MIL-T-21038	Transformers, Pulse, Low Power, General Specification for
	MIL-C-39010	Coils, Fixed, Radio-Frequency, Molded, Established Reliability, General Specification for
	MIL-T-55631	Transformers, Intermediate Frequency, Radio Frequency and Discriminator, General Specification for
*	MIL-C-83446	Coils, Radio Frequency, Chip, Fixed or Variable, General Specification for
	MIL-T-83721	Transformer, Variable, Power, General Specification for
*	MIL-STD-981	Design, Manufacturing and Quality Standards for Custom Electromagnetic Devices for Space Applications
	MIL-STD-1286	Transformers, Inductors, and Coils, Selection and Use of

3. Selection. Selection of transformers, inductors, and coils shall be in accordance with MIL-STD-1286 and the following paragraphs.

4. Audio, power, and high-power pulse transformers and inductors. Audio, power, and high-power pulse transformers and inductors shall conform to MIL-T-27 with grade, class, and life expectancy as listed in table 14-I.

TABLE 14-I. Audio, power, and high power pulse transformers.

Application	Grade	Temperature class
Shipboard, transportable and ground-mobile	4 or 5	R, S, V, or T
Ground-fixed	4 or 5	Q, R, S, or V
Aircraft and missile	4 or 5	R, S, T, or U

Grade 6 transformers and inductors may be used in hermetically sealed or encapsulated assemblies only.

5. Intermediate, radio frequency and discriminator transformers. Intermediate, radio frequency and discriminator transformers shall conform to grade 1, 2, or 4 of MIL-T-55631. The use of grade 3 tranformers shall be limited to hermetically sealed or encapsulated assemblies.

6. Radio frequency coils. Radio frequency coils shall conform to grade 1, class 0, A, B, or C of MIL-C-15305, except that radio frequency coils, fixed, molded, with established failure rate levels shall conform to MIL-C-39010.

7. Low-power pulse transformers. Low-power pulse transformers shall conform to MIL-T-21038 with grade, class, and life expectancy as specified in table 14-II.

TABLE 14-II. Low-power pulse transformers.

Application	Grade	Temperature class	Life expectancy
Shipboard, transportable and ground-mobile	4 or 5	R, S, T, or U	X
Ground-fixed	4 or 5	Q, R, S, or T	X
Aircraft and missile	4, 5, 6 or 7	R, S, U, or V	X

* 8. Radio frequency chip coils. Radio frequency chip coils shall conform to MIL-C-83446.

* 9. Custom electromagnetic devices for space applications. Custom electromagnetic devices for space applications shall conform to MIL-STD-981.

10. General. Transformers and inductors, whether selected from the above or especially designed with procuring activity approval for a particular application, shall conform to the following:

a. Size and weight. The size and weight of tranformers and inductors shall be held to a minimum consistent with required performance and life. Every effort shall be made to use materials of light weight and to employ methods of design and construction which assure minimum size and weight. High temperature rise is permitted when size and weight savings can be effected, provided dependability, performance, efficiency, and required life are obtained. The best available grades of core materials shall be used to the maximum extent justifiable for the particular application.

b. Variable inductors. When a roller or slider is used in contact with the conductor of variable inductors, suitable provision shall be made to limit the travel of the roller or slider to prevent its leaving the conductor.

c. Variable transformers. Variable transformers shall conform to MIL-T-83721.

REQUIREMENT 20

WIRE, HOOKUP, INTERNAL

1. Purpose. This requirement establishes criteria for the selection and application of electrical internal hookup wire.

2. Documents applicable to Requirement 20:

QQ-W-343	Wire, Electrical (Uninsulated)
MIL-W-76	Wire and Cable, Hookup, Electrical, Insulated
MIL-W-5086	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy
MIL-W-5845	Wire, Electrical, Iron and Constantan, Thermocouple
MIL-W-5846	Wire, Electrical, Chromel and/or Alumel, Thermocouple
MIL-W-5908	Wire, Electrical, Copper and Constantan, Thermocouple
MIL-W-16878	Wire, Electrical, Insulated, High Temperature
MIL-W-19150	Wire, Insulated, Hard Drawn Copper
MIL-W-22759	Wire, Electric, Fluoropolymer-Insulated, Copper or Copper Alloy
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
MIL-W-81822	Wire, Electrical, Solderless Wrap, Insulated and Uninsulated
MIL-STD-681	Identification Coding and Application of Hook-up and Lead Wire

3. General requirements

3.1 Wire. Internal hookup wire shall be selected from the types and classes specified by the documents listed herein whenever applicable. Other types of wire may be used provided they are selected from specifications acceptable for the specific application and approved by the procuring activity.

* 3.1.1 Identification. Hookup wires in the equipment shall be, insofar as practicable, distinctly coded in color or numbered. Short hookup wire, six inches or less between termination points, need not be marked if the path of the short wire can be easily and visually traced. The unmarked wire must be specified on the drawing. Codes, when used, shall be in accordance with MIL-STD-681 or as otherwise agreed upon with the procuring activity. Numbers shall not be used where they would be difficult to read or trace, such as in compact assemblies.

3.2 Wire characteristics

3.2.1 Solid or stranded. Stranded wire shall be used for conductors and cables which are normally flexed in use and servicing of the equipment, such as cables attached to the movable half of detachable connectors and hanging cables attached to removable or movable doors and shields. Leads six inches or less in length may be run as solid wires unless they form interconnections between shock isolation mounted parts and nonshock isolation mounted parts. There are some other instances, such as wire wrapping, where a solid conductor may be required regardless of length.

TABLE 20-I. Wire, electrical.

Spec No.	Title	Spec Type or Class	CONSTRUCTION 1/ Conductor: Material	1/ Conductor: Coating	1/ Conductor: Type	2/ Insulation: Primary	2/ Insulation: Primary Cover	2/ Insulation: Jacket/ Topcoat	Max Cond Temp oC	Max rms Volts	Remarks
MIL-W-76	Wire and Cable, Hook-up, Electrical Insulated	LW	Cu/A or CCW	Sn	S,Str	1	8,10,13A3/	8,10,13A3/	80	300	See Note 4
		MW								1000	For US Army use only
		HW								2500	
		HF				2A				1000	
MIL-W-5086	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy	M5086/1	Cu/A	Sn	Str	1		8	105	600	
		M5086/2						8,11			
		M5086/4						8		3000	
		M5086/5						9A	110	600	
		M5086/6	HSA	Ag							
		M5086/7	Cu/A	Sn				8	105		
MIL-W-16878	Wire, Electrical, Insulated, High Temperature	M16878/1	Cu/A, HSA, CCW	Ag,Sn	S,Str	1	8,10,11	1,8,10,11	105	600	See Note 4
		M16878/2								1000	
		M16878/3								3000	
		M16878/4		Ag		3A		3A,3B,4A,13B3/	200	600	
		M16878/5								1000	
		M16878/6								250	
		M16878/7	Cu/A			6	4A,8,10,11	4A,8,10,11		600	
		M16878/8								1000	
		M16878/10		Sn		2A	8,10,11		75	600	
		M16878/11	Cu/A, CCW			4A		4A	200	1000	
		M16878/12		Ag						250	
		M16878/13									
		M16878/14	Cu/A	Ag,Sn		2C			125	600	
		M16878/15		Sn						1000	
		M16878/16								600	
		M16878/17	Cu/A, HSA, CCW	Ag,Sn		1		8	105	3000	
		M16878/18								1000	
		M16878/19								3000	
		M16878/20		Ag		1B		3A,3B,4A,13B3/	200	250	
		M16878/21								600	
		M16878/22								1000	
		M16878/23		M1		1A			260	250	
		M16878/24				1B				600	
		M16878/25				1A					
		M16878/26				1B					
		M16878/27				1A				1000	
		M16878/28				1B					
		M16878/29	Cu/A	Sn	Str	6			150	600	
		M16878/30								1000	
		M16878/31									
		M16878/32		Ag					200		
		M16878/33	Cu/A, CCW	Sn	S,Str	2A			75	600	
		M16878/34	Cu	Ag	Str	1B			200		
		M16878/35		M1					260	1000	

*TABLE 20-I. Wire, electrical.

Spec No.	Title	Spec Type or Class	CONSTRUCTION 1/ Conductor: Material	1/ Conductor: Coating	1/ Conductor: Type	2/ Insulation: Primary	2/ Insulation: Primary Cover	2/ Insulation: Jacket/ Topcoat	Max Cond Temp oC	Max rms Volts	Remarks
MIL-W-19150	Wire, Insulated, Hard Drawn Copper		Cu/M			2A		8			
MIL-W-22759	Wire, Electric, Fluoropolymer Insulated, Copper or Copper Alloy	M22759/9	Cu/A	Ag	Str	3A			200	1000	
		M22759/10		Ni					260		
		M22759/11		Ag					200	600	
		M22759/12		Ni					260		
		M22759/14		Sn		4A		9B	135		
		M22759/15	HSA	Ag							
		M22759/16	Cu/A	Sn		17			150		
		M22759/17	HSA	Ag							
		M22759/18	Cu/A	Sn							
		M22759/19		Ag					260	1000	
		M22759/21		Ni		3A			200		
		M22759/22	HSA	Ag					260	600	
		M22759/23		Ni				7			
		M22759/31									
		M22759/32	Cu/A	Sn		21			150		
		M22759/33	HSA	Ag							
		M22759/34	Cu/A	Sn				21			
		M22759/35	HSA	Ag							
		M22759/41	Cu/A	Ni					200		
		M22759/42	HSA								
		M22759/43	Cu/A	Ag							
MIL-W-81044	Wire, Electric, Cross-Linked Polyalkene etc Insulated	M81044/12	Cu/A	Sn	Str	2B		9B	150	600	See application temp limitation on detail spec sheet
		M81044/13	HSA	Ag							
MIL-W-81381	Wire, Electric, Polyimide Insulated Copper or Copper Alloy	M81381/7	Cu/A	Ag	Btr	19		20	200	600	/11, /12, and /22 have a bright aromatic polyamide braid with clear finisher coatings on 8 AWG and larger
		M81381/8		Ni			4B				
		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					150		
		M81381/22									

TABLE 20-I. Wire, electrical. - Continued

NOTES:

1/ Conductor Code

	Conductor Code	Description
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/ Insulation Code

Insulation Code	Description
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
4A	Fluorinated ethylene propylene/extruded (FEP teflon)
4B	Fluorinated ethylene propylene/dispersion
6	Silicone rubber/extruded
7	Polyimide lacquer (Pure ML)
8	Polyamide/extruded (Nylon)
9A	Polyvinylidene fluoride/extruded (Kynar)
9B	Polyvinylidene fluoride/extruded/cross-linked
10	Braid/synthetic yarn/lacquer impregnated
11	Braid/nylon/impregnated
13A	Braid/glass fiber/impregnated
13B	Braid/TFE coated glass fiber/TFE finish
17	ETFE fluoropolymer
19	Fluorocarbon/polyimide tape
20	Modified aromatic polyimide resin
21	Ethylene-tetrafluoroethylene/cross-linked/modified/extruded

3/ When specified on purchase order

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

3.2.2 Size. Conductors shall be of such cross section, temper, and flexibility as to provide ample and safe current-carrying capacity and strength.

3.2.3 Bare wire. Bare hookup wire shall not be used unless insulated wire is impractical because of circuit characteristics or shortness of wire run. Bare hookup wire shall be type S, soft or drawn and annealed, and coated, and shall conform to QQ-W-343.

3.2.4 Thermocouple wire. Selection of thermocouple wire shall be in accordance with MIL-W-5845, MIL-W-5846, or MIL-W-5908.

4. Detail requirements

4.1 Selection of wire. Selection of internal hookup wire shall be in accordance with table 20-I unless otherwise specified in the detail equipment specification. For solderless wrap applications, wires shall be selected which are in accordance with MIL-W-81822. Certain insulating materials exhibit a cold flow characteristic. Caution should be used in the selection of these materials in applications requiring restrictive clamping or tying, etc., where this feature may result in exposed or shorted conductors.

4.2 Application restrictions

4.2.1 MIL-W-76 shall be used for Army applications only.

4.2.2 MIL-W-16878 shall not be used for Air Force space applications.

4.2.3 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.

4.2.4 Wires with polyvinyl chloride insulation shall not be used in aerospace applications. Use of these wires in any other Air Force application requires prior approval of the procuring activity.

REQUIREMENT 30

SEMICONDUCTOR DEVICES

1. Purpose. This requirement establishes criteria for the selection and application of semiconductor devices.

2. Documents applicable to Requirement 30:

MIL-S-19500	Semiconductor Devices, General Specification for
MIL-STD-701	Lists of Standard Semiconductor Devices
MIL-STD-1547	Parts, Materials, and Processes for Space and Launch Vehicles, Technical Requirements for

3. Selection and application. Semiconductor devices shall be selected and applied in accordance with MIL-STD-701 and, for Space Division, AFSC (SD), MIL-STD-1547.

3.1 JANS level. JANS level devices shall be used in space, launch, and reentry equipment applications for Space Division, AFSC (SD). When JANS parts are not available, parts shall be specified/procured in accordance with the requirements of MIL-STD-1547.

* 3.2 JANTX and JANTXV levels. JANTX, JANTXV, or JANS level devices shall be used in Army Missile Command, Army Laboratory Command, Naval Air Systems Command and Air Force applications other than SD space, launch, and reentry equipment.

* 3.3 JAN level. When JANTX, JANTXV, or JANS level devices are not available and JAN level must be used, the JAN parts shall be screened per JANTX requirements of table II of MIL-S-19500. The JAN product shall also be tested in accordance with JAN requirements of table III (Group A) and table IV (Group B) of MIL-S-19500.

* 3.4 Other semiconductors. When MIL-S-19500 devices are not available, other semiconductors may be used, subject to procuring activity approval. The following information shall be included in the nonstandard part approval request.

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 conformance requirements, including screening for all devices in accordance with table II of MIL-S-19500. All device types shall be tested to the table III (Group A) and Table IV (Group B) quality conformance requirements of MIL-S-19500.

4. Sealing. All semiconductor devices used in equipment shall be hermetically sealed in glass, metal, metal oxide, ceramic, or combinations of these. No plastic (organic or polymeric) encapsulated or sealed devices shall be used without the approval of the procuring activity.

Supersedes
REQUIREMENT 30
1 September 1982

REQUIREMENT 30
29 August 1986

5. Electrostatic sensitive parts. Certain types of semiconductor devices are susceptible to electrostatic discharge damage. Appropriate discharge procedures should be observed prior to handling these parts, and design selections of desired devices should include a consideration of the effectiveness of the input or other protective elements included in the device design.

REQUIREMENT 36

ACCESSIBILITY

1. Purpose. This requirement establishes criteria for accessibility.

2. Documents applicable to Requirement 36:

MIL-STD-280	Definition of Item Levels, Item Exchangeability, Models, and Related Terms
MIL-STD-721	Definition of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities

3. Definitions

3.1 Accessibility. Accessibility is as defined in MIL-STD-721.

3.2 Part, subassembly, and assembly. Part, subassembly, and assembly are as defined in MIL-STD-280.

4. Compatibility. Equipment shall be designed for optimum accessibility compatible with operating, maintenance, electromagnetic compatibility, and enclosure requirements.

* 5. Access. Each article of equipment and each major subassembly forming a part thereof shall provide for the necessary access to its interior parts, terminals, and wiring for adjustments, required circuit checking, and the removal and replacement of maintenance parts. Accessibility for testing and replacement does not apply to parts located in nonrepairable subassemblies or assemblies. For routine servicing and maintenance, unsoldering of wires, wire harnesses, parts or assemblies shall not be required in order to gain access to terminals, soldered connections, mounting screws and the like. Inspection windows shall be provided wherever necessary. Sizes of openings, maximum reach requirements, and allowable sizes and weights of replaceable assemblies shall conform to limits established in MIL-STD-1472.

6. Connections. Connections to parts inside a removable container shall be arranged to permit removal of the container without threading connection leads through the container.

7. Parts. Parts which are identified as replaceable parts for the equipment shall be easily removable and replaceable. These parts shall not be mounted by means of rivets, spot welding, or hard curing compounds. If, in order to check or remove a part, it is necessary to displace some other part, the latter part shall, whenever practicable, be so wired and mounted that it can be moved without being disconnected and without causing circuit detuning or instability.

No unsoldering or soldering of connections shall be necessary when the front panel or any subchassis is removed for maintenance purposes. Design shall be such that where plug-in modules or assemblies are used, they can be easily inserted in the proper location when correctly oriented without damage to equipment or parts being engaged. Plug-in modules and assemblies shall be designed to prevent insertion when incorrectly oriented.

8. Enclosures. Accessibility to chassis, assemblies, or parts contained within cabinets, consoles or other enclosures shall be provided from outside the basic equipment through the use of access doors, by mounting such items on withdrawal slides, swinging doors, through cable extenders and cable retractors, provisions for circuit card extenders which will allow part or module operation in the open position, or other arrangements to permit adequate access for properly servicing the equipment. Automatic or manually operated locks shall be provided to lock the chassis in the servicing position. When withdrawal slides are used they shall be of guided sectional construction with tracks and rollers. Complete removal and access for servicing of electronic equipment contained within cabinets, consoles or other enclosures shall be provided from either the front or rear of the equipment. Guide pins (or locating pins), or the equivalent, shall be provided for mechanical alignment during mounting. Shipboard equipment shall have complete access for maintenance and servicing from the front of the equipment.

* 8.1 Bolt-together racks and enclosures. For Navy ship and shore applications, when bolt-together racks are required, fastening shall be provided to bolt adjacent racks together at the top with external brackets and through the bottom of the rack to a base or foundation. Bottom mounting shall be accessible from the front with minimum disassembly of internal parts or subassemblies.

REQUIREMENT 52

THERMAL DESIGN

1. Purpose. This requirement establishes criteria for thermal design.

2. Documents applicable to Requirement 52:

F-P-300	Filter, Air Conditioning, Viscous-impingement and Dry Types, Cleanable
MIL-F-16552	Filter, Air Environmental Control System, Cleanable, Impingement (High Velocity Type)
MIL-B-23071	Blower, Miniature for Cooling Electronic Equipment (10 to 500 cfm), General Specification for
MIL-F-28717	Filter, Air, Viscous Impingement Type, Cleanable and Reusable, for Equipment Enclosures, and Impingement Oil; General Specification for
MIL-HDBK-251	Reliability/Design, Thermal Applications

3. Auxiliary heating or cooling. Auxiliary heating or cooling means or devices may be employed when the equipment is to be operated for prolonged periods for test and checkout purposes, when such periods are not consistent with normal operating requirements.

4. Forced air cooling. Forced air cooling shall be used only when natural cooling does not provide sufficient cooling or when a significant reduction in overall size and weight can be realized. Exhaust and recirculating fans and blowers shall be driven by brushless motors operating from the available ac power sources, if possible, or by properly shielded dc motors. The design factors to be considered in determining the required fan or blower characteristics include such factors as amount of heat to be dissipated, the quantity of air to be delivered at the pressure drop of the enclosed equipment, the allowable noise level, the permissible level of heat that may be exhausted into the surrounding environment, and other pertinent factors affecting the cooling requirement of the equipment. Miniature blowers shall conform to MIL-B-23071. Induced drafts and ventilation by means of baffles and internal vents shall be used to the greatest practicable extent. Air filters shall be provided for air intakes for fan and blower cooled units when required to protect internal parts. Filters, when used, shall conform to F-P-300, MIL-F-16552, or MIL-F-28717, and shall be readily removable for cleaning without disassembly of the equipment. All ventilation openings shall be designed and located to comply with electromagnetic interference, undesired radiation and enclosure requirements. When practicable, ventilation and air exhaust openings shall not be located in the top of enclosures or in front panels. Air exhaust shall be so directed that it will not inconvenience operating personnel.

4.1 For equipment thermally designed for use with external source supplied cooling air, which may contain entrained water or other contaminants detrimental to the equipment, precautionary measures shall be taken to avoid direct impingement on internal parts and circuitry by channeling or use of heat exchangers. If this is impractical, the water and contaminants shall be removed from the cooling air by suitable water and contaminant removal devices. Consistent with adequate cooling, minimum differential pressure (pressure drop) of the cooling air through the equipment heat exchanger or cold plate shall be maintained. Each separate piece of equipment being cooled shall be marked with the high and low operating temperature to which it is designed, the quantity and characteristics of air required to adequately cool the unit, and the resistance to air flow with respect to the air flow rate.

4.2 Equipment that is intended for use in aircraft and requires forced air cooling shall be designed using cold plates or heat exchangers so that none of the cooling air will come into contact with internal parts, circuitry, or connectors. The only exception to this requirement is equipment that will be used solely in environments such as in the cockpit or air conditioned cabins, where surrounding air is permitted to be drawn into the equipment for direct cooling of heat-producing parts.

* 5. Other cooling methods. Where heat densities or other design requirements make the use of air for cooling impractical, alternate methods such as liquid, evaporative, change of phase material, or heat pipes may be used with the prior approval of the procuring activity.

6. Design guidance. MIL-HDBK-251 may be used as a guide for detail information on thermal design of electronic equipment.

REQUIREMENT 59

BRAZING

1. Purpose. This requirement establishes criteria for brazing.

2. Document applicable to Requirement 59:

MIL-B-7883 Brazing of Steels, Copper, Copper Alloys, Nickel Alloys, Aluminum and Aluminum Alloys

3. Brazing. Brazing of steel, copper, copper alloys, nickel alloys, aluminum, and aluminum alloys shall be in accordance with MIL-B-7883.

4. Improved methods and materials. Improved (state-of-the art) methods and materials may be used provided they equal or exceed the requirements of MIL-B-7883, and provided approval is obtained from the procuring activity.

* 5. Brazing electrical connections. Electrical connections of stranded or insulated wire or those having construction which may entrap fluxes shall not be brazed unless approval is obtained from the procuring activity.

REQUIREMENT 69

INTERNAL WIRING PRACTICES

1. Purpose. This requirement establishes criteria for internal wiring practices.

2. Documents applicable to Requirement 69:

MIL-T-152	Treatment, Moisture and Fungus Resistant, of Communications, Electronic and Associated Electrical Equipment
MIL-V-173	Varnish, Moisture Resistant (For Treatment of Communications, Electronic, and Associated Equipment)
MIL-I-631	Insulation, Electrical, Synthetic - Resin Composition, Non-Rigid
MIL-T-713	Twine: Impregnated, Lacing and Tying
MIL-I-3158	Insulation Tape, Electrical Glass-Fiber (Resin Filled); and Cord, Fibrous-Glass
MIL-I-3190	Insulation Sleeving, Electrical, Flexible, Coated, General Specification for
MIL-T-7928	Terminals, Lug and Splice, Crimp Style, Copper
MIL-I-18057	Insulation Sleeving, Electrical, Flexible Glass Fiber, Silicone Rubber Treated
MIL-I-22076	Insulation Tubing, Electrical, Non-Rigid, Vinyl, Very Low Temperature Grade
MIL-I-23053	Insulation Sleeving, Electrical, Heat Shrinkable, General Specification for
MIL-S-23190	Strap, Clamps, and Mounting Hardware, Plastic, For Cable Harness Tying and Support
MIL-T-43435	Tape, Lacing and Tying
MIL-C-55543	Cable, Electrical, Flat Multiconductor, Flexible, Unshielded
MIL-STD-108	Definition of and Basic Requirements for Enclosure for Electric and Electronic Equipment
MIL-STD-1130	Connections, Electrical, Solderless, Wrapped

3. Clearance and leakage (creepage) distances. Clearance between solder connections or bare conductors, such as on terminal strips, stand offs or similar connections, shall be such that no accidental contact can occur between adjacent connections when subjected to service conditions specified in the equipment specification. For electrical clearance and leakage distances, see table 69-I.

4. Impedance matching. Where rf cables are employed, equipment shall be designed to attain proper impedance matching with the cable and fittings.

* 5. Wiring protection. The wiring shall be secured and protected against chafing due to vibration or movement (such as slide out racks or drawers). For securing of wiring, polyamide clamps or wrapping and tying devices with integral mounting facilities or adhesive bonding are preferred. Metal clamps, if used, shall be cushioned. Individual conductors thus secured shall lie essentially parallel; however, this does not prohibit the use of twisted pairs.

TABLE 69-I. Electrical clearance and leakage (creepage) distances.

Voltage ac (rms) or dc	Condition	Clearance (Inches)	Leakage Distances (inches) Enclosure I	Enclosure II
To 150	A	1/16	1/16	1/16
	B	1/8	1/8	1/4
	C	1/4	3/8	3/4
150-300	A	1/16	1/16	1/16
	B	1/8	1/8	1/4
	C	1/4	1/2	3/4
300-600	A	1/16	1/8	1/8
	B	1/8	1/4	1/4
	C	1/4	1/2	3/4
600-1000	A	1/8	3/8	1/2
	B	1/4	3/4	1
	C	1/2	1-1/2	2

Condition A. For use where the effect of a short circuit is limited to the unit, and where normal operating power does not exceed 50 watts.

Condition B. For use where short circuit protection in the form of fuses, circuit breakers, etc, is provided, and where normal operating power does not exceed 2000 watts.

Condition C. For use where short circuit protection in the form of fuses, circuit breakers, etc, is provided, and where normal operating power exceeds 2000 watts.

Enclosure I. Enclosure I is an equipment enclosure which has no openings, or in which the openings are so constructed that drops of liquid or solid particles striking the enclosure at any angle from 0^{o} to 15^{o} from the downward vertical cannot enter the enclosure either directly or by striking and running along a horizontal or inwardly inclined surface. ("Drip-proof enclosure for other than motors, generators, and similar machines" of MIL-STD-108 meets this description.)

Enclosure II. Enclosure II is any equipment enclosure which affords less protection than enclosure I.

5.1 Insulation cold flow. Where insulated wire that may be susceptible to cold flow is used, care shall be exercised in the design and layout of wiring so that cold flow will be minimal and not cause degradation of operation or performance.

5.2 Cable ducts. Where cable ducts are employed, provisions shall be made for the removal of any wire that may become faulty. For example, covers may be employed at intervals to aid in the removal of a faulty wire.

5.3 Bend radius. The bend radius of polyethylene cable shall not be less than five times the cable diameter to avoid establishing a permanent set in the cable.

5.4 Sleeving. Flexible plastic sleeving, either nonflammable, self extinguishing, or flame retardant, shall be used on cables subject to flexing, such as panel door cables. The sleeving shall be secured under cable clamps at each end, and the cable shall be formed and secured so that the cable will not be subject to abrasion in its normal flexing motion. In cases where abrasion cannot be avoided, additional protection shall be provided.

5.5 Panel door cables. Wiring to parts on a hinged door shall be in a single cable, arranged to flex without being damaged when the door is opened and closed. However, if physical separation between wires is essential for electrical reasons, or if the number of wires involved is so great as to make a single cable impracticable, more than one flexible hinging cable may be employed.

5.6 Through hole protection. Whenever wires are run through holes in metal partitions, shields, and the like, less than 1/8 inch in thickness, the holes shall be equipped with suitable mechanical protection (grommet) of insulation. Panels 1/8 inch or more in thickness either shall have grommets or shall have the hole edges rounded to a minimum radius of 1/16 inch. Grommets for wires operating at rf potentials exceeding 500 volts rms, shall be of ceramic or plastic material of suitable dielectric strength, except for coaxial cables which have outside protection, where rubber or neoprene is acceptable. Insulating grommets are not required for wires or groups of wires passing through shields or other metallic partitions where clearance can be maintained sufficient to preclude the possibility of accidental contact or damage by abrasion.

6. Electrical tape. Only electrical tape made of fungus-inert materials may be used.

7. Wiring

* 7.1 Wiring arrangement. All wiring shall be arranged in a neat and workmanlike manner. The use of preformed cables and wiring harness is preferred to the point-to-point method of wiring. Wires shall be bundled and routed to minimize electrical coupling. Unless suitably protected, wire or cable attached to sensitive circuits shall not be placed adjacent to a disturbing circuit. Materials used for lacing, binding, sleeving, and strapping shall be compatible with the conductor or cable insulation or jacket and shall meet the same flame retardant and self extinguishing requirements. Wiring shall be arranged to permit bundling by one or more of the following methods or permanently mounted in cable ducts.

7.1.1 Lacing. Twine shall be in accordance with type P of MIL-T-713. Type SAR shall not be used where it may be exposed to fungus attack. Tape shall conform to MIL-T-43435. Cordage shall be in accordance with type SR-4.5 of MIL-I-3158.

7.1.2 Binding. Tape for binding shall be as specified in MIL-T-43435.

7.1.3 Sleeving insulation. Sleeving insulation shall conform to MIL-I-631, MIL-I-3190, MIL-I-18057, MIL-I-22076 or MIL-I-23053, as applicable.

* 7.1.4 Wrapping and tying. Plastic devices for wrapping and tying of wires may be used provided that the plastic material does not support combustion, nor yield toxic gases when heated. When the wire bundle is formed and secured, the device shall not loosen when subjected to vibration. Plastic cable straps shall conform to MIL-S-23190.

7.1.5 Tape selection. Minimum tape size shall be in accordance with table 69-II. Tape dimensions shown are nominal and are subject to the tolerances of MIL-T-43435.

TABLE 69-II. Minimum tape size.

Harness diameter (inches)	Tape size (width in inches)
Up to 1/2	.050
1/2 to 1	.085
1 to 2	.110
2 and larger	.200

7.2 Slack. Wires and cable shall be as short as practicable, except that sufficient slack shall be provided to:

a. Prevent undue stress on cable forms, wires and connections, including connections to resiliently support parts.

b. Enable parts to be removed and replaced during servicing without disconnecting other parts.

c. Facilitate field repair of broken or cut wires.

d. Permit units in drawers and slide out racks to be pulled out to the limit of the slide or support travel without breaking connections. Units which are difficult to connect when mounted, shall be capable of movement to a more convenient position for connecting and disconnecting cables. When drawers or racks are fully extended and rotated, if rotatable, the cable bend radius shall not be less than three times the cable assembly diameter. When flat molded cable assemblies are used, the bend radius shall not be less than ten times the cable assembly thickness.

e. Permit replacement of at least two of the particular parts to which the wire or cable is connected. The only exceptions to this provision are cases where rf leads must be as short as possible for electrical reasons and when fixed path rotating is specified or the amount of slack is limited by space available as occurs in automatic machine wired panels.

f. Ensure freedom of motion of lugs or terminals normally intended to have some degree of movement (for example, floating contacts on electron tube sockets).

7.3 Wiring in terminal boxes. Wiring and cables in terminal boxes shall be fanned out to identify terminals for check purposes if test points for required maintenance information are not provided.

7.4 Entrance cabling and wiring. Leads from cable entrances to terminal boards, plugs, jacks, and similar devices shall be harnessed, suitably clamped or supported in a cable duct. Flat cable in accordance with MIL-C-55543 may be used where suitable.

7.5 Wiring (internal). Stranded wire is preferred; however, solid wire may be used in the equipment, provided such wire is so insulated or held in place that it does not fail or show excessive motion likely to result in failure when the equipment is subjected to vibration and shock encountered under the specified service conditions. An uninterrupted wire is preferable to a junction. The following descending order of preference exists when junctions are used, and the choice of the listed junctions shall be determined by consideration of reliability factors, maintenance factors, and manufacturing procedures:

a. Permanent splices

b. Bolted connections

c. Connectors.

7.6 Connections. Wiring to connections within the equipment shall be suitably supported in such manner as to prevent breakage and eliminate changes in characteristics or output as a result of vibration and acceleration or shock encountered under the specified service conditions.

7.7 Connectors, wired in. Plugs and receptacles furnished as integral wired in parts of articles of equipment shall be processed by providing a means to lengthen leakage distances, to spread the area of flexure of connector wires, and to move the flexure away from the terminals.

7.8 Support. Wire and cable shall be properly supported and secured to prevent undue stress on the conductors and terminals and undue change in position of the wire or cable during and after subjection of the equipment to specified service conditions, or after service or repair of the equipment in a normal manner. When shielding on wire or cable is unprotected by an outer insulation, adequate support is necessary to prevent the shielding from coming in contact with exposed terminals or conductors. Twine or tape shall not be used for securing wire and cable.

7.9 Cable and harness design. Cables and separable harnesses shall be of the two-connector type whenever possible. Also, when possible, the two connectors shall be of the same number of contacts and all contacts shall be wired point-to-point (i.e., pin 1 to pin 1, pin A to pin A, or pin 1 to pin A and up in sequence). A minimum number of connector types and contact configurations within a type shall be used consistent with non cross mating requirements and circuit and spare considerations.

8. Wire terminations

8.1 Soldering connections. Studs (soldering posts to which parts are permanently affixed), soldering lugs (projections which solder to ends of wires to facilitate attachment to solderless connections), and soldering terminals (items which are attached to the chassis, or insulating boards, strips, or posts to serve as a solder junction for two or more wires or leads) come under this heading. All soldering studs, lugs, and terminals shall be notched or otherwise provided with means for mechanically securing the wire or lead prior to the application of solder. All solder type studs shall be mounted in such manner as to preclude their loosening or rotation due to soldering operations or from strains due to attached wires or leads.

8.2 Mechanical strength. Soft solder alone shall not be depended upon for mechanical strength.

8.3 Solderless crimp connections. The ends of each wire terminated by solderless crimp type lugs shall meet the following requirements:

a. Insulated, solderless lugs are preferred and shall conform to MIL-T-7928.

b. Where thermal or other considerations prevent the use of insulated lugs, noninsulated solderless lugs conforming to MIL-T-7928 shall be used, provided they are covered with an insulating sleeve.

8.4 Solderless wrapped wire connections. Solderless wrapped wire connections shall be in accordance with MIL-STD-1130. Procuring activity approval is required for Navy airborne and Army missile applications.

8.5 RF connections. Whenever bolts, screws, nuts, studs, or rivets are used in an rf circuit, all connections thereto shall be securely soldered, except that soldered connections are not considered practicable at studs of molded phenolic capacitors, meter terminals, and other places where damage from overheating may result.

8.6 Clamped connections. In no case shall electrical connections depend upon wires, lugs, terminals, and the like, clamped between a metallic member and an insulating material of other than a ceramic or vitric nature. Such connections shall be clamped between metal members, preferably, such as an assembly of two nuts, two washers and a machine screw.

* 9. Connectors, insulation sleeving. Unpotted connectors furnished as integral wired in parts of articles of equipment shall have a piece of insulating tubing placed over each wire in the connector. The tubing shall be long enough to cover the contact and at least 1/2 inch of insulation of the wire attached to it; but in no case shall the length of the tubing exceed 2 inches. The minimum length of 1/2 inch may be reduced to 3/16 inch where restricted volume does not permit longer tubing (such as in miniaturized electronic subassemblies). The tubing shall fit tightly over the contact or be tied securely enough so that it will not slide off. If bare wire is used, the tubing shall be long enough to extend at least 1/4 inch beyond the contact, metal shell or clamp, whichever projects the farthest. This paragraph does not apply to connectors with body insulated crimp-on contacts, to insulation displacement connectors or mass soldered flat cable connectors, nor does it apply to wire wrapped connectors in accordance with MIL-STD-1130.

10. Cables, waveguides, and cable assemblies. Except when otherwise specified in the detail equipment specification, all interconnecting cables carrying rf signals shall make use of coaxial cable or waveguides and shall preferably be terminated in the characteristic impedance of the transmitting media. Conductors intended to carry pulse or other waveforms and which may undesirably couple such signals into other conductors shall not be bound into a cable.

11. Fungus protection. Prior to attachment of terminals to prepared lengths of cables which contain materials that will support fungus, the ends shall be protected against entrance of moisture and fungus by treatment with a fungicidal varnish conforming to MIL-V-173 in accordance with MIL-T-152.

REQUIREMENT 72

SUBSTITUTABILITY

1. Purpose. This requirement establishes criteria for the selection and application of substitute parts.

2. Document applicable to Requirement 72:

* DOD-STD-480 Configuration Control - Engineering Changes, Deviations and Waivers

3. Substitution criteria. Except as noted in paragraph 4, substitute parts shall comply with the following:

* 3.1 Substitution of parts covered by military specifications and standards that include substitutability or supersession information is acceptable. This type substitution does not require submission of engineering change proposals, deviations, or waivers in accordance with DOD-STD-480.

* 3.2 When the equipment design specifies a commercial part, a military specification part may be substituted when the form, fit, function and characteristics of the military part are equal to or better than those of the specified commercial part under equivalent environmental conditions. This type substitution is subject to applicable configuration control procedures of DOD-STD-480 and shall be documented on a parts substitution list as described by DOD-STD-480.

* 3.3 When the equipment design specifies a part that becomes unavailable, a substitute part which meets the form, fit, and functional characteristics of the specified part may be substituted after approval is obtained from the applicable acquisition activity. This type of substitution is subject to the applicable configuration control procedures of DOD-STD-480 and shall be documented on a parts substitution list as described by DOD-STD-480.

4. Initial qualification/reliability demonstration. Substitute parts with quality/reliability characteristics superior to those specified in the parts list shall not be used in equipment to be subjected to qualification or demonstration tests.

INDEX OF DOCUMENTS APPLICABLE TO MIL-STD-454K

Document No.	Applies to Reqmt
SPECIFICATIONS	
Federal	
F-F-300	52
L-P-516	11, 26
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O-E-760	5
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