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MIL-STD-11991B
3 OCTOBER 2023

SUPERSEDING
MIL-STD-11991A
26 AUGUST 2015

DEPARTMENT OF DEFENSE

STANDARD PRACTICE

GENERAL STANDARD FOR PARTS, MATERIALS, AND PROCESSES

AMSC 10417 AREA STDZ

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FOREWORD

1. This standard is approved for use by all Departments and Agencies of the Department of Defense.

2. This standard establishes the requirements for the management of parts, materials, and processes (PM&P) for use during the development, production, and sustainment of military systems. These requirements directly apply to the design, manufacture, and support of military systems. This standard also provides criteria to evaluate the suitability of commercial off-the-shelf (COTS) items for incorporation into military systems.

3. Address comments, suggestions, or questions regarding this document to the Defense Standardization Program Office (DSPO), 8725 John J. Kingman Road, Stop 5100, Fort Belvoir, VA 22060-6220, or email DSPO@dla.mil. Since contact information can change, verify the currency of this address using the ASSIST Online database at https://assist.dla.mil.

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1 SCOPE

1.1 Scope. This standard establishes the requirements for the management of parts, materials, and processes (PM&P) during the design, development, production, modification, and sustainment of military systems. The applicability of individual aspects of the requirements depends on program business and support strategies, technologies used, expected service life, and other factors specific to a particular military system.

2 APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government Documents.

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

FEDERAL SPECIFICATIONS

C-F-206	-	Felt Sheet: Cloth, Felt, Wool, Pressed
FF-N-836	-	Nut: Square, Hexagon, Cap, Slotted, Castle, Knurled, Welding and Single Ball Seat
FF-R-556	-	Rivet, Solid, Small; Rivet, Split, Small; Rivet, Tubular, Small Flat Washer (Burr); and Cap, Rivet, General Purpose
FF-S-85	-	Screw, Cap, Slotted and Hexagon Head
FF-S-86	-	Screw, Cap, Socket-Head
FF-S-92	-	Screw, Machine, Slotted, Cross-Recessed or Hexagon Head

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FF-S-200	-	Setscrews: Hexagon Socket and Spline Socket, Headless
FF-S-210	-	Setscrews: Square Head (Inch) and Slotted Headless (Inch and Metric)
FF-W-84	-	Washers, Lock (Spring)
FF-W-92	-	Washer, Flat (Plain)
FF-W-100	-	Washer, Lock (Tooth)
L-P-516	-	Plastic Sheet and Plastic Rod, Thermosetting, Cast
MMM-A-121	-	Adhesive, Bonding Vulcanized Synthetic Rubber to Steel
MMM-A-132	-	Adhesives, Heat Resistant, Airframe Structural, Metal to Metal
MMM-A-134	-	Adhesive, Epoxy Resin, Metal to Metal Structural Bonding
MMM-A-138	-	Adhesive, Metal to Wood, Structural
MMM-A-181	-	Adhesives, Phenol, Resorcinol or Melamine Base
MMM-A-189	-	Adhesive, Synthetic-Rubber, Thermoplastic, General-Purpose
T-R-605	-	Rope, Manila and Sisal
QQ-A-1876	-	Aluminum Foil
QQ-C-450	-	Copper-Aluminum Alloy (Aluminum Bronze) Plate, Sheet, Strip, and Bar (Copper Alloy Numbers 606, 610, 613, 614, and 630)
QQ-N-281	-	Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections

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QQ-N-286	-	Aluminum Foil

Federal Acquisition Regulation (FAR)

(Copies of these documents are available online at http://www.acquisition.gov.)

Defense Federal Acquisition Regulation Supplement (DFARS)

(Copies of these documents are available online at http://www.acq.osd.mil/.)

National Defense Authorization Act (NDAA)

(Copies of these documents are available online at http://www.gpo.gov/.)

COMMERCIAL ITEM DESCRIPTIONS

A-A-1936	-	Adhesives, Contact, Neoprene Rubber
A-A-3097	-	Adhesives, Cyanoacrylate, Rapid Room Temperature-Curing, Solventless
A-A-50057	-	Rope, Fibrous, Tent-Lay
A-A-50197	-	Thread, Linen
A-A-52080	-	Tape, Lacing and Tying, Nylon
A-A-52084	-	Tape, Lacing and Tying, Aramid
A-A-52094	-	Thread, Cotton
A-A-52401	-	Bearing, Sleeve (Steel-Backed)
A-A-52414	-	Bearing, Roller, Thrust
A-A-55057	-	Panels, Wood/Wood Based; Construction and Decorative
A-A-55524	-	Shunt, Instrument (External, 50 Millivolt, Lightweight Type)

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A-A-59126	-	Terminals, Feedthru (Insulated) and Terminals, Stud (Insulated and Noninsulated)
A-A-59166	-	Coating Compound, Nonslip (for Walkways)
A-A-59313	-	Thread, Compound; Antiseize, Zinc Dust-Petrolatum
A-A-59551	-	Wire, Electrical, Copper (Uninsulated)
A-A-59588	-	Rubber, Silicone
A-A-59770	-	Insulation Tape, Electrical, Pressure Sensitive Adhesive and Pressure Sensitive Thermosetting Adhesive
A-A-59826	-	Thread, Nylon
A-A-59877	-	Insulating Compound, Electrical, Embedding
A-A-59963	-	Thread, Polyester
A-A-59991	-	Thread and Twine, Mildew Resistant or Water Repellent Treated

(Copies of these documents are available online at https://assist.dla.mil.)

ARMY PUBLISHING DIRECTORATE (APD)

DA PAM 385-24	-	Army Radiation Safety Program

(Copies of these documents are available online at http://www.apd.army.mil/.)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-17	-	Cables, Radio Frequency, Flexible and Semirigid, General Specification for
MIL-DTL-85	-	Waveguides, Rigid, Rectangular General Specification for
MIL-DTL-287	-	Waveguide Assemblies, Flexible, Twistable and Non-Twistable, General Specification for

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MIL-DTL-713	-	Twine, Fibrous: Impregnated, Lacing and Tying
MIL-DTL-1222	-	Studs, Bolts, Screws and Nuts for Applications where a High Degree of Reliability is Required; General Specification for
MIL-DTL-3432	-	Cables, (Power and Special Purpose) and Wire, Electrical (300 and 600 Volts)
MIL-DTL-3661	-	Lampholders, Indicator Lights, Indicator Light Housing, and Indicator Light Lenses, General Specification for
MIL-DTL-3890	-	Lines, Radio Frequency Transmission (Coaxial, Air Dielectric), General Specification for
MIL-DTL-3922	-	Flanges, Waveguide, General Purpose, General Specification for
MIL-DTL-3928	-	Switches, Radio-Frequency Transmission Line (Coaxial and Microstrip), General Specification for
MIL-DTL-3933	-	Attenuators, Fixed, Space Level, Non-Space Level General Specification for
MIL-DTL-3970	-	Waveguide Assemblies, Rigid, General Specification for
MIL-DTL-5541	-	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-DTL-6363	-	Lamps, Incandescent, Aircraft Service, General Specification for
MIL-DTL-7793	-	Meter, Time Totalizing
MIL-DTL-7961	-	Lights, Indicators, Press to Test
MIL-DTL-8777	-	Wire, Electrical, Silicone-Insulated, Copper, 600-Volt, 200 Degrees C

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MIL-DTL-9395	-	Switches, Pressure, (Absolute, Gage, and Differential), General Specification for
MIL-DTL-13777	-	Cable, Special Purpose, Electrical, General Specification for
MIL-DTL-15098	-	Lamps, Glow, General Specification for
MIL-DTL-15370	-	Couplers, Directional General Specification for
MIL-DTL-16034	-	Meters, Electrical-Indicating (Switchboard and Portable Types)
MIL-DTL-16878	-	Wire, Electrical, Insulated, General Specification for
MIL-DTL-17060	-	Motors, Alternating Current, Integral-Horsepower, Shipboard Use
MIL-DTL-18240	-	Fastener Element, Self-Locking, Threaded Fastener, 250 Degrees F Maximum
MIL-DTL-22641	-	Adapter, Coaxial to Waveguide, General Specification for
MIL-DTL-22931	-	Cables, Radio Frequency, Semirigid, Coaxial, Semi-Air-Dielectric, General Specification for
MIL-DTL-23971	-	Power Dividers, Power Combiners, and Power Divider/Combiners, General Specification for
MIL-DTL-24044	-	Flanges, Coaxial Line, Rigid, Air Dielectric, General Specification for
MIL-DTL-24211	-	Gaskets, Waveguide Flange General Specification for
MIL-DTL-24640	-	Cables, Lightweight, Low Smoke, Electric, for Shipboard Use, General Specification for
MIL-DTL-25038	-	Wire, Electrical, High Temperature, Fire Resistant, and Flight Critical

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MIL-DTL-25879	-	Switch, Radio Frequency Transmission Line, Coaxial Type SA-521A/A
MIL-DTL-27072	-	Cable, Power, Electrical and Cable, Special Purpose, Electrical, Multiconductor and Single Shielded, General Specification for
MIL-DTL-28791	-	Isolators and Circulators, Radio Frequency, General Specification for
MIL-DTL-28803	-	Display, Optoelectronic, Segmented Readouts, Backlighted, General Specification for
MIL-DTL-28830	-	Cable, Radio Frequency, Coaxial, Semirigid, Corrugated Outer Conductor, General Specification for
MIL-DTL-28837	-	Mixer Stages, Radio Frequency, General Specification for
MIL-DTL-28875	-	Amplifiers, Radio-Frequency and Microwave, Solid-State
MIL-DTL-39030	-	Dummy Loads, Electrical, Coaxial and Stripline, General Specification for
MIL-DTL-55021	-	Cable, Electrical, Shielded Singles, Shielded and Jacketed Singles, Twisted Pairs and Triples, Internal Hookup, General Specification for
MIL-DTL-55041	-	Switches, Waveguide, General Specification for
MIL-DTL-81381	-	Wire, Electric, Polyimide-Insulated, Copper or Copper Alloy
MIL-DTL-81963	-	Servocomponents, Precision Instrument, Rotating, Common Requirements and Tests, General Specification for
MIL-DTL-83522	-	Connectors, Fiber Optic, Single Ferrule, General Specification for

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MIL-DTL-83526	-	Connectors, Fiber Optic, Circular, Environmental Resistant, Hermaphroditic, General Specification for
MIL-DTL-83528	-	Gasketing Material, Conductive, Shielding Gasket, Electronic, Elastomer, EMI/RFI, General Specification for
MIL-PRF-1	-	Electron Tube General Specification for
MIL-PRF-27	-	Transformers and Inductors (Audio, Power, and High-Power Pulse), General Specification for
MIL-PRF-123	-	Capacitors, Fixed, Ceramic Dielectric, (Temperature Stable and General Purpose), High Reliability
MIL-PRF-907	-	Antiseize Thread Compound, High Temperature
MIL-PRF-3098	-	Crystal Units, Quartz General Specification for
MIL-PRF-3150	-	Lubricating Oil, Preservative, Medium
MIL-PRF-6085	-	Lubricating Oil Instrument, Aircraft, Low Volatility
MIL-PRF-6086	-	Lubricating Oil, Gear, Petroleum Base (NATO O-153, O-155)
MIL-PRF-6106	-	Relays, Electromagnetic, General Specification for
MIL-PRF-6855	-	Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes, General Specification for
MIL-PRF-8516	-	Sealing Compound, Synthetic Rubber, Electric Connectors and Electric Systems, Chemically Cured
MIL-PRF-8565	-	Battery Storage, Aircraft, General Specification for
MIL-PRF-8805	-	Switches and Switch Assemblies, Sensitive, Snap Action (Basic, Limit, Push Button and Toggle Switches), General Specification for
MIL-PRF-10304	-	Meters, Electrical Indicating, Panel Type, Ruggedized, General Specification for

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MIL-PRF-13830	-	Optical Components for Fire Control Instruments; Genera Specification Governing the Manufacture, Assembly, and Inspection of
MIL-PRF-15160	-	Fuses, Instrument, Power, and Telephone, General Specification for
MIL-PRF-15733	-	Filters and Capacitors, Radio Frequency Interference, General Specification for
MIL-PRF-17331	-	Lubricating Oil, Steam Turbine and Gear, Moderate Service
MIL-PRF-17672	-	Hydraulic Fluid, Petroleum, Inhibited
MIL-PRF-19207	-	Fuseholders, Extractor Post Type, Blown Fuse, Indicating and Nonindicating, General Specification for
MIL-PRF-19500	-	Semiconductor Devices, General Specification for
MIL-PRF-22684	-	Resistors, Fixed, Film (Insulated) General Specification for
MIL-PRF-23269	-	Capacitors, Fixed, Glass Dielectric, Established Reliability, General Specification for
MIL-PRF-23377	-	Primer Coatings: Epoxy, High-Solids
MIL-PRF-23419	-	Fuse: Cartridge, Instrument Type, General Specification for
MIL-PRF-23586	-	Sealing Compound (With Accelerator), Silicone Rubber, Electrical
MIL-PRF-23648	-	Resistor, Thermal (Thermistor) Insulated, General Specification for
MIL-PRF-23827	-	Grease, Aircraft and Instrument, Gear and Actuator Screw
MIL-PRF-24139	-	Grease, Multipurpose, Water Resistant

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MIL-PRF-24236	-	Switches, Thermostatic, (Metallic and Bimetallic), General Specification for
MIL-PRF-24623	-	Splice, Fiber Optic Cable, General Specification for (Metric)
MIL-PRF-24792	-	Adhesive, Epoxy, Two Part, Fiber Optics
MIL-PRF-24793	-	Adhesive, UV Curable, One Part, Fiber Optics
MIL-PRF-24794	-	Material, Index Matching, Fiber Optics
MIL-PRF-28750	-	Relays, Solid State, General Specification for
MIL-PRF-28776	-	Relays, Hybrid, Established Reliability, General Specification for
MIL-PRF-28861	-	Filters and Capacitors, Radio Frequency/Electromagnetic Interference Suppression, General Specification for
MIL-PRF-28876	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for
MIL-PRF-29504	-	Termini, Fiber Optic Connector, Removable, General Specification for
MIL-PRF-29595	-	Batteries and Cells, Lithium, Rechargeable, Aircraft, General Specification for
MIL-PRF-31033	-	Capacitors, Fixed, Ceramic Dielectric, High Reliability, Discoidal, General Specification for
MIL-PRF-32192	-	Resistors, Chip, Thermal (Thermistor), General Specification for
MIL-PRF-38534	-	Hybrid Microcircuits, General Specification for
MIL-PRF-38535	-	Integrated Circuits (Microcircuits) Manufacturing, General Specification for

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MIL-PRF-39001	-	Capacitors, Fixed, Mica Dielectric, High Reliability, General Specification for
MIL-PRF-39003	-	Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability, General Specification for
MIL-PRF-39005	-	Performance Specification, Resistors, Fixed, Wire-Wound (accurate), Nonestablished Reliability, Established Reliability, General Specification for
MIL-PRF-39006	-	Capacitor, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum, Established Reliability, General Specification for
MIL-PRF-39007	-	Performance Specification, Resistors, Fixed, Wire Wound (Power Type), Nonestablished Reliability, Established Reliability, and Space Level, General Specification for
MIL-PRF-39009	-	Performance Specification, Resistors, Fixed, Wire-Wound (Power Type, Chassis Mounted), Nonestablished
MIL-PRF-39015	-	Resistors, Variable, Wire Wound (Lead Screw Actuated), Nonestablished Reliability and Established Reliability, General Specification for
MIL-PRF-39016	-	Relays, Electromagnetic, Established Reliability, General Specification for
MIL-PRF-39017	-	Resistors, Fixed, Film (Insulated), Nonestablished Reliability and Established Reliability, General Specification for
MIL-PRF-39018	-	Capacitors, Fixed, Electrolytic (Aluminum Oxide), Established Reliability, and Non-Established Reliability, General Specification for
MIL-PRF-46010	-	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting NATO Code - S-1738

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MIL-PRF-49450	-	Battery, Rechargeable, Nickel-Cadmium, Vented, Aircraft
MIL-PRF-49462	-	Resistors, Fixed, Film, High Voltage, General Specification for
MIL-PRF-49467	-	Capacitor, Fixed, Ceramic, Multilayer, High Voltage (General Purpose), General Specification for
MIL-PRF-49470	-	Capacitor, Fixed, Ceramic Dielectric, Switch Mode Power Supply (General Purpose and Temperature Stable), Standard Reliability and High Reliability, General Specification for
MIL-PRF-49471	-	Batteries, Non-Rechargeable, High Performance
MIL-PRF-55182	-	Resistors, Fixed, Film, Nonestablished Reliability, Established Reliability, and Space Level, General Specification for (w/Amendment 1)
MIL-PRF-55310	-	Oscillator, Crystal Controlled, General Specification for
MIL-PRF-55342	-	Performance Specification, Resistors, Fixed, Film, Chip, Nonestablished Reliability, Established Reliability, Space Level, General Specification for
MIL-PRF-55365	-	Capacitor, Fixed, Electrolytic (Tantalum), Chip, Established Reliability, Nonestablished Reliability, and High Reliability, General Specification for
MIL-PRF-81322	-	Grease, Aircraft, General Purpose, Wide Temperature Range, NATO Code G-395
MIL-PRF-81329	-	Lubricant, Solid Film, Extreme Environment, NATO Code Number S-1737
MIL-PRF-81733	-	Sealing and Coating Compound, Corrosion Inhibitive
MIL-PRF-83401	-	Resistor Networks, Fixed, Film, and Capacitor-Resistor Networks, Ceramic Capacitor and Fixed Film Resistors, General Specification for

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MIL-PRF-83421	-	Capacitors, Fixed, Metallized, Plastic Film Dielectric, (DC, AC, or DC and AC), Hermetically Sealed in Metal Cases or Ceramic Cases, Established Reliability, General Specification for
MIL-PRF-83536	-	Relays, Electromagnetic, Established Reliability 5 amperes and Below
MIL-PRF-83726	-	Relays, Hybrid and Solid State, Time Delay, General Specification for
MIL-PRF-85045	-	Cables, Fiber Optic, General Specification for

(Copies of these documents are available online at https://assist.dla.mil.)

DEPARTMENT OF DEFENSE STANDARDS

MIL-PRF-24508	-	Grease, High Performance, Multipurpose (Metric)
MIL-A-3920	-	Adhesive, Optical, Thermosetting
MIL-PRF-8625	-	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-A-24179	-	Adhesive, Flexible Unicellular-Plastic Thermal Insulation
MIL-A-46146	-	Adhesives-Sealants, Silicone, RTV, Noncorrosive (for use with Sensitive Metals and Equipment)
MIL-DTL-23071	-	Blowers, Miniature, for Cooling Electronic Equipment General Specification for
MIL-B-81793	-	Bearings, Ball, Annular, For Instruments and Precision Rotating Components
MIL-PRF-572	-	Cord, Yarns and Monofilaments Organic Synthetic Fiber
MIL-C-675	-	Coating of Glass Optical Elements (Anti-Reflection)
MIL-C-9074	-	Cloth, Laminated, Sateen, Rubberized

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MIL-C-10578	-	Corrosion Removing and Metal Conditioning Compound (Phosphoric Acid Base)
MIL-C-24723	-	Castings, Nickel-Copper Alloy
MIL-DTL-3954	-	Dummy Loads, Electrical, Waveguide, General Specification for
MIL-E-85082	-	Encoders, Shaft Angle to Digital, General Specification for
MIL-PRF-2312	-	Felt, Hair or Wool: Mildew Resistant and Moisture Resistant Treatment for
MIL-G-20098	-	Gypsum, Calcined
MIL-G-81704	-	Glass, Aircraft Instrument, Lighting Wedge and Cover
MIL-I-631	-	Insulation, Electrical, Synthetic - Resin Composition, Nonrigid
MIL-I-1361	-	Instrument Auxiliaries, Electrical Measuring: Shunts, Resistors, and Transformers
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-I-19166	-	Insulation Tape, Electrical, High-Temperature, Glass Fiber, Pressure-Sensitive
MIL-I-22076	-	Insulation Tubing, Electrical Nonrigid, Vinyl, Very Low Temperature Grade
MIL-I-22129	-	Insulation Tubing, Electrical, Polytetrafluoroethylene Resin, Nonrigid
MIL-I-23264	-	Insulators, Ceramic, Electrical and Electronic, General Specification for

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MIL-I-24391	-	Insulation Tape, Electrical, Plastic, Pressure-Sensitive
MIL-DTL-24728	-	Interconnection Box, Fiber Optic, General Specification for
MIL-I-24092	-	Insulating Varnishes and Solventless Resins for Application by the Dip Process
MIL-I-24768	-	Insulation, Plastics, Laminated, Thermosetting; General Specification for
MIL-I-46058	-	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)
MIL-PRF-15719	-	Lubricating Grease (High-Temperature, Electric Motor, Ball and Roller Bearings)
MIL-L-23398	-	Lubricant, Solid Film, Air-Cured, Corrosion Inhibiting, NATO Code Number S-749
MIL-M-13508	-	Mirror, Front Surfaced Aluminized: for Optical Elements
MIL-M-16125	-	Meters, Electrical, Frequency
MIL-M-17059	-	Motor, 60 Cycle, Alternating Current, Fractional H.P. (Shipboard Use)
MIL-M-24041	-	Molding and Potting Compound, Chemically Cured, Polyurethane
MIL-DTL-5757	-	Relays, Electromagnetic, General Specification for
MIL-R-7885	-	Rivets, Blind, Structural, Mechanically Locked Spindle and Friction Locked Spindle, General Specification for
MIL-DTL-24243	-	Rivets, Blind, Nonstructural, Retained Mandrel, General Specification for
MIL-S-22432	-	Servomotors, General Specification for

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MIL-S-22820	-	Servomotor-Tachometer Generator, AC; General Specification for
MIL-T-22821	-	Tachometer Generator, AC; General Specification for
MIL-T-81556	-	Tachometer Generator, AC; General Specification for
MIL-V-3144	-	Vials, Level
MIL-W-80	-	Window, Observation, Acrylic Base, Antielectrostatic, Transparent (For Indicating Instrument)
MIL-DTL-530	-	Webbing, Textile, Cotton, General Purpose, Natural or In Colors
MIL-DTL-4088	-	Webbing, Textile, Woven Nylon
MIL-DTL-27265	-	Webbing, Textile, Woven Nylon Impregnated
MIL-STD-22	-	Welded Joint Design
MIL-STD-171	-	Finishing of Metal and Wood Surfaces
MIL-STD-186	-	Protective Finishing For Army Missile Weapon Systems
MIL-STD-188-125-1	-	High-Altitude Electromagnetic Pulse (HEMP) Protection for Ground-Based C41 Facilities Performing Critical, Time-Urgent Missions Part 1 Fixed Facilities
MIL-STD-188-125-2	-	High-Altitude Electromagnetic Pulse (HEMP) Protection for Ground-Based C4I Facilities Performing Critical, Time- Urgent Missions - Part 2 - Transportable Systems
MIL-STD-188-200	-	System Design and Engineering Standard for Tactical Communications
MIL-STD-202	-	Test Method Standard Electronic and Electrical Component Parts

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Check the source to verify that this is the current version before use.

MIL-STD-276	-	Impregnation of Porous Metal Castings and Powdered Metal Components
MIL-STD-403	-	Preparation for and Installation of Rivets and Screws, Rocket, Missile, and Airframe Structures
MIL-STD-710	-	Synchros, 60 and 400 HZ, Selection and Application of
MIL-STD-750	-	Test Methods for Semiconductor Devices
MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-866	-	Grinding of Chrome Plated Steel and Steel Parts Heat Treated to 180,000 PSI or Over
MIL-STD-883	-	Microcircuits
MIL-STD-889	-	Dissimilar Metals
MIL-STD-981	-	Design, Manufacturing and Quality Standards for Custom Electromagnetic Devices for Space Applications
MIL-STD-1311	-	Test Methods for Electron Tubes
MIL-STD-1334	-	Process for Barrier Coating of Anti-Friction Bearings
MIL-STD-1353	-	Electrical Connectors, Plug-in Sockets and Associated Hardware, Selection and Use of
MIL-STD-1472	-	Human Engineering
MIL-STD-1568	-	Material and Processes for Corrosion Prevention and Control in Aerospace Weapons Systems
MIL-STD-1580	-	Destructive Physical Analysis for Electronic, Electromagnetic, and Electromechanical Parts
MIL-STD-1678-1	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements)

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Check the source to verify that this is the current version before use.

MIL-STD-1678-2	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements)
MIL-STD-1678-3	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 3: Physical, Mechanical, Environmental and Material Measurements)
MIL-STD-1678-4	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 4: Test Sample Configuration and Fabrication Requirements)
MIL-STD-1678-5	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements)
MIL-STD-1678-6	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 6: Parts and Support Equipment Commonality and Standardization Requirements, Cable Harness Configurations)

(Copies of these documents are available online at https://assist.dla.mil.)

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-17/4	-	Composite Materials Handbook - Volume 4 Metal Matrix Composites
MIL-HDBK-17/5	-	Composite Materials Handbook Volume 5 Ceramic Matrix Composites
MIL-HDBK-217	-	Reliability Prediction of Electronic Equipment
MIL-HDBK-225	-	Synchros Description and Operation
MIL-HDBK-231	-	Encoders Shaft Angle to Digital
MIL-HDBK-275	-	Guide for Selection of Lubricant Fluids and Compounds for Use in Flight Vehicles and Components
MIL-HDBK-338	-	Electronic Reliability Design Handbook

Source: http://assist.dla.mil -- Downloaded: 2024-01-04T20:50Z
Check the source to verify that this is the current version before use.

MIL-HDBK-415	-	Design Handbook for Fiber Optic Communications Systems
MIL-HDBK-454	-	General Guidelines for Electronic Equipment
MIL-HDBK-660	-	General Guidelines for Electronic E Fabrication of Rigid Waveguide Assemblies (Sweep Bends and Twists)
MIL-HDBK-730	-	Materials Joining
MIL-HDBK-83377	-	Adhesive Bonding (Structural) For Aerospace and Other Systems, Requirements for
MIL-HDBK-83575	-	General Handbook for Space Vehicle Wiring Harness Design and Testing)

(Copies of these documents are available online at https://assist.dla.mil.)

2.2.2 Other Government Documents, Drawings, and Publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEFENSE STANDARDIZATION PROGRAM OFFICE

SD-22	-	Diminishing Manufacturing Sources and Material Shortages

(Copies of these documents are available online at https://assist.dla.mil.)

DEFENSE LOGISTICS AGENCY (DLA)

DSCC 06013	-	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum
DSCC 06014	-	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum
DSCC 06015	-	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum

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DSCC 06016	-	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum
DSCC 06019	-	Capacitors, Fixed, Ceramic, Chip, High Frequency
DSCC 06022	-	Capacitors, Fixed, Ceramic, Chip, High Frequency

(Copies of these documents are available online at https://www.dla.mil/Land-and-Maritime/.)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA SP-8063	-	Lubrication, Friction, and Wear
NASA-STD-6012	-	Corrosion Protection for Space Flight Hardware

(Copies of these documents are available online at https://standards.nasa.gov/.)

NASA RP-1124	-	Outgassing Data for Selecting Spacecraft Materials

(Copies of these documents are available online at http://ntrs.nasa.gov/search.jsp.)

NASA ELECTRONIC PARTS AND PACKAGING PROGRAM (NEPP)

MSFC-STD-3029	-	Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments
MSFC-SPEC-469	-	Specification, Titanium and Titanium Alloys, Heat Treatment of
NASA/TP—2003–212244	-	PEM-INST-001: Instructions for Plastic Encapsulated Microcircuit (PEM) Selection, Screening, and Qualification

(Copies of these documents are available online at https://nepp.nasa.gov/index.cfm/.)

2.3 Non-Government Publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Source: http://assist.dla.mil -- Downloaded: 2024-01-04T20:50Z
Check the source to verify that this is the current version before use.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A354	-	Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
ASTM A449	-	Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/ 105/90 ksi Minimum Tensile Strength, General Use
ASTM A494/494M	-	Standard Specification for Castings, Nickel and Nickel Alloy
ASTM B16/B16M	-	Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
ASTM B22/B22M	-	Bronze castings for Bridges and Turntables
ASTM B26/B26M	-	Standard Specification for Aluminum-Alloy Sand Castings
ASTM B30	-	Copper-Base Alloys in Ingot Form
ASTM B36/B36M	-	Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar
ASTM B61	-	Steam or Valve Bronze Castings
ASTM B62	-	Composition Bronze or Ounce Metal Castings
ASTM B66	-	Bronze Castings for Steam Locomotive Wearing Parts
ASTM B67	-	Car and Tender Journal Bearings, Lined
ASTM B85/B85M	-	Standard Specification for Aluminum-Alloy Die Castings
ASTM B98/B98M	-	Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes
ASTM B99/B99M	-	Standard Specification for Copper-Silicon Alloy Wire for General Applications

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Check the source to verify that this is the current version before use.

ASTM B105	-	Standard Specification for Hard-Drawn Copper Alloy Wires for Electric Conductors
ASTM B108/B108M	-	Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B121/B121M	-	Standard Specification for Leaded Brass Plate, Sheet, Strip, and Rolled Bar
ASTM B122/B122M	-	Standard Specification for Copper-Nickel-Tin Alloy, Copper-Nickel-Zinc Alloy (Nickel Silver), and Copper-Nickel Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM B124/B124M	-	Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B148	-	Aluminum-Bronze Sand Castings
ASTM B150/B150M	-	Standard Specification for Aluminum Bronze Rod, Bar, and Shapes
ASTM B152/B152M	-	Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B166	-	Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696), Nickel-Chromium-Cobalt- Molybdenum Alloy (UNS N06617), and Nickel-Iron- Chromium-Tungsten Alloy (UNS N06674) Rod, Bar, and Wire
ASTM B168	-	Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696), Nickel-Chromium-Cobalt- Molybdenum Alloy (UNS N06617), and Nickel-Iron- Chromium-Tungsten Alloy (UNS N06674) Plate, Sheet, and Strip-290
ASTM B169/B169M	-	Standard Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar

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Check the source to verify that this is the current version before use.

ASTM B187/B187M	-	Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes
ASTM B196/B196M	-	Standard Specification for Copper-Beryllium Alloy Rod and Bar
ASTM B206/B206M	-	Standard Specification for Copper-Nickel-Zinc (Nickel Silver) Wire and Copper-Nickel Alloy Wire
ASTM B271/B271M	-	Copper-Base Alloy Centrifugal Castings
ASTM B272	-	Standard Specification for Copper Flat Products with Finished (Rolled or Drawn) Edges (Flat Wire and Strip)
ASTM B283/B283M	-	Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed)
ASTM B298	-	Standard Specification for Silver-Coated Soft or Annealed Copper Wire
ASTM B369	-	Copper-Nickel Alloy Castings
ASTM B427	-	Gear Bronze Alloy Castings
ASTM B488	-	Standard Specification for Electrodeposited Coatings of Gold for Engineering Uses
ASTM B505/B505M	-	Copper-Base Alloy Continuous Castings
ASTM B584	-	Copper Alloy Sand Castings for General Applications
ASTM B644	-	Standard Specification for Copper Alloy Addition Agents
ASTM B763/B763M	-	Copper Alloy Sand Castings for Valve Application
ASTM B770	-	Copper-Beryllium Alloy Sand Castings for General Applications
ASTM B806	-	Copper Alloy Permanent Mold Castings for General Applications

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Check the source to verify that this is the current version before use.

ASTM B828	-	Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C1036	-	Standard Specification for Flat Glass
ASTM D295	-	Standard Test Methods for Varnished Cotton Fabrics Used for Electrical Insulation
ASTM D495	-	Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation
ASTM D635	-	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D1000	-	Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
ASTM D1056	-	Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber
ASTM D1667	-	Standard Specification for Flexible Cellular Materials-Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2000	-	Standard Classification System for Rubber Products in Automotive Applications
ASTM D2400	-	Standard Specification for Varnished Glass-Polyester Cloth Used for Electrical Insulation
ASTM D2754	-	Standard Specification for High-Temperature Glass Cloth Pressure-Sensitive Electrical Insulating Tape
ASTM D2863	-	Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D3295	-	Standard Specification for PTFE Tubing, Miniature Beading and Spiral Cut Tubing

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Check the source to verify that this is the current version before use.

ASTM D3574	-	Standard Test Methods for Flexible Cellular Materials–Slab, Bonded, and Molded Urethane Foams
ASTM D3955	-	Standard Specification for Electrical Insulating Varnishes
ASTM D4388	-	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes
ASTM D5213	-	Standard Specification for Polymeric Resin Film for Electrical Insulation and Dielectric Applications
ASTM D5363	-	Standard Specification for Anaerobic Single-Component Adhesives (AN)
ASTM D5948	-	Standard Specification for Molding Compounds, Thermosetting
ASTM E595	-	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
ASTM F3125/F3125M	-	Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
ASTM F448	-	Standard Test Method for Measuring Steady-State Primary Photocurrent
ASTM F615M	-	Standard Practice for Determining Safe Current Pulse Operating Regions for Metallization on Semiconductor Components (Metric)
ASTM F744M	-	Standard Test Method for Measuring Dose Rate Threshold for Upset of Digital Integrated Circuits (Metric)
ASTM F773M	-	Standard Practice for Measuring Dose Rate Response of Linear Integrated Circuits (Metric)

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Check the source to verify that this is the current version before use.

ASTM F980	-	Standard Guide for Measurement of Rapid Annealing of Neutron-Induced Displacement Damage in Silicon Semiconductor Devices
ASTM F996	-	Standard Test Method for Separating an Ionizing Radiation-Induced MOSFET Threshold Voltage Shift Into Components Due to Oxide Trapped Holes and Interface States Using the Subthreshold Current–Voltage Characteristics
ASTM F1190	-	Standard Guide for Neutron Irradiation of Unbiased Electronic Components
ASTM F1192	-	Standard Guide for the Measurement of Single Event Phenomena (SEP) Induced by Heavy Ion Irradiation of Semiconductor Devices
ASTM F1262M	-	Standard Guide for Transient Radiation Upset Threshold Testing of Digital Integrated Circuits (Metric)
ASTM F1263	-	Standard Guide for Analysis of Overtest Data in Radiation Testing of Electronic Parts
ASTM F1467	-	Standard Guide for Use of an X-Ray Tester (≈ 10 keV Photons) in Ionizing Radiation Effects Testing of Semiconductor Devices and Microcircuits
ASTM F1892	-	Standard Guide for Ionizing Radiation (Total Dose) Effects Testing of Semiconductor Devices
ASTM F1893	-	Guide for Measurement of Ionizing Dose-Rate Survivability and Burnout of Semiconductor Devices

(Copies of these documents are available online at http://www.astm.org/.)

BATTELLE MEMORIAL INSTITUTE

MMPDS	-	Metallic Materials Properties Development and Standardization Handbook

(Copies of these documents are available online at https://www.mmpds.org/.)

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AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	-	Standard Symbols for Welding, Brazing, and Nondestructive Examination
AWS A3.0M/A3.0	-	Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying
AWS C3.4	-	Specification for Torch Brazing
AWS C3.5	-	Specification for Induction Brazing
AWS C3.6	-	Specification for Furnace Brazing
AWS C3.7M/C3.7	-	Specification for Aluminum Brazing
AWS C6.2	-	Specification for Friction Welding of Metals
AWS D1.1	-	Structural Welding Code - Steel
AWS D1.2	-	Structural Welding Code-Aluminum
AWS D17.1/D17.1M:2010	-	Specification for Fusion Welding for Aerospace Applications
AWS D17.2/D17.2M:2013	-	Specification for Resistance Welding for Aerospace Applications

(Copies of these documents are available online at https://www.aws.org/.)

COMPOSITES HANDBOOK

CMH-17	-	Composite Materials Handbook

(Copies of these documents are available online at https://www.cmh17.org/.)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	-	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series) - Includes Errata July 2013

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ASME B18.6.3	-	Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.6.7M	-	Metric Machine Screws - Supersedes IFI 513: 1981
ASME B18.3	-	Socket Cap, Shoulder, Set Screws, and Hex Keys (Inch Series)
ASME B18.18	-	Quality Assurance for Fasteners
ASME B18.21.1	-	Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.29.1	-	Helical Coil Screw Thread Inserts - Free Running and Screw Locking (Inch Series)

(Copies of these documents are available online at http://www.asme.org/.)

AEROSPACE INDUSTRIES ASSOCIATION (AIA)

AIA/NAS NAS547	-	Fastener, Rotary, Quick-Operating, High Strength
AIA/NAS NAS498	-	Fasteners, Alloy Steel Externally Threaded, 95 ksi Fsu, 450°F
AIA/NAS NASM1312	-	Fastener Test Methods
AIA/NAS NASM1515	-	Fastener Systems for Aerospace Applications
AIA/NAS NAS1686	-	Rivet, Blind, Aluminum Sleeve, Mechanically Locked Spindle, Bulbed
AIA/NAS NAS1687	-	Rivet, Blind, Nickel-Copper and Nickel Alloy, Mechanically Locked Spindle, Bulbed
AIA/NAS NASM5591	-	Fasteners, Panel, Nonstructural
AIA/NAS NASM5674	-	Rivets, Structural, Aluminum Alloy, Titanium Columbium Alloy, General Specification For
AIA/NAS NASM6812	-	Fasteners, Externally Threaded, Alloy Steel, Corrosion Resistant Steel, Aluminum, 60,000 PSI to 125,000 PSI

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AIA/NAS NASM7838	-	Bolt, Internal Wrenching, 160 ksi Ftu
AIA/NAS NASM8814	-	Rivets, Blind, Nonstructural Type
AIA/NAS NASM22978	-	Fastener, Rotary, Quick-Operating, High-Strength
AIA/NAS NASM25027	-	Nut, Self-Locking, 250 °F, 450 °F, and 800 °F
AIA/NAS NASM27384	-	Rivet, Blind, Drive Types
AIA/NAS NASM28728	-	Dial, Control, Multi-Turn Counters, General Specification For
AIA/NAS NASM33522	-	Rivets, Blind, Structural, Mechanically Locked and Friction Retainer Spindle, (Reliability And Maintainability) Design and Construction Requirement for
AIA/NAS NASM33540	-	Safety Wiring, Safety Cabling, Cotter Pinning, General Practices For
AIA/NAS NASM33557	-	Nonstructural Rivets For Blind Attachment; Limitations for Design and Usage

(Copies of these documents are available online at https://www.aia-aerospace.org/standards/.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ESD S20.20	-	Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
ANSI/NEMA C18.1M	-	Portable Primary Cells and Batteries with Aqueous Electrolyte
ANSI/NEMA WC 27500	-	Standard for Aerospace and Industrial Electrical Cable

(Copies of these documents are available online at http://www.ansi.org/.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

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NEMA FI 3	-	Calendared Aramid Papers Used For Electrical Insulation
NEMA MW 1000	-	Magnet Wire
NEMA RE 2	-	Electrical Insulating Varnish

(Copies of these documents are available online at http://www.nema.org.)

ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

IPC-1791	-	Trusted Electronic Designer, Fabricator and Assembler Requirements
IPC 2220	-	Design Standards Series
IPC 2221	-	Generic Standard on PWB Design
IPC 2222	-	Sectional Standard on Rigid PWB Design
IPC 2223	-	Sectional Design Standard for Flexible Printed Boards
IPC 6010	-	Family of Board Performance Documents
IPC 7711/7721	-	Rework, Modification and Repair of Electronic Assemblies
IPC-9797	-	Press-fit Standard for Automotive Requirements and other High-Reliability Applications
IPC A-610	-	Acceptability of Electronic Assemblies
IPC/WPHA-A-620	-	Requirements and Acceptance for Cable and Wire Harness Assemblies
IPC CC-830	-	Qualification and Performance of Electrical Insulating Compound for Printed Wiring Assemblies
IPC J-STD-001/001ES	-	Requirements for Soldered Electrical and Electronic Assemblies
IPC J-STD-002	-	Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires

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IPC J-STD-003	-	Solderability for Printed Boards
IPC J-STD-004	-	Requirements for Soldering Fluxes
IPC J-STD-005	-	Requirements for Soldering Pastes
IPC J-STD-006	-	Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications
IPC J-STD-020	-	Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices
IPC J-STD-033	-	Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices
IPC J-STD-075	-	Classification of Non-IC Electronic Components for Assembly Processes
IPC J-STD-609	-	Marking and Labeling of Components, PCBs and PCBAs to Identify Lead (Pb), Lead-Free (Pb-Free) and Other Attributes

(Copies of these documents are available online at http://www.ipc.org/.)

JOINT ELECTRON DEVICE ENGINEERING COUNCIL (JEDEC)

JEDEC JEP70	-	Guide to Standards and Publications Relating to Quality and Reliability of Electronic Hardware
JEDEC JEP149	-	Application Thermal Derating Methodologies
JEDEC JEP122	-	Failure Mechanisms and Models for Semiconductor Devices
JEDEC JEP133	-	Guide for the Production and Acquisition of Radiation- Hardness- Assured Multichip Modules and Hybrid Microcircuits
JEDEC JESD22-A100	-	Cycled Temperature-Humidity-Bias Life Test
JEDEC JESD22-A103	-	High Temperature Storage Life

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JEDEC JESD22-A104	-	Temperature Cycling
JEDEC JESD22-A108	-	Temperature, Bias, and Operating Life
JEDEC JESD22-A119	-	Low Temperature Storage Life
JEDEC JESD22-A120	-	Test Method for the Measurement of Moisture Diffusivity and Water Solubility in Organic Materials Used in Electronic Devices
JEDEC JESD22-A121	-	Test Method for Measuring Whisker Growth on Tin and Tin Alloy Surface Finishes
JEDEC JESD47	-	Stress-Test-Driven Qualification of Integrated Circuits
JEDEC JESD57	-	Test Procedures for the Measurement of Single-Event Effects in Semiconductor Devices from Heavy Ion Irradiation
JEDEC JESD74	-	Early Life Failure Rate Calculation Procedure for Semiconductor Components
JEDEC JESD89	-	Measurement and Reporting of Alpha Particle and Terrestrial Cosmic Ray-Induced Soft Errors in Semiconductor Devices
JEDEC JESD201	-	Environmental Acceptance Requirements for Tin Whisker Susceptibility of Tin and Tin Alloy Surface Finishes
JEDEC JESD625	-	Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices

(Copies of these documents are available online at http://www.jedec.org/.)

AUTOMOTIVE ELECTRONICS COUNCIL (AEC)

AEC Q100	-	Failure Mechanism Based Stress Test Qualification for Integrated Circuits

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Check the source to verify that this is the current version before use.

AEC Q101	-	Failure Mechanism Based Stress Test Qualification for Discrete Semiconductors
AEC Q200	-	Stress Test Qualification for Passive Components

(Copies of these documents are available online at http://www.aecouncil.com/.)

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61967	-	Integrated Circuits - Measurement of Electromagnetic Emissions
IEC 62396-1	-	Process management for avionics – Atmospheric radiation effects – Part 1: Accommodation of atmospheric radiation effects via single event effects within avionics electronic equipment
IEC TR 62240-1	-	Process management for avionics – Electronic components capability in operation – Part 1: Temperature uprating
IEC TS 62668-1	-	Process management for avionics – Counterfeit prevention – Part 1: Avoiding the use of counterfeit, fraudulent and recycled electronic components

(Copies of these documents are available online at http://www.iec.ch.)

RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA)

RTCA DO-160	-	Environmental Conditions and Test Procedures for Airborne Equipment

(Copies of these documents are available online at http://www.rtca.org.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) INTERNATIONAL

SAE AMS2175	-	Castings, Classification and Inspection of
SAE AMS2430	-	Shot Peening, Automatic
SAE AMS2770	-	Heat Treatment of Wrought Aluminum Alloy Parts

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SAE AMS2771	-	Heat Treatment of Aluminum Alloy Castings
SAE AMS2772	-	Heat Treatment of Aluminum Alloy Raw Materials
SAE AMS3276	-	Sealing Compound, Integral Fuel Tanks and General Purpose, Intermittent Use to 360°F (182°C)
SAE AMS3277	-	Sealing Compound, Polythioether Rubber Fast Curing for Integral Fuel Tanks and General Purpose, Intermittent Use to 360°F (182°C)
SAE AMS3638	-	Tubing, Irradiated Polyolefin Plastic, Electrical Insulation Pigmented, Semi-Rigid, Heat Shrinkable, 2 to 1 Shrink Ratio (Stabilized Type)
SAE AMS3653	-	Tubing, Electrical Insulation Standard Wall, Extruded Polytetrafluoroethylene (PTFE)
SAE AMS3654	-	Tubing, Electrical Insulation Light Wall, Extruded Polytetrafluoroethylene (PTFE)
SAE AMS3655	-	Tubing, Electrical Insulation Thin Wall, Extruded Polytetrafluoroethylene (PTFE)
SAE AMS4842	-	Castings, Leaded Bronze, Sand and Centrifugal 80Cu-10Sn-9.5Pb as Cast
SAE AMS4845	-	Tin Bronze Castings, Sand and Centrifugal 87.5Cu-10Sn-2Zn as Cast
SAE AMS4855	-	Leaded Red Brass, Sand and Centrifugal Castings 85Cu-5.0Sn-5.0Pb- 5.0 Zn as Cast
SAE AMS4860	-	Manganese Bronze, Sand and Centrifugal Castings 63Cu-24 Zn-6.2Al-3.8Mn as Cast
SAE AMS4862	-	Manganese Bronze, Sand and Centrifugal Castings 63Cu-24 Zn-6.2Al-3.8Mn-3.0Fe High Strength, as Cast
SAE AMS4890	-	Copper-Beryllium Alloy Castings 97Cu – 2.1Be – 0.52Co – 0.28Si Solution Heat Treated (TBOO)

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SAE AMS4900	-	Titanium Sheet, Strip, and Plate Commercially Pure Annealed, 55 ksi (379 MPa) Yield Strength - UNS R50550
SAE AMS4901	-	Titanium Sheet, Strip, and Plate Commercially Pure Annealed, 70.0 ksi (485 MPa) - UNS R50700
SAE AMS4902	-	Titanium Sheet, Strip, and Plate Commercially-Pure Annealed 40.0 ksi (276 MPa) Yield Strength - UNS R50400
SAE AMS4903	-	Titanium Alloy Sheet, Strip, and Plate 6Al - 4V Solution Heat Treated - UNS R56400
SAE AMS4904	-	Titanium Alloy Sheet, Strip, and Plate 6Al - 4V Solution Heat Treated and Aged - UNS R56400
SAE AMS4907	-	Titanium Alloy, Sheet, Strip, and Plate 6.0Al - 4.0V, Extra Low Interstitial Annealed - UNS R56401
SAE AMS4909	-	Titanium Alloy, Sheet, Strip, and Plate 5Al - 2.5Sn, Extra Low Interstitial Annealed - UNS R54521
SAE AMS4910	-	Titanium Alloy, Sheet, Strip, and Plate 5Al - 2.5Sn Annealed - UNS R54520
SAE AMS4911	-	Titanium Alloy, Sheet, Strip, and Plate 6Al - 4V Annealed - UNS R56400
SAE AMS4915	-	Titanium Alloy Sheet, Strip, and Plate 8Al - 1V - 1Mo Single Annealed - UNS R54810
SAE AMS4916	-	Titanium Alloy Sheet, Strip, and Plate 8Al - 1Mo - 1V Duplex Annealed - UNS R54810
SAE AMS4917	-	Titanium Alloy Sheet, Strip, and Plate 13.5V - 11Cr - 3.0Al Solution Heat Treated - UNS R58010
SAE AMS4918	-	Titanium Alloy, Sheet, Strip, and Plate 6AI - 6V - 2Sn Annealed - UNS R56620

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SAE AMS4919	-	Titanium Alloy Sheet, Strip, and Plate 6AI - 2Sn - 4Zr - 2Mo - 0.08Si Duplex Annealed - UNS R54620
SAE AMS4921	-	Titanium Bars, Wire, Forgings, and Rings Commercially Pure 70 ksi (483 MPa) Yield Strength - UNS R50700
SAE AMS4939	-	Titanium Alloy Sheet, Strip, and Plate 3Al - 8V - 6Cr - 4Mo - 4Zr Solution Heat Treated - UNS R58640
SAE AMS4940	-	Titanium Alloy Sheet, Strip, and Plate 6Al - 6V - 2Sn Solution Heat Treated and Aged - UNS R56620
SAE AMS4970	-	Titanium Alloy Bars, Wire, and Forgings 7Al - 4Mo Solution and Precipitation Heat Treated - UNS R56740
SAE AMS4988	-	Titanium Alloy Sheet, Strip, and Plate 6Al - 6V - 2Sn Solution Heat Treated - UNS R56620
SAE AMS4989	-	Titanium Alloy Sheet, Strip, and Plate 3Al - 2.5V Annealed - UNS R56320
SAE AMS4990	-	Titanium Alloy Sheet, Strip, and Plate 6Al - 6V - 2Sn Solution Heat Treated and Aged - UNS R56620
SAE AMS5342	-	Steel, Corrosion-Resistant, Investment Castings 16Cr - 4.1Ni - 0.28Cb (Nb) - 3.2Cu Homogenization, Solution, and Precipitation Heat Treated (H1100) 130 ksi (896 MPa) Tensile Strength (17-4) - UNS J91280 and UNS J92200
SAE AMS5343	-	Steel, Corrosion-Resistant, Investment Castings 16Cr - 4.1Ni - 0.28Cb - 3.2Cu Homogenization, Solution, and Precipitation Heat Treated (H1000) 150 ksi (1034 MPa) Tensile Strength (17-4) - UNS J92200; UNS J92180
SAE AMS6900	-	Titanium Alloy Bars, Forgings and Forging Stock 5Al - 2.5Sn Annealed - UNS R54520
SAE AMS6901	-	Titanium Alloy Bars, Forgings and Forging Stock 5Al - 2.5Sn, Extra Low Interstitial Annealed - UNS R54521

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SAE AMS6905	-	Titanium Alloy Bars, Forgings and Forging Stock 6.0Al - 2.0Sn - 4.0Zr - 2.0Mo Duplex Annealed - UNS R54620
SAE AMS6906	-	Titanium Alloy Bars, Forgings, and Forging Stock 6.0Al - 2.0Sn - 4.0Zr - 6.0Mo Solution Heat Treated and Aged - UNS R56260
SAE AMS6907	-	Titanium Alloy Bars, Forgings and Forging Stock 6.0Al - 2.0Sn - 4.0Zr - 6.0Mo Duplex Annealed - UNS R56260
SAE AMS6910	-	Titanium Alloy Bars, Forgings and Forging Stock 8Al - 1Mo - 1V Duplex Annealed - UNS R54810
SAE AMS6915	-	Titanium Alloy Bars, Forgings and Forging Stock 7.0Al - 4.0Mo Annealed - UNS R56740
SAE AMS6920	-	Titanium Alloy Bars, Forgings and Forging Stock 3Al - 8V - 6Cr - 4Mo - 4Zr Solution Heat Treated - UNS R58640
SAE AMS6921	-	Titanium Alloy Bars, Forgings and Forging Stock 3Al - 8V - 6Cr - 4Mo - 4Zr Solution Heat Treated and Aged - UNS R58640
SAE AMS6925	-	Titanium Alloy Bars, Forgings and Forging Stock 13V - 11Cr 3Al Solution Heat Treated - UNS R58010
SAE AMS6926	-	Titanium Alloy Bars, Forgings and Forging Stock 13V - 11Cr 3Al Solution Heat Treated and Aged - UNS R580105316
SAE AMS6930	-	Titanium Alloy Bars, Forgings and Forging Stock 6.0Al -4.0V Solution Heat Treated and Aged - UNS R56400
SAE AMS6931	-	Titanium Alloy Bars, Forgings and Forging Stock 6.0Al -4.0V Annealed - UNS R56400

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SAE AMS6932	-	Titanium Alloy Bars, Forgings and Forging Stock 6.0Al –4.0V Extra Low Interstitial Annealed - UNS R56401
SAE AMS6935	-	Titanium Alloy Bars, Forgings and Forging Stock 6.0Al –6.0V – 2.0Sn Solution Heat Treated and Aged - UNS R56620
SAE AMS6936	-	Titanium Alloy Bars, Forgings and Forging Stock 6Al - 6V - 2Sn Annealed - UNS R56620
SAE AMS6940	-	Titanium Alloy Bars, Forgings and Forging Stock 3.0Al -2.5V Annealed - UNS R56320
SAE AMS-A-8576	-	Adhesive, Acrylic Base, for Acrylic Plastic
SAE AMS-A-21180	-	Aluminum-Alloy Castings, High Strength
SAE AMS-A-25463	-	Adhesive, Film Form Metallic Structural Sandwich Construction
SAE AMS-A-22771	-	Aluminum Alloy Forgings, Heat Treated
SAE AMS-C-6183	-	Cork and Rubber Composition Sheet; for Aromatic Fuel and Oil Resistant Gaskets
SAE AMS-C-7438	-	Core Material, Aluminum, for Sandwich Construction
SAE AMS-F-7190	-	Forging, Steel, For Aircraft/Aerospace Equipment and Special Ordnance Applications
SAE AMS-G-25871	-	Glass, Laminated, Aircraft Glazing
SAE AMS-H-6875	-	Heat Treatment of Steel Raw Materials
SAE AMS-H-81200	-	Heat Treatment of Titanium and Titanium Alloys
SAE AMS-P-5315	-	(R) Acrylonitrile-butadiene (NBR) Rubber for Fuel-Resistant Seals 60 to 70
SAE AMS-QQ-N-290	-	Nickel Plating (Electrodeposited)

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SAE AMS-QQ-P-416	-	Plating, Cadmium (Electrodeposited)
SAE AMS-S-8802	-	(R) Sealing Compound, Temperature Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion
SAE AMS-STD-401	-	Sandwich Constructions and Core Materials; General Test Methods
SAE AMS-STD-595	-	Colors Used in Government Procurement
SAE ARP1199	-	(R) Selection, Application, and Inspection of Electric Overcurrent Protective Devices
SAE ARP4754	-	(R) Guidelines for Development of Civil Aircraft and Systems
SAE ARP5316	-	Storage of Elastomer Seals and Seal Assemblies Which Include an Elastomer Element Prior to Hardware Assembly
SAE ARP5890	-	(R) Guidelines for Preparing Reliability Assessment Plans for Electronic Engine Controls
SAE AS12500	-	Corrosion Prevention and Deterioration Control in Electronic Components and Assemblies
SAE AS1933	-	Age Controls for Hose Containing Age-Sensitive Elastomeric Material
SAE AS5372	-	(R) Fuse, Current Limiter Type, Aircraft
SAE AS5553	-	(R) Fraudulent/Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
SAE AS6174	-	Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materiel
SAE AS6294	-	Requirements for Plastic Encapsulated Microcircuits in Space Applications

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SAE AS8943	-	Bearings, Sleeve, Plain and Flanged, Self-Lubricating -65 to +250 degrees F
SAE AS9100	-	Quality Management Systems - Requirements for Aviation, Space and Defense Organizations
SAE AS13572	-	Springs, Helical, Compression and Extension (Stabilized Type)
SAE AS22520/10	-	Crimping Tools, Type 2, Terminal, Hand, Wire Termination, for Coaxial, Twinaxial, Triaxial, Shielded Contacts and Ferrules, Terminal Lugs, Splices, and End Caps
SAE AS22759	-	(R) Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy
SAE AS23190	-	Wiring, Positioning, and Support Accessories
SAE AS50861	-	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy
SAE AS50881	-	(R) Wiring Aerospace Vehicle
SAE AS53731	-	Fuse Holder, Block Type, Aircraft (Stabilized Type)
SAE AS81044	-	Wire, Electrical, Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer, or Polyarlyene Insulated, Copper or Copper Alloy
SAE AS81550	-	(R) Insulating Compound, Electrical, Embedding, Reversion Resistant Silicone
SAE AS81765	-	Insulating Components, Molded, Electrical, Heat Shrinkable, General Specification For
SAE AS81822	-	Wire, Electrical, Solderless Wrap, Insulated and Uninsulated, General Specification for (Stabilized Type)
SAE AS81934	-	Bearings, Sleeve, Plain and Flanged, Self-lubricating

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SAE AS81935	-	Bearings, Plain, Rod End, Self-Aligning, Self Lubricating, General Specification for
SAE AS81936	-	Bearings, Plain, Self-Aligning (CuBe Ball, CRES Race), General Specification for
SAE EIA 557	-	Statistical Process Control Systems
SAE EIA-STD-4899	-	(R) Requirements for an Electronic Components Management Plan
SAE GEIA-HB-0005-1	-	Program Management/Systems Engineering Guidelines for Managing the Transition to Lead-Free Electronics
SAE GEIA-STD-0005-1	-	Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder
SAE GEIA-STD-0005-2	-	Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High Performance Electronic Systems
SAE GEIA-STD-0008	-	Derating of Electronic Components
SAE GEIA-STD-0009	-	Reliability Program Standard for Systems Design, Development, and Manufacturing
SAE J537	-	Storage Batteries
SAE J2360	-	(R) Automotive Gear Lubricants for Commercial and Military Use
SAE STD-0016	-	Standard for Preparing a DMSMS Management Plan
SAE TB-0003	-	Counterfeit Parts & Materials Risk Mitigation
SAE Z26.1	-	Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways - Safety Standard

(Copies of these documents are available online at http://www.sae.org/.)

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VMEBUS INTERNATIONAL TRADE ASSOCIATION (VITA)

ANSI/VITA 51.2-2016	-	Physics of Failure Reliability Predictions

(Copies of these documents are available online at http://vita.com/.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9000	-	Quality Management Systems - Fundamentals and Vocabulary
ISO 9211	-	Optics and Optical Instruments - Optical Coatings
ISO 10110	-	Optics and Optical Instruments - Preparation of Drawings for Optical Elements and Systems

(Copies of these documents are available online at http://www.iso.org/iso/home/standards.htm.)

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-440	-	Fiber Optic Terminology
TIA-455-64 (FOTP-64)	-	Procedure for Measuring Radiation-Induced Attenuation in Optical Fibers and Optical Cables

(Copies of these documents are available online at http://www.tiaonline.org/standards/.)

INDEPENDENT DISTRIBUTORS OF ELECTRONICS ASSOCIATION (IDEA)

IDEA-STD-1010	-	Acceptability of Electronic Components Distributed in the Open Market

(Copies of these documents are available online at http://www.idofea.org/.)

TELECORDIA

GR-468-CORE	-	Generic Reliability Assurance Requirements for Optoelectronic Devices Used in Telecommunications Equipment

(Copies of these documents are available online at http://telecom-info.telcordia.com/site-cgi/ido/index.html.)

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OTHER NON-GOVERNMENT DOCUMENTS

"Survey of Potential Data for Design Allowable MIL-Handbook Utilization for Structural Silicon-Based Ceramics," prepared by IIT Research Institute, Materials and Manufacturing Technology Division, Chicago, IL 60616, December 1981, Final Report in Contract No.
DAAG 46-79-C-0078.

"Thermophysical Properties of Matter - the TPRC Data Series," Volumes 2, 5, 8, 9, 11, and 13, IFI/Plenum, New York-Washington 1970.

"Engineering Properties of Selected Ceramic Materials," published and distributed by the American Ceramic Society, Inc., 4055 N. High Street, Columbus, Ohio 43214, 1966.

"Fracture Mechanics of Ceramics," Volumes 1-6, Plenum Press, New York-London 1974 (Volumes 1 and 2), 1978 (Volumes 3 and 4), 1983 (Volumes 5 and 6).

2.4 Order of Precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3 DEFINITIONS

3.1 Approved supplier. A supplier that has been formally assessed and determined by the buying organization to have adequate procedures for providing parts and/or materials. The approval process includes assessment of adequate counterfeit avoidance, detection, containment, and reporting procedures.

3.2 Authenticity. The process of using inspections, tests, or other methods to determine whether a part or material has been knowingly misrepresented by a supplier and is therefore considered a counterfeit part or material. Parts or materials which pass the authenticity process are considered likely to be authentic, valid versions of the item intended to have been purchased.

3.3 Authorized supplier. A supplier that is authorized by the original component manufacturer to buy parts or materials directly from the manufacturer. Parts provided from authorized suppliers typically have never left the manufacturer's authorized supply chain and are accompanied by full manufacturer support and warranty. Also referred to as a franchise supplier or distributor.

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3.4 Broker. A type of unauthorized supplier, typically an independent distributor, that buys and sells parts or materials without maintaining stock and without an original component manufacturer (OCM) authorization.

3.5 Certificate of conformance (C of C). A document provided by a contractor or supplier to formally declare that the furnished supplies or services called for by the contract are in accordance with all applicable requirements.

3.6 Commercially Available off-the-Shelf (COTS) item (From 48 C.F.R § 2.101)

(1) Means any item of supply (including construction material) that is—

(i) A commercial product (as defined in paragraph (1) of the definition of "commercial product" in this section); (see the text box below)

From 48 C.F.R § 2.101. Commercial product means — (1) A product, other than real property, that is of a type customarily used by the general public or by nongovernmental entities for purposes other than governmental purposes, and— (i) Has been sold, leased, or licensed to the general public; or (ii) Has been offered for sale, lease, or license to the general public;

(ii) Sold in substantial quantities in the commercial marketplace; and

(iii) Offered to the Government, under a contract or subcontract at any tier, without modification, in the same form in which it is sold in the commercial marketplace; and

(2) Does not include bulk cargo, as defined in 46 U.S.C. 40102(4), such as agricultural products and petroleum products.

3.7 Component. For the purposes of this document, the words "component" and "part" are used interchangeably. In the context of system acquisition, the word component may include subsystems, assemblies, subassemblies, and other major elements of an end item; it does not include elements of relatively small annual acquisition value.

3.8 Component obsolescence management. The range of management actions taken to avoid or resolve the effects of components not being procurable due to the manufacturer(s) ceasing production. Component obsolescence management should be considered an element of risk management.

3.9 Component qualification. The process used to demonstrate that the component is capable of meeting its application specification for all the required conditions and environments.

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3.10 Component quality assurance. All activities and processes required to provide adequate confidence that each individual component meets the performance and environmental requirements.

3.11 Component selection. The process of choosing a specific component for a specific application.

3.12 Component standardization. The process of developing and agreeing on (by consensus of decision) uniform engineering criteria for products and methods for achieving compatibility, interoperability, interchangeability, or commonality of material. Standardization is used to reduce proliferation of parts in inventory.

3.13 Configuration item. An aggregation of hardware, firmware, computer software, or any of their discrete portions, which satisfies an end use function and is designated by the government for separate configuration management. Configuration items may vary widely in complexity, size, and type such as from an aircraft, electronic, or ship system to an electronic piece part or limited life epoxy. Any item required for Logistics Support (LS) and designated for separate procurement is a configuration item.

3.14 Contracting activity. An element of an agency designated by the agency head which has been delegated contracting authority regarding acquisitions functions. The term is synonymous with the term “procuring activity.”

3.15 Contracting officer. A contracting officer is a person with the authority to enter into, administer, or terminate contracts and make related determinations and findings. The term includes authorized representatives of the contracting officer, acting within the limits of delegated authority.

3.16 Contractor. A company retained under contract to develop and/or produce hardware/equipment or related activities at any tier.

3.17 Corrosion prevention and control (CPC). The rigorous application of engineering design and analysis, quality assurance (QA), nondestructive inspection (NDI), manufacturing, operation and support technologies to prevent the initiation of corrosion, avoid functional impairment due to corrosion, and define processes for the tracking and repair of corrosion problems.

3.18 Counterfeit parts and materials. A counterfeit part or material is an item that is an unlawful or unauthorized reproduction, substitution, or alteration that has been knowingly mismarked, misidentified, or otherwise misrepresented to be an authentic, unmodified electronic part from the original manufacturer, or a source with the express written authority of the original

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manufacturer or current design activity, including an authorized aftermarket manufacturer. Unlawful or unauthorized substitution includes used electronic parts represented as new, or the false identification of grade, serial number, lot number, date code, or performance characteristics (DFARS 202.101). Examples of counterfeit parts/materials include, but are not limited to:

(1) Items which do not contain the proper internal construction (die, manufacturer, wire bonding, etc.) consistent with the ordered item.

(2) Items which have been used, refurbished or reclaimed, but represented as new product.

(3) Items which have different package style, surface plating/finish, or anodization/treatment than the ordered items.

(4) Items which have not successfully completed the OCM's full production and test flow but are represented as completed product.

(5) Items sold as upscreened, which have not successfully completed upscreening.

(6) Items sold with modified labeling or markings intended to misrepresent the item's form, fit, function, or grade.

Note: Some of the examples above may be more correctly defined as fraudulent parts. However, the term 'counterfeit' in this document applies to both fraudulent and counterfeit parts.

3.19 Defect/defective. Any condition or characteristic in any supply or service furnished by the contractor under the contract that is not in compliance with the requirements of the contract.

3.20 Derating. Reliability derating of a part or material is the intentional reduction of its electrical, mechanical, and thermal stresses to provide a safety margin between the applied stress and the actual demonstrated limit of the part capabilities. As used herein, the term "derating" refers to "reliability derating", which is the reduction beyond the manufacturer's specified derating.

3.21 Design activity. An activity that has, or has had, responsibility for the design of an item. The activity may be Government, commercial, or nonprofit organization.

3.22 Disposition. The determination of how defective or nonconforming items should be treated. Dispositions include rework, repair, return to vendor, use as is, or scrap.

3.23 Distributor. An organization that stores, splits, repacks, and distributes completely finished components that have been declared by the manufacturer as conforming to their specifications. Also, see "authorized supplier" and "broker" definitions herein.

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3.24 Document. Document applies to the specifications, drawings, lists, standards, pamphlets, reports and printed, typewritten or other information, relating to the design, procurement, manufacture, test or acceptance inspection of items or services.

3.25 Drawings (engineering). An engineering document or digital data file(s) that discloses, directly or by reference, by means of graphic or textual presentations, or combinations of both, the physical and functional requirements of an item.

3.26 Electrostatic discharge (ESD). ESD is transfer of an electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field. The level of susceptibility of a device is found by ESD classification testing and is used as the basis for assigning an ESD class.

3.27 End item. A production product assembled, completed, and ready for issue or deployment.

3.28 Equipment. See End Item.

3.29 Firmware. The combination of a hardware device and computer instructions or computer data that reside as read-only software on the hardware device. The software cannot be readily modified under program control.

3.30 Government-Industry Data Exchange Program (GIDEP). GIDEP is a data-sharing program between government and industry that is financed by the Armed Services and managed by the Navy. It is a repository of failure history, usage, and/or test reports on PM&P and other commodities. The data are submitted by and distributed to member companies/agencies.

3.31 High reliability parts. Parts intended for high reliability (hi-rel) applications which are procured to a manufacturer controlled test program as described in the manufacturer's catalog. They are controlled only by the manufacturer, who assigns them a special part number and provides a certificate of conformance (C of C) that they have been tested as advertised. The manufacturer's hi-rel program is usually based on MIL-STD, MIL-SPEC, or industry standard equivalent approved test methods. However, it is the responsibility of the user to verify that testing meets the requirements specified herein.

3.32 Inspection. Visual examination of the item (hardware) and in accordance with an associated descriptive document that compares appropriate characteristics with predetermined standards to determine conformance to requirements. May require optical aids.

3.33 Life cycle. The five basic technology phases (as follows) make up the product life cycle:

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3.33.1 Introduction. The first of five basic technology life cycle phases indicated by new product announced in the marketplace, often with substantial advertising exposure, small but rapidly growing sales volume, and small numbers of users.

3.33.2 Growth. The second of five basic technology life cycle phases indicated by growing sales volumes, entry into the marketplace of additional manufacturers and third party offerors, and a growing number of product users.

3.33.3 Maturity. The third of five basic technology life cycle phases indicated by steady product sales, wide availability from manufacturers, and substantial supporting infrastructure from manufacturers and third party offerors.

3.33.4 Decline. The fourth of five basic technology life cycle phases indicated by declining product sales volumes, reduced prices, declining product user base, or announcements by manufacturers that the product will no longer be manufactured in the near future.

3.33.5 Phase out. The final period of time in the five basic technology life cycle phases. Phase Out is indicated by announcements from vendors that the product will no longer be manufactured, or the absence of new product availability.

3.34 Line replaceable unit (LRU). A combination of components and/or modules installed in an item of equipment or system that is replaceable in the operational environment. A LRU may be a printed wiring board (PWB), black box, component, major component, alternator, carburetor, avionics, tank engine, or road wheel assembly installed on a weapon system. This repair by replacement is normally accomplished as far forward as possible by unit/organizational maintenance personnel.

3.35 Lot (Materials). Unless the procurement specification provides a more restrictive definition, a lot (or batch) of materials is defined as the specific quantity of material produced in a continuous operation or production cycle and offered for acceptance at any one time. All materials in the same lot have the same lot date code, batch number, or equivalent identification.

3.36 Lot (Parts). See the definitions in the applicable part procurement standards/documents for the definitions of production, inspection, and receiving lot/batch. Unless otherwise specified in the applicable detail specification, a production lot of parts refers to a group of parts of a single part type; defined by a single design and part number; and produced in a single production run by means of the same production processes, the same tools and machinery, same raw material, and the same manufacturing and quality controls. All parts in the same lot have the same lot date code, batch number, or equivalent identification.

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3.37 Material. For the purposes of this document, material is a metallic or nonmetallic element, alloy, mixture, or compound used in a manufacturing operation that becomes a permanent portion of the manufactured item, or which can leave a remnant, residue, coating, or other substance that becomes or affects a permanent portion of a manufactured item. Environmental materials (moisture, oxygen in the air, etc.) such as those used in tooling or equipment not intended to modify or leave residues are not meant to be covered by this definition.

3.38 May. Expresses nonmandatory provisions.

3.39 Mission critical item. If defective, will prevent command and control, sensors, weapons, combat, or flight systems from achieving mission primary objectives. A failure of the mission critical item would affect system or personnel safety, mission success, or operational readiness. Examples of mission critical items include, but are not limited to, items having limited operating life (controlled items), one shot devices, items causing single points of failure, or items that cannot be tested before flight or use.

3.40 Modified. Changed sufficiently as to require additional qualification testing (i.e. delta qual) to meet mission requirements. For the purposes of this document, basic part or material substitutions to remedy obsolescence or procurement issues with production of an existing design, using components or materials that are equivalent or better quality levels to those used in the original design, does not constitute a modification.

3.41 Non-conforming Items. Parts and materials that do not meet all requirements of this document. Non-conforming items are further defined as all parts and materials from manufacturing lots that do not pass drawing and specification requirements, including radiation hardness when required.

3.42 Nonstandard application. The use of a EEE part, mechanical part, or material in an application that is outside of the vendor’s or manufacturer's recommended usage application or in an application outside of the intended design. For example, the use of parts outside the manufacturer’s specified ratings.

3.43 Obsolete/obsolescence. A lack of availability of a part or material, including raw material, resulting from a manufacturer or manufacturer authorized source due to discontinuance. Items considered to be temporarily not available by a manufacturer or source or not available in time to meet a schedule demand are not considered to be obsolete.

3.44 Original component manufacturer (OCM). An entity that designs and/or engineers a part, with design authority for that part and/or the process used to produce the part. An OCM may contract out the manufacturing, test, and/or distribution of their product.

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3.45 Original equipment manufacturer (OEM). A company that manufactures products that it has designed and built using components and sells under the company's brand name.

3.46 Outgassing/offgassing. The emanation of volatile materials, organic or inorganic, under vacuum or non-vacuum conditions resulting in a mass loss and/or material condensation on nearby surfaces. For the purposes of this document, material “outgassing” and “offgassing” are used synonymously.

3.47 Packaging, Handling, Storage, and Transportation (PHST). The resources, processes, procedures, design considerations, and methods to ensure all system, equipment, and support items are preserved, packaged, handled, and transported properly. This includes environmental considerations, equipment preservation requirements for short- and long-term storage, and transportability. One of the traditional logistics support (LS) elements.

3.48 Part. Any single unassembled hardware element of a major or minor component, accessory, or attachment that is not normally subject to disassembly without the destruction or impairment of its design use. Examples include but are not limited to elements inside custom devices, resistors, integrated circuits, and connectors.

3.48.1 Electrical, Electronic and Electromechanical (EEE) part. The term “electronic” part is used in a broad sense in this document and includes electrical, electromagnetic, electromechanical, and electro- optical (EEEE) parts. This definition includes any part that can carry, store, or transmit electrical current, and/or electromagnetic or optical waves in the intended application. Examples are semiconductors, wire, connectors, oscillators, fiber optics, magnetics, etc. This definition also includes “embedded” software or firmware (see DFARS 202.101) and accessory parts required for assembly and functionality in the intended hardware application whether current carrying or not, such as insulation spacers/preforms, attachment parts.

3.48.2 Mechanical part. The term mechanical piece parts (non-electrical parts) is used in a broad sense in this document and includes such simple mechanical items as nuts, bolts, washers, pins, terminals, and discrete parts (other than required as an EEEE accessory in EEE Parts herein), that cannot be disassembled into their component sections without rendering them unfit for their intended use. Such mechanical piece parts have a single, non-electrical function (other than electrical grounding) and contain one or more necessary material items. Formed, machined, shaped or otherwise fabricated items such as brackets, enclosures, etc., and processed portions of packages used by electronic assemblies, with no electrical circuitry, ground plane, or thermal functions are considered as mechanical parts.

3.49 Part/material qualification. The entire process by which products are obtained from manufacturers, examined and tested, and then identified on a list of qualified products, is

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known as qualification. Testing of product compliance with specification requirements in advance of and independent of any specific procurement action, is known as qualification testing.

3.50 Integrated product team (IPT). A multidisciplinary group of people who are collectively responsible for delivering a defined product or process. The IPT is composed of people who plan, execute, and implement life-cycle decisions for the system being acquired. It includes empowered representatives (stakeholders) from all of the functional areas involved with the product—all who have a stake in the success of the program, such as design, manufacturing, test and evaluation (T&E), and logistics personnel, and, especially, the customer. Because the activities relative to a system's acquisition change and evolve over its life cycle, the roles of various IPTs and IPT members evolve. When the team is dealing with an area that requires a specific expertise, the role of the member with that expertise will predominate; however, other team members' input should be integrated into the overall life-cycle design of the product. Some teams may assemble to address a specific problem and then become inactive or even disband after accomplishing their tasks. Experience supports the continuation of IPTs throughout the entire program acquisition. Having IPT members with experience on the program was a primary factor in providing continuity, reducing the program's overall schedule, and requiring minimal program training.

3.51 PM&P Management Plan (PMP). A plan that references or defines the processes and practices for selecting and applying PM&P items for use in hardware/equipment. It addresses all relevant aspects of managing/controlling PM&Ps during system design, development, production, and post- production support. Also referred to as a PM&P Control Plan (PM&PCP).

3.52 Piece part. See the definition of "part" specified herein. The terms "piece part" and "part" are interchangeable in this document.

3.53 Plastic encapsulated/encased part. Plastic encapsulated/encased parts include any non-hermetically sealed EEE part. This includes any EEEE item such as, but not limited to, plastic encapsulated microcircuit (PEM), plastic encapsulated device (PED), organic coated capacitors, or integrated circuit (IC) die used for chip-on-board (COB) assemblies.

3.54 PM&P technical requirements. PM&P requirements stated or derived from requirements documents. Examples are natural space environments, radiation hardness performance levels, reliability requirements, quality levels, etc.

3.55 Prime Contractor/"Prime". The company or corporation that has the direct contract with the Government. The prime contractor is directly responsible to the procuring activity for ensuring compliance with all the provisions of this document. The prime contractor is responsible for ensuring the flow down of requirements to all subcontractors, suppliers and sub-

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tier providers and for managing the implementation of the entire program's PM&P activity to comply with this document.

3.56 PWA. The generic term for an assembly that uses a printed board for component mounting and interconnecting purposes. The terms “circuit card assembly (CCA)”, “printed board assembly (PBA)”, “printed circuit assembly (PCA)”, “printed circuit board assembly (PCBA)”, “printed wiring assembly (PWA)”, and “printed wiring board assembly (PWBA)” are used synonymously for the purposes of this document.

3.57 Printed wiring board (PWB). The general term for completely processed printed circuit and printed wiring configurations in a predetermined arrangement on a common base. This includes single- sided, double-sided and multilayer boards with rigid, flexible, and rigid-flex base materials. The terms “circuit card”, “printed board”, “printed circuit board (PCB)”, and “printed wiring board (PWB)” are used synonymously for the purposes of this document.

3.57.1 Printed circuit. A conductive pattern that is composed of printed components, printed wiring, discrete wiring, or a combination thereof, that is formed in a predetermined arrangement on a common base. This is also a generic term that is used to describe a printed board that is produced by any of a number of techniques.

3.57.2 Printed wiring. A conductive pattern that provides point-to-point connections but not printed components in a predetermined arrangement on a common base.

3.58 Process. A process is an operation, treatment, or procedure used during fabrication of materials, parts, subassemblies and/or assemblies that modifies an existing configuration, creates a new configuration that alters the form/fit/function, and/or changes the chemical, physical, and/or the mechanical properties of the parent item.

3.59 Procuring activity. A component of an executive agency having a significant acquisition function and designated as such by the head of the agency. Unless agency regulations specify otherwise, the term "procuring activity" is synonymous with the term "contracting activity."

3.60 Program technical requirements. These requirements are either stated directly or derived from the system requirements document, technical requirements document, or listed as technical compliance documents in the contract.

3.61 Prohibited PM&P items. Prohibited PM&P are those items that do not meet PM&P technical requirements. Some items are not acceptable under any circumstances, while others may be acceptable for a specific application or other special circumstance or with other mitigating factors.

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3.62 Qualification tests. Tests defined by the applicable part or material standard and/or procurement specification. For items above the part level, qualification testing is a formal contractual requirement that demonstrates that the design, manufacturing, and assembly have resulted in hardware conforming to specifications under all life cycle environments with margins suitable to account for degradation during the intended application life and for design and manufacturer variability.

3.63 Reliability safety critical. A term applied to a condition, event, operation, process, or item whose proper recognition, control, sequencing, performance or tolerance is essential for safe system operation or use.

3.64 Repair. Repair is the act of restoring the functional capability of nonconforming materiel in a manner that does not ensure compliance of the materiel with applicable drawings or specifications.

3.65 Repairable item. An item that can be restored to perform all of its required functions by corrective maintenance.

3.66 Rework. Rework is the act of reprocessing nonconforming materiel in a manner that ensures full compliance of the material to applicable drawings or specifications.

3.67 Screening. Tests intended to remove nonconforming parts from an otherwise acceptable lot.

3.68 Shall. The emphatic form of the verb, shall be used throughout sections 4 and 5 of the standard whenever a requirement is intended to express a provision that is binding.

3.69 Should. Expresses nonmandatory provisions.

3.70 Standard part or material. A part or material that complies with applicable federal, military, or government adopted industry specifications and standards.

3.71 Storage. A non-transitory, semi-permanent or permanent holding, placement, or leaving of parts or material.

3.72 Subcontractor /"Sub". A company or corporation that has a contract with a prime contractor or other lower tier contractor. Subcontractors and suppliers are subordinate contractors to the prime and are required to meet the provisions of this document.

3.73 Supplier. An entity that provides a product or service, typically an OEM, OCM, or authorized distributor. See the "OEM", "OCM", "distributor", and "broker" definitions herein.

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3.74 Supply chain (manufacturing or production). The linked network of all organizations, resources, activities, and technology associated with the production of finished products. Encompasses the tiers of subcontractors contributing their individual stages of manufacturing processing and manufactured components or subassemblies to the final product as assembled and delivered to the customer.

3.75 Supply chain traceability. Documented evidence of a part's or material's supply chain history. This refers to documentation of all supply chain intermediaries and handling transactions.

3.76 Suspect counterfeit part or material. A part or material in which there is an indication by visual inspection, testing, or other information that it may have been misrepresented by a supplier, and therefore may meet the definition of a counterfeit part and/or material.

3.77 Unauthorized supplier. A supplier that is not authorized by the original component manufacturer to buy parts or materials directly from the manufacturer or has procured parts or materials from outside the manufacturer's authorized supply chain. Parts provided from unauthorized suppliers typically are not accompanied by manufacturer support and warranty. See the definitions for "broker" and "distributor" specified herein.

3.78 Uprating/uprated part. A part that has been assessed for its capability to meet the performance requirements of the application in which it is used, outside the manufacturer's specified requirements (voltage, temperature, frequency, etc.) and has been determined capable of meeting those requirements as approved by the procuring activity.

3.79 Will. Used to express a declaration of purpose on the part of the Government. It may be necessary to use "will" in cases when simple futurity is required.

3.80 Abbreviations and acronyms. The following abbreviations and acronyms are used in this standard or are commonly associated with parts, materials, and processes.

AC	–	alternating current
AFMC	–	Air Force Materiel Command
AGMA	–	American Gear Manufacturers Association
ASMC	–	acquisition management systems control
AWG	–	American Wire Gauge
AWS	–	American Welding Society
BME	–	base metal electrode
CAIR	–	COTS Assembly Integration Report

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CCA	–	circuit card assembly
CDR	–	critical design review
CECOM	–	Communications-Electronics Command
CEV	–	corona extinction voltage
CMOS	–	complimentary metal-oxide semiconductor
CoA	–	certificate of analysis
COB	–	chip-on-board
C of C	–	certificate of conformance
COTS	–	commercial off-the-shelf
CPC	–	corrosion prevention and control
CTE	–	coefficient of thermal expansion
CVCM	–	collected volatile condensable mass
DC	–	direct current
DEMP	–	dispersive electromagnetic pulse
DFARS	–	Defense Federal Acquisition Regulation Supplement
DID	–	data item descriptions
DMSMS	–	diminishing manufacturing sources and material shortages
DPA	–	destructive physical analysis
DRAM	–	dynamic random access memory
EDS	–	energy dispersive x-ray spectroscopy
EDX	–	energy dispersive x-ray spectroscopy
EEE	–	electrical, electronic and electromechanical
EEEE	–	electrical, electromagnetic, electromechanical, and electro-optical
ELDRS	–	enhanced low dose rate sensitivity
EMI	–	electromagnetic interference
ENIG	–	Electroless Nickel/Immersion Gold
EPA	–	Environmental Protection Agency
ER	–	established reliability
ESD	–	electrostatic discharge
ESR	–	equivalent series resistance
ESS	–	environmental stress screening
ETFE	–	ethylene-tetrafluoroethylene
FAR	–	Federal Acquisition Regulation

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FET	–	field-effect transistor
FOD	–	foreign object debris
FRB	–	failure review board
FTIR	–	fourier transform infrared
GIDEP	–	Government-Industry Data Exchange Program
HAST	–	highly accelerated stress testing
HEMP	–	high-altitude electromagnetic pulse
Hi-Rel	–	high reliability
HNC	–	hardness non-critical
HVAC	–	heating, ventilation and air conditioning
I/O	–	input/output
IC	–	integrated circuit
IEMP	–	internal electromagnetic pulse
IPT	–	integrated product team
ITAR	–	International Traffic in Arms Regulation
JFET	–	junction field-effect transistor
LCD	–	liquid crystal display
LED	–	light-emitting diodes
LET	–	linear energy transfer
LRU	–	line replaceable unit
LS	–	logistics support
MAPTIS	–	Materials and Processes Technical Information Service
MCM	–	multi-chip module
MLCC	–	multilayer ceramic capacitor
MMPDS	–	Metallic Materials Properties Development and Standardization
MOSFET	–	metal-oxide-semiconductor field-effect transistor
MSDS	–	material safety data sheet
MSFC	–	Marshall Space Flight Center
MSL	–	moisture sensitivity level
NDA	–	non-disclosure agreement
NDAA	–	National Defense Authorization Act
NDI	–	nondestructive inspection
NSWC	–	Naval Surface Warfare Center

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NTC – negative temperature coefficient

NVG – night vision goggle

OCM – original component manufacturer

ODC – ozone depleting chemical

OEM – original equipment manufacturer

OSHA – Occupational Safety and Health Administration

PAP – production acceptance procedure

PAT – performance acceptance testing

PCA – physical configuration audit

PCB – printed circuit board

PDA – percent defective allowable

PDR – preliminary design review

PED – plastic encapsulated device

PEM – plastic encapsulated microcircuit

PETS – pre-irradiation elevated temperature stress

PHST – packaging, handling, storage, and transportation

PIND – particle impact noise detection

PLD – programmable logic device

PM&P – parts, materials, and processes

PM&PCP – PM&P Control Plan

PMP – PM&P Management Plan

PROM – programmable read-only memory

PS – product specification

PSA – pressure sensitive adhesive

PTC – positive temperature coefficient

PTFE – polytetrafluoroethene

PTH – plated-through hole

PVC – polyvinyl chloride

PWA – printed wiring assembly

PWB – printed wiring board

QA – quality assurance

QCI – quality conformance inspection

QML – Qualified Manufacturers List

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QP	–	qualification plan
QPL	–	Qualified Products List
QR	–	qualification report
RDM	–	radiation design margin
RF	–	radio frequency
RFI	–	radio frequency interference
RHA	–	radiation hardness assurance
RHR	–	roughness height reading
RMS	–	root mean square
RTV	–	room temperature vulcanization
SAM	–	scanning acoustic microscopy
SAW	–	surface acoustic wave
SCC	–	stress corrosion cracking
SCD	–	specification control drawing
SEE	–	single event effects
SGEMP	–	systems-generated electromagnetic pulse
SMD	–	standard microcircuit drawing
SOI	–	silicon-on-insulator
SPC	–	statistical process control
T&E	–	test and evaluation
TEMP	–	test and evaluation master plan
TID	–	total ionizing dose
TML	–	total mass loss
TMR	–	thermo-mechanical response
UL	–	underwriters laboratories
UTS	–	ultimate tensile strength
UV	–	ultraviolet
XL-ETFE	–	ethylene-tetrafluoroethylene
XRF	–	x-ray fluorescence

4 GENERAL REQUIREMENTS

4.1 General. All parts, materials, and processes used in the system shall reliably perform the function(s) allocated to them by the application design throughout the system life

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cycle, using appropriate risk mitigations when required. The requirements herein apply to all parts, materials, and processes, including COTS, custom, and subcontracted components.

4.1.1 PM&P Management. Documented procedures shall provide management, such as through an Integrated Product Team (IPT), of PM&P selection and implementation to ensure that the system meets its requirements throughout its life cycle. The *DoD Integrated Product and Process Development Handbook* defines an approach to apply an IPT to managing the PM&P elements of a system.

4.1.2 Equipment Categories. The PM&P requirements will depend on the application stresses and performance requirements, which can generally be organized by equipment categories to support more efficient flow down of requirements for the varied use conditions and requirements of military systems. The implementation of the requirements as specified herein shall utilize the equipment categories defined in TABLE I.

TABLE I. Equipment categories and definitions.

Category	Category Definition
A	Continuous use systems. Non-repairable systems under space environment conditions such as satellite systems that encounter severe environment conditions from launch, flight trajectory and orbit. System flow-down radiation hardness requirements* (low dose rate, high total dose) must be satisfied.
B	Impulse (single shot) systems. Equipment encountering extreme conditions related to launch (air, ground and sea), flight trajectory, and vehicle return. Can be subjected to periods of long-term storage. Once deployed, equipment is non-repairable. System flow-down radiation hardness requirements (possible high dose rate, low total dose) must be satisfied.
C	Aircraft systems. Equipment exposed to extreme turbulence, air temperature and pressure fluctuations, and/or vibration.
D	Ground and Sea-based mobile systems. Repairable systems exposed to one or more of the following: temperature and humidity fluctuations, vibration, shock, and Electromagnetic Environmental Effects.
E	Stationary ground systems. Repairable systems in temperature and humidity controlled environments readily accessible to maintenance. Equipment in this category is typically in constant use.
T	Targets. Test-specific, non-deployable systems, sometimes encountering extreme conditions related to launch (air, ground and sea) and flight trajectory, and test vehicle return.

NOTES: *Refer to Appendix D for more information on Radiation Harness Assurance.

4.2 Parts, Materials, and Processes (PM&P)

Documented procedures shall ensure that requirements for PM&P are derived from the system level requirements to satisfy all the requirements for the deliverable equipment, allocated to the part, material, and process level. SAE EIA-STD-4899 provides requirements for plans covering

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electronic components (parts), and SAE AS8030 provides requirements for plans covering electronic assembly materials and processes.

4.2.1 Life Cycle Stresses. Documented procedures shall ensure that the capabilities of all PM&P are defined, uniquely identified, and documented to the extent required to ensure that they satisfy the application life cycle conditions, including manufacturing, operating, storage, and transportation stresses. TABLE II provides summaries of common life cycle stresses below.

TABLE II. Life cycle stresses.

Stress	Application Consideration	Guidance Standards
Temperature limits	Components usage outside the temperature limits specified by the component manufacturer is discouraged. Damage can occur when specified maximum or minimum temperature limits are exceeded during manufacturing, operation, storage, or transport.	IEC TR 62240-1 GEIA-STD-0008 RTCA DO-160 JESD22-A103 JESD22-A108 JESD22-A119
Temperature variations	Temperature cycling over long periods of time can cause damage due to mismatches of coefficient of thermal expansion (CTE) between the component and other materials in an assembly.	JESD22-A104
Heat dissipation and cooling	Proper heat dissipation and cooling methods may be required to prevent damage to the component assemblies. The component is considered to be used within the manufacturer’s rating when the manufacturing thermal profiles and the application thermal and electrical stress analysis are verified to be within the manufacturer’s recommended specifications by test and data collection.	JEP149
Mechanical shock	Mechanical stress limits may be exceeded when components are exposed to mechanical shock. Variations in mechanical fit from production or temperature cycling may increase susceptibility to mechanical shock.	MIL-STD-810
Mechanical vibration	Damage can occur due to long-term exposure to certain mechanical vibration profiles. Variations in mechanical fit from production or temperature cycling may increase susceptibility to mechanical vibration.	MIL-STD-810
Natural radiation	Radiation due to cosmic rays, neutrons, heavy ions, etc., may cause Single Event Effects (SEE).	IEC 62396 series JESD89

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Stress	Application Consideration	Guidance Standards
Induced radiation	Damage can result from exposure to nuclear radiation and X-ray inspection.	
Moisture and corrosion	Damage can result from exposure to moist and/or corrosive environments, particularly when elevated temperatures are experienced.	JESD22-A100 JESD22-A120 J-STD-020
Electromagnetic capability	Assemblies can produce electromagnetic noise through electrical transitions, and assemblies can be susceptible to electromagnetic interference.	IEC 61967 series
Electrostatic discharge	Handling of components can induce electrostatic discharge that can cause component damage.	ESD-S20.20 JESD 625
Other relevant stresses	As applicable from system use environment or customer specifications.	

4.3 PM&P Selection. Documented procedures shall ensure that PM&P selected for a system meet all application requirements, including natural and induced stresses.

4.3.1 PM&P Specification. Documented procedures shall ensure that documented specifications define all PM&P requirements necessary to meet system application requirements.

4.3.2 PM&P Availability. Documented procedures shall ensure that availability and level of obsolescence risk are considered as major selection criteria for parts, materials, and processes.

4.3.3 Standardization. At each level of design authority, documented procedures shall minimize distinct part numbers and part manufacturers to the extent practical to meet performance requirements, and reduce logistics, sustainment, and production costs.

4.3.4 Qualification. Documented procedures shall define the part, material, and process qualification approach, qualification plan, test procedures, sampling plan, criteria of acceptance, and test results to ensure all components meet the application and/or customer requirements. SAE ARP6379 provides a framework for application specific qualification applicable to all part types.

4.3.5 Qualification by Similarity. Parts and materials may be qualified by similarity when supporting data are available. Supporting data should verify that the design, construction, performance, operational environment, and manufacturing processes are equivalent to a previously qualified part or material. The part or material shall also be manufactured at the same facility to the same baseline as previously qualified PM&P.

4.3.6 Reliability. Documented procedures shall ensure the reliability of parts in the system, based on; (1) credible data from testing the parts or from use of similar parts in similar

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environments, and (2) analysis comparing the available data to the application. The following specifications, standards, and handbooks are for reference purposes only. They can be used to aid in the development of the documented procedures stated herein:

SAE ARP4754	MIL-HDBK-338
SAE ARP5890	MIL-HDBK-454
MIL-HDBK-217	SAE GEIA-STD-0009

4.3.6.1 Derating. Derating shall be in accordance with Appendix A.

4.3.6.2 Parts and Materials Outside Rated Stress Levels. Documented procedures shall describe methods to limit, identify, and report the practice of using parts and materials outside the manufacturers' specified conditions. This practice is commonly called uprating or upscreening. Recommendations and guidelines on how to do it are contained in IEC TR 62240-1 and may be used in addition to the parts management plan prepared according to this standard.

4.3.6.3 Life-Limited PM&P. Documented procedures shall identify all the PM&P in a given design that are susceptible to wear-out prior to the end of the design life of the application.

Documented procedures shall ensure that all relevant life-limiting or early wear-out failure mechanisms are properly understood and verified to allow the system to meet all requirements. The following specifications, standards, and handbooks are for reference purposes only. They can be used to aid in the development of the documented procedures stated herein:

JEDEC JESD74	ANSI/VITA 51.2-2011
JEDEC JEP122	

4.3.7 Quality System for Part and Material Manufacturers. Documented procedures shall ensure that the part and material manufacturers and distributors have documented quality management systems that satisfy the relevant parts of the ISO 9000 and SAE AS9100 family or equivalent, validated by suitably trained auditors, and addressed any risks of the component manufacturer or distributor quality management system.

Additional information on quality and reliability standards for electronic hardware can be found in JEDEC JEP70.

4.3.8 Part and Material Manufacturer Process Management. The documented processes shall identify the methods used to qualify part manufacturers, including the part manufacturer's internal manufacturing and quality processes, that demonstrate that the parts produced meet the part specifications with demonstrable repeatability. Guidance regarding this requirement is contained in ISO 9000 and SAE AS9100.

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4.3.9 Compatibility with Assembly/Manufacturing Processes. Documented procedures shall ensure that parts and materials are compatible with the equipment/manufacturing assembly processes, including repair and rework.

4.3.10 Maintainability and Testability. Documented procedures shall ensure that the maintainability and testability of the part in the application are consistent with the application requirements.

4.3.11 Prohibited Parts, Materials, and Processes. Documented procedures shall ensure that fielded systems do not include prohibited parts, materials, and processes defined in Appendix C without procuring activity approval.

4.4 Life Cycle Management. Documented procedures shall ensure that all parts, materials, and processes included in delivered equipment meet the system requirements for the application life cycle.

4.4.1 Procurement. Documented procedures shall ensure procurement of parts and materials that meet the allocated system requirements.

4.4.2 Counterfeit Prevention. Documented procedures shall ensure avoidance of counterfeit parts and materials, and that potential counterfeit parts and materials are controlled to not impact system performance. Parts procured from sources other than the original manufacturer, or a source approved by the original manufacturer, requires approval by the procuring activity. Counterfeit prevention requirements are in Appendix F.

4.4.3 Continuous Monitoring. The manufacture of parts and materials shall be accomplished in accordance with documented processes and processing controls that ensure the reliability and quality required. This documentation shall be in sufficient detail to provide a controlled manufacturing baseline for the manufacturer, which ensures that subsequent production items can be manufactured which are equivalent in performance, quality, dimensions, and reliability to initial production items used for qualification. Documented procedures shall ensure investigation of parts, materials, and processes failure issues, when those failures indicate a trend, to determine root cause and take appropriate corrective actions.

4.4.4 Non-Conforming Materials and Parts. Documented procedures shall ensure that non- conforming materials and parts cannot be installed and/or fielded without procuring activity approval.

4.4.5 Change Monitoring. Documented procedures shall include detecting, tracking, monitoring, and notification of supplier part, material, and process changes to the extent required by the application criticality and/or sensitivity to change, to determine the effects of these changes on system performance and any required appropriate corrective actions.

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4.4.6 Obsolescence. Documented procedures shall establish and maintain a proactive obsolescence management approach that meets the criteria of SAE STD-0016. Refer to Appendix G for additional details on obsolescence.

4.4.7 Design, Construction, and Use Data. Documented procedures shall include collection, storage, retrieval, analysis, and reporting of all relevant data for the design, manufacturing, and usage in service for all parts, materials, and processes. Procedures and processes shall be implemented to ensure that when parts or materials, once installed in an assembly and then removed from the assembly for any reason, are not re-installed in any fielded, qualification, or proto-qualification hardware item.

4.4.8 Data and Record Retention. Part attribute data, data files, incoming inspection test data, lot qualification and acceptance test samples and data (coupons, DPA samples and/or slugs, etc.), DPA samples, traceability data, and other data as determined by the procuring activity shall be retained for a period specified by the procuring activity.

4.4.9 Configuration Management. Documented procedures shall ensure that the hardware configuration is maintained in conjunction with the PM&P, including a controlled PM&P list for each assembly and documentation of all changes.

4.4.10 Reuse of Parts and Materials. Documented procedures shall ensure that parts and materials that have been permanently installed in an assembly and are removed from the assembly for any reason shall not be reused without prior approval of the procuring activity.

4.4.11 Supply Chain Risk Management. Documented procedures shall describe methods used to assess supply chain risks and to mitigate threats, vulnerabilities, and disruptions potentially caused by them.

4.4.12 System Security Engineering. Documented procedures shall describe methods to identify, assess, and address cybersecurity hardware and cybersecurity software assurance risks to parts, materials, and processes.

4.5 COTS Management. Documented procedures shall establish and maintain a COTS management approach that meets the criteria of EIA-933, General Requirements (Section 4), COTS Management (Appendix B), and Prohibited PM&P (Appendix C), and ensures meeting all system applications requirements.

4.6 Subcontractor Management. Documented procedures shall ensure the flow down of all applicable requirements as specified herein to the lowest applicable tier so that all parts,

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materials, and processes meet the application requirements and include verification of compliance.

5 DETAILED REQUIREMENTS

5.1 General. The detailed requirements define baseline performance criteria for parts, materials, and processes (PM&P). The PM&P management, application, selection, and life cycle management shall comply with Section 4. The PM&P selected for a system application may depart from these detailed requirements to the extent that they meet the general requirements identified herein, demonstrate acceptable application performance, and are approved by the procuring activity.

5.2 Parts Requirements.

5.2.1 Printed Wiring Boards. Printed wiring boards (PWBs) shall be designed in accordance with IPC 2220 Series Class 3 and fabricated in accordance with IPC 6010 Series Class 3 or Class 3/A. The use of Class 3 versus Class 3A shall be governed by the end use of the PWB under consideration. All processes used to design, qualify, manufacture, and test products shall be documented and shall meet all program requirements. In case of conflict, the provisions of this document shall apply.

As technology changes, new design and performance specifications will be added to the IPC 2220 Series and the IPC 6010 Series. For technologies not addressed by this document, refer to the applicable IPC 2220 and IPC 6010 Series focus specifications. Technologies not addressed in this document or in an applicable IPC 2220 and IPC 6010 Series focus specifications shall be approved by the procuring activity before use or inclusion. Suppliers of PWBs should meet the requirements of IPC-1791.

5.2.2 Capacitors. All capacitors selected for the system application shall meet the requirements specified herein, unless otherwise approved by the procuring activity. Capacitors shall meet the requirements for the applicable reference specification and address application considerations in design reviews and change proposals as defined in TABLE III. For capacitor styles not identified, the specifications shall be approved by the procuring activity.

5.2.2.1 Single Layer Ceramic (SLC) Chip Capacitors. SLC chip capacitors shall meet the requirements of MIL-PRF-123, and as specified herein. Terminal strength shall be replaced with die shear strength as specified in method 2019 of MIL-STD-883, except AuSn eutectic or conductive epoxy shall be used to attach the capacitor. Mounting SLC chip capacitors for bond and die shear testing shall be as described herein. Voltage-temperature limits shall correspond to the dielectric class used for the SLC chip capacitor.

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5.2.2.2 Mounting SLC Chip Capacitors for Testing. When it is specified in the test procedure that the capacitors shall be mounted, they shall be mounted on a suitable substrate (for example, 99 percent alumina). The substrate material shall be such that it will not be the cause of, nor contribute to, the failure of any test for which it may be used. The capacitors shall be mounted on the substrate as follows:

a. A substrate shall be prepared with metallized surface land areas. The metallized land areas of the substrate shall be selected to facilitate testing of the chips shall be of the proper spacing to accommodate the attachment of the applicable chips to the card.

b. The capacitors to be tested shall each be attached to one land area by any convenient method (such as AuSn intermetallic or conductive epoxy).

c. The connection to the common land area shall begin with a thermosonic ball bond of a one mil gold wire to the exposed capacitor terminal and end with a stitch bond on the common land area of the substrate.

TABLE III. Capacitor styles reference documents.

Capacitor Style / Dielectric Material	Reference Specification	Style Code	Application Considerations
Ceramic, Multilayer	MIL-PRF-123 and MIL-PRF-55681 and DSCC Dwgs 06019 and 06022	CKS, CDR	3/, 4/, 5/, 6/
Ceramic, Single Layer	Tailored use of MIL-PRF-123 as specified herein	--	3/, 4/, 5/, 6/, 7/
Ceramic, High Voltage	MIL-PRF-49467	HVR	3/, 4/, 5/, 6/, 7/
Ceramic, Stacked	MIL-PRF-49470	SM	3/, 4/, 5/, 6/
Ceramic Capacitor Arrays for Filter Connectors	Tailored use of MIL-PRF-123	--	3/, 4/, 5/, 6/
Ceramic, Multilayer, Base Metal Electrode	MIL-PRF-32535	--	6/
Metallized Film	MIL-PRF-83421	CRH	8/, 9/
Glass	MIL-PRF-23269	CYR	1/
Mica	MIL-PRF-39001	CMS	1/
Polymer Tantalum	MIL-PRF-32700	--	11/
High Voltage Reconstituted Mica	MIL-PRF-39001	--	1/
Tantalum Foil	MIL-PRF-39006	CLR	1/

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Capacitor Style / Dielectric Material	Reference Specification	Style Code	Application Considerations
Solid Tantalum (Low Impedance Applications)	MIL-PRF-39003/10	CSS	10/, 11/
Solid Tantalum Chip	MIL-PRF-55365	CWR	10/, 11/
Wet Tantalum-Tantalum Case	MIL-PRF-39006/22 & /25 and DSCC Dwgs 06013 and 06014	CLR79, CLR81	12/
	MIL-PRF-39006/30 & /31 and DSCC Dwgs 06015 and 06016	CLR90, CLR91	12/
Electrolytic, Aluminum	MIL-PRF-39018	--	14/
Types in AEC Q200	AEC Q200		13/

1/ Obsolete for new designs.

2/ Use of capacitors shall be in accordance with the requirements contained in the detailed sections of this document for each capacitor type. For additional capacitor use and information, see MIL-HDBK-198.

3/ Piezoelectric induced changes in capacitance.

4/ Thermal expansion mismatch with substrate.

5/ Cracking from thermal shock and handling.

6/ Base Metal Electrode (BME) capacitors require compliance with MIL-PRF-32535 (Class T for equipment categories A, B, and C; Class M for other categories).

7/ Dielectric protection (encapsulants) to preclude arcing.

8/ Short circuit clearing energy (500 mJ for metalized film).

9/ Use above 400 kHz requires verification that ESR meets application requirements.

10/ 1 ohm/volt series circuit impedance required. At less than 1 ohm/volt, applied voltage shall be less than 0.4 times rated voltage.

11/ Surge current screen and Weibull grading required.

12/ Account for ESR change with frequency.

13/ Additional assessment required for Hardware Categories A, B, C.

14/ Requires contracting activity approval. Not for use in storage applications >1 year for any equipment category.

5.2.3 Connectors. Connectors shall be in accordance with MIL-STD-1353 and the requirements contained herein. All connectors selected for the system application shall meet the requirements specified herein, unless otherwise approved by the procuring activity. MIL-HDBK-454 provides connector application information. Connectors shall meet the requirements for the most applicable reference specification and address application considerations in design reviews and change proposals.

5.2.3.1 Press-fit Connectors for Printed Wiring Boards. Press-fit connectors and the related PWBs shall comply with IPC-9797.

5.2.4 Resonators and Oscillators.

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5.2.4.1 Ceramic Resonators. Ceramic resonators shall meet the requirements of MIL-PRF-3098 as adjusted for ceramic resonator device technology.

5.2.4.2 Quartz Crystals. Quartz crystals shall be in accordance with MIL-PRF-3098 and meet the application life cycle requirements.

5.2.4.3 Crystal Oscillators and Crystal Filters. Quartz crystal oscillators shall be in accordance with MIL-PRF-55310 and meet the application life cycle requirements.

5.2.5 Microcircuits and Semiconductors. Microelectronic and semiconductor device stress ratings and functional characteristics shall meet the application requirements. These devices include monolithic, hybrid, radio frequency, and microwave microcircuits and semiconductors. Microcircuit devices are listed in QML-38535, and standard microcircuit drawings (SMDs) are listed in MIL-HDBK- 103. Hermetic microelectronic and semiconductors shall meet the requirements of TABLE IV.

TABLE IV. Hermetic microcircuit and semiconductor requirements.

Equipment Category	Microcircuit 1/	Semiconductor 1/
A	MIL-PRF-38535 (Class S) MIL-PRF-38534 (Class K)	MIL-PRF-19500 (JANS)
B	MIL-PRF-38535 (Class S, B) MIL-PRF-38534 (Class K, H)	MIL-PRF-19500 (JANS, JANTXV, JANTX)
C	MIL-PRF-38535 (Class S, B) MIL-PRF-38534 (Class K, H)	MIL-PRF-19500 (JANS, JANTXV, JANTX)
D	AEC Q100, MIL-PRF-38535 (Class S, B), or MIL-PRF-38534 (Class K, H)	AEC Q101 or MIL-PRF-19500(JANS, JANTXV, JANTX)
E	AEC Q100, MIL-PRF-38535 (Class S, B), or MIL-PRF-38534 (Class K, H)	AEC Q101 or MIL-PRF-19500 (JANS, JANTXV, JANTX, JAN)
T	AEC Q100, MIL-PRF-38535, or MIL-PRF-38534 consistent with application requirements	AEC Q101 or MIL-PRF-19500 consistent with application requirements

1/ Plastic encapsulated microcircuits and semiconductors shall meet the requirements of 5.2.5.1.

5.2.5.1 Plastic Encapsulated Microcircuits and Semiconductors. All use of plastic encapsulated microcircuits (PEMs) and plastic encapsulated semiconductors shall be reviewed and approved by the procuring activity before use. Qualification of PEMs and PESs shall comply with TABLE V. Additionally, PEMs shall be moisture sensitivity classified in accordance with J-STD-020. PEMs shall be handled in accordance with J-STD-033 for their determined moisture sensitivity classification. PEMs shall have an operating temperature range consistent with the application requirements. PEMs with a moisture sensitivity level - MSL >4 shall not be approved

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without documented justification. PEMs mounted on a double sided surface mount PWA shall have a MSL rating of <3 if the PEM will be exposed to wave solder. These requirements apply to microcircuits and semiconductors with non-hermetic (e.g., polymer) seals, and such cavity construction may require additional tests to assess effects of moisture in the cavity.

TABLE V. Plastic encapsulated microcircuit and semiconductor requirements.

Equipment Category	Microcircuit	Semiconductor 1/
A	PEM-INST-001	PEM-INST-001
B	JESD47 with sequential environments 2/	JESD47 with sequential environments 2/
C	AEC Q100, MIL-PRF-38535 (Class N), or MIL-PRF-38534	AEC Q101
D	AEC Q100, MIL-PRF-38535 (Class N), or MIL-PRF-38534	AEC Q101
E	AEC Q100, MIL-PRF-38535 (Class N), or MIL-PRF-38534	AEC Q101
T	AEC Q100, MIL-PRF-38535, or MIL-PRF-38534 consistent with application requirements	AEC Q101 consistent with application requirements

1/ Plastic encapsulated microcircuits requirements may need some adjustment for application to semiconductors.

2/ Sequential environments include Preconditioning followed by two cycles of Temperature Humidity (or HAST) and Temperature Cycling.

5.2.5.2 Other Plastic Encapsulated Devices. Other plastic encapsulated devices (e.g., passive devices in microcircuit style packages) shall be submitted on a case-by-case basis to the procuring activity for evaluation in the application before disposition.

5.2.5.3 Surface Acoustic Wave Devices. Surface Acoustic Wave (SAW) device requirements shall assure meeting system application requirements. SAW Devices shall comply with MIL-PRF-38535.

5.2.6 EMI and RFI Filters. Low-pass Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) filters shall be in accordance with MIL-PRF-28861, MIL-PRF-15733, or AEC Q200. Performance specifications MIL-PRF-28861 (Class S and Class B) and MIL-PRF-15733 provide the general requirements for low-pass RFI and EMI filters and capacitors used to suppress EMI and RFI. Class S is the highest product assurance level of the MIL-PRF-28861 specification and is intended for space applications.

5.2.6.1 Electrical Filters. Electrical filters shall be in accordance with MIL-PRF-15733 and MIL-PRF-28861.

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5.2.6.2 Discoidal Capacitor Filters. Filters furnished to the requirements of MIL-PRF-28861 contain shunting ceramic discoidal capacitors and series inductors. Feed-through shunting discoidal capacitor types (C circuit configuration) are also referred to as a filter and shall be in accordance with MIL-PRF-31033.

5.2.7 Circuit Protection Devices.

5.2.7.1 Fuses. Fuses shall meet the requirements of SAE AS5372, MIL-PRF-15160 or MIL-PRF- 23419, as suitable for the application. Fuse holders shall comply with MIL-PRF-19207 or SAE AS53731. SAE ARP1199 and MIL-HDBK-454 (Guidelines 8 and 39) provide application information. Solid body construction shall be used in applications that expose the fuse to a vacuum, unless leak rate characterization ensures meeting application requirements with a hollow body device. Alternate approaches to meeting particular requirements shall be proven equivalent or more stringent than specified herein.

For Category A applications, the following in-process controls shall apply.

a. Solid Body Fuses. Fuse elements shall be visually inspected at 10X minimum magnification prior to encapsulation of all items. Radiographic inspection shall be viewed at 7X minimum at a minimum of 2 orthogonal views or 360° turn and meet the requirements of MIL-PRF-23419/12.

b. Hollow body, wire element, fuses. Fuse element attachment shall be visually inspected on all items at 10X magnification minimum, except that for fuses with opaque bodies, radiographic inspection viewed at 7X minimum shall be acceptable at a minimum of 2 orthogonal views, or 360° turn using real-time x-ray (preferred).

c. Chip Fuse Radiographic inspection. The radiographic examination shall include the following accept and reject criteria:

d. There shall be a minimum of two views. View 1 shall show the plan view of the part. View 2 shall show a side view of the part on an edge that does not contain terminations.

(1) The sensitivity of the radiograph shall be such that a lead particle .004 inch (0.10 mm) in diameter shall be visible. Use of double emulsion film is optional.

(2) Contact between internal fuse element and external termination shall be verified (internal film-to-end termination interface).

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(3) Internal element position shall be verified. Element material shall be completely encapsulated by arc suppressive cover glass. There shall be no exposed element at the sides of the part.

(4) There shall be no cracks in the arc suppressive cover glass or in the ceramic base.

(5) There shall be no voids in the arc suppressive glass greater than 0.010 inches in diameter.

(6) There shall be no voids in the end terminations greater than 0.005 inches in diameter.

(7) There shall be no foreign materials in the fuse greater than 0.005 inches in diameter.

5.2.7.2 Circuit Breakers. Circuit breakers are available in various sizes and configurations including thermal, magnetic, thermal-magnetic, and solid state types. Circuit breakers shall be selected and applied in accordance with MIL-PRF-39019, MIL-PRF-55629, and MIL-PRF-83383.

Trip-free circuit breakers shall be used. Non-trip-free circuit breakers shall be used only when the application requires overriding of the tripping mechanism for emergency use.

a. Manual operation. Circuit breakers shall operate manually to the ON and OFF positions. Circuit breakers shall not be used as ON-OFF switches unless such breakers have been specifically designed and tested for that type of service.

b. Position identification. Circuit breakers shall have easily identified ON, OFF, and TRIPPED positions except that the TRIPPED position may be the same as the OFF position with no differentiation between OFF and TRIPPED being required.

c. Orientation. Circuit breakers shall operate when permanently inclined from -30° to 30° from the normal vertical or normal horizontal position. The trip point of an inclined unit shall not vary more than +5% of the current specified for normal position mounting. Circuit breakers used on flight equipment and portable test equipment shall operate within the limits of the detail specification when the equipment is in any position or rotation about its three principal axes.

5.2.8 Magnetic Devices. Magnetic devices shall be in accordance with MIL-STD-981. Class S shall apply to Hardware Categories A, B and C, and Class B shall apply to categories D,

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E, and T. Magnetic devices compliant with AEC Q200 meet the requirements for Categories C, D, E, and T.

5.2.9 Electron Tubes. Electron tubes shall be in accordance with MIL-PRF-1. Methods for testing the environmental, physical, and electrical characteristics of electron tubes as required by MIL-PRF-1 are specified in MIL-STD-1311.

5.2.10 Relays. Relays shall be in accordance with the relevant specification in TABLE VI.

TABLE VI. Relay specifications.

Military Specification	Description
MIL-DTL-5757	Relays, Electromagnetic, General Specification for
MIL-PRF-6106	Relays, Electromagnetic, General Specification for
MIL-PRF-28776	Relays, Hybrid, Established Reliability, General Specification for
MIL-PRF-39016	Relays, Electromagnetic, Established Reliability, General Specification for
MIL-PRF-28750	Relays, Solid State, General Specification for
MIL-PRF-83726	Relays, Hybrid and Solid State, Time Delay, General Specification for
MIL-PRF-83536	Relays, Electromagnetic, Established Reliability 5 amperes and below

5.2.11 Resistors and Thermistors. Resistors and thermistors shall be in accordance with the appropriate specification in TABLE VII. MIL-HDBK-199 provides selection, design, and application information for resistors and thermistors. Resistors shall be, as a minimum, established reliability (ER) failure rate level “P” for missile and associated tactical mission essential equipment. When a resistor used is not covered by a military specification and a new specification or drawing is prepared, the nearest appropriate military specification for the type of resistor shall be used as a guide and the product assurance requirements shall be provided as detail requirements to ensure a minimum life failure rate level of 0.1% per 1,000 hours. Variable resistors shall not be used in new design without prior approval of the procuring activity.

The reference documents in TABLE VII list the types covered and indicates the applicable specifications where detailed requirements are set forth. Alternate approaches to meeting particular requirements shall be proven equivalent or more stringent than specified herein.

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TABLE VII. Resistor and thermistor specifications.

Military Specification	Description
MIL-PRF-23648	Resistor, Thermal (Thermistor) Insulated, General Specification for
MIL-PRF-32192	Resistors, Chip, Thermal (Thermistor), General Specification for
MIL-PRF-39005	Performance Specification, Resistors, Fixed, Wire-Wound (accurate), Nonestablished Reliability, Established Reliability, General Specification For
MIL-PRF-39007	Performance Specification, Resistors, Fixed, Wire Wound (Power Type), Nonestablished Reliability, Established Reliability, and Space Level, General Specification For
MIL-PRF-39009	Performance Specification, Resistors, Fixed, Wire-Wound (Power Type, Chassis Mounted), Nonestablished
MIL-PRF-39015	Resistors, Variable, Wire Wound (Lead Screw Actuated), Nonestablished Reliability and Established Reliability, General Specification For
MIL-PRF-39017	Resistors, Fixed, Film (Insulated), Nonestablished Reliability and Established Reliability, General Specification For
MIL-PRF-49462	Resistors, Fixed, Film, High Voltage, General Specification for
MIL-PRF-55182	Resistors, Fixed, Film, Nonestablished Reliability, Established Reliability, and Space Level, General Specification for (w/Amendment 1)
MIL-PRF-55342	Performance Specification, Resistors, Fixed, Film, Chip, Nonestablished Reliability, Established Reliability, Space Level, General Specification for
MIL-PRF-83401	Resistor Networks, Fixed, Film, and Capacitor-Resistor Networks, Ceramic Capacitor and Fixed Film Resistors, General Specification for

5.2.12 Switches. Electrical Switches shall meet the application requirements for rated current, load type, operating cycles, and environmental conditions. Guideline 58 of MIL-HDBK-454 provides guidance on switch application. Switches shall meet the qualification requirements of the most similar device specification in TABLE VIII, and represent the type classification consistent with the application requirements.

TABLE VIII. Switch specifications.

Reference document	Description
MIL-DTL-3786	Switches, Rotary (Circuit Selector, Low-Current Capacity), General Specification for

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Reference document	Description
MIL-DTL-3928	Switches, Radio Frequency Transmission Line (Coaxial)
MIL-DTL-3950	Switches, Toggle, Environmentally Sealed, General Specification for
MIL-DTL-6807	Switches, Rotary, Selector Power, General Specification for
MIL-DTL-8834	Switches, Toggle, Positive Break
MIL-DTL-9395	Switches, Pressure, (Absolute, Gage, and Differential), General Specification for
MIL-DTL-9419	Switch, Toggle, Momentary, Four-Position On, Center Off, General Specification for
MIL-DTL-12211	Switch, Pressure
MIL-DTL-12285	Switch, Thermostatic
MIL-DTL-13484	Switch, Sensitive: 30 Volts Direct Current Maximum, Waterproof
MIL-DTL-13625	Switch, Pull, Switch, Push, Switch, Pull; Beam Selecting, Headlight, Electrical (28 Volts Direct Current Maximum, for Military Vehicles)
MIL-DTL-13735	Switches, Toggle: 28 Volts Direct Current
MIL-DTL-15291	Switches, Rotary, Snap Action and Detent/Spring Return Action, General Specification for
MIL-DTL-15743	Switches, Rotary, Enclosed
MIL-DTL-21604	Switches, Rotary, Multipole and Selectors; General Specification for
MIL-DTL-24317	Switches, Multistation, Pushbutton (Illuminated and Non-Illuminated)
MIL-DTL-28788	Switches, Air and Liquid Flow, Sensing
MIL-DTL-28827	Switches, Thermostatic (Volatile Liquid), Hermetically Sealed
MIL-DTL-83731	Switches, Toggle, Unsealed and Sealed, General Specification for
MIL-PRF-22710	Switches, Code Indicating Wheel (Printed Circuit), Thumbwheel and Pushbutton General
MIL-PRF-22885	Switches, Push Button, Illuminated, General Specification for
MIL-PRF-24236	Switches, Thermostatic, (Metallic and Bimetallic), General Specification for
MIL-PRF-83504	Switches, Dual In-line Package (DIP), General Specification for
MIL-PRF-8805	Switches and Switch Assemblies, Sensitive, Snap Action (Basic, Limit, Push Button and
MIL-S-16032	Switches and Detectors, Shipboard Alarm Systems
MIL-S-18396	Switches, Meter and Control, Naval Shipboard
W-S-896	Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification) for

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5.2.13 Waveguides and Related Devices. Waveguides and related devices shall be in accordance with the appropriate specification in TABLE IX and shall conform to a specification listed in the table or to a specification imposed by the listed standard.

MIL-HDBK-660 shall be used as a guide to the fabrication of rigid waveguide assemblies where bends and twists are required to satisfy a particular application. Other waveguides and related devices shall be in accordance with the documents in TABLE IX.

TABLE IX. Waveguide reference documents.

Item Description		**Reference Document**
Amplifier, RF and microwave	DIP, coaxial, TO, and flatpack	MIL-DTL-28875
Attenuators	Fixed and variable coaxial and waveguide	MIL-DTL-3933
Circulators	RF-SMA and waveguide	MIL-DTL-28791
Couplers	Directional coaxial waveguide and printed circuit	MIL-DTL-15370
Coupling assemblies	Quick-disconnect for Subminiature waveguide flanges	MIL-DTL-3954
Dummy loads	Waveguide, coaxial and stripline	MIL-DTL-39030
Flanges	Waveguide and coaxial	MIL-DTL-3922 MIL-DTL-24044
Gaskets	Pressure sealing for use with cover flanges and flat face	MIL-DTL-24211
Isolators	RF-SMA and stripline	MIL-DTL-28791
Mixer stages	RF-DIP, flatpack, TO and connector	MIL-DTL-28837
Power dividers, combiners, and divider/combiners	Solder terminals, and divider/combiners plug-in, flatpack, TO and connector	MIL-DTL-23971
Switches	Waveguide to waveguide manual and electro mechanically operated	MIL-DTL-55041
	RF coaxial	MIL-DTL-25879 MIL-DTL-3928
Waveguide assemblies	Flexible and rigid	MIL-DTL-287 MIL-DTL-3970 MIL-HDBK-660
Waveguides	Rigid rectangular, rigid circular, single, and double ridge	MIL-DTL-85 MIL-DTL-22641

5.2.14 Motors, Dynamotors and Rotary Power Converters. Alternating current motors shall be in accordance with MIL-M-17059 or MIL-DTL-17060, except that any motor used with

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a miniature blower for cooling electronic equipment shall be in accordance with MIL-DTL-23071.

5.2.14.1 Rotary Servo Devices. Rotary servo devices, including servomotors, synchros, tachometer generators, encoders, and transolvers, shall be in accordance with MIL-DTL-81963. Additional specification information can be found in TABLE X for the appropriate rotary servo device. MIL-HDBK-225 and MIL-HDBK-231 contain additional information for system application.

TABLE X. Rotary servo devices reference documents.

Item Description	Reference Document	
Servomotor	MIL-S-22432	Servomotor, General Specification
Synchros	MIL-STD-710	Synchros, 60 and 400 Hz, Selection and Application of
Tachometer generator	MIL-T-22821	Tachometer Generator AC; General Specification for
Encoder	MIL-E-85082	Encoders, Shaft Angle to Digital, General Specification for
Servomotor-tachometer generator	MIL-S-22820	Servomotor-Tachometer Generator, AC; General Specification for
Servtorqs	MIL-S-81746	Servtorq, General Specification for

5.2.14.2 Electromagnetic Counters. For electromagnetic counters, numbers shall snap into place with an upward movement of the counter drum indicating a numerical increase. The height-to-width ratio of numeral shall preferably be one-to-one. When the last digits have no operational and maintenance value, they shall be read from left to right. Large horizontal spaces between number drums, when more than three digits are displayed, shall be avoided. Mounting shall be as close to the panel surface as possible to provide maximum viewing angle and minimum shadow effects from ambient lighting.

5.2.15 Wire and Cable

5.2.15.1 Hookup Wire. Internal hookup wire shall be selected from the types and classes specified by the documents listed in TABLE XI. For solderless wrap applications, wires shall be in accordance with SAE AS81822.

a. MIL-DTL-16878 shall not be used for Air Force or Navy aerospace applications.

b. SAE AS22759 wire with only single polytetrafluoroethylene insulation used in Air Force space and missile applications shall require the approval of the procuring activity.

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

d. Silver plated copper wire shall not be used in applications involving Army missile systems without certification by the wire manufacturer that it passes the sodium polysulfide test in accordance with ASTM B298. Silver plated copper wire shall not be used in conjunction with water-soluble solder fluxes. Wire shall be stored and handled in such a way so as to minimize exposure to moisture.

TABLE XI. Electrical wire reference documents.

Reference Document	Description
SAE-AS50861	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy
MIL-DTL-16878	Wire, Electrical, Insulated, General Specification for
SAE-AS22759	Wire, Electrical, Fluoropolymer Insulated, Copper or Copper Alloy
SAE AS81044	Wire, Electrical, Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer, or Polyarlyene Insulated, Copper or Copper Alloy
MIL-DTL-81381	Wire, Electric, Polyimide- Insulated, Copper or Copper Alloy

5.2.15.2 Magnet Wire. Magnet wire shall be in accordance with NEMA MW 1000.

5.2.15.3 Coaxial Cable. Coaxial cable, both flexible and semi-rigid, shall be in accordance with MIL-DTL-17.

5.2.15.4 Wiring and Cabling. Wiring external to electronic enclosures shall be in accordance with the requirements below. Additional guidance may be found in MIL-HDBK-83575. Wiring internal to electronic enclosures should conform to the guidelines provided in MIL-HDBK-454, Guidelines 20 and 69.

a. Electrical and Handling Considerations – Insulations. The characteristics of the insulation used on wire shall be used in the selection of the proper wire type for each application.

b. Electrical and Handling Considerations – Conductors. The characteristics of the conductors used in the wire or cable shall be considered when selecting the proper wire type for each application. Conductor strands shall be made of soft annealed copper (22 AWG or larger), high strength copper alloy (24 AWG to 28 AWG), or beryllium-copper alloy (30 AWG or smaller). The conductor strands shall be coated with silver or nickel.

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5.2.15.5 Electrical Connections. Electrical connections for cable and wire shall be in accordance with IPC/WHMA-A-620 Class 3, IPC/WHMA-A-620-S (Space and Military Addendum), or IPC J-STD-001, class 3 or Space and Military Addendum, as applicable. The use of Class 3 versus Space and Military Addendum shall be governed by the end use of the electrical connection under consideration, where the Space and Military Addenda apply to applications with significant temperature cycling and vibration/shock exposure. For equipment categories A, B, and C, the Space and Military Addenda shall apply for these specifications. MIL-HDBK-454, Guideline 69, provides application guidance.

5.2.15.6 Radio Frequency Cables and Transmission Lines. Radio frequency cables and transmission lines shall be in accordance with the appropriate specification in TABLE XII. Other types of cable may be used provided they are selected from specifications acceptable for the specific application and approved by the procuring activity.

TABLE XII. RF cables and transmission line specifications.

Reference Document	Description
MIL-DTL-17	Cables, Radio Frequency, Flexible and Semirigid, General Specification for
MIL-DTL-3890	Lines, Radio Frequency Transmission (Coaxial, Air Dielectric), General Specification for
MIL-DTL-22931	Cables, Radio Frequency, Semirigid, Coaxial, Semi-Air-Dielectric, General Specification for
MIL-C-23806	Cable, Radio Frequency, Coaxial, Semirigid, Foam Dielectric, General Specification
MIL-DTL-28830	Cable, Radio Frequency, Coaxial, Semirigid, Corrugated Outer Conductor, General Specification for

5.2.15.7 Multi-Conductor Cables. Multi-conductor cable shall be in accordance with the appropriate specification in TABLE XIII. Other types of cable may be used provided they are selected from specifications acceptable for the specific application and approved by the procuring activity. MIL-HDBK-454, Guideline 71, provides additional application information

TABLE XIII. Multi-conductor cable specifications.

Reference Document	Description
MIL-DTL-3432	Cable (Power and Special Purpose) and Wire, Electrical (300 & 600V)
MIL-DTL-24640	Cables, Lightweight, Low Smoke, Electric, for Shipboard Use, General Specification for
MIL-DTL-27072	Cable, Power, Electrical and Cable, Special Purpose, Electrical, Multi-conductor and Single Shielded, General Specification for

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Reference Document	Description
MIL-DTL-55021	Cable, Electrical, Shielded Singles, Shielded and Jacketed Singles, Twisted Pairs and Triples, Internal Hookup, General Specification for

5.2.15.8 Interconnection Cables. Selection of wire for interconnection between units shall be in accordance with the appropriate specification in TABLE XIV. Selection of multi-conductor cable for interconnection between units shall be in accordance with MIL-HDBK-454, Guideline 71, provides additional application information (see TABLE XV).

TABLE XIV. Electrical interconnection wire specifications.

Reference Document	Description
SAE AS50861	Wire, Electric, PVC Insulated, Copper or Copper Alloy
MIL-DTL-8777	Wire, Electrical, Silicone-Insulated, Copper, 600-Volt, 200 Degrees C
MIL-DTL-16878	Wire, Electrical, Insulated, General Specification for
SAE AS22759	Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy
MIL-DTL-25038	Wire, Electrical, High Temperature, Fire Resistant, and Flight Critical
SAE AS81044	Wire, Electrical, Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer, or Polyarlyene Insulated, Copper or Copper Alloy
MIL-DTL-81381	Wire, Electric, Polyimide-Insulated, Copper or Copper Alloy

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TABLE XV. Electrical interconnection wire, multiconnector.

			Conductor			Shield braid 3/			Jacket 3/		
Specification number	**Basic Title**	**Basic Wire Specifications**	**Number of conductors**	**Volts RMS**	**Temp 2/**	**Strand material**	**Strand coating**	**% Coverage**	**Material 1/**	**Type**	**Remarks**
MIL-DTL-3432	Cable (Power and Special (Purpose) and Wire, Electrical (300& 600V)	A-A-59551 & Insulation	Unlimited and mixed sizes 4/ 5/	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-dienne rubber, polyurethane thermoplastic elestomer or natural rubber	Extruded & Vulcanized	
ANSI/NEMA WC 27500	Cable, Electric Aero Space Vehicle	M5086/1 M5086/2 M5086/3	2-7 1-7 1-7	600	105°C	Copper Copper	Tin Tin		None Polyamide (Nylon)	Extruded or Impregbaird	(a) Fluorinated ethylene propylene (b) Polytetra-fluoroethylene
		M22759/12 M22759-23	1-7 1-7		260°C 260°C	Copper Copper	Nickel Nickel	85 85	(a) (b)	Extruded or Tape	
		M81044/9	1-7		100°C	Copper	Tin	85	Polyvinylidene fluoride	Extruded	
		M81381/8 /10 and /14	2-7 1-7		200°C 200°C	Copper	Nickel	85	FEP/polyimide	Film Tape	
		M81381/11	2-7		200°C						
		M81381/12 M81381/13	1-7 1-7		150°C 200°C	Copper Copper	Tin Nickel	85 85	FEP/polyimide	Film Tape	

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			Conductor			Shield braid 3/			Jacket 3/		
Specification number	**Basic Title**	**Basic Wire Specifications**	**Number of conductors**	**Volts RMS**	**Temp 2/**	**Strand material**	**Strand coating**	**% Coverage**	**Material 1/**	**Type**	**Remarks**
MIL-DTL-13777	Cable Special Purpose Electrical	MIL-C-17 A-A-59551 ASTM A580 &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-DTL-24640	Cable, Electrical, Light weight for ship board use	MIL-W-81044	2-77 pair	600	150°C	Copper Tape Tinned		85	Crosslinked Polyalkene, Crosslinked Alkaneimide polymer, or Polyarylene	Extruded	
MIL-DTL-27072	Cable Special Purpose, Electrical, Multi-conductor	MIL-DTL-17 M16878/1 M16878/2 M16878/3 M16878/4 M16878/5 M16878/6 M16878/10 M16878/13	2-36	Various 600 1000 3000 600 1000 250 600 250	Not spec 105°C 105°C 105°C 200°C 200°C 200°C 75°C 200°C	Copper Note: MIL-DTL-27072 applicable detail specification sheets control materials for each specific cable configuration.	Tin, Silver	85	Sheath of PVC, polyethylene, polychloroprene, polyamide, TFE-Teflon, or FEP-Teflon		Flexible multiconductor 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

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Specification number	Basic Title	Basic Wire Specifications	Conductor: Number of conductors	Conductor: Volts RMS	Conductor: Temp 2/	Shield braid 3/: Strand material	Shield braid 3/: Strand coating	Shield braid 3/: % Coverage	Jacket 3/: Material 1/	Jacket 3/: Type	Remarks
NEMA WC 27500	Cable,	MIL-DTL-8777	1-7	600	200°C	Various	Various	85	Various	Braided	For general aerospace flight vehicle applications
	Electrical, Shielded and Unshielded	SAE AS 22759	1-7	Various	Various	Various	Various	85	Various	Extruded or Braided	
	Aerospace	MIL-DTL-25038	1-7	600	260°C	Various	Various	85	TFE coated glass fiber	Braided	
		MIL-W-81044	1-7	600	150°C	Various	Various	85	Various	Extruded	
		MIL-DTL-81381	1-7	600	Various	Various	Various	85	Various	Tape	
MIL-DTL-55021	Cable, Twisted Pairs & Triples, Internal Hookup, General Specification for	MIL-DTL-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 or Tape	

1/ 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.

2/ See applicable detail specification sheet for temperature limitations.

3/ See applicable detail specification sheet for materials control of specific cable configurations impact bend, and twist.

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.

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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 torque. 7/ For use under abusive mechanical conditions and where resistance to weather, oil and ozone are requirements.

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5.2.16 Optics and Photonics

5.2.16.1 Optical Elements and Coatings Optical elements and coatings shall be in accordance with ISO 10110, ISO 9211, and MIL-PRF-13830, and as necessary to meet system application requirements.

5.2.16.2 Photonics. Photonics Devices shall be in accordance with MIL-PRF-38534 with functional performance defined by Telcordia GR-468-CORE, as required by the application. For pigtailed devices, the fiber cable shall be in accordance with the requirements of MIL-PRF-85045 for Category A applications.

5.2.16.3 Indicator Lights and Lampholders. Indicator lights, indicator light housings, lampholders, lenses, and lamps shall be in accordance with the appropriate specification in TABLE XVI.

a. Visual display and legend lights. Visual display and legend lights shall comply with the requirements in MIL-STD-1472.

b. Night vision goggles. Night vision goggle (NVG) compatibility considerations for cockpit indicator lights shall be considered where use of night vision goggles by cockpit crews is possible.

TABLE XVI. Indicator lights specifications.

Reference Document	Description
MIL-DTL-3661	Lampholders, Indicator Lights, Indicator Light Housing, and Indicator Light Lenses, General Specification for
MIL-DTL-6363	Lamps, Incandescent, Aircraft Service, General Specification for
MIL-DTL-7961	Lights, Indicators, Press to Test
MIL-DTL-15098	Lamps, Glow, General Specification for
MIL-PRF-19500	Semiconductor Devices, General Specification for

5.2.16.4 Light Emitting Diodes. LEDs used as indicator lights shall conform to the applicable specification sheets of MIL-PRF-19500.

5.2.16.5 Fiber Optics. Fiber optics shall be in accordance with MIL-PRF-85045. Fiber optic system design guide information is available in MIL-HDBK-415. Definitions of terminology used in fiber optics technology shall be as specified in TIA-440. The following criteria shall be considered for selection and application of fiber optics:

a. System and subsystem design. Fiber optic system and subsystem designs shall be in accordance with the criteria specified in MIL-STD-188-200.

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b. Test procedures. Standardized test procedures for fiber optic components shall be as specified in MIL-STD-1678-1, MIL-STD-1678-2, MIL-STD-1678-3, MIL-STD-1678-4, MIL-STD-1678-5, and MIL-STD-1678-6.

c. Splices. Fiber optic splices shall conform to MIL-PRF-24623.

d. Cable assemblies. Cable assemblies shall conform to MIL-PRF-49292.

e. Connectors. Fiber optic connectors shall conform to MIL-PRF-28876, MIL-C-83522, and MIL-DTL-83526. Insert arrangements for MIL-PRF-28876 connectors shall conform to MIL-STD-2163. Removable terminals for fiber optic connectors shall conform to MIL-PRF-29504.

f. Interconnection boxes. Fiber optic interconnection boxes shall conform to MIL-DTL-24728.

g. Tools and inspection equipment. Fiber optic tools, inspection equipment, and related kits shall conform to, MIL-K-83525 and SAE AS22520/10.

h. Transmitters and receivers. Fiber optic transmitters and receivers shall conform to MIL-M-24791.

i. Adhesives shall conform to the following:

(1) Two part epoxy adhesives shall conform to MIL-PRF-24792.

(2) Ultraviolet (UV) curable adhesives shall conform to MIL-PRF-24793.

(3) Materials. Index matching materials shall conform to MIL-PRF-24794.

5.2.17 Mechanical Piece Parts. Mechanical piece parts, such as screws, bolts, washers, nuts, terminal, lugs, etc., shall be procured in accordance with the requirements contained within this section, the part specification, and the system application. The following criteria shall be considered for selection and application of mechanical piece parts:

a. For fasteners, ASME B18.18 shall be used. For terminals A-A-59126 shall be used.

b. Class 3 screw threaded products shall be procured and tested to the requirements of NASM1515 and NASM1312

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All applications of mechanical piece parts shall be classified according to the potential impact of a part failure on the system. Two application categories shall be identified and are defined as follows:

a. Mission or Safety Critical. A mechanical piece part failure that can cause severe injury, death, mission degradation, or system loss.

b. For these applications, the Original Equipment Manufacturer (OEM) or its authorized franchised distributor of the mechanical piece part shall be required to conduct 100% screening of all nondestructive quality conformance inspection (QCI) requirements specified. All destructive QCI tests and screens shall be performed on a manufacturing lot sampling basis as specified. The seller shall perform all testing required and shall ensure that the product meets these requirements.

(1) Copies of certifications, chemical analyses, and test data shall be provided with the mechanical piece parts.

(2) Fasteners shall be from the same manufacturing lot and traceability shall be maintained to that lot.

(3) All mechanical piece parts used in Mission or Safety Critical Applications shall be included on the critical items list.

(4) Engineering drawings shall identify all "Mission or Safety Critical" mechanical piece part applications. Physical Configuration Audit (PCA) procedures or other government reviews of engineering drawings shall include verification of this requirement.

c. Other. All other failure consequences.

5.2.17.1 Bearings. Bearings shall be in accordance with the appropriate specification in TABLE XVII. Replacement of the bearing shall be possible without use of special tools, unless such provisions would adversely affect the proper functioning or service life of the bearing. The following criteria shall be considered for selection and application of bearings:

a. Lubricant. Adequate lubricant shall be provided either within the bearing or externally in the form of oil reservoirs or grease relubrication facilities, except as noted in unlubricated bearings below. Where lubricant replenishment is required, precaution shall be taken to prevent purged or lost lubricant from entering, and adversely affecting, the operation of the electronic equipment. Where bearings coated with preservative are installed in closed housings, the preservatives shall be compatible with the lubricant used in the assembly.

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b. Barrier coating. Bearings requiring a barrier coating shall be coated in accordance with MIL-STD-1334.

c. Electrical grounding. Ball and roller bearings used for rotating electrically energized equipment shall be electrically shunted to avoid current flow through the bearings.

TABLE XVII. Bearings specifications.

Reference Document	Description
MIL-B-81793	Bearings, Ball, Annular, For Instruments and Precision Rotating Components
SAE AS8943	Bearings, Sleeve, Plain and Flanged, Self-Lubricating -65 to +250 degrees F
SAE AS81934	Bearings, Sleeve, Plain and Flanged, Self-Lubricating
SAE AS81935	Bearings, Plain, Rod End, Self-Aligning, Self-Lubricating, General Specification for
SAE AS81936	Bearings, Plain, Self-Aligning (CuBe Ball, CRES Race), General Specification for
A-A-52401	Bearing, Sleeve (Steel-Backed)
A-A-52414	Bearing, Roller, Thrust

5.2.17.2 Gaskets. Rubber gaskets, intended to prevent leakage of petroleum products, glycol, alcohol and water, shall be in accordance with SAE AMS-C-6183 or ASTM D2000. Shielding gaskets intended to suppress EMI/RFI shall be in accordance with MIL-DTL-83528. O-ring gaskets shall be in accordance with SAE AMS-P-5315.

5.2.17.3 Gears. Gears not operating in a lubricant bath shall be made of corrosion resistant materials. Gears operating in a lubricant bath containing a corrosion inhibiting additive may be made of noncorrosion resistant materials. The following criteria shall be considered for selection and application of gears:

a. Designation. Gears shall be designated, dimensioned, toleranced, and inspected in accordance with the applicable specifications from the American Gear Manufacturers Association (AGMA), Standards & Information Sheets.

b. Planetary or epicyclic gearing. Planetary or epicyclic gearing is preferred to worm gearing.

c. Nonmetallic gears. Nonmetallic gears may be used when they meet load, life, and environmental requirements of the applicable specification.

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5.2.17.4 Level Vials. Level vials shall conform to MIL-V-3144 and shall be centrally positioned in their holes and fastened with gypsum cement conforming to MIL-G-20098.

5.2.17.5 Rivets. Nonstructural rivets shall be in accordance with FF-R-556 (Small solid, split, tubular, and general purpose rivets), NASM8814 (Nonstructural blind rivets), or MIL-DTL-24243 (Blind, nonstructural, retained mandrel type rivets). Structural rivets shall be in accordance with NASM5674 (Aluminum and Aluminum Alloy solid rivets), MIL-R-7885 / NAS1686 / or NAS1687 (Structural, blind, pull-stem rivets), or NASM27384 (Blind, drive type rivets). The following criteria shall be considered for selection and application of rivets:

a. Rivets shall be used in preference to other hardware for securing parts not requiring removal.

b. Wherever the thickness of metal which accepts the heads of flush rivets is less than the height of the rivet heads, the material shall be dimpled rather than countersunk. The distance from the center of rivet holes to the edges of the material, in which the rivets are placed, shall not be less than one and a half times the rivet diameter.

c. Design and limitations of rivets shall be in accordance with NASM33522 and NASM33557. Rivets for joining magnesium parts shall be composition 5056 anodized aluminum alloy or an aluminum alloy having equal galvanic compatibility with the magnesium being used.

5.2.17.6 Shock and Vibration Isolators. Shock and vibration isolators shall not be used unless it is impractical to design and construct the equipment to meet the shock and vibration requirements specified in the detail equipment specification. The following criteria shall be considered for selection and application of shock and vibration isolators:

d. Design of isolators. The isolators may be of resilient material or metallic type and may employ viscous damping. The design of the isolators shall be such that failure of the resilient material will not set the supported component free.

e. Installation of isolators. All isolators shall be readily replaceable without a major disassembly of the equipment. All electrical connections between a resilient supported component and its foundation shall be flexible. Sufficient clearance shall be provided between parts to preclude the possibility of a cushioned part striking any other part.

f. Electrical bypass of shock mounts. All shock mounted assemblies shall be electrically bypassed by a flexible bonding strap of copper at least one inch wide by 1/16 inch thick, except in such cases where a strap of this size would impair the action

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of the shock mount. Deviations from this requirement are subject to the approval of the procuring activity.

g. Resilient materials for isolators. The resilient material used in isolators shall be ozone resistant and meet the required performance when exposed to any temperature within the range specified herein under the environment conditions.

5.2.17.7 Springs. The following criteria shall be considered for selection and application of springs:

a. Helical springs. Helical springs shall conform to SAE AS13572.

b. Carbon steel springs. Carbon steel springs shall be suitably plated or finished to resist corrosion.

c. Corrosion resisting steel. Corrosion resisting steel springs are preferred where electrical conductivity is not a consideration and where they are adequate for the purpose intended.

d. Fatigue limits. Fatigue limits of the springs shall not be adversely affected by corrosion, operating temperature, and other environmental conditions in service. Fatigue limits shall be consistent with the maximum specified operating cycles for the respective part or equipment or, if such is not specified, with the maximum duty cycle to be expected during the equipment service life.

e. Electrical conductivity. Electrical conductivity of contact springs shall not be adversely affected by corrosion, operating temperature, and other environmental conditions in service.

f. Enclosure. Where practicable, springs shall be enclosed in housings, or otherwise captivated, in order to prevent broken pieces from entering and adversely affecting the equipment.

g. Heat treatment. Springs made of materials that achieve their desired properties by heat treatment, such as copper-beryllium alloys, annealed carbon steels, CRES steels, or heat resisting alloys, shall be heat treated to the specified temper after forming.

h. Grain orientation. Flexure and forming of springs shall occur perpendicular to the grain of the material. Deviation from the perpendicular shall not exceed 45°.

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5.2.17.8 Fastener Hardware. Fastener hardware shall be in accordance with the appropriate specification in TABLE XVIII. The following criteria shall be considered for selection and application of fastener hardware:

a. Fastening of soft materials to soft materials. The mounting or assembly of parts made of soft materials to soft materials shall be accomplished by one of the following methods:

(1) A through-screw or bolt secured by a self-locking nut or plain nut.

(2) A through-screw or bolt secured by a plain nut with a thread locking compound applied to the threads of the screw or bolt and nut.

(3) A screw or bolt in a threaded device such as a threaded bushing; a staked, clinched or pressed-in nut; or a threaded insert. The bushing, nut, or insert shall be secured to, or shall be installed in, the parent structure in accordance with the applicable procedures. The engaged length of threaded inserts in the parent material shall be at least one and a half times the nominal diameter of the internal thread. Where the material thickness is insufficient to accommodate a one and a half times thread diameter insert, a shorter insert may be used in applications where maximum strength is not of primary importance; or a solid threaded bushing (which provides equal strength with less length because of the greater outside diameter of the bushing) shall be used. When the screw or bolt is to be installed in an aluminum alloy part, the aluminum alloy part shall be provided with threaded inserts of corrosion resistant steel or other suitable materials. When the screw or bolt is to be installed in a plastic material part, the plastic part shall be provided with threaded inserts. If lock washers or self-locking threaded inserts are not used, a thread-locking compound in accordance with TABLE XVIII shall be applied to the threads of the screw or bolt.

(4) A screw or bolt in a tapped hole, with a thread-locking compound in accordance with TABLE XVIII applied to the threads of the screw or bolt.

(5) A stud in a tapped hole. Self-locking nuts shall be avoided on stud- mounted components, unless the stud material is compatible with the strength and material of the nut used.

b. Fastening of hard materials to soft materials. In addition to the methods outlined above, a screw or bolt may be used in a threaded bushing, staked, clinched or pressed-in nut, threaded insert or tapped hole.

c. Fastening of soft materials to hard materials. In addition to the methods outlined above, a self-locking screw or bolt may be used in a hole tapped into the hard

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material. Self-locking screws or bolts with nonmetallic locking devices shall not be used where the specified service conditions or processing, such as baking of paints or soldering, might deteriorate the locking device.

d. Fastening of hard materials to hard materials. Any of the methods outlined above may be used.

e. Fastening of brittle materials. Brittle castings or parts made of ceramic or other brittle materials shall be properly cushioned when necessary to prevent breakage. Washers or gaskets of suitable material and compressibility shall be used between the facing surfaces of the brittle part and other brittle or metal parts, when practicable, to prevent breakage or damage to the protected parts during assembly or from severe shock, vibration, or temperature changes encountered under the specified service conditions. Lead washers shall not be used. Parts that are secured with threaded devices and pliable washers shall not use lock washers as the locking device and other appropriate locking devices shall be considered.

f. Fastening with aluminum alloy or magnesium fasteners. The use of threaded fasteners made of aluminum alloy or magnesium to mate with threaded parts of aluminum alloy or magnesium shall be avoided wherever possible. Where such is required, an antiseize compound in accordance with TABLE XVIII shall be used to prevent seizing of the threads.

g. Flat washers. Flat washers shall be used for the following applications:

(6) Between screw heads and soft materials, unless a washer head screw, or similar type that provides a bearing surface equivalent to the bearing surface of the appropriate flat washer, is being used.

(7) Between a nut or washer and a soft material.

(8) Where lock washers are used for securing a soft material, a flat washer shall be provided to prevent marring or chipping of the material or the applied protective coating, except in areas where an electrical ground is required.

(9) Except where it conflicts with electromagnetic interference considerations, a flat washer shall be used between an organically finished material and lock-washers, bolt and screw heads, or nuts.

h. Thread engagement. The length of the screws and bolts installed with nuts shall be such that the exposed portion is a minimum length equivalent to one and a half thread pitches plus the chamber. Maximum length shall be limited by the nearest larger

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standard screw length. For highly stressed applications, screws or bolts shall have a minimum thread engagement of one and a half times their nominal diameter in tapped parts other than nuts. In normal applications, screws or bolts shall have a minimum engagement length equal to their nominal diameter in tapped parts other than nuts. When the assembly is not frequently disassembled and where maximum strength is not required, less thread engagement may be used.

i. Set screws. One set screw may be used on a flatted shaft. Two set screws at 90° to 120° displacement shall be used when the shaft is not flatted. Cone-point set screws shall not be used, except when the opposing metal has been properly countersunk to receive the cone-point.

j. Access devices. Fasteners for use with access devices shall be readily removable for replacement purposes without damaging the attached panel or access door.

(10) Nonstructural applications. Quarter-turn fasteners shall be used only to retain nonstructural access to devices where quick access is required.

(11) Structural applications. Rotary, quick-operating, high strength panel fasteners shall be used to retain structural access devices where quick access is required.

(12) Threaded fasteners. Threaded fasteners used with access devices shall be self-aligning, captive type hardware.

k. Screws or bolts without nuts. Applications requiring the use of screws or bolts without nuts shall use one of the following screw locking methods:

(1) Lock washers under the heads of the screws or bolts.

(2) Self-locking screws.

(3) Self-locking threaded inserts.

(4) A locking or retaining compound in accordance with the requirement below applied to the threads.

(5) Safety wire through drilled heads in accordance with the requirement below.

l. Countersunk head screws. Countersunk head screws, when not secured by other locking means, shall be secured by the application of a thread-locking compound in accordance with the requirement below. Staking by means of upsetting metal is acceptable for permanent assemblies with prior approval by the procuring activity when other means are impracticable or unsatisfactory for design reasons.

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m. Thread-forming, thread-cutting, and drive screws. Thread-forming, thread-cutting, and drive screws shall not be used except for attaching identification plates.

n. Safety wiring and cotter pins. Safety wiring and cotter pins shall not be used on terminals such as screws and threaded studs that are required to function as electrical terminals.

o. Thread-locking and retaining compounds. Thread-locking and retaining compounds shall not be used where required electrical conductivity is impaired or failure of the compound would endanger personnel or damage the equipment.

TABLE XVIII. Fastener hardware reference documents.

Fastener	Type	Material Specification
Screws	Machine screws	FF-S-92 ASME B18.6.3 ASME B18.6.7M
	Cap screws	FF-S-85 FF-S-86 ASME B18.2.1
	Set-screws	FF-S-200 FF-S-210 ASME B18.3
	Self-locking screws	MIL-DTL-18240
Bolts	Hex bolts	ASME B18.2.1 ASTM A449 ASTM A354 ASTM F3125/F3125M
	Bolt studs	MIL-DTL-1222
	Aircraft bolts	AIA/NAS NASM6812
	Internal wrenching bolts	AIA/NAS NASM7838
	Shear bolts	NAS498
Nuts	General purpose nuts	FF-N-836
	High temperature nuts	MIL-DTL-1222
	Self-locking nuts	NASM25027
	Sheet spring nuts	Procuring Activity

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Fastener	Type	Material Specification
Washers	Spring lock washers	FF-W-84
		ASME B18.21.1
	Tooth lock washers	FF-W-100
		ASME B18.21.1
	Flat washers	FF-W-92
		ASME B18.22.1
Other	Safety wiring and cotter pins	NASM33540
	Quarter turn fasteners	NASM5591
	Rotary quick operating high strength fasteners	NASM22978
		NAS547
	Helical coil	ASME B18.29.1
Compounds	Thread-locking and retaining compounds	ASTM D5363
	Antiseize compounds	A-A-59313

5.2.18 Electrical-Indicating Meters and Accessories

5.2.18.1 Electrical-Indicating Meters, Ruggedized. Meters shall be in accordance with the appropriate specification in TABLE XIX. For analog meters, the normal operating value of the quantity to be indicated shall be between 0.3 and 0.8 of full-scale deflection, wherever practicable.

TABLE XIX. Electrical-indicating meter specifications.

Reference Document	Description
MIL-DTL-7793	Meter, Time Totalizing
MIL-DTL-16034	Meters, Electrical-Indicating (Switchboard And Portable Types)
MIL-M-16125	Meters, Electrical, Frequency
MIL-PRF-10304	Meters, Electrical Indicating, Panel Type, Ruggedized, General Specification For

5.2.18.2 Shunts. External meter shunts shall be in accordance with A-A-55524 or MIL-I-1361, as indicated by hardware design.

5.2.18.3 Iron and Direct Current Fields. Meters shall be so mounted that large masses of iron and direct current fields will not affect their operation. Iron vane type meters shall be mounted so that transformers or choke coils carrying current will not affect their operation.

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5.2.18.4 Shielding. External thermocouple radio frequency meters, especially those carrying currents above one ampere, and the leads thereto, shall be shielded as necessary to protect the thermocouples from currents caused by stray radio frequency fields. For meters operating at high radio frequency voltage above ground, shielding shall also be provided against stray capacity currents through the meter to the panel of the equipment.

5.2.18.5 Scales, Dials and Pointers. Unless otherwise specified in the detail specification, scales, dials, and pointers shall be in accordance with MIL-STD-1472.

5.2.19 Other Parts

5.2.19.1 Controls. Manually operated multiturn counters control dials shall be in accordance with NASM28728. The following criteria shall be considered for selection and application of controls:

a. Arrangement and location. Controls shall be arranged to facilitate smooth and rapid operation. All controls which have sequential relations, which are related to a particular function or operation or which are operated together, shall be grouped together along with their associated displays. Controls shall be conveniently located with respect to associated visual displays. Controls shall be of such size and so spaced that the manipulation of a given control does not interfere with the setting of an adjacent control. Adjustment controls, with required test points, shall be grouped and so marked as to provide for simplicity and ease of maintenance.

b. Mechanical operation. Infrequently required controls shall be screwdriver adjusted. Play and backlash in controls shall be held to a minimum commensurate with intended operational functions and shall not cause poor contact or inaccurate setting. Controls shall operate freely and smoothly without binding, scraping, or cutting. Controls may be lubricated when lubrication does not interfere with operation and is specified in the detail equipment specification.

c. Shafts and couplings. Shafts subject to removal may have their couplings secured by two setscrews 90° to 120° apart. Flexible couplings may be used for controls where the use of rigid couplings would interfere with the satisfactory operation or mounting of such controls.

5.2.19.2 Batteries. Batteries shall not be used unless approved by the procuring activity. MIL-HDBK-454, Guideline 27, provides information on specification and application of batteries.

5.2.19.3 Tuning Dial Mechanisms. The following criteria shall be considered for selection and application of tuning dial mechanisms:

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a. Dial. The division marking and lettering on tuning dials shall be suitably etched. Dial markings shall be legible at a distance of 0.6 meter from all points within a solid angle of 60° defined by a surface of revolution about a line through the center of the dial and perpendicular to the panel. Minimum space between characters shall be one stroke width. The width of the lubber line or pointer tip shall not exceed the width of the graduation marks. Except for digital tuning indicators, for which only one calibration number will be seen, dials shall be marked so that at least two calibration numbers on each band can be seen at any dial setting.

b. Balance and friction. Weighted tuning knobs shall be counterbalanced. Friction in tuning dial mechanism shall allow smooth and easy adjustment of the operating knob over the entire operating range of the mechanism, but shall have sufficient resistance, or shall incorporate a positive locking device to maintain the setting under all specified service conditions. Friction shall be achieved through dry or elastic resistance rather than by fluid resistance.

c. Flexible control shafts. Flexible shaft assemblies shall be used when a flexible mechanical connection is required between the tuning knob and the tuned device.

d. Tuning ratio. The tuning ratio used shall be the optimum which will permit both rapid and precise setting.

5.2.19.4 Readouts. The following criteria shall be considered for selection and application of readouts:

a. Optoelectronic type readouts. Optoelectronic type readouts shall conform to MIL-DTL-28803.

b. Light emitting diode displays. Visible light emitting diode displays shall conform to MIL-PRF-19500/708.

c. Night vision goggles. Night vision goggle (NVG) compatibility considerations for cockpit readouts and displays shall be considered where use of night vision goggles by cockpit crews is possible.

5.3 Materials Requirements

5.3.1 Metals. Metallic Materials Properties Development and Standardization (MMPDS) Handbook shall be used as the basic document for defining strength allowables and other mechanical and physical properties for metallic materials. When data are not contained in the MMPDS Handbook, contractor allowables developed in accordance with the MMPDS

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Handbook may be used with prior approval of the procuring activity. The following criteria shall be considered for selection and application of metals:

a. Forging Design. Forgings shall be produced in accordance with SAE AMS-F-7190, SAE AMS-A-22771, or SAE AMS4970. Recognized industrial association or contractor specifications shall be used for alloys not covered by the above specifications.

b. Forging Surfaces. Surfaces of structural forgings in regions identified by analyses as fatigue critical or in regions of major attachment shall be shot peened or placed in compression by other means demonstrated to be equivalent. Those areas of forgings requiring lapped, honed, or polished surface finishes for functional purposes shall be shot peened prior to surface finishing operations.

c. Stress Corrosion Considerations. Alloys and heat treatments, which result in a high resistance to stress corrosion cracking as defined in MSFC-STD-3029 Table 1, shall be utilized in all structural, load- carrying applications. Materials that are subject to stress corrosion cracking conditions and do not have a high resistance to stress corrosion cracking as defined in MSFC-STD-3029 Table 1. shall be considered a non-standard material and shall require procuring activity approval.

d. Castings. Castings shall be classified and inspected in accordance with SAE AMS2175. Structural castings shall be procured to SAE-AMS-A-21180, SAE AMS5343, or other document in accordance with approval from the procuring activity.

e. Dissimilar Metals. Use of dissimilar metals in contact, as defined by MIL-STD-889, shall be limited to applications where similar metals cannot be used due to design requirements. When use is unavoidable, metals shall be protected against galvanic corrosion by a method listed in MIL-STD-889. Composite materials containing graphite fibers shall be treated as graphite in MIL-STD-889.

5.3.1.1 Aluminum and Aluminum Alloys. Aluminum and aluminum alloys shall be in accordance with the appropriate specification in TABLE XX. The following criteria shall be considered for selection and application of aluminum and aluminum alloys:

a. Forging Design. Forgings shall be produced in accordance with SAE-AMS-A-22771 for aluminum alloys.

b. Aluminum alloys. Structural parts that do not need to be grounded or electrically bonded shall be anodized in accordance with MIL-PRF-8625 or upon procuring activity approval be coated with a chemical film in accordance with MIL-DTL-5541.

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c. Heat Treatment. Heat treatments not included in above specifications may be used if sufficient test data are available to prove that the specific heat treatment improves the mechanical and/or physical properties of the specific aluminum alloys without altering susceptibility to degradation.

d. Forming and Straightening. Forming and straightening operations shall be limited to processes that do not result in stress corrosion sensitivity of the part, or to detrimental residual stresses, or losses in mechanical properties, or fracture toughness on structurally critical parts.

e. Use of 7075-T6, 2024-T3, 2024-T4, and 2014-T6 sheet (<0.25 inches thick) requires approval before use. Other forms of 7075 shall be heat-treated to the T73XX temper.

TABLE XX. Aluminum reference documents.

Reference Document	Description
ASTM B85/B85M	Standard Specification for Aluminum-Alloy Die Castings
ASTM B108/B108M	Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B26/B26M (alloy 43 temper F, alloy 356, or alloy 195)	Standard Specification for Aluminum-Alloy Sand Castings
SAE-AMS-A-21180	Aluminum-Alloy Castings, High Strength
QQ-A-1876	Aluminum Foil
SAE AMS2770	Heat Treatment of Wrought Aluminum Alloy Parts
SAE AMS2771	Heat Treatment of Aluminum Alloy Castings
SAE AMS2772	Heat Treatment of Aluminum Alloy Raw Materials

5.3.1.2 Beryllium. Beryllium and beryllium alloys shall be tested under simulated service conditions and exhibit mission life, including any expected corrosive environments. This restriction applies to alloys with greater than 5% beryllium. The following criteria shall be considered for selection and application of beryllium:

a. Toxicity. The toxicity of beryllium dust and fumes is a critical problem and minimization of exposure shall be a goal during fabrication, assembly, installation, and usage of beryllium parts.

b. Storage. Beryllium products that may generate dust or particles shall be stored in closed containers, which shall only be opened in a controlled environment.

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c. Design. Design of beryllium parts shall include consideration of its low impact resistance, and notch sensitivity, particularly at low temperatures, and its directional material properties and sensitivity to surface finish requirements.

5.3.1.3 Magnesium. Magnesium alloys shall not be used for structural applications, in any area subject to wear, abrasion, erosion or where fluid entrapment is possible. Magnesium alloys shall not be used except in areas where exposure to corrosive environments is prevented and protection systems are maintained. The following criteria shall be considered for selection and application of magnesium:

a. Stress Corrosion Cracking. Magnesium and magnesium alloy products shall be treated after forming to avoid stress corrosion cracking.

b. Corrosion. Magnesium and magnesium alloy products shall not be used without a corrosion protection system designed for its mission, manufacturing and storage environment.

c. Dissimilar Metals. Dissimilar metal protection shall be used regardless of the environmental controls.

5.3.1.4 Ferrous Alloys (Steels). The following criteria shall be considered for selection and application of ferrous alloys:

a. Forging Design. Forgings shall be produced in accordance with SAE-AMS-F-7190.

b. Heat Treatment of Steels. Steel parts shall be heat-treated as specified to meet the requirements of SAE-AMS-H-6875. High strength steels heat-treated at or above 200 ksi Ultimate Tensile Strength (UTS) shall not be used unless approved by the procuring activity. Heat treatments not included in SAE-AMS-H-6875 may be used if test data demonstrates that the heat treatment improves the mechanical and/or physical properties of the specific steel without altering susceptibility to degradation and prior approval by the procuring activity.

c. Drilling and Machining of High Strength Steels. The drilling of holes, including beveling and spot facing, in martensitic steel hardened to 180 ksi UTS or above shall be avoided. Microhardness and metallurgical examination of test specimens typical of the part shall be used to determine if martensite areas are formed as a result of drilling or machining operations. The surface roughness of finished holes shall not be greater than 63 RHR (Roughness Height Reading), and the ends of the holes shall be deburred by a method which has been demonstrated not to cause untempered martensite. An

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etching procedure may be used as an alternate to metallurgical testing to determine the presence of untempered martensite.

d. Grinding of High Strength Steels. Grinding of martensitic steels hardened to 180 ksi UTS and above shall be performed in accordance with MIL-STD-866. Grinding of chromium plated martensitic steels hardened to 180 ksi UTS and above shall also be performed in accordance with MIL-STD-866.

e. Corrosion Resistant steels:

(1) Austenitic Stainless Steels. Free machining stainless steels intended for fatigue critical applications shall not be performed. Sulfur or selenium additions improve machinability but lower fatigue life.

(2) Precipitation Hardened Stainless Steels. These steels shall be aged at temperatures not less than 1000ºF. Exception is made for castings which may be aged at 935ºF ±15ºF, fasteners which may be used in the H950 condition and springs which have optimum properties at the CH 900 condition.

f. Forming or Straightening of Steel Parts. Procedures and tooling shall be used to minimize warping during heat treatment of steel parts. Steel parts shall be formed or straightened as follows:

(1) Parts hardened up to 165 ksi UTS may be straightened at room temperature.

(2) Parts hardened from 165 to 200 ksi UTS may be straightened at room temperature provided they are given a stress relieving heat treatment subsequent to straightening.

(3) Parts hardened over 200 ksi UTS shall be hot formed or straightened within a temperature range from the tempering temperature to 50ºF below the tempering temperature.

g. Shot Peening. After final machining, all surfaces of critical or highly stressed parts which have been heat treated to or above 200 ksi UTS except for rolled threads, inaccessible areas of holes, pneumatic or hydraulic seat contact areas, and thin sections or parts which if shot peened could violate engineering and functional configuration, shall be shot peened in accordance with SAE AMS2430. Areas requiring lapped, honed, or polished surfaces shall be shot peened prior to finishing.

h. Stress Corrosion Cracking. The assembly stresses of low alloy steel heat treated above 200 ksi UTS shall not exceed the stress corrosion threshold limitation for the particular material and grain-flow orientation.

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i. Low Alloy High Strength Steel Corrosion Prevention. All low alloy, high strength steel parts heat treated at 180 ksi UTS and above, including fasteners, shall require corrosion preventative metallic coatings by a process that is non-embrittling to the alloy/heat treatment combination.

5.3.1.5 Titanium. Titanium shall be in accordance with the appropriate specification in TABLE XXI and TABLE XXII. The following criteria shall be considered for selection and application of titanium:

a. Forging Design. Forgings shall be produced in accordance with SAE AM4970 for titanium alloys.

b. Hardenability. Titanium alloys have limited hardenability with section size and shall not be used in sections which exceed their specified limits.

c. Titanium Contamination. Care shall be exercised to ensure that contamination from cleaning fluids and other chemicals used on titanium are not detrimental to performance. The following materials can induce stress corrosion, hydrogen embrittlement, or reduce fracture toughness and shall be prohibited from the manufacturing, assembly or contact with titanium or its alloys.

(1) Hydrochloric Acid
(2) Silver
(3) Halogenated solvents
(4) Methyl Alcohol
(5) Mercury and Mercuric Compounds
(6) Trichloroethylene/Trichloroethane
(7) Carbon Tetrachloride
(8) Halogenated Cutting Oils
(9) Halogenated Hydrocarbons
(10) Cadmium or silver plated clamps, tools, fixtures or jigs

d. Fretting of Titanium. Design of components manufactured with titanium and titanium alloys shall prevent fretting.

e. Surface Corrosion Considerations. The surfaces of titanium and titanium alloy mill products shall be 100% machined, chemically milled or pickled to a sufficient depth to remove all contaminated zones and layers formed while the material was at elevated temperature. This includes contamination as a result of mill processing, heat-treating and elevated temperature forming operations.

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f. Heat treatment. For titanium alloy products not covered in MSFC-SPEC-469, heat treatment shall be in accordance with SAE-AMS-H-81200, or as specified in the engineering design or approved by the procuring activity.

TABLE XXI. Titanium reference documents.

Reference Document	Description
MIL-T-81556	Titanium and Titanium Alloys, Extruded Bars and Shapes, Aircraft Quality
MSFC-SPEC-469	Specification, Titanium and Titanium Alloys, Heat Treatment of
SAE AMS4901	Titanium Sheet, Strip, and Plate Commercially Pure Annealed, 70.0 ksi (485 MPa) - UNS R50700
SAE AMS4900	Titanium Sheet, Strip, and Plate Commercially Pure Annealed, 55 ksi (379 MPa) Yield Strength - UNS R50550
SAE AMS4902	Titanium Sheet, Strip, and Plate Commercially-Pure Annealed 40.0 ksi (276 MPa) Yield Strength - UNS R50400
SAE AMS4940	Titanium Sheet, Strip, and Plate Commercially Pure Annealed, 25.0 ksi (172 MPa) Yield Strength - UNS R50250
SAE AMS4910	Titanium Alloy, Sheet, Strip, and Plate 5Al - 2.5Sn Annealed - UNS R54520
SAE AMS4909	Titanium Alloy, Sheet, Strip, and Plate 5Al - 2.5Sn, Extra Low Interstitial Annealed - UNS R54521
SAE AMS4915	Titanium Alloy Sheet, Strip, and Plate 8Al - 1V - 1Mo Single Annealed - UNS R54810
SAE AMS4916	Titanium Alloy Sheet, Strip, and Plate 8Al - 1Mo - 1V Duplex Annealed - UNS R54810
SAE AMS4911	Titanium Alloy, Sheet, Strip, and Plate 6Al - 4V Annealed - UNS R56400
SAE AMS4903	Titanium Alloy Sheet, Strip, and Plate 6Al - 4V Solution Heat Treated - UNS R56400
SAE AMS4904	Titanium Alloy Sheet, Strip, and Plate 6Al - 4V Solution Heat Treated and Aged - UNS R56400
SAE AMS4907	Titanium Alloy, Sheet, Strip, and Plate 6.0Al - 4.0V, Extra Low Interstitial Annealed - UNS R56401
SAE AMS4918	Titanium Alloy, Sheet, Strip, and Plate 6AI - 6V - 2Sn Annealed - UNS R56620
SAE AMS4988	Titanium Alloy Sheet, Strip, and Plate 6Al - 6V - 2Sn Solution Heat Treated - UNS R56620
SAE AMS4990	Titanium Alloy Sheet, Strip, and Plate 6Al - 6V - 2Sn Solution Heat Treated and Aged - UNS R56620
SAE AMS4919	Titanium Alloy Sheet, Strip, and Plate 6AI - 2Sn - 4Zr - 2Mo - 0.08Si Duplex Annealed - UNS R54620

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Reference Document	Description
SAE AMS4989	Titanium Alloy Sheet, Strip, and Plate 3Al - 2.5V Annealed - UNS R56320
SAE AMS4917	Titanium Alloy Sheet, Strip, and Plate 13.5V - 11Cr - 3.0Al Solution Heat Treated - UNS R58010
SAE AMS4939	Titanium Alloy Sheet, Strip, and Plate 3Al - 8V - 6Cr - 4Mo - 4Zr Solution Heat Treated - UNS R58640

TABLE XXII. Titanium alloys selection.

Type	Alloy	Condition	Specification
Commercially Pure Titanium	CP-70	70 ksi Yield Strength	AMS4921
Alpha Titanium Alloys	5AI-2.5Sn	Annealed	AMS6900
	5AI-2.5Sn (ELI)	Annealed	AMS6901
	8AI-1Mo-1V	Duplex Annealed	AMS6910
Alpha-Beta Titanium Alloys	3AI-2.5V	Annealed	AMS6940
	6AI-4V	Annealed	AMS6931
		STA	AMS6930
	6AI-4V (ELI)	Annealed	AMS6932
	6AI-6V-2Sn	Annealed	AMS6936
		STA	AMS6935
	6AI-2Sn-4Zr-2Mo	Duplex Annealed	AMS6905
	6AI-2Sn-4Zr-6Mo	Duplex Annealed	AMS6907
		STA	AMS6906
	7AI-4Mo	Annealed	AMS6915
Beta Titanium Alloys	3AI-8V-6Cr-4Mo-4Zr	ST	AMS6920
		STA	AMS6921
	13V-11Cr-3AI	ST	AMS6925
		STA	AMS6926

5.3.1.6 Solder. Solder shall be in accordance with the appropriate specification in TABLE XXIII.

TABLE XXIII. Solder reference documents.

Reference Document	Description
J-STD-004 Class 3/3A	Requirements for Soldering Fluxes
J-STD-005, Class 3/3A	Requirements for Soldering Pastes

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Reference Document	Description
J-STD-006, Class 3/3A	Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications

5.3.1.7 Other Metals and Alloys. Other metals, such as nickel and copper and their alloys, which have common heritage in aerospace applications, may be used with prior approval by the procuring activity. Other metals and alloys without this heritage shall not be used unless a design trade study/testing is performed and maintained that (1) demonstrates the desirability over commonly used materials, and (2) clearly demonstrates that no additional reliability risks or hazards will be incurred by using these uncommon materials. The following criteria shall be considered for selection and application of other metals and alloys:

a. Stress Corrosion Cracking. For those metals and alloys which are not covered in the MMPDS Handbook or MSFC-STD-3029, or which have no available stress corrosion data or documented use history, testing in accordance with MSFC-STD-3029 shall be performed to demonstrate that the metal or alloy is free from stress corrosion cracking from the environment and stress level in its application.

b. Finishing. As necessary, other metals and alloys shall be finished in accordance with MIL-STD-171 and MIL-STD-186 to meet the corrosion resistance requirements of the detail specification.

5.3.1.7.1 Brass. Brass parts and assemblies shall be in accordance with the appropriate specification in TABLE XXIV.

TABLE XXIV. Brass reference documents.

Reference Document	Description
ASTM B36/B36M	Standard Specification for Brass Plate, Sheet, Strip, And Rolled Bar
ASTM B121/B121M	Standard Specification for Leaded Brass Plate, Sheet, Strip, and Rolled Bar
ASTM B16/B16M	Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
ASTM B124/B124M	Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes

5.3.1.7.2 Bronze. Bronze parts and assemblies shall be in accordance with the appropriate specification in TABLE XXV, as indicated by hardware design and usage.

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TABLE XXV. Bronze parts and assemblies reference documents.

Reference Document	Description
ASTM B22/B22M	Bronze castings for Bridges and Turntables
ASTM B30	Copper-Base Alloys in Ingot Form
ASTM B61	Steam or Valve Bronze Castings
ASTM B62	Composition Bronze or Ounce Metal Castings
ASTM B66	Bronze Castings for Steam Locomotive Wearing Parts
ASTM B67	Car and Tender Journal Bearings, Lined
ASTM B124/B124M	Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B148	Aluminum-Bronze Sand Castings
ASTM B150/B150M	Standard Specification for Aluminum Bronze Rod, Bar, and Shapes
ASTM B169/B169M	Standard Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar
ASTM B176	Copper-Alloy Die Castings
ASTM B271/B271M	Copper-Base Alloy Centrifugal Castings
ASTM B283/B283M	Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed)
ASTM B369	Copper-Nickel Alloy Castings
ASTM B427	Gear Bronze Alloy Castings
ASTM B505/B505M	Copper-Base Alloy Continuous Castings
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM B763/B763M	Copper Alloy Sand Castings for Valve Application
ASTM B770	Copper-Beryllium Alloy Sand Castings for General Applications
ASTM B806	Copper Alloy Permanent Mold Castings for General Applications
SAE AMS4842	Castings, Leaded Bronze, Sand and Centrifugal 80Cu-10Sn-9.5Pb as Cast
SAE AMS4845	Tin Bronze Castings, Sand and Centrifugal 87.5Cu-10Sn-2Zn as Cast
SAE AMS4855	Leaded Red Brass, Sand and Centrifugal Castings 85Cu-5.0Sn-5.0Pb-5.0 Zn as Cast
SAE AMS4860	Manganese Bronze, Sand and Centrifugal Castings 63Cu-24 Zn-6.2Al-3.8Mn as Cast
SAE AMS4862	Manganese Bronze, Sand and Centrifugal Castings 63Cu-24 Zn-6.2Al-3.8Mn-3.0Fe High Strength, as Cast
SAE AMS4890	Copper-Beryllium Alloy Castings 97Cu – 2.1Be – 0.52Co – 0.28Si Solution Heat Treated (TBOO)
QQ-C-450	Copper-Aluminum Alloy (Aluminum Bronze) Plate, Sheet, Strip, and Bar (Copper Alloy Numbers 606, 610, 613, 614, and 630)

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5.3.1.7.3 Copper. Copper parts and assemblies, except copper wire, shall be in accordance with the appropriate specification in TABLE XXVI.

TABLE XXVI. Copper reference documents.

Reference Document	Description
ASTM B187/B187M	Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes
ASTM B272	Standard Specification for Copper Flat Products with Finished (Rolled or Drawn) Edges (Flat Wire and Strip)
ASTM B644	Standard Specification for Copper Alloy Addition Agents
ASTM B152/B152M	Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B122/B122M	Standard Specification for Copper-Nickel-Tin Alloy, Copper-Nickel-Zinc Alloy (Nickel Silver), and Copper-Nickel Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM B206/B206M	Standard Specification for Copper-Nickel-Zinc (Nickel Silver) Wire and Copper-Nickel Alloy Wire
ASTM B98/B98M	Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes
ASTM B99/B99M	Standard Specification for Copper-Silicon Alloy Wire for General Applications
ASTM B105	Standard Specification for Hard-Drawn Copper Alloy Wires for Electric Conductors
ASTM B124/B124M	Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM A494/A494M	Standard Specification for Castings, Nickel and Nickel Alloy
MIL-C-24723	Castings, Nickel-Copper Alloy
ASTM B196/B196M	Standard Specification for Copper-Beryllium Alloy Rod and Bar

5.3.1.7.4 Nickel Alloys. Nickel alloy parts and assemblies shall be in accordance with the appropriate specification in TABLE XXVII.

TABLE XXVII. Nickel alloy reference documents.

Reference Document	Description
QQ-N-281	Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural And Special Shaped Sections
QQ-N-286	Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500)
SAE AMS-QQ-N-290	Nickel Plating (Electrodeposited)

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Reference Document	Description
ASTM B166	Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696), Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617), and Nickel-Iron-Chromium-Tungsten Alloy (UNS N06674) Rod, Bar, and Wire
ASTM B168	Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696), Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617), and Nickel-Iron-Chromium-Tungsten Alloy (UNS N06674) Plate, Sheet, and Strip

5.3.1.8 Finishes for Metals. Metals and alloys shall be finished in accordance with the appropriate specification in TABLE XXVIII.

TABLE XXVIII. Metal finish reference documents.

Reference Document	Description
MIL-STD-171	Finishing of Metal and Wood Surfaces
MIL-STD-186	Protective Finishing for Army Missile Weapon Systems
NASA STD 6012	Corrosion Protection for Space Flight Hardware

5.3.1.9 Castings. Mission and safety critical castings shall be procured to SAE AMS5342 or approved equivalent. The following criteria shall be considered for selection and application of castings:

a. Die castings. Die castings shall not be used where the casting might be subject to impact. Zinc alloy die castings shall not be used where dimensional changes of the casting could affect use of equipment.

b. Porous castings. When required, castings shall be impregnated in accordance with MIL-STD-276.

c. Castings shall be classified and inspected in accordance with SAE AMS 2175.

d. Repair of unmachined castings. Repair of minor discontinuities or defects in unmachined or raw castings shall be permitted only when specific approval has been granted by the procuring activity, or is specified on the engineering documentation Repair of machined castings. Repair of defects in machined castings shall be permitted only when approval has been granted by the procuring activity.

5.3.2 Polymeric Materials. Specifications for composition and processing shall be used to ensure a polymeric material meets all physical, chemical, and mechanical requirements of the

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intended application. Polymeric materials shall be evaluated and tested or documented on the basis of detailed history for compatibility with temperature, pressure, radiation and fluid or gas environments. Tests for compatibility with hazardous fluids and gases such as oxygen or hydrogen shall consider energy sources available in the proposed application that could initiate adverse reactions. The following criteria shall be considered for selection and application of polymeric materials:

a. Outgassing. All materials shall meet the outgassing requirements specified in Appendix E.

b. Stability. The materials shall be hydrolytically stable and not subject to reversion for their intended environments including manufacturing, testing, transportation and storage.

c. Storage. Polymers that are procured in non-cured or partial cured states, such as prepregs or frozen premixes, shall be held in controlled temperature storage. Reduced temperatures or specific humidity storage conditions shall be implemented as recommended by the manufacturer.

d. Hygroscopic Materials. The hygroscopic nature of materials shall be factored in the contamination analysis.

e. Fluoropolymers. Fluoropolymers such as PTFE, Teflon(R), FEP and TFE may creep or cold flow under pressure, or degrade when exposed to radiation environments. These materials shall not be used in these applications

5.3.2.1 Elastomers. Elastomeric components shall be hydrolytically stable, not subject to reversion, and possess resistance to aging, low temperature, ozone, heat aging, working fluids, lubricants and propellants for the system for the mission life, manufacturing and storage life for which they are designed. Elastomeric materials in contact with hydrazine shall be prohibited. Rubber materials, except cellular rubber types, used for the absorption of noise, shock or vibration, or for applications where resiliency is required, shall be in accordance with ASTM D2000. The type, class, and grade (including suffixes) of rubber materials shall be chosen in accordance with requirements of the applications. The following criteria shall be considered for selection and application of elastomers:

a. Cured Elastomers. Cured elastomers that are age sensitive shall be controlled by SAE AS1933 and SAE ARP5316. All cured elastomeric materials shall be cure dated either on the item itself or on the packaging. Cured elastomeric materials shall be protected from sunlight, fuel, oil, water, dust, and ozone. A maximum storage

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temperature 37.8ºC (100ºF) is recommended; the maximum storage temperature shall not exceed 51.7ºC (125ºF).

b. Non-cured Elastomers. Materials that are procured in non-cured state such as sealants and potting compounds shall be held in controlled temperature storage not to exceed 26.7ºC (80ºF). Reduced temperature storage conditions shall be implemented as recommended by the manufacturer.

5.3.2.1.1 Synthetic Rubber. A general purpose synthetic rubber conforming to MIL PRF-6855 shall be used where resistance to oil and fuel is required. A high silicone conforming to A-A-59588 shall be used where resistance to high and low temperature is required.

5.3.2.1.2 Cellular Rubber. Cellular rubber used for the absorption of noise, shock and vibration, or where resiliency is required, shall be in accordance with ASTM D1056, ASTM D1667, or ASTM D3574.

5.3.2.2 Plastics. Plastic materials that are determined to be "burning" when subjected to Test Methods ASTM D635 and ASTM D2863, shall be considered flammable and shall not be used.

5.3.2.2.1 Foamed Plastics. Foamed plastics used shall be hydrolytically stable and shall not be subject to reversion. The following criteria shall be considered for selection and application of foamed plastics:

a. Foamed plastics shall comply with the outgassing requirements specified in Appendix E.

b. Foam plastics shall not be used for metal skin reinforcement, or as a core material in sandwich structural components. Foam plastics may be used in plastic sandwich parts, or as low density filler putties or syntactic foam.

5.3.2.2.2 Anti-Electrostatic Plastic Materials. Anti-electrostatic plastic materials for dials and other transparent/translucent anti-electrostatic applications shall conform to MIL-W-80.

5.3.2.2.3 Plastic Materials for High-Frequency Applications. Where frequencies higher than 100 kHz or circuit Q higher than 25 are involved or associated with circuits, the plastic materials shall conform to ASTM D5948.

5.3.2.2.4 Laminated Thermosetting Plastics. A silicone resin glass-cloth material conforming to MIL-I-24768/17shall be used where thermosetting plastic sheets are used for maintaining insulation of greater than one megohm or for temperatures > 43ºC.

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5.3.2.3 Lubricants. Lubricants shall be selected in accordance with the appropriate specification in TABLE XXIX. The following criteria shall be considered for selection and application of lubricants:

a. Silicones. Silicone compounds shall not be used as lubricants.

b. Graphite base lubricants. Graphite base lubricants shall not be used.

c. Volatility. Low volatility lubricants shall be used where practical.

d. Compatibility. The lubricant shall be chemically inert with regard to the materials it contacts.

e. NASA SP-8063 shall be used as a guide in the design and application of lubricants for space flight systems and components. Lubricants shall comply with the outgassing requirements specified in Appendix E.

TABLE XXIX. Lubricants reference documents.

Reference Document	Description
MIL-PRF-3150	Lubricating Oil, Preservative, Medium
MIL-PRF-6085	Lubricating Oil Instrument, Aircraft, Low Volatility
MIL-PRF-6086	Lubricating Oil, Gear, Petroleum Base (NATO O-153, O-155)
MIL-PRF-15719	Lubricating Grease (High-Temperature, Electric Motor, Ball and Roller Bearings)
MIL-PRF-17331	Lubricating Oil, Steam Turbine and Gear, Moderate Service
MIL-PRF-17672	Hydraulic Fluid, Petroleum, Inhibited
MIL-L-23398	Lubricant, Solid Film, Air-Cured, Corrosion Inhibiting, NATO Code Number S-749
MIL-PRF-23827	Grease, Aircraft and Instrument, Gear and Actuator Screw
MIL-PRF-24139	Grease, Multipurpose, Water Resistant
MIL-PRF-24508	Grease, High Performance, Multipurpose (Metric)
MIL-PRF-46010	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting NATO Code - S-1738
MIL-PRF-81322	Grease, Aircraft, General Purpose, Wide Temperature Range, NATO Code G-395
MIL-PRF-81329	Lubricant, Solid Film, Extreme Environment, NATO Code Number S-1737
SAE J2360	(R) Automotive Gear Lubricants for Commercial and Military Use

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5.3.2.3.1 Anti-Seize Compound. Anti-seize compound shall be in accordance with MIL-PRF-907 and the application guidance specified in MIL-HDBK-275.

5.3.2.4 Adhesives, Sealants, Coatings and Encapsulants. The following criteria shall be considered for selection and application of adhesives, sealants, coatings and encapsulants:

a. Coatings. Conformal coatings shall be qualified to IPC-CC-830, or MIL-I-46058.

b. Outgassing. All materials shall meet the outgassing requirements specified Appendix E.

c. Glass Transition Temperature. The secondary or glass transition temperature of silicone-based adhesives or sealants subjected to application to cryogenic temperatures during test or usage shall be a minimum of 30ºF lower than the usage qualification temperature.

5.3.2.4.1 Adhesives. Adhesives shall be selected in accordance with the appropriate specification in TABLE XXX. Adhesives not included in the following specifications may also be selected from other commercial or military specifications with prior approval by the procuring activity. The following criteria shall be considered for selection and application of adhesives:

a. Deleterious effects the adhesive selected shall have no deleterious effects on the bonded assembly or nearby items when the bonded assembly is in storage, transit, or use under the environmental conditions for which it was designed.

b. Thermoplastic All thermoplastic adhesives shall not be used in critical structural applications.

TABLE XXX. Adhesives reference documents.

Reference Document	Description
MMM-A-121	Adhesive, Bonding Vulcanized Synthetic Rubber to Steel
MMM-A-132	Adhesives, Heat Resistant, Airframe Structural, Metal to Metal
MMM-A-134	Adhesive, Epoxy Resin, Metal to Metal Structural Bonding
MMM-A-138	Adhesive, Metal To Wood, Structural
MMM-A-181	Adhesives, Phenol, Resorcinol or Melamine Base
MMM-A-189	Adhesive, Synthetic-Rubber, Thermoplastic, General-Purpose
MIL-A-3920	Adhesive, Optical, Thermosetting
MIL-A-24179	Adhesive, Flexible Unicellular-Plastic Thermal Insulation
MIL-A-46146	Adhesives-Sealants, Silicone, RTV, Noncorrosive (for use with Sensitive Metals and Equipment)

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Reference Document	Description
A-A-1936	Adhesives, Contact, Neoprene Rubber
A-A-3097	Adhesives, Cyanoacrylate, Rapid Room Temperature-Curing, Solventless
SAE AMS-A-8576	Adhesive, Acrylic Base, for Acrylic Plastic
SAE AMS-A-25463	Adhesive, Film Form Metallic Structural Sandwich Construction
MIL-HDBK-83377	Adhesive Bonding (Structural) For Aerospace And Other Systems, Requirements for

5.3.2.4.2 Encapsulants and Embedment Materials. Encapsulants and embedment materials shall be of a nonreversion type and shall be selected from the following specifications: MIL-PRF-8516, A-A-59877, MIL-PRF-23586, MIL-M-24041, and SAE AS81550. For Air Force applications, approval for use of any material other than transparent silicone, in accordance with MIL-I-81550, shall be requested through the procuring activity. The encapsulation or embedment of microelectronic modules and equipment modules shall be avoided, except where specifically indicated by the requirements of a particular application.

5.3.2.4.3 Paint Finishes. Paint finishes shall be in accordance with MIL-STD-171. The colors of paints shall be in accordance with SAE AMS-STD-595. Consideration shall be given to human factors, camouflage, and standardization in the specification of paint colors in accordance with applicable requirements in MIL-STD-1472.

5.3.2.4.4 Non-Slip Coating. Platforms, steps, walkways, and other common working surfaces shall have a nonslip surface coating applied. Such coatings, as well as their methods of application, shall comply with A-A-59166, subject to approval of the procuring activity.

5.3.3 Composites. Composites are considered to be combinations of materials differing in composition or form on a macroscale. The constituents retain their identities in the composite; that is, they do not dissolve or otherwise merge completely into each other although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another.

a. Polymer Matrix Composites Polymer Matrix Composites consist of an organic matrix reinforced by high modulus and/or high strength fibers. The fiber reinforcement takes the form of continual unidirectional filaments (tape), woven fabric (cloth), chopped fibers etc. The fiber materials are boron, carbon, aromatic polyamide etc. Guidance in the processing and production of polymer matrix composite materials can be found in the 436124L DOD/NASA Structural Composites Fabrication Guide. Guidance in the effective utilization of advanced composite materials and design concepts in aerospace structures can be found in the 436125L DOD/NASA Advanced Composites Design Guide, Vol I - Vol IV. Further guidance can be found in the Composite Materials Handbook (CMH-17) Volumes 1 through 3.

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b. Metal Matrix Composites. In a metal matrix composite, the metal serves the same purpose as the organic binder of an organic matrix composite. Aluminum, magnesium and titanium alloys are common metal matrices. Metal matrix composites shall be designed using the guidelines of MIL-HDBK-17 Volume 4

c. Ceramic Matrix Composites. A material consisting of two or more constituents where a ceramic matrix is normally the principal component and the additional constituents are incorporated to strengthen, toughen, and/or enhance the thermo-physical properties. Ceramic matrix composites shall be designed using the guidelines of MIL- HDBK-17 Volume 5.

5.3.4 Ceramic Materials. Ceramic material not used for electrical purposes may be glazed or unglazed and need not be treated. Ceramics used for electrical purposes shall be glazed. The surface of glazed ceramics shall be smooth, uniform, and free from porosity. Ceramics shall be treated in accordance with directions furnished by the manufacturer of the material where glazing is impractical; such treatments shall be approved by the procuring activity. The following criteria shall be considered for selection and application of other ceramic materials:

a. Limitations on Material Use. Glasses and ceramics are limited in their use as structural elements due to their brittleness at ambient temperatures and lack of suitable nondestructive inspection techniques to ensure adequate strength and fracture resistance for specific stress and environmental conditions. Mechanical properties and fracture toughness information, as well as a plan to ensure adequate quality, shall be required to demonstrate ability to use these materials in their intended application including manufacturing, testing, storage and transportation.

b. Materials Design Information. There is no central source of materials design on glasses and ceramics similar to the MMPDS Handbook for metals. The following sources of information are useful:

(1) Larsen, D. C., Adams, J. W., and S. A. Bortz, “Survey of Potential Data for Design Allowable MIL-Handbook Utilization for Structural Silicon-Based Ceramics,” prepared by IIT Research Institute, Materials and Manufacturing Technology Division, Chicago, IL 60616, December 1981, Final Report in Contract No. DAAG 46-79-C-0078.

(2) Touloukian, Y. S., Powell, R. W., Ho, C. Y., and P. G. Klemens, “Thermophysical Properties of Matter - the TPRC Data Series,” Volumes 2,5,8,9,11, and 13, IFI/Plenum, New York-Washington 1970.

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(3) Lynch, J. F., Ruderer, C. G., and W. H. Duckworth, “Engineering Properties of Selected Ceramic Materials,” published and distributed by the American Ceramic Society, Inc., 4055 N. High Street, Columbus, Ohio 43214, 1966.

(4) Bradt, R. C., D. Hasselman, P. H., and F. F. Lange, “Fracture Mechanics of Ceramics,” Volumes 1-6, Plenum Press, New York-London 1974 (Volumes 1 and 2), 1978 (Volumes 3 and 4), 1983 (Volumes 5 and 6).

5.3.5 Glass. Glass shall be shatterproof in accordance with SAE Z26.1, unless otherwise approved by the procuring activity. Glass used for the protection of instruments, meters, cathode ray tube faces, and for viewing dials and indicators, shall be in accordance with MIL-G-81704. Glare-proof glass shall be used when equipment to be viewed will be illuminated from an outside source.

5.3.5.1 Glass Insulators and Glass-Bonded Mica Insulation. Electrical tape shall be selected from the types in MIL-I-3158, ASTM D2400, ASTM D2754, and MIL-I-19166.

a. Laminated Thermosetting Plastic Materials selected shall conform to MIL-I-24768/2 and MIL-I-24768/3. The preferred base is glass cloth. Electrical insulators fabricated from laminated thermosetting-plastic sheets, plates, rods, and tubes (except transparent plastics) shall be treated after all machining and punching operations with a suitable moisture barrier unless the plastic has a moisture absorption of 1.0% or less, or is used in a hermetically sealed container.

5.3.5.2 Glass Fiber. Glass fiber materials shall not be used as the outer covering on cables, wires or other components where they may cause skin irritation to operating or maintenance personnel.

5.3.5.3 Optical Glass and Optical Components. Optical glass used in the fabrication of optical components shall comply with MIL-PRF-13830. Glass mirrors shall conform to MIL-M-13508.

5.3.5.4 Non-Optical Glass. Non-optical glass products shall conform to SAE AMS-G-25871 or ASTM C1036.

5.3.5.5 Glass Coating. All optical or non-optical glass requiring anti-reflective coatings shall be treated in accordance with MIL-C-675.

5.3.6 Sandwich Assemblies. Design of all sandwich assemblies shall include venting and prevent entrance and entrapment of water or other contaminants in the core structure. Sandwich assemblies shall be tested in accordance with SAE AMS-STD-401. Aluminum honeycomb core sandwich assemblies shall use SAE AMS-C-7438 perforated core. Non-metallic

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cores may be used in structural applications where technically advantageous with prior approval by the procuring activity. Nonmetallic structural sandwich assemblies shall be approved by the procuring activity after qualification for specific applications by passing a test program subjecting them to anticipated worst-case environments including mission, and ground testing.

5.3.7 Fabric Base Materials.

5.3.7.1 Fabric and Thread. The following criteria shall be considered for selection and application of fabric and thread:

a. Color. The color of the fabric and thread shall be in accordance with SAE AMS-STD-595. For treated materials this requirement shall be met after treatment.

b. Shrinkage. Fabric and threaded shall be preshrunk or allowance shall be made for the shrinkage in order to provide for satisfactory fit of the finished article after the article is immersed in water and then dried.

5.3.7.2 Felt. Wool felt shall be in accordance with C-F-206 and shall be given Type III treatment in accordance with MIL-PRF-2312. Hair felt shall conform to MIL-PRF-2312 and shall be mildew proof as specified therein.

5.3.7.3 Webbing. Cotton webbing shall conform to MIL-DTL-530, class 4 or 7. Class 7 shall be used when webbing will come in contact with natural or synthetic rubber or class 4 when prolonged contact with the skin may occur. Nylon webbing shall conform to MIL-DTL-4088 or class R of MIL-DTL-27265.

5.3.7.4 Thread. Thread shall conform to A-A-52094, A-A-59963, A-A-50197, or A-A-59826. Cotton and linen thread shall be treated in accordance with A-A-59991. Type I, class 2 mildew inhibiting agent shall be used when thread will come in contact with natural or synthetic rubber or type I, class 1 when prolong contact with the skin may occur.

5.3.7.5 Lacing Twine, Tape and Straps. Lacing twine, tape and straps for cable harnesses and other applications shall conform to MIL-DTL-713, Type P (waxed), A-A-52080 through A-A-52084, and SAE AS23190, respectively.

5.3.7.6 Rope. Rope shall be in accordance with T-R-605 or A-A-50057. For severe outdoor use polyamide rope shall be used, subject to the approval of the procuring activity. Cords, yarns, and monofilaments shall conform to MIL-PRF-572. Types PVCA, AR, VCR, and CTA shall not be used where they may be exposed to fungus attack.

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5.3.7.7 Cotton and Linen. No cotton or linen-base materials shall be used except for mechanical applications. Such parts shall be vacuum impregnated with a varnish in accordance with ASTM D3955 and ASTM D295 and dried after machining operations are completed.

a. Cotton duck. Medium texture number 4 shall be used for heavy-duty service and hard texture number 12 shall be used for services requiring light weight.

b. Sateen. Laminated, two-ply rubberized cotton sateen shall conform to MIL-C-9074. This sateen shall not be used when prolonged contact with the skin may occur.

c. Fabric or tape. Cotton or linen shall not be used in the form of fabric or tape except as follows:

(1) In construction of rotating electrical machinery where no other tape of sufficient mechanical strength is available.

(2) On coils or parts such as inductors, transformers, and relays where the coil is subsequently completely encapsulated and covered against moisture and fungus.

5.3.8 Other Materials

5.3.8.1 Cork. Cork shall be treated with a fungus-resistant agent containing water reducible zinc naphthenate.

5.3.8.2 Wood. Unless otherwise specified, wood shall not be used except in approved component parts. When specified, solid wood shall be free from any defects that would adversely affect use of parts made of wood. Plywood shall be Group A – (CS-35) Hardwood plywood or Group B - (PS-1). Softwood plywood construction and industrial, in accordance with A-A-55057. Plywood shall be treated with Type A preservative for moisture and fungus resistance for interior or exterior usage, whichever is applicable.

5.3.8.3 Flux. Flux used for the joining of parts to make a nonelectrical connection in the process of soldering shall conform to J-STD-004, Class 3; J-STD-005, Class 3; and J-STD- 006, Class 3 as indicated by hardware design.

5.3.8.4 Flammable Materials. Flammability is a complex characteristic which combines ease of ignition, surface flammability, heat contribution, smoke production, fire gasses, and fire endurance. Flammability is a function of chemical composition, physical configuration, temperature, availability of oxygen, and retardants or additives. The following criteria shall be considered for selection and application of flammable materials:

a. Materials. Materials used in military equipment shall, in the end item configuration, be noncombustible or fire retardant in the most hazardous conditions of

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atmosphere, pressure, and temperature to be expected in the application. Fire retardant additives may be used provided they do not adversely affect the specified performance guidelines of the basic materials. Fire retardance shall not be achieved by use of non-permanent additives to the basic material.

b. Flammability test. The test used to determine the flammability of material shall be the test specified in the material specification.

c. Other flammability test. If the specification does not have such a test, testing shall be in accordance with ASTM D635, ASTM D1000, or MIL-STD-202, Method 111, as applicable.

d. Other materials. Materials not covered by the above tests shall be tested in accordance with a procedure approved by the procuring activity. UL shall be used to develop test methods and offers a comparative scale to define degree of flammability.

5.3.8.5 Fungus-Inert Materials. For material which, in all modified states and grades, is not a nutrient to fungi, the following criteria shall be considered for selection and application:

a. Preferred materials. Fungus-inert materials listed in group I of TABLE XXXI are preferred for use. These materials need not be tested for fungus resistance prior to use. The appearance of a particular material in TABLE XXXI does not constitute approval for its use.

b. Acceptable materials. Those materials listed in group II of TABLE XXXI may be used, provided it has been demonstrated that they meet the guidelines of (d) below. When materials are compounded with a permanently effective fungicide in order to meet the fungus test guideline, there shall be no loss of the original electronic or physical properties required by the basic material specification. Fungicides containing mercury shall not be used.

c. Hermetically sealed applications. Fungus nutrient materials may be used untreated within hermetically sealed enclosures.

d. Fungus testing. TABLE XXXI Group II materials shall be subjected to the fungus test specified in method 508 of MIL-STD-810 for a period of 28 days. Certification by a qualified laboratory or by the material producer, based on test data on record that the material meets grade O or grade 1 guidelines of table 508-I, method 508 of MIL-STD-810, shall be submitted to the procuring activity before use.

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TABLE XXXI. Fungi susceptibility of materials.

Group I - Fungus-inert materials (Fungus-inert in all modified states and grades)	
Acrylics	Polyamide 1/
Acrylonitrile-styrene	Polycarbonate
Acrylonitrile-vinyl-chloride copolymer	Polyester-glass fiber laminates
Asbestos	Polyethylene, high density (above 0.940)
Ceramics	Polyethylene terephthalate
Chlorinated polyester	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 - Fungus nutrient materials (May require treatment to attain fungus resistance)	
ABS (acrylonitrile-butadiene-styrene)	Polyethylene, low and medium
Acetal resins	density (0.940 and below)
Cellulose acetate	Polymethyl methacrylate
Cellulose acetate butyrate	Polyurethane (the ester types
Epoxy-glass fiber laminates	are particularly susceptible)
Epoxy-resin	Polyricinoleates
Lubricants	Polyvinyl chloride
Melamine-formaldehyde	Polyvinyl chloride-acetate
Organic polysulphides	Polyvinyl fluoride
Phenol-formaldehyde	Rubbers, natural and synthetic
Polydichlorostyrene	Urea-formaldehyde

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

5.3.8.6 Insulating Materials, Electrical. The following criteria shall be considered for selection and application of electrical insulating materials. Insulating materials used for encapsulation and embedment (potting) and for conformal coating are excluded the requirements in this section.

a. Ceramics. Ceramic insulators shall conform to MIL-I-23264.

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b. Sleeving and tubing. Sleeving and tubing shall conform to MIL-I-631, MIL-I-3190, MIL-I-22076, MIL-I- 22129, SAE AMS3638, SAE AMS3653, SAE AMS3654, SAE AMS3655, or ASTM D3295. MIL-I-631 shall also apply to film, film tape, and sheet and sheet tape forms of insulation.

c. Plastic, thermosetting, cast. When used for electrical insulation, parts fabricated from cast thermosetting plastic materials shall be in accordance with L-P-516.

d. Plastic, thermosetting, laminated. Materials selected shall conform to MIL-I-24768/2 and MIL-I-24768/3 or NEMA FI 3. The preferred base is glass cloth. Electrical insulators fabricated from laminated thermosetting-plastic sheets, plates, rods, and tubes (except transparent plastics) shall be treated after all machining and punching operations with a suitable moisture barrier unless the plastic has a moisture absorption of 1.0% or less, or is used in a hermetically sealed container.

e. Plastic, thermosetting, molded. Molded parts which undergo subsequent machining shall be vacuum impregnated with a suitable moisture barrier material and dried after all surface-breaking operations have been completed. Cotton and linen shall not be used as filler material in any electrical insulator. Materials having moisture absorption of 1.0% or less, and those used in hermetically sealed containers, need not be impregnated.

f. Varnish, electrical insulating. Insulating varnish shall conform to NEMA RE 2 or MIL-I-24092.

g. Heat shrinkable insulators. For applications requiring heat shrinkable insulators other than sleeving, such as strain relief boots or enclosure feed-throughs, the material shall conform to SAE AS81765.

h. Polyvinyl chloride. Polyvinyl chloride insulating materials shall not be used in aerospace applications. Their use in other applications requires procuring activity approval.

5.3.8.6.1 Arc-Resistant Materials. The following criteria shall be considered for selection and application of arc-resistant materials used for insulation of electrical power circuits:

a. Materials. Materials shall conform to TABLE XXXII. The materials listed have passed the minimum guidelines of 115 seconds when subjected to the arc-resistance test of ASTM D495 and are listed in approximate order of arc resistance.

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b. Applications. Materials may be masked, if necessary, during any treatment of the equipment in which they are used which might result in degradation of the arc-resistant properties of the material. For parts which may be exposed to other than high-voltage, low-current arcing, the materials shall be evaluated for overall thermal and electrical characteristics. Suitability for the specific application and the potential for satisfactory performance in elevated humidity, as defined in the detail equipment specification, shall also be considered.

TABLE XXXII. Arc-resistant materials.

Materials	Specification	Types
Plastic(s), thermosetting, molding		CMI-5, GDI-30, GDI-30F, MAG, MAI-30, MAI-60, MAI-100, MAT-30, MDG, MME, MMI-5, MMI-30, MSG MSI-30, SDG, SDG-F, SDI-30
Molding, epoxy compounds	ASTM D5948	MEE
Laminated rods and tubes, Laminated sheets	MIL-I-24768	GMG
Glass cloth, silicone resin	MIL-I-24768	GSG
Sheet and rod, cast	L-P-516	E-2
Sheet and strip, polyimide	ASTM D5213	All
Silicone rubber	A-A-59588	All

5.3.8.6.2 Electrical Breakdown Prevention. The following criteria shall be considered for prevention of corona and electrical breakdown:

a. Corona prevention. The corona extinction voltage (CEV) shall be at least 150% of the peak circuit voltage, corresponding to the maximum specified steady-state rms supply voltage. This guideline applies:

(1) When the equipment is terminated with the cabling, or other accessory equipment, with which it is intended to be used and;

(2) When the equipment is operated under the specified environmental service conditions and;

(3) When the equipment is supplied with the specified power source frequencies and voltages including commonly recurring transients.

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b. Electrical breakdown prevention. The equipment shall be designed and manufactured with electrical clearance spacing, leakage (creepage) distances, and insulation characteristics adequate to prevent electrical breakdown. This guideline applies under all specified environmental service conditions including service life and using the specified operating voltages (including transients). Liquid dielectrics, gases other than air, or pressurization to prevent electrical breakdown shall not be used unless approved by the procuring activity.

c. Insulation systems. Corona can occur within cavities between an insulating material and a metal surface which are in contact. Cavities at interfaces where high voltages are encountered shall be avoided.

d. Metal parts. Sharp edges and points shall be avoided on metal parts included in high intensity electric fields.

e. Corona testing. There are many factors which determine whether or not corona will occur, including temperature, humidity, ambient pressure, test specimen shape, rate of voltage change, and the previous history of the applied voltage. Test methods such as ASTM D1868 may be used but the test results lack accuracy and repeatability and require great care due to the personnel hazards involved.

f. Electrical breakdown testing. The insulating material shall be evaluated under the actual environmental conditions which apply to the equipment. Test at power frequencies, 25 to 800 Hz in accordance with ASTM D149.

5.3.8.6.3 Electrical Tape. Electrical tape shall be selected in accordance with the appropriate specification in TABLE XXXIII. Fabric or textile pressure sensitive (adhesive or friction) tape shall not be used, except as specified herein. Moisture absorbing tape may be used for mechanical purposes or when included in hermetically sealed assemblies as approved by the procuring activity.

TABLE XXXIII. Electrical tape reference documents.

Reference Document	Description
MIL-I-3158	Insulation Tape, Electrical Glass-Fiber (Resin-Filled): and Cord, Fibrous-Glass
A-A-59770	Insulation Tape, Electrical, Pressure Sensitive Adhesive and Pressure Sensitive Thermosetting
ASTM D2754	Standard Specification for High-Temperature Glass Cloth Pressure-Sensitive Electrical Insulating Tape
MIL-I-19166	Insulation Tape, Electrical, High-Temperature, Glass Fiber, Pressure-Sensitive

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Reference Document	Description
MIL-I-24391	Insulation Tape, Electrical, Plastic, Pressure-Sensitive
ASTM D4388	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes

5.4 Processes Requirements. Processing specifications herein represent minimum standards of quality required for military, space, and associated hardware. In most instances, manufacturing, installation, and inspection processes are controlled by contractor specifications. The use of these specifications is encouraged provided that the minimum standards of quality and quality assurance required by the appropriate contractual specifications are achieved.

a. Corrosion Considerations. Precautions shall be taken during manufacturing, testing, and installation operations to maintain corrosion prevention requirements and environment control to prevent the introduction of contamination, corrosion, or corrosive elements.

b. Statistical Process Control (SPC). Process quality controls shall be maintained through a formal, documented, statistical process control program meeting the requirements of SAE EIA 557.

c. Process Records. Written or computerized process records that demonstrate successful application and completion of all required processes and related quality assurance requirements shall be maintained for the life of the program. Certifications of compliance shall not be considered acceptable proofs without associated results of analyses or documentation showing successful processing or testing.

d. Cleaning Prior to Application. All processes involving adhesives, prepregs, sealants, coatings and encapsulants shall require careful surface preparation to ensure adequate adhesion. Each qualified material shall be associated with one or more documents describing its application and usage. Each application document shall detail the specific cleaning procedure for all surfaces to be coated or bonded and a maximum time period between surface preparation and bonding or coating, after which surfaces shall be reprocessed. Materials covered by this section shall be qualified with the specific surface preparation procedure described.

e. Cleaning and Storage. All materials, parts, and assemblies that have been subjected to processing shall be appropriately cleaned and maintained in a cleaned state prior to the next process, test, use, or installation. Where appropriate, verification of appropriate levels of cleanliness and freedom from contamination shall be required.

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5.4.1 Adhesive Bonding. Structural bonding shall conform to the guidelines of MIL-HDBK-83377. The following criteria shall be considered for adhesive bonding:

a. Bonding of structural components, except for high temperature nozzle bonds, shall be tested under simulated service conditions using tag-end test specimens whenever possible to demonstrate that the materials and processes selected will provide the desired properties for the entire life of the component. When thermal cycle testing is required, the rate of temperature change shall not exceed the expected rate of temperature change in service.

b. Hardware qualifications and acceptance tests plus lap shear witness coupons processed concurrently using the same material cleaning method and cure cycles can be used in lieu of tag-end test specimens. As a minimum, structural bonds shall require lap shear witness coupons processed concurrently using the same material cleaning method and cure cycles.

5.4.2 Welding. The welding of aluminum alloys, steel alloys, corrosion resistant and heat resistant alloys shall be in accordance with AWS D17.1/D17.1M:2010. For non-launch critical welds, AWS D1.1 and AWS D1.2 are acceptable alternatives. All friction welding processes shall be in accordance with AWS C6.2 or approved alternative by the procuring activity. The following criteria shall be considered for welding:

a. Weld Design Selection. The design selection of parent materials and weld methods shall be based on consideration of the weldments, including adjacent heat affected zones. Welding procedures shall be selected to provide the required weld quality, minimum weld energy input, and protection of the heated metal from contamination. The suitability of the equipment, processes, welding supplies, and supplementary treatments selected shall be demonstrated through qualification testing of welded specimens representing the materials and joint configuration of production parts. As a minimum requirement, welding operators shall be qualified in accordance with AWS D17.1/D17.1M:2010. In addition, each operator shall be provided the necessary training and qualification requirements for certification and the applicable welding equipment for specific welding tasks.

b. Weld Filler Material. Weld rod or wire used as filler metal on hi-reliability critical weldments shall be fully certified and documented for composition, type, heat number, manufacturer, and supplier to provide traceability to the end use item. In addition, qualitative analysis and nondestructive testing will be conducted on segments of each filler rod or wire as necessary to ensure that the correct filler metal is used on each critical welding task. Quantitative analyses of weld filler metal on a lot by lot basis

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will be considered acceptable, provided that each structural weldment is subjected to simulated service testing or proof loading prior to acceptance.

c. Weld Repair. To minimize weld repair, welding methods, procedures, and specifications shall be carefully selected. Weld repair is limited to the rework of welding defects in a production weld as revealed by inspection. Weld repair does not include the correction of dimensional deficiencies by weld buildup or "buttering" of parts in areas where the design did not provide a welded joint. All weld repairs shall be fully documented to facilitate procuring activity review. Documentation as a minimum shall include weld procedures and schedules, location of the rework, nature of the problem and appropriate inspection and qualification requirements for acceptance. The weld repair process and inspection shall be qualified to the same level of assurance as the primary process specification drawing requirement using the same inspection technique that found the original defect and by all other methods of examination that were originally required for the affected area. The results are subject to review by procuring activity.

d. Weld Rework. Weld rework shall be minimized by discriminating selection of acceptable methods, procedures and specifications developed by the contractor. Weld rework is limited to the rework of welding defects in a production weld as revealed by inspection. Weld rework does not include the correction of dimensional deficiencies by weld buildup or "buttering" of parts in areas where the design did not provide for a welded joint. All weld rework shall be fully documented. Documentation as a minimum shall include weld procedures and schedules, location of the rework, nature of the problem and appropriate inspection and qualification requirements for acceptance. The quality of reworked welds shall be confirmed by 100% inspection of both surface and subsurface, using visual, dimensional and nondestructive techniques. Rework of welds in high performance or critical parts shall not be permitted.

e. Cleaning After Welding. Welded assemblies shall be cleaned to remove rust, scale, oxidation products, and excess flux by sandblasting, wire brushing, or other suitable means. Prior to painting, steel parts that have been arc welded or acetylene welded shall, in addition, be subjected to vat passivation or phosphoric acid etch in accordance with MIL-C-10578. Acid used for cleaning shall be completely neutralized and removed.

f. Welding Process. Preheating shall be employed where distortion is likely to result from welding. Welds shall have thorough penetration and good fusion and shall be free from scabs, blisters, abnormal pock marks, and other harmful defects. Where undesirable internal stresses are likely to result from welding, welded items shall be

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stress-relieved. Inert-gas shielded arc welding shall be used, when practical, for welding of aluminum magnesium or stainless steel.

5.4.2.1 Structural Welding. The joint areas of all parts to be welded shall be cleaned of contaminants and materials which may be detrimental to obtaining satisfactory welds. Degradation of material properties in the heat affected zone caused by welding shall be considered. Weldments shall be stress relieved when induced stress resulting from welding, design configuration, or materials welded may be harmful. See AWS A2.4 for welding symbols, AWS A3.0 for welding terms and definitions, and MIL-STD-22 for welded joint designs. MIL-HDBK-730 provides guidance in this field of materials joining and its related processes. The following criteria shall be considered for structural welds:

a. Arc and gas welding. Welding by arc and gas methods shall be performed by operators who have passed the applicable certification tests and have a certificate of proficiency in accordance with AWS D17.1/D17.1M:2010. Welding of aluminum, magnesium, and steel alloys shall conform to AWS D17.1/D17.1M:2010.

b. Resistance welding. Resistance welding of joints shall conform to AWS D17.2/D17.2M:2013.

5.4.2.2 Resistance Welds for Electrical Interconnections. The following criteria shall be considered for resistance welds of electrical and electronic interconnections and part leads:

a. Contaminants. All surfaces of leads, or parts, to be welded shall be free of contaminants which would adversely affect forming of the welded joint.

b. Electrical connections. Except where needed to meet electromagnetic interference or system compatibility guidelines, welded electrical connections shall not be used where it may be necessary to disconnect, replace, or reconnect a part or module during servicing.

c. Excess conductor wire. Excess conductor wire shall be trimmed sufficiently close to provide adequate clearance to prevent possible electrical shorting but not so close as to cause damage to the welded joint.

d. Strain relief. Each part lead terminating at a connection point shall have allowance for strain relief to minimize tensile or shear stress.

5.4.3 Brazing. Brazing shall be in accordance with the appropriate specifications listed below. Metals not covered by AWS C3.4, AWS C3.5, AWS C3.6 and AWS C3.7 shall not be brazed. Subsequent fusion welding operations in the vicinity of brazed joints or other operations involving high temperatures which might affect the brazed joint are prohibited. Brazed joints

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shall be designed for shear loading and shall not be used to provide strength in tension for structural parts. Allowable shear strength and design limitations shall conform to those recommended in the MMPDS Handbook. The following criteria shall be considered for brazing:

a. Stranded or insulated wire connections. Electrical connections of stranded or insulated wire, or those having construction which may entrap fluxes, shall not be brazed.

b. Resistance brazing. The current and electrode size for resistance brazing shall be selected so that the heat will be distributed over a large enough area to allow the brazing alloy to flow freely, but not large enough to cause overheating.

5.4.3.1 Torch Brazing. Torch brazing of steel, copper, copper alloys, and nickel alloys, shall be in accordance with AWS C3.4.

5.4.3.2 Induction Brazing. Induction brazing of steel, copper, copper alloys, and nickel alloys, shall be in accordance with AWS C3.5.

5.4.3.3 Furnace Brazing. Furnace brazing of steel, copper, copper alloys, and nickel alloys, shall be in accordance with AWS C3.6.

5.4.3.4 Aluminum and Aluminum Alloy Brazing. Brazing of aluminum and aluminum alloys shall be in accordance with AWS C3.7M/C3.7.

5.4.4 Fastener Installation. The installation of mechanical fasteners and associated parts, including cleaning prior to installation and application of protective finishes, shall meet the requirements of NASA-STD-6012 and MIL-STD-403. The following criteria shall be considered for fastener installation:

a. Lubrication on fasteners, corrosion inhibiting materials or locking materials shall be tested for outgassing in accordance with ASTM E595. Non-compliant materials shall be removed prior to installation, unless approved by the procuring activity.

b. Torque values and staking requirements shall be defined in the engineering drawings for all fasteners.

c. Fasteners installed in dissimilar metals shall be in accordance with MIL-STD-889.

d. Anaerobic curing agents (i.e., Loctite®) typically do not pass outgassing and shall be tested for outgassing in accordance with ASTM E595. Non-compliant materials shall be removed prior to installation, unless approved by the procuring activity.

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e. Fasteners attached to surfaces to which do not meet the requirements for galvanic couples shall be wet stalled with MIL-PRF-23377 primer, or MIL-PRF-81733, SAE AMS3277, or equivalent sealant. Neither primer nor sealant should be applied to the threaded portion of fasteners for which torque requirements are established without the coating. All non-aluminum fasteners installed in aluminum structure shall be over coated with a minimum thickness of 0.006” of MIL-PRF-81733, SAE AMS3277, SAE AMS-S- 8802, SAE AMS3276, or equivalent sealant. After installation, all attaching parts shall be coated with primer or primer and topcoat corresponding to the finish requirements of the surrounding area. Exceptions must be approved by the procuring activity.

5.4.5 Printed Wiring Assemblies. Printed wiring assemblies (PWAs) shall be in accordance with class 3 for IPC A-610 and IPC J-STD-001. The Military and Space Addendum for J-STD-001 shall apply for equipment categories A, B, and C, and for other applications with significant temperature cycling, vibration, and/or shock.

5.4.5.1 Soldering. Soldering to make electrical and electronic connections to terminals, wires, cables, connectors, PWBs and like parts shall conform to IPC J-STD-001, Class 3 or Space and Military Addendum, as determined by 5.4.5. The following criteria shall be considered for soldering:

a. When using the J-STD-001-S (Space and Military Addendum) for surface mounted chip components, the “minimum end overlap” shall be 50% of the end cap.

b. Mounting and soldering configurations not addressed in these standards shall be qualified for the life and environments of the mission by testing, with the end product requirements documented. Use of these configurations shall require customer approval.

c. Heat sensitive components, such as fuses, shall be protected by heat sinks or other means.

d. Solders shall meet the requirements of 5.3.1.6.

e. Terminal Soldering. Step-soldering with a high temperature solder conforming to J-STD-006 shall be used when it is necessary to solder terminals to the PWB.

f. Solder in the Bend Radius. For through-hole mounted components, the solder in the bend radius shall only be acceptable for axial leaded components with a body diameter of 0.125 inch or less, and with leads formed to a 90° bend.

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g. Solder splice joints. Solder splice joints shall be made in accordance with IPC/WHMA-A-620 Class 3 or IPC/WHMA-A-620-Space Addendum, as applicable. The use of Class 3 versus Space Addendum shall be governed by the end use of the solder splice join under consideration.

h. Nonelectrical joints. Mechanical soldering of nonelectrical (structural) joints shall be in accordance with ASTM B828 for copper tubes and fittings.

5.4.5.2 Electrostatic Discharge Control. ESD control shall be in accordance with the requirements of MIL-STD-1686 or ANSI/ESD S20.20.

5.4.5.3 Storage and Handling. Protection against electrostatic damage to electrostatic sensitive devices shall be provided in accordance with 5.4.5.2. Procedures shall be established for handling parts and materials including receipt of parts and materials, inspections, interim storage, cleaning, kitting, assembly, and test. The procedures used shall be identified on the "build" documentation. The following criteria shall be used as a minimum for establishing handling and storage procedures:

a. Control of environment, such as temperature, humidity, contamination, and pressure.

b. Measures and facilities to segregate and protect parts and materials routed to different locations such as to a materials review crib, to a laboratory for inspection, or returned to the manufacturer for unacceptable shipments.

c. Measures to control and limit personnel access to parts and materials during receiving inspection and storage.

d. Measures for protection against shock or vibration or both during transportation and storage.

e. Measures to provide protection during transit to prevent packages from being dropped or dislodged.

f. Protective work surfaces on which sensitive parts and materials are handled during operations such as test, assembly, inspection, and kit organizing.

g. Measures to handle unique parts and materials, especially materials or parts for which the manufacturer has specified special storage, shipping, or handling requirements.

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5.4.5.4 Contamination Prevention and Control. The contractor PMP shall address a contamination control approach that describes the procedures that will be followed to control Foreign Object Debris/Damage (FOD). It shall establish the implementation and describe the methods that will be used to measure and maintain the levels of cleanliness required during each of the various phases of the item's lifetime. Possible contaminants include all materials of molecular and particulate nature whose presence degrades hardware performance. Special areas of concern are:

a. Assembly and Test Areas. Efforts to maintain clean assembly and test areas are required. Extraneous paper, work tools, materials, chemicals, food, drinks, personal care items, or other like materials are not permitted.

b. HVAC Systems. Heating, ventilation and air conditioning (HVAC) systems shall be reviewed and, where necessary, controlled to meet the requirements of maintaining a non-contaminating workspace. Particulate material, chemical fumes, and cross contamination from other areas shall be considered.

c. Human Contact. When necessary, human contact with parts and materials shall be controlled; finger contact, particulate materials, and body fluids shall be considered.

d. Clean Rooms. When clean rooms are required for the manufacturing of parts and materials, the clean room facility shall be in accordance with the applicable clean room standard.

5.4.5.5 Part and Material Identification and Marking. Parts and materials shall be clearly identified on the containers or the packaging. Part markings shall remain legible after processing. The part marking information shall include all required traceability information. Identification and markings shall clearly indicate contents and any other necessary information such as safety warnings, ESD or moisture sensitivity. Components and PWBs shall be labeled in accordance with IPC J-STD-609.

5.4.5.6 Moisture Sensitivity Levels. Moisture or process sensitive components (as classified by IPC J-STD-020, IPC J-STD-075 or other documented classification procedure) shall be handled in conformance with IPC J-STD-033. Documented procedures shall track all moisture sensitive components to ensure the floor life is not exceeded. Rework procedures involving solder reflow shall not be performed on components with Moisture Sensitivity Level 4 (MSL 4) or higher.

5.4.5.7 Conformal Coat. Conformal coat material shall conform to IPC-CC-830. All PWAs, except RF applications in which performance is degraded by coating, shall be conformally coated with materials specified in Section 2240 of J-STD-001-S (Space and Military

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Addendum). Coating restrictions are noted in C.4.2.3. The coated assemblies shall exhibit no blisters, cracking, crazing, peeling, wrinkles, measling, evidence of reversion or corrosion at 3-5X magnification. A pinhole, bubble, or combination thereof, shall not bridge more than 50% of the distance between non-common conductors. Conformal coating to mitigate risk for tin whisker risk mitigation shall comply with GEIA-STD-0005-2, class 2C.

5.4.5.8 Rework and Repair. Rework or repair of PWAs shall only be performed after defects have been documented. Repair of PWAs shall only be performed upon approval of the procuring activity. IPC 7711/7721 may be used as a guide for performing rework or repair. Prohibited repairs methods from IPC 7711/7721 are listed in C.4.1.4

5.4.5.9 Wiring Harness Assembly. Wiring harness assembly shall conform to IPC/WPHA-A-620 Class 3 or IPC/WHMA-A-620-Space Addendum, as applicable. The use of Class 3 versus Space Addendum shall be governed by the end use of the solder splice join under consideration.

5.4.6 Environmental Stress Screening. Considerations will be made to perform Environmental Stress Screening (ESS), according to MIL-STD-810, based on system application, program requirements, and product history. ESS is performed to ensure product quality, by precipitating defects introduced into the product by faulty components and the manufacturing process. The equipment shall withstand any specified combination of environmental conditions without mechanical or electrical damage or degradation which will result in performance below the minimum specified by the procuring activity. These tests, where applicable and considering any limitations, shall be used in materiel design, production and throughout the equipment life cycle as a method of assuring performance reliability.

5.4.7 Additive Manufacturing. When using parts produced with Additive Manufacturing processes, the Contractor shall define and implement processes and qualification requirements to assure that such parts meet the system application performance requirements.

5.4.7.1 Application Definition. For additive manufactured parts, a part specification shall fully define the application life cycle requirements to support effective test and analysis of the part in order to meet all application requirements.

5.4.7.2 Process Control and Qualification. For additive manufactured parts, a part specification shall define and require process control and qualification requirements, including:

a. identification and control of key process variables and materials,

b. process control established and documented for feedstock and material,

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c. quality control measures, such as build cycle witness test specimens for microstructure assessment and thermo-mechanical properties characterization, and

d. part qualification requirements to assure fully meeting application requirements.

5.4.8 Paint Finishes. Paint finishes shall comply with MIL-STD-7179.

5.5 Prohibited PM&P. Appendix C defines the PM&P that are considered to be reliability suspect, have limited application, involve restricted or special controls, or are otherwise unacceptable for use in DoD electronic hardware and associated mechanical hardware unless otherwise approved by the procuring activity.

6 NOTES

(This section contains information of a general or explanatory nature that may be helpful but is not mandatory.)

6.1 Intended use. This standard is intended for use in standardizing requirements for the selection and application of parts, materials, and processes (PM&P) for use during the development, production, and sustainment of military systems. This standard also provides criteria to evaluate the suitability of commercial off-the-shelf (COTS) items for incorporation into military systems.

6.2 Acquisition requirements. Acquisition requirements should specify the following:

a. Title, number, and date of this standard.

6.3 Associated Data Item Descriptions (DIDs). This standard has been assigned an Acquisition Management Systems Control (ASMC) number authorizing it as the source document for the following DID. When it is necessary to obtain the data, the applicable DID must be listed on the Contract Data Requirements List (DD Form 1423).

DID Number	DID Title
DI-STDZ-81993	Parts, Materials, and Processes (PM&P) Management Plan

The above DID was current as of the date of this standard. The ASSIST database should be researched at https://assist.dla.mil to ensure that only current and approved DIDs are cited on the DD Form 1423.

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6.4 Tailoring guidance for contractual application. The requirements in section 4 and section 5 of this standard should be tailored in each acquisition to the needs of that particular program.

6.5 Subject term (key word) listing

Adhesives

Capacitors

Commercial off-the-shelf (COTS)

Composites

Connectors

Counterfeit parts and materials

Derating

Encapsulation

Materials selection

Mechanical piece parts

Metals

Microcircuits

Parts selection

Plastic encapsulated microcircuits (PEMs)

Polymeric materials

Printed wiring assembly (PWA)

Printed wiring board (PWB)

Prohibited parts, materials, and processes (PM&P)

Resistors

Semiconductors

Soldering

Thermistors

Welding

Wire and cable

Wiring harness assembly

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6.6 International Standardization Agreement implementation. Wherever inch/pound dimensions are used in this document, metric equivalents in accordance with FED-STD-376 will be acceptable.

6.7 Changes from previous issue. Margin notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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DERATING

A.1 SCOPE

A.1.1 Scope. This appendix details the requirements for derating parts. Derating of a part is the intentional reduction of its electrical, mechanical, and thermal stresses to provide a safety margin between the applied stress and the actual demonstrated limit of the part capabilities. The derating policy established herein is intended to reduce the occurrence of stress related failures and help ensure long term reliability.

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

A.2 REQUIREMENTS

A.2.1 Derating Requirements. These requirements provide derating factors to be applied as a percentage of maximum rated values for critical device parameters such as applied voltages, operating currents, power dissipation, and operating temperatures (ambient, case, or junction). The maximum rated values are typically obtained from the applicable procurement specification, drawing, or manufacturer's data sheets. Circuit designers and part users shall evaluate all part applications and ensure adequate derating. **The manufacturer's maximum ratings shall never be exceeded.**

The derating level for each part in the system shall be documented by part or drawing number, reference designator (if applicable), next higher assembly drawing number, rated stress (determined by the part manufacturer), applied stress for the criteria identified in A.3.1, and approval from the procuring activity for any part that exceeds the derating criteria.

A.3 DERATING CRITERIA

A.3.1 Derating Criteria. The derating criteria contained herein apply to worst-case values of electrical and environmental stresses expected for the part during equipment life, including acceptance tests, qualification tests, storage, and field handling and use. Part tolerance and part parameter degradation over the equipment shall also be included.

The recommended derating factors are based on the best information currently available and do not preclude further derating. Parts not covered in these guidelines lack sufficient empirical data and failure history. Consult with the procuring activity if derating information is needed for a specific part not contained in this document.

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Exceeding these criteria and criteria for parts not listed herein shall require approval from the procuring activity.

A.3.2 Capacitors. Critical stress parameters for capacitors are applied voltage and case temperature. Voltage derating for capacitors is accomplished by multiplying the maximum operating voltage by the appropriate derating factor shown in TABLE A-I.

TABLE A-I. Capacitor derating factors.

Type 1/	**Voltage Derating Factor 2/**	**Maximum Case Temperature 3/ 4/**
Aluminum Electrolytic	Not allowed for use 8/	Not allowed for use 8/
Ceramic 5/	0.50	20°C below maximum rating
Glass	0.50	20°C below maximum rating
Plastic Film	0.50	20°C below maximum rating
Mica	0.50	20°C below maximum rating
Tantalum, Non-solid	0.50	20°C below maximum rating
Tantalum, Solid 7/	0.50 0.30 6/	70°C 110°C
Variable	Not allowed for use	Not allowed for use

1/ Consult with the procuring activity for applicable derating criteria for applications requiring the use of devices with different construction than indicated in the Table.

2/ The derating factor applies to the sum of peak AC ripple and DC polarizing voltages.

3/ Maximum case temperature is defined as the prevailing temperature in the vicinity of the part or the medium surrounding the part.

4/ Maximum case temperature applies to applications where capacitor is operating at or below maximum derated voltage. For operation above this temperature, consult the procuring activity for correct derating factor.

5/ In low voltage applications (<10 Vdc) with high series impedance (>1 Mega-ohm), multilayer ceramic capacitors with thin dielectrics or other defects may develop low and unstable insulation resistances. In these applications, the capacitor rated voltage shall be at least 100 Vdc unless the dielectric thickness of the low voltage capacitor is determined to be equal to or greater than 0.8 mils or the lot has been subjected to humidity and steady state, low voltage testing. Note that capacitors procured to MIL-PRF-123 are screened for this failure mode and are recommended for low voltage applications.

6/ Derate voltage linearly from 70°C to 110°C.

7/ Solid tantalum capacitors, especially when used in power supply filter applications, are subject to in-rush current failures. In order to protect against this failure mechanism, only surge current tested capacitors shall be used. In addition, the effective circuit resistance shall be a minimum of 0.1 ohm/Volt or 1.2 ohms, whichever is greater. For applications where the capacitors have not been surge current tested, the effective capacitor circuit resistance shall be at least 1 ohm/Volt or 3 ohms, whichever is greater. See A.3.2.1 for additional derating guidelines pertaining to solid tantalum capacitors.

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8/ Aluminum electrolytic capacitors stored >1 year can result in increased DC leakage current. For applications that address this failure concern, 50% voltage derating and use 20°C below rated temperature applies.

A.3.2.1 Solid Tantalum Capacitors. Additional derating notes for solid tantalum capacitors are as follows:

a. For non-surge current tested capacitors only, charge and discharge currents shall be limited to a maximum of 1 amp for each capacitor. Non-surge current tested capacitors require approval of the procuring activity.

b. Surge Voltage. The applied surge voltage factor shall be 0.65. Surge voltage is defined as any voltage increase lasting less than 1 millisecond with a duty factor less than 10%.

c. Transient Voltage. Applied transient voltages factor shall be 0.8. Transient voltage is defined as any voltage increase lasting less than 100 µs with a duty factor less than 5%.

d. Reverse Voltage. The applied reverse voltage shall not exceed 1.5% of the rated voltage.

e. RMS Current. RMS current shall be limited so that the power generated does not exceed 80% of the rated power. Calculate power generated as follows:

(1) $I_{RMS} \leq (P/ESR)0.8$

(2) ESR is specified within the detail specification at 25°C, 100 kHz. To adjust ESR for fundamental frequency, consult vendor technical data sheets for ESR as a function of frequency or contact the procuring activity.

A.3.3 Crystals and Crystal Oscillators.

A.3.3.1 Crystals. Principal stress parameters are drive level, power dissipation, and operating temperature. Drive level shall not exceed 50% of specified maximum rating. Operating temperature shall be maintained within the manufacturer's specified operating temperature range.

A.3.3.2 Crystal Oscillators. Derating of crystal oscillators is accomplished by multiplying the parameter by the appropriate derating factor specified below in TABLE A-II.

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TABLE A-II. Crystal oscillator derating factors.

Critical Stress Parameters	Derating Factors
Supply Voltage 1/	0.80
Operating AC/DC Output Current or Fanout	0.80
Maximum Junction Temperature	40°C below the manufacturer's maximum rating

1/ Under no circumstances shall input voltage, if applicable, be allowed to exceed the supply voltage.

A.3.4 Diodes. Derating for diodes is accomplished by multiplying the critical stress parameter by the appropriate derating factor and by limiting junction temperatures as specified below in TABLE A-III.

TABLE A-III. Diode Derating Factors.

Diode Type	Critical Stress Parameter 2/	Derating Factor	Maximum Junction Temperature
Small Signal Switching, Rectifier, Power Schottky, Thyristors	Reverse Voltage	0.60	40°C below the manufacturer's rating
	Forward Current	0.5	
	Surge Current	0.5	
	Power	0.5	
Varactor, Varicap	Power	0.50	40°C below the manufacturer's rating
	Reverse Voltage	0.75	
	Forward Current	0.75	
Voltage Regulators	Power	0.50	40°C below the manufacturer's rating
	Zener Current	0.75	
Voltage Reference	Power	0.5	40°C below the manufacturer's rating
	Zener Current	1/	
Transient Absorption Zener, Transient Voltage Suppressor	Power Dissipation	0.50	40°C below the manufacturer's rating
	Average Current	0.60	
FET Current Regulator	Peak Operating Voltage	0.75	40°C below the manufacturer's rating
RF/Microwave Diodes			40°C below the manufacturer's rating
PIN, multiplier, Schottky, mixer, detector, Gunn, step recovery, tunnel	Power	0.50	
	Reverse Voltage	0.60	
	Forward Current	0.50	

1/ Operate at manufacturer's specified IZT to optimize temperature compensation.

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2/ Transient voltage and current rating in accordance with manufacturer's guidance.

A.3.5 EMI Filters. Lumped element or potted EMI Filters are derated by multiplying the critical stress parameter by the appropriate derating factor (see TABLE A-IV). Operating temperatures shall not exceed the specified maximum value (see TABLE A-IV). See A.3.6 herein for hybrid-based filter deratings.

TABLE A-IV. EMI filter derating factors.

Filter Type	Critical Stress Parameter	Derating Factor	Maximum Operating Temperature
ALL	Rated Current Rated Voltage	0.75 0.50	30°C below the manufacturer's maximum rating

A.3.6 Hybrids and Multi-Chip Modules. Unlike traditionally packaged electronic components, the hybrid or Multi-Chip Module (MCM) thermal environment for each application must be considered separately on its own merit. With failure rates being an exponential function of temperature for all electronic components, it is essential to perform an accurate thermal analysis to predict reliability of each component constituting the hybrid or MCM. Package density/mounting determines the thermal rise particular to the individual package design.

Derating of hybrid and MCM devices are accomplished by considering the most reliability-limiting element contained within the packaged device. All internal passive and active devices need to be considered separately by referring to the individual part sections within this document and obtaining the parts and radiation specialists' concurrences.

A.3.7 Magnetic Devices. Magnetic devices such as transformers, inductors and coils are derated by reducing operating temperature based on the insulation class used and by reducing maximum operating voltage, current, and temperature (see TABLE A-V).

TABLE A-V. Magnetic device derating factors.

Device Type	Critical Stress Parameter	Derating Factor	Maximum Operating Temperature 1/
ALL	Rated Current Rated Voltage	0.60 0.50	35°C below the manufacturer's maximum rating

1/ Maximum operating temperature equals ambient temperature plus temperature rise plus 10°C allowance for hot spots. This temperature should be below the derated operating temperature. Use MIL-PRF-27 for guidance.

A.3.8 Microcircuits. Derating of silicon microcircuits is accomplished by multiplying the critical stress parameter by the appropriate derating factor as shown in TABLE A-VI.

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TABLE A-VI. Microcircuit derating factors.

Critical Stress Parameters	Digital	Linear
Maximum Supply Voltage 1/	0.90	0.80
Recommended Supply Voltage 2/	+/- 5%	
Input Voltage	Input voltage shall not be allowed to exceed the supply voltage unless specifically approved by the procuring activity	0.70
Operating AC/DC Output Current or Fanout	0.80	
Power Dissipation	0.80	0.75
Maximum Junction Temperature	40°C below the manufacturer's maximum operating temperature rating	
Max. Operating Frequency	0.80	

1/ Use manufacturer's recommended operating conditions, but do not exceed 90% of maximum supply voltage for digital devices and 80% of maximum supply voltage for linear devices. For voltage regulators, derate VIN- VOUT to 0.9(VIN_{max} – VOUT).

2/ For low voltage (< 5V) devices, use manufacturer's recommended operating conditions.

A.3.9 Optoelectronic Devices. Derating is accomplished by multiplying the appropriate stress parameter by its derating factor and by limiting temperatures (see TABLE A-VII), such as junction for semiconductors.

TABLE A-VII. Optoelectronic device derating factors.

Device Type	Critical Stress Parameter	Derating Factor	Maximum Temperature
Light Emitting Diodes, Photo Diodes, & Photo Transistors	Power Dissipation	0.50	30°C below the manufacturer's maximum rating
	Forward Current	0.70	
	Voltage	0.70	
Laser Diodes	Power Dissipation	0.50	30°C below the manufacturer's maximum rating
	Forward Current	0.70	
Optocouplers 1/	Power Dissipation	0.50	30°C below the manufacturer's maximum rating
	Forward Current	0.70	
	Breakdown Voltage	0.70	

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Device Type	**Critical Stress Parameter**	**Derating Factor**	**Maximum Temperature**
Fiber Optic Cable	Bend radius, min.	2.00	Manufacturer's maximum rating
	Cable tension	0.50	
	Fiber tension proof	0.20	

1/ For optimum coupling efficiency, use manufacturers recommended operating conditions.

A.3.10 Protective Devices. Derating of protective devices such as fuses and circuit breaks is accomplished by multiplying the current rating by the appropriate derating factors specified below.

A.3.10.1 Fuses. Fuses require approval from the procuring activity.

Fuses are derated by applying the appropriate factors as shown in the derating table for cavity-style fuses (see TABLE A-VIII) and the derating curve for solid body styles. Fuse derating factors are based on data from fuses mounted on printed wiring boards (PWBs) with conformal coating and operating in a vacuum environment. For other types of mounting, consult the procuring activity for recommendations.

Derating of cavity style fuses allows for the potential loss of air pressure within the cavity over time. This reduces the filament cooling mechanism resulting in lower blow current ratings.

TABLE A-VIII. Fuse derating factors.

Derating Factor (Current)	**Temperature Derating**	**Voltage Derating**
0.5	Apply additional derating of 0.5%/°C for fuse body temperatures above 25°C	To prevent the occurrence of open circuit enduring arcs, open circuit voltage shall not exceed 50% of the fuse voltage rating.

A.3.10.2 Circuit Breakers. Derate circuit breakers by multiplying the current rating by the appropriate derating factor specified below in TABLE A-IX.

TABLE A-IX. Circuit breaker derating factors.

Contact Application	**Contact Current Derating Factor**	**Maximum Operating Temperature**
Resistive	0.75	
Capacitive	0.75 1/	
Inductive	0.40	

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Contact Application	Contact Current Derating Factor	Maximum Operating Temperature
Motor	0.20	20°C below maximum rated temperature
Filament	0.10	

1/ Use series resistance to ensure those circuits do not exceed the derated value.

A.3.11 RF and Microwave Devices. RF and microwave devices shall be derated by multiplying the critical stress parameter by the appropriate derating factor as shown in TABLE A-X unless otherwise specified. Some parts contain internal active or passive elements. Derating guidelines for internal elements shall be referred to within this document.

For "hybrid" (e.g., Microwave Integrated Circuit, Integrated Microwave Assembly) and "lumped element" type RF devices, derating shall apply to the constituent individual element parts and a table shall be produced detailing the derating of each item. Criteria shall be in accordance with the respective section of this document.

RF switches are subject to burnout in RF hot switching applications of moderate to high power levels. Hot switching is allowed only in low RF power applications (< +20dBm or 100mW) with the procuring activity concurrence.

TABLE A-X. RF and microwave devices derating factors.

Critical Stress Parameter	Derating Factor
RF Input Power Junction/Channel Temperature	0.70 40°C below maximum rating

A.3.12 Relays and Switches. Principal stress parameters for relays and switches are continuous contact current and temperature. Derating is accomplished by reducing maximum contact currents based on operating temperature, load conditions and power as shown in TABLE A-XI.

TABLE A-XI. Relays and switches derating factors.

Critical Stress Parameter 1/	Derating Factor
Contact Current 2/ 3/	0.75 (for Resistive Load) 0.75 (for Capacitive Load 0.40 (for Inductive Load) 0.20 (for Motor Load) 0.10 (for Lamp Filament Load)

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Critical Stress Parameter 1/	Derating Factor
Contact Power	0.50
Temperature	20°C below maximum rating

1/ Do not derate relay coil voltage or current. Operating at less than nominal coil voltage can result in switching failures and reduced relay reliability.

2/ For transient current surges, during switching, that exceed the maximum derated contact current, use the following derating criteria:

For $t \leq 10$ µs: $I_{SM} \leq 4 \times I_{DM}$

For $t > 10$ µs: $(I_{SM})^2 \times t \leq 16 \times (I_{DM})^2 \times 10^{-5}$ (A^2s)

Where: t = Period of time during which transient current

exceeds I_{DM} I_{SM} = Maximum surge current

allowed

I_{DM} = Maximum derated contact current

3/ Derate the rated resistive load limit by the listed derating factor for the type of load being switched.

A.3.13 Resistors. Resistors are derated by multiplying the resistor's maximum rated power and voltage by the appropriate power factor. This factor is also a function of the resistor maximum operating temperature as shown below in TABLE A-XII.

TABLE A-XII. Resistor derating factors. 1/

Resistor Type 4/	Description	Power Derating Factor	Derating Temperatures (°C)		Voltage Derating Factor 2/ 3/
			T1	T2	
RCR, RL	Fixed Film (MIL-PRF-22684), Fixed Carbon	0.60	70	106	0.7
RNC, RNR, RNN	Fixed Metal Film (MIL-PRF-55182)	0.60	125	155	0.7
RLR	Fixed Film, Insulated (MIL-PRF-39017)	0.60	70	118	0.7
RBR	Fixed Wire Wound, Accurate (MIL-PRF-39005)				
1.0%		0.6	125	137	0.7
0.5%		0.35	125	132	0.7
0.1%		0.25	125	130	0.7
RTR	Variable, Wire Wound (MIL-PRF-39015)	0.55	85	124	0.7
RWR	Fixed Wire Wound, Power (MIL-PRF-39007)	0.60	25	160	0.7
RER	Fixed Wire Wound, Power, Chassis Mount (MIL-PRF-39009)	0.50	25	160	0.7

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Resistor Type 4/	Description	Power Derating Factor	Derating Temperatures (°C)		Voltage Derating Factor 2/ 3/
			T1	T2	
RZO	Fixed Film, Networks (MIL-PRF-83401)	0.55	70	103	0.7
RM	Fixed Film, Chip (MIL-PRF-55342)	0.55	70	118	0.7

1/ For all resistor types at operating temperatures ≤ T1, multiply nominal power rating by the appropriate power factor. For operation above T1, derate linearly from the T1 power level to the zero power level at T2.

2/ Maximum applied voltage shall not exceed 70% of maximum rated voltage. Where no maximum voltage is specified, applied voltage shall be limited to $0.7\sqrt{PR}$ where P is the maximum rated power in Watts and R is nominal resistance in ohms.

3/ This voltage derating applies to DC and regular waveform AC applications. For pulse and other irregular waveforms consult the applicable the procuring activity.

4/ The derating criteria applies to capacitors with construction equivalent to the cited military specifications. For applications requiring the use of devices with different construction consult with the procuring activity for applicable derating criteria.

A.3.14 Thermistors. This derating criteria applies to positive temperature coefficient (PTC) and negative temperature coefficient (NTC) thermistors. Critical stress parameters for thermistors are power dissipation and operating temperature. Derate power to 50% of maximum rated power at a given temperature. Note that maximum rated power is defined as the maximum power the thermistor can dissipate for an extended period of time and still maintain acceptable stability of its characteristics.

A.3.15 Transistors. Derating for transistors is accomplished by multiplying the critical stress parameter by the appropriate derating factor and by limiting junction and channel temperatures as shown below in TABLE A-XIII.

TABLE A-XIII. Transistor derating factors.

Transistor Type	Critical Stress Parameter	Derating Factor	Maximum Junction/Channel Temperature
Bipolar	Power Dissipation	0.60	40°C below the manufacturer's maximum rating
	Breakdown Voltage 1/	0.60	
	Collector Current	0.60	
Field Effect Junction	Power Dissipation	0.60	
	Breakdown Voltage 1/	0.60	

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Transistor Type	Critical Stress Parameter	Derating Factor	Maximum Junction/Channel Temperature
Metal-Oxide-Semiconductor	Current	0.60	40°C below the manufacturer's maximum rating
GaAs	Power Dissipation	0.60	30°C below the manufacturer's maximum rating
	Voltage 1/	0.60	
	Reverse Current	0.60	
	Forward Current	0.80	

1/ Voltage derating factor applies to worst-case combination of DC, AC and transient voltages.

A.3.16 Connectors, Wire, and Cable. Derating for connectors, wire, and cable is accomplished by reducing current, voltage, and temperature stress as shown in TABLE A-XIV. For connectors, the design shall observe limits on the individual contacts and the entire connector. For wire and cable, SAE AS50881 provides derating requirements.

TABLE A-XIV. Connector derating factors.

Critical Stress Parameter 1/	Derating Factor
Current	0.75
Voltage	0.75
Temperature	30°C below maximum rating

1/ Use within manufacturer's ratings. Normally, only a percentage of individual contacts may be used at their maximum current rating without exceeding the connector's overall rating. Consult the part manufacturer for guidance.

A.3.17 Mechanical Parts. Mechanical parts shall not be exposed to stresses that exceed 25% of the yield strength. Fatigue life for the application stress and strain shall be four times the expected life in the application consistent with the system reliability requirements.

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COTS MANAGEMENT

B.1 SCOPE

B.1.1 Scope. This appendix provides the processes to ensure that COTS assemblies meet system requirements. For the purposes of this document, COTS assemblies include items such as printed wiring assemblies/circuit card assemblies (such as single board computers), relays, disk drives, LCD matrices, servers, printers, laptop computers, etc.

The use of COTS assemblies includes the following steps, (1) review and understand the design, internal parts, materials, configuration control, and qualification methods of all "as-received" COTS assemblies, and their capabilities with respect to their application in the System; (2) identify risks, and where necessary, (3) take additional action to mitigate the risks associated with the performance and reliability of the COTS assembly in the system.

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

B.2 REQUIREMENTS.

B.2.1 Requirements. The requirements of this appendix apply to all COTS assemblies integrated into the system, whether the COTS assembly is obtained from the COTS assembly manufacturer, a distributor, or other supplier or subcontractor. All COTS assemblies shall meet the allocated functional performance and reliability requirements to meet the system requirements. Any COTS selection and acceptance process shall address these four steps:

a. Define requirements for the COTS item allocated from system requirements for each application.

(1) Identify and select candidate COTS items with potential to meet allocated requirements based on analysis and test.

(2) Perform a qualification test to verify the products meet application requirements.

(3) Approve and procure only those products for system use that meet all application requirements.

An overview of the COTS management process is shown in FIGURE B-1. The design activity shall write the COTS product selection, evaluation, qualification, and production acceptance plans and conduct product selection and testing. The procuring activity shall review the product

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qualification and production acceptance plans in addition to the selection and testing results to determine acceptance status.

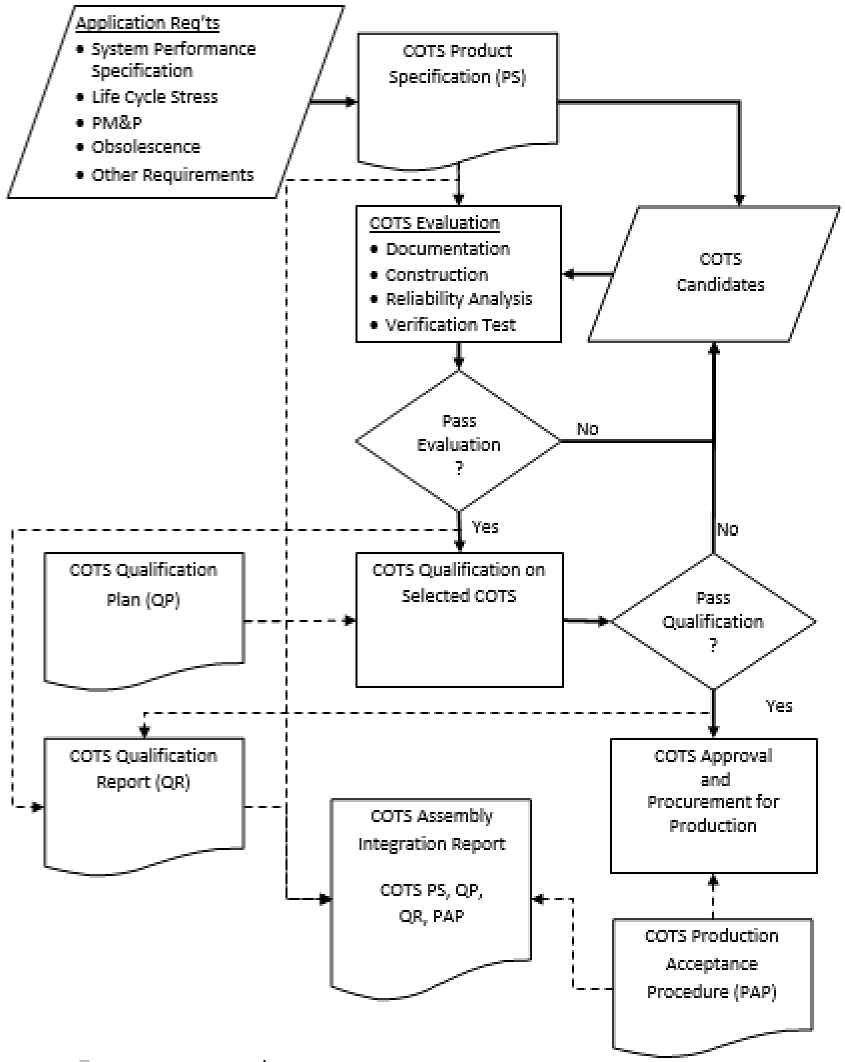

FIGURE B-1. COTS management process.

B.2.2 COTS Requirements Definition. The design activity shall define and document the COTS product performance requirements consistent with the Performance Specification of the system, other applicable specifications, requirements and management plans, and as specified herein.

B.2.2.1 Requirements Documentation. The COTS product requirements shall be documented in a Product Specification (PS) maintained under configuration control. The COTS product requirements shall identify all the necessary attributes to ensure meeting system requirements including operational, performance, environmental, reliability, maintenance, support, configuration, and system effectiveness requirements for the given product application

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allocated from the Performance Specification of the system. Where necessary, the requirements are expanded or derived to encompass the specifications provided by the COTS suppliers.

To meet the reliability and other performance requirements of the system requires sufficient product design disclosure and configuration management to allow complete design verification and product support. Determination of the amount of required disclosure shall be established prior to the start of the product identification in B.2.3, and be based on the product type and intended application.

B.2.2.2 Life Cycle Application Stress Requirements. The PS for COTS items shall address the entire system life cycle and include suitable verification methods, including testing that represents the life cycle for the particular application.

B.2.2.3 Obsolescence Management. The COTS product shall be managed in accordance with the Obsolescence Management Plan.

B.2.2.4 Counterfeit Prevention. The COTS manufacturer and supplier shall meet the requirements of the Counterfeit Prevention Plan.

B.2.3 COTS Candidate Identification and Selection. The supplier specification and data for candidate COTS items shall be compared to the documented product requirements, including the PS. Candidate COTS that do not meet all critical requirements shall not be considered for selection. A final list of the most highly rated candidates is then generated based on requirement compliance, cost, and schedule.

The COTS selection shall be supported by analysis and test. Compliance results obtained from the supplier and design activity evaluation will be used to determine design margin and if additional mitigation and/or requirement modifications are required for the selected product. Testing beyond the requirements to determine the amount of design margin may be required due the small number of units being tested to help reduce the risk of qualification failures performed in B.2.4.

B.2.3.1 COTS Candidate Design Evaluation. The candidate design evaluation is performed on the top candidates based on the initial evaluation results. The evaluation consists of documentation analysis, data analysis, and testing to determine if the candidate product meets the product requirements. Failure to meet the requirements may require additional design mitigation, product modification, and/or requirement modification. The candidate product will be tested to assess compliance to product requirements.

Design evaluation shall be performed on the candidate product prior to final selection to determine the hardware's compliance to the product requirements. The evaluation shall use the

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appropriate method for verification such as test, inspection, demonstration, and/or analysis. Environmental testing during evaluation is recommended to minimize unforeseen product modifications and/or mitigation during the qualification effort. If design evaluation data are to be used to fulfill qualification test requirements, then the procedures defined in B.2.4 shall be followed. The design activity is responsible for developing an evaluation test plan and conducting the evaluation testing.

The evaluation product shall be fabricated using methods and procedures used for the standard production of the product that would be used in production.

B.2.3.1.1 Documentation Audit. An audit and review of COTS supplier application and design documentation shall be performed to verify that product documentation is sufficient to support subsystem development and integration of the products. Supplier documentation shall include the hardware, software, and firmware documentation necessary to sufficiently allow for design verification and product support. Non-disclosure agreements (NDAs) may be required to obtain supplier data.

B.2.3.1.1.1 Hardware Documentation. Supplier documentation shall be provided for hardware to allow for design verification and product support.

a. Functional overview which describes how the product meets requirements.

b. Functional block diagram and detailed description for the operation of the product in the system.

c. Product electrical and mechanical interface description, including items such as input/output (I/O) pin characteristics and signal description, unit loads, timing diagrams, and signal source and destination, as well as mechanical interfaces.

d. Product application notes and restrictions.

e. Product power and thermal requirements.

f. Product physical description.

g. Schematics.

h. Parts list: The evaluation hardware can be used to generate a parts list if the supplier's parts list is not initially available.

i. Product materials.

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j. Assembly drawing.

k. Printed wiring board drawing.

l. Reliability prediction.

m. Environmental conditions ratings.

n. Warranties.

B.2.3.1.1.2 Product Resident Software Program Documentation. Supplier documentation shall be provided for software to allow for design verification and product support.

a. Source code.

b. Object codes.

c. Firmware. A complete design disclosure package for firmware including Built In Test Executive (BITE)

B.2.3.1.1.3 Parts List Audit. An audit shall be held to review the supplier's parts list for component quality, to identify critical/problem parts, and to assess the level of adherence to the PM&P Management Plan (PMP), including the problem and Prohibited PM&P list.

B.2.3.1.2 Product Construction Assessment. The product construction shall be reviewed for capability to meet the system requirements. The COTS product shall comply with the requirements of the Lead-Free Control Plan and the PMP, including the problem and Prohibited PM&P list. The assessment will be used to determine the feasibility of compliance to the specified environmental requirements prior to actual qualification testing.

B.2.3.1.3 Reliability Analysis. A reliability analysis of each product shall be performed based on the application life cycle stresses. Actual field reliability data or accelerated life testing data can also be used to determine the product reliability in the application. The COTS product shall meet the derating requirements.

B.2.3.1.4 COTS Candidate Test Evaluation. The COTS product shall undergo suitable testing to indicate minimal risk of failing the Qualification requirements of B.2.4, and to determine any required risk mitigations for implementation on qualification products.

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B.2.3.1.5 COTS Product Selection. The design evaluation results are graded for compliance to the list of product specification requirements. Products that do not meet all of the critical requirements during the evaluation are no longer considered. Remaining products are then rated based on compliance to the requirements that are categorized as mitigatable. The output is a list of candidate products that meet all critical product requirements. Using this list, a top candidate is selected based on requirement conformance, evaluation test results, supplier selection criteria, cost, and schedule. Only the top candidate proceeds to the Qualification Phase, unless qualification of alternate products or second sources is required. Selection to a single product shall be completed during a review with the procuring activity. Product selection status shall be reported at the Preliminary Design Review (PDR) and Critical Design Review (CDR).

B.2.4 COTS Qualification. Product qualification testing verifies that the selected product, including the baseline configuration, all necessary modifications, and mitigation, meets all the associated program requirements documented in the PS. The qualification approach shall be documented in a Qualification Plan (QP), approved by the procuring activity, and in accordance with B.2.6.2 that includes sufficient product verification tests and analyses to confirm that the selected COTS product meets all requirements. Generally, only the selected product will be qualified unless second sources are required or desired. Testing results obtained during the COTS Evaluation of B.2.3 may be used to fulfill the qualification test requirements provided that the requirements identified in the COTS Qualification of B.2.4 are met. The product is approved for use after successful completion of the qualification testing and approval of the Qualification Report (QR) by the procuring activity.

B.2.4.1 Use of COTS Evaluation Results. Product qualification testing shall use, to the greatest extent possible, the testing and test results performed during the product design evaluation of B.2.3, provided that the following test requirements shown below in (a)-(f) are performed.

Qualification testing shall be required for the final configuration of the product that includes any modifications. Mitigation designs shall be accepted at the next level of testing. The product does not require qualification testing before modifications are made. The design activity is responsible for developing the qualification test plan and conducting qualification testing. The procuring activity shall review and approve the qualification test plan. Procuring activity authorization shall be required to begin qualification testing.

Qualification test results shall be included in the Product QR. The procuring activity concurrence shall be made by approval of the final Product QP and QR.

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The following shall be performed to allow use of evaluation data to fulfill the qualification test requirements:

a. A copy of the program test plan is provided to the procuring activity prior to the start of testing. This can be accomplished with the Test and Evaluation Master Plan (TEMP) and the Hardware Configuration Item test plans. The intent is to define what tests will be performed to what requirements. The procuring activity will review and comment on the plan, but concurrence is not required to begin evaluation testing.

b. Test configuration shall be recorded with regard to hardware, software, and firmware at the time of test.

c. Qualification test levels, information, results, design, test setup, changes, and conclusions shall be recorded in an Engineering log book or equivalent.

d. In the event of an environmental test failure, as defined by normal qualification test rules, the procuring activity concurrence is required to continue with an evaluation test and the information shall be reported to the procuring activity if the testing is desired to be used for qualification requirement fulfillment. Incomplete data exchange or non- concurrence at this point can be the single point for denial of data re-use.

e. Data and overall test results accumulated during evaluation testing shall be discussed with the procuring activity at the conclusion of testing or prior to the start of qualification testing if the data are to be used for qualification fulfillment. The data and results shall then be documented in the qualification Test Plan/Report when the data are used to fulfill the qualification requirements by means of analysis using the evaluation data. The analysis shall also address any differences between the configuration as tested and the production release baseline.

f. The procuring activity reserves the right to call for regression or repeat testing within the program plan.

B.2.4.2 Corrective Action. In the event of a failure experienced during qualification test or analysis, a detailed failure report shall be issued to a Failure Review Board (FRB) documenting the findings and corrective action. The FRB shall consist of individuals from the procuring activity and other required technical disciplines. Based on the nature of the failure, the corrective action shall be implemented within an agreed upon period of time. All performing organizations shall be notified. The FRB and the procuring activity have final approval for all corrective actions.

B.2.4.3 Physical Configuration Audit. A Physical Configuration Audit (PCA) shall be conducted prior to start of qualification testing to establish the configuration of the product and

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that all the associated documentation is complete and correct. The audit shall verify, but not be limited to, the correct identification, hardware and firmware revision, parts used, and quality level as defined by the product's assembly and/or procurement drawing. In the case of non-disclosed designs, the PCA conducted shall become the baseline configuration for the product. All subsequent procurements of this product shall be compared to this configuration to determine if qualification testing shall be repeated. For some COTS products, destructive assessment may be required on a sample to verify the configuration.

B.2.4.4 Functional Tests. Product functional tests shall target two areas of concern: (1) evaluation of supplier-specified capabilities and (2) relationships of external interfaces. The tests of the following sections B.2.4.4.1 and B.2.4.4.2 shall be required.

B.2.4.4.1 Supplier Specified Capabilities. The functional tests shall verify compliance of all supplier specified capabilities.

B.2.4.4.2 External Interfaces. Qualification of the external interfaces shall consist of verifying the critical electrical and timing relationships of all used external interfaces. Timing will be measured compared to the applicable specifications to determine the extent of compliance. Electrical characteristics (voltage levels, noise, reflections, crosstalk, etc.) shall be measured and verified.

B.2.4.5 Mechanical Tests. Mechanical tests shall be in accordance with the applicable requirements identified in the PS.

B.2.4.6 Qualification Verification Methods. Requirements can be verified by analysis, demonstration, test, and inspection. TABLE B-I identifies the recommended method of verification. The table contains a representation of the types of qualification test requirements that may apply. The list of required qualification tests for a given product shall be derived from the PS and documented in the Product QP.

TABLE B-I. Recommended verification methods for qualification tests.

Requirement	Verification Method
Physical Configuration Audit	Inspection
Supplier Specified Capabilities	Test
External Interfaces	Test
Power Dissipation	Test
Power Supply Margin	Test
BITE	Analysis
Durability	Analysis, Demonstration
Life	Test

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Requirement	Verification Method
Visual Inspection	Inspection
Materials	Test, Analysis, Inspection, Demonstration
Safety	Inspection
Temperature, Operating	Test
Temperature, Non-Operating	Test
Humidity	Test
Vibration	Test
Mechanical Shock	Test
Pressure/Altitude	Test
Electromagnetic Interference and Magnetic Fields	Test
Ambient Acoustic Noise	Inspection, Test
Structureborne Noise	Inspection, Test
Thermal Shock	Test
Inclination/Motion	Analysis

B.2.5 COTS Approval and Production Management. Upon successful completion of the QP and approval of the QR by the procuring activity, the COTS product is approved for production use when the product meets the requirements of the Production Acceptance Procedure (PAP). The COTS product configuration that successfully completed the QP requirements represents the Production Qualified Baseline. The PAP shall include procurement requirements, incoming inspection, performance testing, stress screening, and life cycle management, and shall require the procuring activity approval.

B.2.5.1 COTS Production Procurement. The procurement requirements specified by contract or purchase order shall ensure compliance with the PAP and shall address Counterfeit Prevention in accordance with the Counterfeit Prevention Plan.

Products purchased as spares require the same level of acceptance testing prior to being submitted to the supply system to provide assurance that the spares will function properly when installed in the final application.

B.2.5.2 Incoming Inspection. Upon receipt of products the following shall be performed:

a. Configuration verification shall be performed to ensure product has been fabricated, tested, and inspected to the revision levels specified in the procurement contract. Change monitoring may require destructive physical analysis (DPA) of a

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small sample of units to ensure that the Qualification still applies to the delivered configuration.

b. Visual inspection shall be performed to verify product marking and keying in accordance with the applicable PS. Visual inspection shall be performed on a sample basis as defined in the contract or purchase order. Visual inspection shall not be required until completion of all modifications to the product is made. Only the modifications to the product approved by the procuring activity may be performed after the products are received from the product supplier.

c. Programmable device verification shall be performed on all programmable devices to ensure the devices are programmed to the specified revision. The verification is accomplished by examining the device marking and the electrical contents. Programmable read-only memory (PROM) shall be verified electrically by performing a PROM verify check. PROM verify compares each memory location and compares the data to the supplier disclosed data for the given device revision. Programmable logic devices (PLDs) shall be verified electrically by performing functional testing at the product level.

d. Final functional and DC parametric tests shall be performed to ensure the products are functioning properly after completion of all required modifications to the product. Testing is dependent upon the extent of the modifications.

Refer to Appendix H for more information on incoming inspection.

B.2.5.3 COTS Performance Acceptance Testing. The COTS Performance Acceptance Testing (PAT) shall be performed on all of the products and consists of product testing performed by the COTS manufacturer, and any additional product testing performed by the design activity or third party test facility to ensure meeting system requirements.

When all performance testing is to be performed by the COTS manufacturer, Government Source Inspection may be required to ensure system performance.

B.2.5.4 Environmental Stress Screening. The requirement to perform environmental stress screening (ESS) on all of the products purchased for production shall be based upon program requirements, and product failure and change history, to ensure product quality, by precipitating defects introduced into the product by faulty components and the manufacturing process. ESS can be performed by the product supplier, the design activity, or another test facility. The procuring activity shall approve the ESS requirements prior to testing. Electronic COTS items typically require temperature cycling and vibration screens.

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B.2.5.5 COTS Product Assurance and Life Cycle Management. The products shall meet the requirements of the Quality Program Plan and Obsolescence Management Plan. The PAP shall include change control imposed in the procurement requirements of B.2.5.1, or change monitoring in B.2.5.2, to ensure that changes to the Qualified Production Baseline do not affect system performance.

B.2.6 COTS Documentation. Upon completion of product qualification, a COTS Assembly Integration Report (CAIR) shall be prepared for each COTS application and include the PS, QP, QR, and PAP. The CAIR shall include application information including hardware and software interfaces and shall be sufficient to allow the product to be incorporated into the system. The CAIR shall also include user notes and restrictions as defined from the product evaluation and qualification phases.

B.2.6.1 COTS Product Specification. A product Source Control Drawing or Specification Control Drawing (SCD) shall be generated for each COTS product and application type. Determination to generate a Source Control Drawing versus a SCD is dependent on product type and product uniqueness. Products that can be interchanged without system impact will be procured using a SCD. Products that are unique and cannot be exchanged will be procured using a Source Control Drawing. The SCD shall reference the specific PS.

The SCD need not duplicate information and/or requirements defined in the PS but shall be sufficient to verify delivered products are identical to those defined by the Product Procurement Baseline including subsequent controlled changes. The appropriate supplier(s) along with the commercial part/catalog number shall be defined. The SCD shall also define any alterations/modifications to the catalog item that will be performed to the product by the supplier prior to delivery. Modifications to the product made after receipt of the product shall be documented in a separate modification drawing.

B.2.6.2 COTS Product Qualification Plan. A QP and Procedure shall be written for each COTS product requiring qualification. The document shall include all test requirements and procedures. The QP and Procedure shall be generated using the requirements specified in the PS, which is generated from the product requirements list and any required subsequent changes.

B.2.6.3 Product Qualification Report. A Product QR shall be prepared and issued for each product type, which documents the qualification test results and compliance to the QP. Corrective action for any qualification failures will be identified in the report and a follow-up report of the closed-out action items shall be appended to the original Product QR upon completion. The complete Product QR shall then be submitted to the procuring activity for approval, which constitutes product acceptance for program use.

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B.2.6.4 Production Acceptance Procedure. A PAP in accordance with B.2.5 shall be prepared and implemented for each product, and address requirements differences for different applications of the same COTS product.

B.3 COTS ACCELERATED LIFE TESTING REQUIREMENTS

B.3.1 Accelerated Life Testing. Accelerated life testing provides a methodology for assessing product reliability within reasonable test times to ensure meeting system requirements and identify needed design and process corrective actions. Accelerated testing includes exposure to stresses that represent the life cycle stresses from manufacturing and integration, storage, transportation, field handling, and use. The test stresses shall not exceed the system specification environmental limits except where justified by physics of failure analysis.

Temperature cycling, temperature storage, vibration, shock, power cycling, and humidity represent the most common stresses applicable to electronic equipment. Other COTS item types may have other critical life cycle stresses, as addressed by the Performance Specification of the system.

An accelerated test flow is shown in FIGURE B-2 to represent the life cycle profile for electronics to serve as the baseline test to assess reliability.

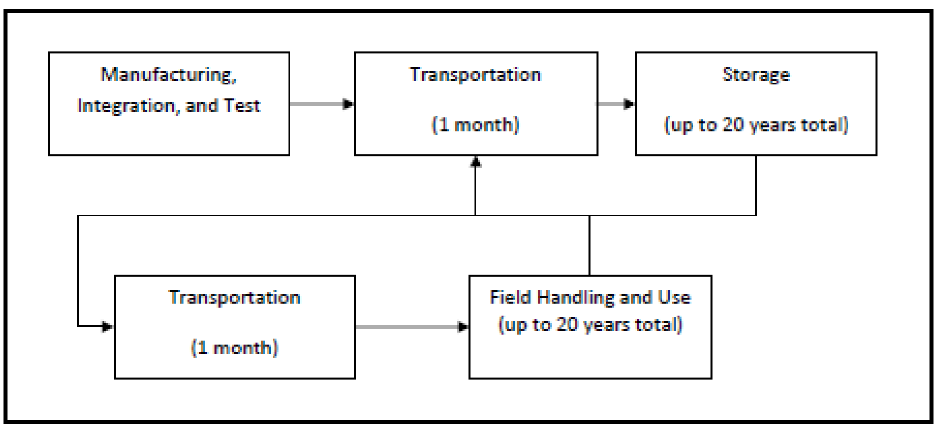

FIGURE B-2. Example of system life cycle.

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PROHIBITED PM&P

C.1 SCOPE

C.1.1 Scope. This appendix defines the parts, materials, and processes (PM&P) that are considered to be reliability suspect, have limited application, involve restricted or special controls, or are otherwise unacceptable for use in aerospace and defense electronic hardware and associated mechanical hardware.

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

C.1.2 Intended Use. This appendix establishes a baseline for suspect selection, design, and application practices proposed for use within aerospace and defense electronic and associated mechanical hardware. All PM&P shall meet the requirements herein unless otherwise approved by the procuring activity or their designated representative prior to use in hardware manufacture/assembly. Deviations (i.e. all PM&P that do not meet the requirements herein) shall be identified in writing, and submitted for evaluation and approval in a manner as agreed to by the Government, and may be granted specifically for the intended application only. Proposed deviations will be evaluated in light of the current state of technology of the part, material, or process and the intended system application. Evaluation and implementation shall be performed to ensure all requirements are met.

C.1.3 General Notes.

C.1.3.1 Part/component. The term component is used interchangeably with the term part.

C.1.3.2 Government/customer. Unless otherwise designated by contract, the term customer is interchangeable with the term Government. The term customer used herein refers to the Government procuring activity.

C.1.3.3 Rationale. The term rationale refers to the justification evolved from lessons learned through actual application in DoD and other high reliability systems to identify a part, material, or process as a Prohibited PM&P.

C.2 PROHIBITED PARTS REQUIREMENTS

C.2.1 Prohibited Part Specifications and Pedigree. For the purposes of this document the term part refers to any electronic part (includes electrical, electromagnetic, electromechanical, and electro-optical (EEEE) parts) and associated mechanical parts.

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C.2.1.1 Use of Prohibited Materials. Any part with prohibited materials used in their construction.

Rationale: Prohibited materials pose a significant risk of failing to meet the system requirements without qualification data to support use in the intended system application.

C.2.1.2 Outside Vendor's Specifications. Parts and materials used outside of the vendor's specifications for the specific part or material (minimum temperature, maximum voltage, etc.).

Rationale: Parts used outside of a vendor's specification can be a high reliability/performance risk if not characterized properly. Use SAE EIA-STD-4899 for guidance. Complex devices may be very difficult to characterize and manage due to manufacturer non-disclosure agreements (NDAs).

C.2.1.3 Unqualified Parts. Parts not qualified for intended system application life cycle environmental stress and duty cycle requirements.

Rationale: Parts without qualification data to support use in the intended system application pose a significant risk of failing to meet the system requirements.

C.2.1.4 Non-OEM/OCM/Franchised Distributor Parts. Parts procured from a source other than the original equipment manufacturer (OEM), original component manufacturer (OCM), or its franchised/authorized distributor without a Government approved process. The Government approved process shall include an OEM certificate of conformance (C of C) and/or certificate of analysis (CoA). The Government approved process shall include requirements for participating in the Government-Industry Data Exchange Program (GIDEP) including submission of counterfeit information to the customer and/or the GIDEP agency. The Government approved process shall consider FAR clauses 27.201- 2(b), 32.1009, and 33.209, DFAR 252.246-7003, FAR 52.203-13, FAR 52.211-5 and the FY12 National Defense Authorization Act (NDAA). Any part whose identity or pedigree has been deliberately altered, misrepresented, or offered as an unauthorized product substitution is considered a counterfeit part/non-conforming product.

Rationale: Counterfeit items are widespread and difficult to detect, procuring from franchise distributors minimizes counterfeit component and material procurement. Most counterfeit parts have performance, workmanship, or reliability issues. Additionally, the potential exists for receiving parts with unknown histories and/or storage or handling conditions such as failed, rejected or scrapped parts, electrostatic discharge (ESD) damaged parts, or used parts.

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References for counterfeit avoidance process developments include SAE AS5553, IDEA-STD- 1010, and SAE TB-0003 (Counterfeit Parts & Materials Risk Mitigation).

C.2.1.5 Reused, Reinstalled, Recycled, Reattached, or Salvaged Parts. Reused, reinstalled, recycled, reattached, or salvaged parts without a Government approved process. Parts previously installed or otherwise attached to another assembly are considered used and not new.

Rationale: Reused, reinstalled, recycled, reattached, or salvaged parts can result in new failure modes and/or latent failure conditions introduced, part/assembly life shortened, an unknown and difficult to determine overall reliability. Mechanical fasteners pose a special risk due to the ease of removal and reinstallation. The Government approved process shall consider FAR clause 52.211-5.

C.2.1.6 Parts with Date Codes Over 5 Years Old. Parts with date codes more than 5 years old at the time of assembly without a Government approved process.

Rationale: Depending on construction, handling, and storage, parts can become unsolderable, contaminated, damaged, and otherwise degraded. Recertification can eliminate most concerns of damage issues associated with long-term handling and storage. Recertification can provide baseline properties for reliability forecasting.

C.2.2 Prohibited Microcircuits and Semiconductors.

C.2.2.1 Microcircuits. Microcircuits not equivalent to or better than MIL- PRF-38535 Class M, B, or Q standard microcircuit drawing (SMD); MIL-PRF-38534 Class H SMD; or AEC-Q100.

Rationale: Microcircuits shall utilize known standards as much as possible. Other industry standards, such as aerospace or telecommunications, may be considered equivalent depending on the application and subject to customer agreement.

C.2.2.2 Non-Hermetic Microcircuits and Semiconductors. Non-hermetic microcircuits, semiconductors, RF devices, and microwave devices without a Government approved selection, qualification, and control process. Non-hermetic devices include plastic encapsulated microcircuits (PEMs) as well as vented component packages.

Rationale: Most non-hermetic parts are commercial/industrial grade and vary widely in construction, quality, and reliability and change without notice. Many non-hermetic devices are not intended for high reliability applications like aerospace, medical, or military and can present a reliability risk. PEMs devices with a moisture sensitivity level (MSL) of 4 or higher are susceptible to moisture ingress during manufacturing and can lead to reduced reliability. Large

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integrated circuit components with vented packages allow cleaning residue to enter the die cavity leading to corrosion issues.

C.2.2.3 Discrete Semiconductors. Discrete semiconductors not equivalent to or better than MIL-PRF-19500 JANTX quality level or AEC-Q101.

Rationale: These components shall utilize known standards as much as possible. Other industry standards, such as aerospace or telecommunications, may be considered equivalent depending on the application and subject to customer agreement.

C.2.2.4 Selenium Rectifiers. Use of selenium rectifiers.

Rationale: These components have known degradation and reliability concerns.

C.2.2.5 Discrete Diodes. Discrete diodes that do not meet MIL-PRF-19500 Category I metallurgical bond or equivalent metallurgical bonded-thermally matched with double plug construction; diodes that contain point-contact (whisker) wire conductors; or diodes with plated silver button contacts.

Rationale: Metallurgical bonding is a more robust bonding method. Coefficient of thermal expansion (CTE) issues may arise if not thermally matched.

C.2.3 Prohibited Passive Electrical Components.

C.2.3.1 Non-High Reliability Passive Components. Passive components with failure rate level greater than 0.1% per 1000 hours or not manufactured for high reliability applications.

Rationale: Supplier quality and device reliability are generally unacceptable. Passives intended for medical, military, aerospace, and automotive applications are candidates when failure rate data are not known, and are subject to Government approval.

C.2.3.2 Silver Case Wet Slug Tantalum Capacitors. Use of silver case wet slug tantalum capacitors.

Rationale: Cannot tolerate reverse voltage very well. Silver electroplating from the case onto and beneath the oxide layer increases current leakage paths, resulting in increased dissipation and internal heat rise, liberation of gasses, and catastrophic failure. The formulation of hydrogen and oxygen gasses at the electrodes creates excessive internal pressure, and can result in electrolyte leakage or bursting of the case. Note: Tantalum cased capacitors may be used, but shall be per MIL-PRF-39006/22 and MIL-PRF-39006/25.

C.2.3.3 Aluminum Electrolytic Capacitors. Use of aluminum electrolytic capacitors.

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Rationale: Elastomer seal allows evaporation of electrolyte under long term storage or use conditions resulting in degradation of part. Use at high altitude or in a vacuum accelerates electrolyte evaporation. Non-hermetic construction makes parts susceptible to corrosion from some printed wiring board (PWB) cleaning agents. Excessive ripple current causes heating, which accelerates evaporation of electrolyte.

C.2.3.4 Plastic Film Capacitors. Use of non-hermetically sealed plastic film capacitors.

Rationale: Susceptible to insulation resistance failure from moisture introduced in humid environments or by PWB cleaning processes.

C.2.3.5 Polyester Capacitors. Use of polyester capacitors.

Rationale: In extended charge and elevated temperatures, polyester capacitors have been shown to be prone to material breakdown under steady state DC and at high temperatures (i.e. 80°C or higher).

C.2.3.6 Carbon Composition Resistors. Use of carbon composition resistors.

Rationale: They readily absorb moisture and the value increase significantly. If the procuring activity authorizes use, only use MIL-SPEC established failure rate levels R or S and in very dry conditions.

C.2.3.7 Resistors using Nichrome Film Elements. Use of resistors using Nichrome film elements.

Rationale: They are susceptible to corrosion/dissolution when operated under humid conditions causing large increases in resistance values or open circuit failures. If the procuring activity authorizes use, care shall be taken during handling, storage, and PWB assembly so as not to compromise the integrity of the outside coating.

C.2.3.8 Ceramic Capacitors with Piezoelectric Output. Ceramic capacitors with excessive piezoelectric output error that affects circuit function.

Rationale: Strain on ceramic capacitors can create piezoelectric outputs that prevent proper circuit performance. Mitigations reducing these effects, such as using BP dielectric (e.g., in place of more sensitive BX), strain reducing leads, and lower length-to-width ratio, can allow their use.

C.2.4 Prohibited General Parts.

C.2.4.1 Circuit Protection Fuses. Use of circuit protection fuses.

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Rationale: Circuit protection fuses pose reliability and maintenance concerns. Trip-free circuit breakers (with arc/noise protection for semiconductor devices) and semiconductor/passive protection schemes are preferred.

C.2.4.2 Vacuum Tubes. Use of vacuum tubes.

Rationale: Vacuum tubes pose reliability and maintenance concerns. In most applications, semiconductors are more reliable. In some applications, exceptions can include cathode ray tubes or application-specific qualified traveling-wave tubes with customer approval.

C.2.4.3 Disc Crystals. Crystals without adequate mounting support. Disc crystals, including those in oscillators, with fewer than four-point mounts.

Rationale: Two- and three-point mount disc crystals are inadequate for military vibration and shock requirements. Cantilevered (“diving board”) rectangular crystals are discouraged.

C.2.4.4 Relays. Reed relays, relays that are not hermetically sealed, or relays that are not solid state.

Rationale: Reed relays incur differentials of CTE in materials which may lead to fracturing of the switches under temperature cycling inherent in military applications. Prohibition of reed relays dates back to the early 1970’s due to the poor reliability reputation of these parts at that time. Non-hermetic relays are not preferred for military applications due to the introduction of contaminants and moisture. For non-solid state rationale, see mechanized switches.

C.2.4.5 Mechanically Adjustable Devices. Mechanically adjustable (variable) devices including capacitors, resistors, and magnetic devices where the value is intended to be fixed in the application.

Rationale: Mechanically adjustable parts are subject to contamination, oxidation, etc, resulting in catastrophic failure or parametric changes such as resistance drift. Designs requiring variations due to manufacturing or interface differences shall use fixed-value (select on test) parts when the needed parameter is determined. Staking may reduce risk.

C.2.5 Prohibited Electromechanical and Mechanical Components.

C.2.5.1 Slide-On or Snap-On BNC Connectors. Use of slide-on and snap-on BNC connectors.

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Rationale: Slide-on and snap-on BNC connectors are at risk for coupling integrity during severe environments in addition to concerns for moisture and mechanical wear. Twist lock BNC connectors are acceptable for use.

C.2.5.2 Locking Devices. Fiber inserts, sheet spring nuts, and sheet spring washers as locking devices (includes lock washers).

Rationale: These types of locking devices pose vibration risks and shape retention issues for long-term reliability.

C.2.5.3 Lock Washers. Use of lock washers.

Rationale: Lock washers can generate metal shavings when secured. Reduce the possibility of metal shavings being generated or distributed in the system. Split type or star type shall not be used as locking devices. By "biting" into the surface, they often damage it and create debris. In addition, their overall effectiveness is poor.

C.2.5.4 Miniature Switches or Connectors. Miniature switches or connectors not environmentally protected and/or encapsulated.

Rationale: Not environmentally protecting and/or encapsulating the device can lead to introduction of contaminants during the PWB cleaning processes, coating procedures, storage, etc.

C.2.5.5 Mechanized Switches. Use of mechanized switches.

Rationale: Mechanized switches are generally a high failure rate item. Many switch internal mechanisms not proven for long-term reliable operation. These types of switches are subject to moisture and contamination ingestion leading to failures (shorts, opens, high resistance, etc.). Contact oxidation can cause intermittent operation. Hot spot heating, arcing, and mechanical wear (fretting), all of which can lead to excessive oxidation, unreliable operation, and switch failure. Note: For some applications, special lubricants may provide an acceptable mitigation.

C.2.5.6 Cinch, Compression, or Spring Style Connectors. Use of cinch, compression, or spring style connectors.

Rationale: The use of these style connectors can result in contamination and foreign object issues. There is concern with long-term robustness of spring and/or compression style materials and contact function.

C.2.5.7 Unkeyed Multi-Pin Connectors. Use of unkeyed multi-pin connectors.

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Rationale: Unkeyed multi-pin connectors can result in production issues and/or potential hardware damage in assembly. Maintenance issues for external ground connections.

C.2.5.8 Non-Gold Plated Contact Electrical Connectors. Use of electrical connectors with contacts/pins that are not gold plated.

Rationale: Other electrical connector contact/pin finishes are very susceptible to tarnish and oxidation. See also the requirements for gold plating herein.

C.2.6 Prohibited Component Package Types.

C.2.6.1 Open Type Magnetic Devices. Open type magnetic devices such as exposed core, coils, wire, and/or internal elements not environmentally protected or encapsulated or both.

Rationale: Open type magnetic devices are susceptible to possible introduction of corrosive contamination during PWB cleaning operations, mechanical stresses during PWB assembly, damage to windings and posts if not protected, and long-term moisture/contamination intrusion.

C.2.6.2 Sockets and Socketed Devices. Sockets and socketed devices for electronic devices, such as relays, integrated circuits, and discrete semiconductors. Includes printed wiring assembly (PWA) level slide-on or press-fit terminations.

Rationale: Sockets and socketed devices result in inadequate retention of parts leading to possible intermittent contact in shock and vibration environments. Sockets in general are subject to oxidation between the leads and socket contacts ("fretting"). For some ground applications, lubricants may provide an acceptable mitigation. Not intended to cover PWB connectors or cable connectors.

C.3 PROHIBITED MATERIALS REQUIREMENTS

C.3.1 Prohibited Material Specification Specifications and Pedigree.

C.3.1.1 Outside Vendor's Specifications. Materials used outside of the vendor's specifications for the specific part or material (minimum temperature, coefficient of thermal expansion, etc.).

Rationale: Materials used outside of the vendor's specifications can be a high reliability/performance risk if not characterized properly. Use SAE EIA-STD-4899 for guidance. Materials may be very difficult to characterize and manage due to manufacturer non-disclosures.

C.3.1.2 Unqualified Materials. Materials not qualified for intended system application life cycle environmental stress and duty cycle requirements.

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Rationale: Materials without qualification data to support use in the intended system application pose a significant risk of failing to meet the system requirements.

C.3.1.3 Non-OEM/OCM/Franchised Distributor Materials. Materials procured from a source other than the OEM, OCM, or its franchised/authorized distributor without a Government approved process. The Government approved process shall include an OEM C of C or CoA. The Government approved process shall include requirements for participating in the GIDEP including submission of counterfeit information to the customer and the GIDEP agency. The Government approved process shall consider FAR clauses 27.201- 2(b), 32.1009, and 33.209, DFAR 252.246-7003, FAR 52.203-13, FAR 52.211-5 and the FY12 National Defense Authorization Act (NDAA). Any material whose identity or pedigree has been deliberately altered, misrepresented, or offered as an unauthorized product substitution is considered a counterfeit material/non-conforming product.

Rationale: Counterfeit items are widespread and difficult to detect. Procuring from franchise distributors minimizes counterfeit material procurement. Most counterfeit materials have performance, workmanship, or reliability issues. Additionally, the potential exists for receiving materials with unknown histories, storage or handling conditions. References for counterfeit avoidance process developments include

and SAE TB-0003 (Counterfeit Parts & Materials Risk Mitigation).

C.3.1.4 Reused, Reinstalled, Recycled, Reattached, or Salvaged Parts and Materials. Reused, reinstalled, recycled, reattached, or salvaged parts and materials without a specific process approved by the Program Office and the Government Contracting Officer or Contracting Officer Technical Representative. Parts or materials previously installed or otherwise attached to another assembly are considered used and not new.

Rationale: New failure modes and/or latent failure conditions are introduced, part/assembly life can be shortened, overall reliability is unknown and can be difficult to determine. Mechanical fasteners pose a special risk due to the ease of removal and reinstallation. Reference FAR clause 52.211-5.

C.3.1.5 Expired Materials. Materials used beyond the shelf life without a Government approved process.

Rationale: A material must be used within its shelf life (e.g., manufacturer's expiration date) or subjected to inspection, test, restoration, or disposal action. Use of a material beyond the shelf life can result in a detrimental effect to the material's properties and/or performance.

C.3.2 Non-Compliant Materials.

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C.3.2.1 MIL-STD-186 Non-Compliant. Not compliant to MIL-STD-186, except as noted herein.

Rationale: This standard contains general military best practice for protecting components and for material selection for corrosion and deterioration control. Note some MIL-STD-186 items are listed herein for emphasis and additional clarification; however, MIL-STD-186 shall be referred to for additional specific design considerations.

C.3.2.2 SAE AS12500 Non-Compliant. Not compliant to SAE AS12500, except as noted herein.

Rationale: This handbook contains missile system best practice for protecting components and for material selection for corrosion and deterioration control. Note some SAE AS12500 items are listed herein for emphasis and additional clarification.

C.3.2.3 CPC Guidebook Non-Compliant. Not utilizing applicable policy and guidance from the DoD Corrosion Prevention and Control (CPC) Planning Guidebook.

Rationale: This document implements Public Law 10 U.S.C. 2228 and contains specific DoD policy, guidance, and technical considerations for developing and implementing a corrosion prevention and control program for DoD weapon systems and infrastructure. Guidance is in accordance with the DoD *Corrosion Prevention and Control* policy letter, signed by the Acting Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]), 12 November 2003, and the *Facility Corrosion Prevention and Control* memorandum, signed by the Deputy Under Secretary of Defense for Installations and Environment, 10 March 2005. Note some items are listed herein for emphasis and additional clarification; however, this document shall be referred to for additional specific technical and design considerations.

C.3.2.4 Inadequate Corrosion/Deterioration Protection. Paints, finishes, coatings, and materials not adequate for corrosion/deterioration protection in the intended application, and not utilizing MIL-STD-186, SAE AS12500, or an approved equivalent.

Rationale: These documents contain industry best practices for protecting components and materials for corrosion and deterioration control and shall be used.

C.3.3 Hazardous Materials.

C.3.3.1 Mercury and Compounds Containing Mercury. Use of mercury and compounds containing mercury.

Rationale: Hazardous concerns.

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C.3.3.2 Flammable Materials. Materials used in the end item configuration that may demonstrate unintended flammable properties in item-specified worst case environments. Plastic/polymer materials exceeding Underwriters Laboratories (UL) 94, defined levels V-0, VTM-0, 5VA, or HBF as applicable, or UL 1694 SC-0 or SC-TC 0. Flammable or combustible liquids as defined in Occupational Safety and Health Administration (OSHA) 1910.106.

Rationale: Fire hazard, "flammable" is subjective, refer to applicable UL (solids), and OSHA (liquids) definition levels. Test methods and degrees of flammability for polymers are defined in UL 94 and UL 1694. Flammable materials that may ignite in worst case environments are undesirable in military applications. Systems using ordnance items intended to become flammable generally require Government agency fuse and safety board type approvals.

C.3.3.3 Radioisotopes/Radioactive Materials. Radioisotopes/radioactive materials, except as allowed by DA PAM 385-24.

Rationale: Safety concerns and require extensive accountability. DA PAM 385-24, *The Army Radiation Safety Program*, allows some specific exceptions. OSHA and export regulated.

C.3.3.4 ODCs and Highly Toxic Chemicals. Class 1 ozone depleting chemicals (ODCs) and highly toxic chemicals.

Rationale: Environmental laws, Environmental Protection Agency (EPA) regulated. Refer to your contractual hazardous materials requirements and all applicable federal and state guidelines.

C.3.3.5 Pentachlorophenol. Pentachlorophenol, commonly referred to as "Penta" or "PCP", as a wood product preservative.

Rationale: This generally applies to shipping and storage containers and is considered highly reactive. Use one of the following wood preservatives in accordance with MIL-DTL-15011: (a) Copper-8-quinolinolate reduced with water down to 1.8% Copper-8-quinolinolate as metal, (b) Zinc Naphthenate reduced with water down to 3% Zinc as metal, or (c) Copper Naphthenate reduced with water down to 2% Copper as metal.

C.3.4 Prohibited Metals.

C.3.4.1 Lead-free Tin Alloy. Tin alloy solders, coatings, and finishes with less than 3% Pb by weight that are internal and external to EEEE parts/components, related hardware, and mechanical surfaces. Plating over an existing pure tin or tin alloy coating or finish with less than 3% lead. Exceptions are tin-plated insulated electrical wire compliant to applicable military or ASTM standards. Other than parylene or urethane conformal coat for tin whisker risk mitigation.

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Risk mitigation plans for use of pure tin or tin alloys with less than 3% Pb shall require Government approval.

Rationale: Potential for tin whisker and tin pest. The finish and application shall be evaluated for risk mitigation for EEEE applications especially terminals and leads. Surfaces with tin shall be coated with a tin alloy containing not less than 3% Pb alloy. This applies to all piece parts, internal and external. The restriction also includes plating over an existing pure tin finish, see GIDEP ALERTs from 2003. Risk mitigation techniques shall be evaluated on a case-by-case basis. Incoming lot inspection with X-ray fluorescence (XRF) or energy dispersive X-ray spectroscopy (EDS or EDX) shall be utilized. GEIA-STD-0005-1, GEIA-STD-0005-2, SAE GEIA-HB-0005-1, JEDEC JESD22-A121 and JEDEC JESD201 are available for guidance on tin whisker testing and risk mitigation. Level 2C shall be the minimum, however, these documents require tailoring with customer approval for detail requirements. The required conformal coating for whisker mitigation is parylene or a verified minimum MIL-I-46058, type UR urethane (e.g., Conathane®) thickness of 3-4 mil on leads. Other coatings are subject to customer approval. A customer approved robotic process is required.

C.3.4.2 Copper Wire Bonds. Copper wires for microcircuit and semiconductor packaging.

Rationale: While copper wire has been demonstrated as a feasible bonding method, the process control for copper wire bonding does not provide consistent interconnect reliability.

C.3.4.3 Aluminum Alloys 2024-T3 or T4. Use of Aluminum alloys 2024-T3 or T4.

Rationale: Subject to stress corrosion cracking. The 2024-T3 and 2024-T4 heat treat conditions are susceptible to stress corrosion cracking (SCC) and exfoliation corrosion. Use the T6, T8, or 5000/6000 series instead.

C.3.4.4 Aluminum Alloys 7001-T6, 7278-T6, 7050-T6, and 7075-T6. Use of Aluminum alloys 7001-T6, 7278-T6, 7050-T6, and 7075-T6.

Rationale: Subject to stress corrosion cracking. The 7xxx series alloys are susceptible to SCC and exfoliation corrosion in the high strength T6 condition. Use these alloys in the over-aged conditions (T7x, such as the T73 or T76 tempers) which have slightly lower properties but improved corrosion resistance.

C.3.4.5 Magnesium and Magnesium Alloys. Use of magnesium and magnesium alloys.

Rationale: Corrodes easily and difficult to protect from corrosion. Flammability risk. Uncoated magnesium will readily corrode in many environments. Magnesium may also have severe

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galvanic corrosion issues because of its voltage potential (extremely anodic to most other metals).

C.3.4.6 Precipitation Hardening Stainless Steels. Precipitation hardening stainless steels in the H900, H950, or H1000 tempers. CRES 400 series stainless steels, without passivation and a top coating. Exceptions are fasteners in the CH950 condition, springs in the CH 900 condition, 17-4 PH castings aged at 1000°F, and PH13-8Mo H1000.

Rationale: Stress corrosion concerns. See MIL-STD-1568 for 400 series requirements. These high strength tempers are prohibited due to resulting low elongation, susceptibility to stress corrosion cracking, and rapid crack growth properties. Use H1025 or higher temper in most cases. The use of PH13-8Mo H1000 is commonly accepted for high strength/corrosion resistant applications due to the elongation values.

Precipitation hardening steels shall be aged at temperatures not less than 1025°F (i.e. H1025). Exception is made for castings that may be aged at 1000°F ±15°F, for fasteners that may be used in the CH950 condition, and for springs, which have optimum properties in the CH 900 condition.

C.3.4.7 Silver-Plated Wire. Silver-plated wire that has less than 40 micro inches of silver and without manufacturer certification for passing deterioration control tests per ASTM B298. Certification and shelf life of bulk material shall be controlled. Immediately after wire samples are cut, open ends in the bulk material shall be sealed against moisture intrusion. For long term storage (more than 1 year) wire shall be stored in dry pack bags that are sulfur and chlorine free, pH neutral, at less than or equal to 30C and less than 50% moisture with indicators. Before using wire samples that have been in storage for more than one year, the user shall verify the manufacturers ASTM B298 certificate, the storage conditions, and perform solderability per JSTD-003B or newer rev with specimens from each end of the sample wire taken from the bulk material. In addition, wire stored longer than ten years shall be approved by the procuring activity.

Rationale: Corrosion red plague. Mitigated if wire is compliant to ASTM B298 testing and certification by the manufacturer. Wire with 80 microinches or more silver is preferred. It is essential that platings be defect free and of uniform thickness. Imperfections ranging from porosity to deep scrapes penetrate the silver plating and reveal the copper core of a wire strand. Such damage may result from the use of defective wire-drawing dies, wear action between strands during stranding and braiding operations or when conductor strands are wound and re-wound from reels to bobbins. For confidence in wire to be used after two years of storage it shall be recertified to ASTM B298 and data suggests it shall have more than 80 microinches silver to pass more than 10 years of storage. Wire stock shall be handled with extreme care during storage and use to prevent mechanical damage to the plating and shall be stored in a controlled environment which minimizes exposure to humidity.

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C.3.4.8 Bare Hook-Up Wire. Bare hook-up wire with the exception of grounding straps.

Rationale: More susceptible to arcing, and handling/environment degradation if not coated.

C.3.4.9 Aluminum without Chromate Conversion Coating. Aluminum without chromate conversion coating in accordance with MIL-DTL-5541 or equivalent. Surfaces requiring low electrical resistance that are not Class 3 coated in accordance with MIL-DTL-5541.

Rationale: Corrosion concern The low electrical resistance of MIL-DTL-5541 Class 3 chromate conversion coating does not provide adequate protection for many aluminum alloys in applications requiring handling or exposed climatic conditions. Use MIL-DTL-5541 Class 1A coating for most applications. The brand name "chem film", or equivalent, as a the primary single coating is not considered adequate for corrosion protection.

C.3.4.10 SAE AMS-QQ-P-416 Type II Non-Compliant Cadmium Plating. Cadmium plating not in accordance with SAE AMS-QQ-P-416 Type II (supplementary chromate treatment).

Rationale: Contamination concern, not an adequate corrosion resistance finish for most applications without a treatment. Is considered an EPA toxic material. Cadmium will corrode, it acts as the sacrificial anode for the base metal. It requires a supplementary treatment and shall also be overcoated with at least a primer for exterior applications. The use of Cadmium shall state the type II that involves the supplementary treatment.

C.3.4.11 Zinc or Zinc Alloys. Zinc or zinc alloys with greater than 20% zinc, including plating. If approved by the Government for specific applications zinc plating shall have a Type II supplementary treatment.

Rationale: Zinc plating without a Type II supplementary chromate treatment is a contamination concern and not an adequate corrosion resistance finish for most applications without a treatment. Zinc will corrode, it acts as the sacrificial anode for the base metal. It requires a supplementary treatment and shall also be over coated with at least a primer for exterior applications. Also see AMS 2417, AMS 2402 for cautions on corrosion rate, volume of corrosion product, supplementary treatment and corrosion testing.

C.3.4.12 ASTM B488 Non-Compliant Gold Plated Electrical Contacts/Pins. Gold plated electrical contacts/pins not equivalent to ASTM B488, Class 1.25 (50 microinches thickness or more). Gold plated contacts/pins without 50 microinch or more nickel underplating/undercoating in the contact area. Gold plated electrical contacts/pins with silver underplating/undercoating.

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Rationale: Lack of underplating can allow copper and gold to diffuse into each other, increasing contact resistance and corrosion degradation. 50 microinches gold thickness and Ni underplate is considered a minimum to prevent diffusion and durability issues in most applications. Silver migrates easily and is not a very effective diffusion barrier.

C.3.4.13 Silver or Silver Alloys. Silver or silver alloys used for electrical connections for example inside relays, pins on connectors, terminations on chip devices, leads on electronic devices, balls on area array packages, traces on PWBs (for example immersion silver), solder (including tin-silver-copper alloys, known as SAC alloys), etc.

Rationale: Silver gets a contaminated (dirty) surface from reacting to gases/contamination in the air like sulfur.

In the presence of moisture and an electric field, silver migrates and can create short circuits very rapidly. Soldering of silver-plated lugs and contacts is frequently a delicate operation because of the solubility (leaching) of silver in tin due to silver scavenging (see *Microelectronic Packaging Handbook,* 1989, by Rao Tummala). Silver can create a dissimilar metal reaction if in contact with exposed copper. SAC solder and solder balls can grow whiskers, SAC solder formulations may not be as durable in some applications and vendors will change formulations without notice. SAC solders/solder balls must be thoroughly tested for a given solder process and application and closely monitored for alloy content." High content silver is a reliability risk in tin-lead solder processes (see IPC-HDBK-001). Chip devices with silver or silver and palladium have, in general, greatly reduced resistance to solder leaching/dissolution but must have leach resistance barriers such as nickel or copper between the termination and the solder. IPC 4553 does not recommend immersion silver for high reliability applications including military systems.

C.3.4.14 Bare Corrodible Metal Surfaces and Galvanic Metal Couples. Bare corrodible metal surfaces and galvanic metal couples with over 100mV potential difference. Exceptions are allowed in accordance with MIL-STD-186.

Rationale: Galvanic corrosion concern. Mitigation techniques shall be approved by the Government. MIL-STD-186, MIL-STD-889, and SAE AS12500 may be used as guidance. Dissimilar metal couples up to 350 mV may be acceptable in desiccated moisture controlled environment with visual indicators but shall have written Government approval for each specific application.

C.3.4.15 Nickel-Plated Aluminum Construction. Use of nickel-plated aluminum construction.

Rationale: See MIL-STD-186. Nickel plated aluminum is a concern for use in corrosive environments due to galvanic corrosion concerns from use of dissimilar metals. Other surface

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treatments, including anodizing, chem film, and cadmium plating, are corrosion resistant and more damage tolerant than nickel plating.

C.3.4.16 Nickel-Plated Aluminum Connectors. Use of nickel-plated aluminum connectors.

Rationale: See MIL-STD-186. For connectors, rough handling of nickel-plated aluminum connectors may crack the hard nickel plating on the soft aluminum substrate in corrosive environments, this can lead to pitting corrosion of the aluminum. If nickel plating is used a double zincate coating shall proceed the nickel. Cadmium plating (or new approved cadmium substitutes) is preferred and shall always have a supplemental chromate surface treatment (see cadmium plating herein), SAE AMS-QQ-P-416 Cadmium Type II plating is the preferred plating on aluminum connectors in corrosive environments. Mating of Nickel-plated aluminum connectors with Cadmium plated connectors is prohibited.

C.3.4.17 Electroless Nickel/Immersion Gold. Electroless Nickel/Immersion Gold (ENIG) without a Government approved process and storage/handling controls.

Rationale: PWBs are very sensitive to plating bath control, handling and storage. Solderability issues arise from “black pad,” gold porosity, and contamination from environment storage and handling. See IPC-4552 for requirements and controls.

C.3.4.18 Black Metal Oxide Coating. Black metal oxide coating on metal parts as defined by MIL-DTL-13924.

Rationale: Black oxide coating is primarily for decorative purposes and is not for corrosion protection.

C.3.5 Prohibited Polymeric Materials.

C.3.5.1 PVC Plastics and PVC Electrical Insulation. Use of polyvinyl chloride (PVC) plastics and PVC electrical insulation.

Rationale: PVC is subject to degradation from out-gassing and depletion of plasticizers, subject to acceleration by vacuum and/or high ambient temperatures. Flammable and gives off toxic fumes when burning. Plasticizer outgassing may also introduce contamination source.

C.3.5.2 Corrosive Type RTV Adhesives/Sealants. Use of corrosive type room temperature vulcanization (RTV) adhesives/sealants that emit acetic acid during cure.

Rationale: Acetic acid is corrosive. Some RTVs revert under military use conditions. Suspect RTVs include: Dow Corning DC 140, DC 731, DC 732, DC 734, DC 891, DC 1890, DC 20-078,

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DC 30-079, DC 30-121, and DC 92-007; General Electric RTV 102, RTV 103, RTV 106, RTV 108, RTV 109, RTV 112, RTV 116, RTV 118, RTV 192, and RTV 198.

C.3.5.3 Polymer Materials Susceptible to Reversion. Adhesives, sealants, foam, and potting materials that are susceptible to reversion.

Rationale: Outgassing, corrosion, poor adhesion, and ineffective protection can be a result. The tin-catalyzed family of silicones are susceptible to depolymerization (reversion) under high heat and/or oxygen- starved environments (such as nitrogen purged electronic housings). Oxygen is an inhibitor to silicone reversion. Use platinum or alcohol cured silicone systems in nitrogen purged environments. See also C.3.5.2.

C.3.5.4 Susceptible Rubber and Plastics. Rubber and plastics not protected from exposure that are susceptible to ozone damage or degrade with exposures to UV light.

Rationale: Susceptible to cracking, becomes an ineffective seal or insulator. Certain rubbers and plastics have very limited life expectancies in air with excessive ozone or with excessive UV exposure.

C.3.5.5 PTFE Insulated Wire. Wire with polytetrafluoroethene (PTFE) insulation in applications with a high probability of producing cold flow of the insulation.

Rationale: Can be a much lower wear resistance. Insulation cold flow concerns which can lead to shorting wherever the wire is routed over sharp corners or constrained. May be mitigated by wire routing and protection against sharp edges and pressure points on insulation. MIL-W-16878 does not have a QPL and is not a preferred choice.

C.3.5.6 Fluoropolymer Insulated Wire. Wire with fluoropolymer insulation, such as radiation cross-linked ethylene-tetrafluoroethylene (XL-ETFE).

Rationale: If stored in sealed plastic/metal bags or other enclosures for several months or longer corrosion can occur on metal surfaces and optics. GIDEP ALERTS from 2003 show that baking out is not enough to reduce risk. Hot-humid conditioning may be acceptable for some applications. Long-term field storage affects are not well characterized but may be minimized by allowing insulation to outgas in open air or dry gas environments prior to assembly. See NASA historical information.

C.3.5.7 Polyimide Tapes. Polyimide tapes, such as Kapton®, with silicone adhesives, fabric electrical (adhesive or friction type), or textile electrical (adhesive or friction types), including temporary usage during assembly of electronic hardware.

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Rationale: Susceptible to moisture absorption, sources of contamination due to outgassing and surface migration of adhesives.

C.3.5.8 Polyimide as an Electrical Insulator. Use of polyimide, including Kapton® and UPILEX®, as an electrical insulator.

Rationale: FN and HN grade Polyimide is susceptible to moisture degradation and subsequent arcing problems. Copper alloy wire and flex circuits require a secondary protective layer or adhesive overcoat, such as multilayer TFE/Polyimide/TFE. Polyimide insulation maybe used in exoatmospheric applications with Government approval due to limited radiation resistant insulating material.

C.3.5.9 Platinum Catalyzed Silicone Rubber. Platinum catalyzed silicone rubber in contact with high sulfur content materials.

Rationale: Platinum catalyzed silicone rubber will not cure when used as coatings, thermal barriers, or potting compounds on PWAs or when in contact with materials with high sulfur content such as black foam padding used for mechanical protection/damping, pressure sensitive adhesive (PSA) tapes, etc. The sulfur reacts with the platinum catalyst and which precludes catalyzation of the silicone rubber, i.e. it will not cure.

C.3.6 Prohibited General Materials.

C.3.6.1 High Activity Solder Flux. Solder fluxes with activity levels classified as high.

Rationale: Must have demonstrated appropriate verification methods to ensure the removal of residual contaminants. Ionic contamination is a concern.

C.3.6.2 Lubricants and Greases or Other Materials which Contain Graphite. Use of lubricants and greases or other materials which contain graphite.

Rationale: Graphite is a concern for corrosion, i.e. galvanic incompatibility with a variety of metals.

Graphite/carbon compounds when used as other than a lubricant may be acceptable in some applications

C.3.6.3 Non-Fungal Resistant Materials. Materials not inherently moisture and fungus resistant.

Rationale: Materials are required to be non-nutritive to fungus. Contamination may be a concern. Materials that are environmentally sensitive to moisture and fungus attack may degrade

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and not perform as expected. Open-cell materials are a moisture concern. Organically filled phenolic materials are a fungus concern.

C.3.6.4 Desiccants, Organic or Polymeric Materials. Desiccants, organic or polymeric materials (e.g. lacquers, varnishes, coatings, adhesives, or greases) inside cavities of packages/housings with bare microcircuit/semiconductor die, optics, or other elements. Materials compliant with MIL-STD-883 Method 5011 or equivalent industry specification, are acceptable.

Rationale: Potential for outgassing and corrosion. Not effective for long term harsh environments without adequate characterization. ASTM E595 maybe an acceptable test for vacuum environments.

C.3.6.5 Cotton and Linen. Use of cotton and linen.

Rationale: Very flammable material. Degradation of insulating properties over time.

C.4 PROHIBITED PROCESSES REQUIREMENTS

C.4.1 Prohibited Processes.

C.4.1.1 Improper Soldering, Mounting, or Handling of Ceramic Parts. Solder iron mounting or rework of single and multilayer ceramic capacitors or other ceramic parts without a customer approved and validated procedure. Improper reflow profiles that induce excessive thermal shock. Mounting of ceramic parts that creates excessive stress in the assembly. Handling ceramic parts with bare metal tweezers.

Rationale: Both single layer and multilayer ceramic capacitors are easily damaged (microcracks, dielectric damage, etc.) by touch-up and rework with soldering irons due to uncontrolled thermal shock stresses. Ceramic capacitors are easily cracked when exposed to thermal or mechanical stresses. The assembly, manufacturing and rework processes need to be qualified and shown to produce quality solder joints without resulting in damage to thermal shock sensitive components. The manufacturer's detailed processing and handling recommendations shall be followed, especially those relating to hand and mass reflow soldering operations. Hand soldering with soldering irons is strongly discouraged, but if used, under no circumstance shall a soldering iron contact the body or end cap of a ceramic capacitor, and the temperature change rates shall be controlled to prevent thermal shock. In addition, the PWB and the components shall be preheated to further reduce the thermal shock potential when hand soldering. Also, bare metal tweezers shall not be used to handle/pick-up ceramic chip capacitors which can induce cracks or chip-outs to edges or sides of the capacitor body. When equipment containing ceramic capacitors is to be subjected to a range of temperature, the stresses resulting from a mismatch of coefficients of thermal expansion of all elements involved require accommodation. For PWBs that may

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experience excessive board deflection, capacitors with flexible terminations should be considered for use to reduce the risk of capacitor cracking.

C.4.1.2 Unqualified Welding Operators. Welding operators not qualified in accordance with AWS D17.1/D17.1M:2010, and without certification level II or III NDE/NDI. Operators not provided the necessary training and qualifications requirements to certify each operator and the applicable welding equipment for specific welding tasks.

Rationale: This area is critical with small “mom & pop” shops that support larger subcontractors. They need to have certified operators in the areas of welding and brazing according to the process specification identified on the drawing. The preferred welding specification shall be AWS D17.1/D17.1M:2010 and brazing specification shall meet the requirements of the applicable American Welding Society (AWS) specification replacement for MIL-B-7883.

C.4.1.3 Lead forming or Changes to Lead Finishes. Lead forming or changes to lead finishes without inspections for component degradation.

Rationale: Devices are susceptible to breakage and degradation from fixtures, handling, and heat. Need to follow military and industry specifications for inspections such as, seal testing, scanning acoustic microscopy, solderability, and high power visuals, and electrical testing to qualify and monitor processes. In appropriate fixture, handling, and processes will damage and degrade parts affecting long term reliability.

C.4.1.4 PWA Repair. For PWA repair, the use of IPC 7711/7721, Methods 3.2, 3.5.2, 3.5.3, 4.2.5, 4.2.6, 4.2.7, 4.3.2, 4.3.3, 4.3.4, 5.2, 5.3, 6.2.1, 6.2.2, or 6.3.

Rationale: These repair methods introduce unacceptable risk into the repair/rework processes.

C.4.1.5 Solderability. Solderability not in accordance with MIL-STD-883, J- STD-002, or J-STD-003, as applicable.

Rationale: Use industry accepted methods.

C.4.2 Prohibited Design Practices.

C.4.2.1 Unapproved Derating Criteria. Not using Government approved electronic derating criteria.

C.4.2.2 Not Using IPC Design Standards. Not using design standards IPC 2221, IPC 2222, IPC 2223, or additional design considerations in IPC documents listed herein.

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C.4.2.3 Conformal Coating of PWAs. PWAs without 3-4 mil urethane coat (see tin alloy restriction for type) or Parylene-C conformal coatings.

Rationale: Protection of PWAs from exterior contaminants and handling. Shown to reduce component mounting fatigue during vibration and shock, must be compatible with rigid components like glass body diodes. Parylene is preferred and shows superior performance in the areas of protection for tin whisker, handling protection, prevention of moisture contamination, prevention of arcing, low out gassing, and ease of rework.

C.4.2.4 Stacked Components on PWAs. PWAs with stacked (“piggybacked mounted”) components, or with components/leads using other components/leads for support or attachment, including butt joint connections.

Rationale: Difficulty with consistently mounting parts in "nonstandard" configurations leads to collateral damage. Serviceability issue, all components shall be accessible for replacement without disturbing other components. Reliability concerns with degrading parts and attachment areas. When stacked capacitors are approved, use stacked capacitors in accordance with MIL-PRF-49470 "T" level.

C.4.2.5 Jumper Wires. Jumper wires not detailed on the engineering drawing and approved by the customer.

Rationale: If too dense, then reliability is an issue, can introduce EMI and noise into circuit, can cause performance problems if operators do not follow exact routing. Mounting process can easily degrade part and attach reliability.

C.4.2.6 Glass Bodied Components and Magnetic Elements. Glass bodied components and magnetic elements not evaluated for coefficient of thermal expansion (CTE) matching to mounting substrate and to coating/staking materials, and not protected by buffer material when epoxy coatings are used.

Rationale: Breakage of components at low temperature, and temperature cycling in general. See 2003 GIDEP ALERTs for 1N4148 diodes. High modulus (greater than 0.5×10^6 psi) encapsulants or coatings have been known to crack devices.

C.4.2.7 Overhanging Parts or Components. Parts or components overhanging the edge of a PWA.

Rationale: Damage to parts. Possible installation interference.

C.4.2.8 Dual-Sided PWA with Through-Hole Components. Through-hole components mounted on both sides of a PWA

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Rationale: Susceptible to wave solder damage. Must be mounted by hand which is labor intensive and operator sensitive.

C.4.2.9 Unsupported Large-Bodied Components. Large-bodied components mounted without support and staking.

Rationale: Leads subject to damage or breakage under vibration environment.

C.4.2.10 Inadequate Dissipation for High Power Components. High heat-dissipation components mounted without adequate heat sinks.

Rationale: Heat degrades surrounding components, creates hot spots and degrades reliability of most EEE components. Need to pay attention to surrounding materials and temperature sensitive parts and may require exotic cooling techniques. May be difficult to meet component derating guidelines. Refer to manufacturers application notes for best heat sinking.

C.4.2.11 Multiple Leads or Wires Mounted in a Single PTH. Use of multiple leads or wires mounted in a single plated through-hole (PTH).

Rationale: All components shall be accessible for replacement without disturbing other components. Can be difficult to get a good solder joint and can easily degrade the integrity of the joint and the hole.

C.4.2.12 Crimped Aluminum Electrical Aircraft Wire. Use of crimped aluminum electrical aircraft wire.

Rationale: Due to high CTE of aluminum, thermal cycling causes loosing of crimps resulting in increased electrical resistance. Possible fire hazard from overheating at wire junctions due to corrosion of aluminum wire and increased junction resistance.

C.4.2.13 Traps or Crevices Susceptible to Moisture Collection. Use of traps or crevices susceptible to moisture collection.

Rationale: These areas are overly prone to corrosion conditions.

C.4.2.14 Unsealed Permanent Fasteners. Use of unsealed permanent fasteners.

Rationale: Extends life by helping to prevent accelerated corrosion. Recommend installing with wet primer of polysulfide sealant.

C.4.2.15 Unprotected Bearings. Use of unprotected bearings.

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Rationale: Helps prevent shortened life.

C.4.2.16 Untested Adhesively Bonded Designs. Untested adhesively bonded designs, long term/accelerated environment testing such as temperature cycling, humidity and vibration shall be considered.

Rationale: These connections/interfaces are difficult to model and characterization is not adequately performed by the manufacturer for many applications.

C.4.2.17 Maintenance Procedures for Corrosion Protection. Maintenance procedures for corrosion protection without customer logistics and product assurance program approval.

Rationale: These procedures can become unacceptable cost and personnel burdens to the Government and must be coordinated with the responsible agencies.

C.4.2.18 Tantalum Capacitors. Use of tantalum capacitors without surge testing and the required series impedance.

Rationale: Tantalum capacitors are increasingly being used in low impedance circuits, and In Circuit Test (ICT) machinery and fast rise time functional testers for PWA test purposes As a result they are more likely to see a surge condition. Surge testing shall not be done in parallel charge circuits. Surge testing on 100% of capacitors at the manufacture simulates worst case conditions normally seen by the user. Extra derating in the application and series impedance can reduce the concern The reason for including a separate resistance into the circuit is to act as protection against voltage spikes and limit current surges to the capacitor. Additionally, in high ripple applications, it acts as an external heat sink and limits thermal stress to the dielectric by sharing the load. In practice, its inclusion may degrade the circuit performance in certain applications, e.g., in power supply o/p filtering. Also, as PWBs become more densely packed and inter-component track lengths are reduced, the capacitors are given greater visibility of any surges or spikes.

C.4.2.19 Improper Part Mounting. Parts not mounted on printed wiring assemblies in according to the manufacturer intended construction. Examples include “dead bug” mounting of parts with leads by attaching the body to the PWA and leads facing away from the PWA surface with electrical connection by wires.

Rationale: Dead bug construction provides uncertain mechanical and electrical connection unlikely to provide consistent performance. Special qualification procedures required to assess performance.

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RADIATION HARDNESS ASSURANCE

D.1 SCOPE

D.1.1 Scope. This appendix defines necessary infrastructure that is needed for incorporation and implementation of Radiation Hardness Assurance (RHA) program tasks. The contractor PMP shall include an RHA appendix that details the RHA Program Plan when RHA is a program requirement.

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

D.2 PROCEDURE

D.2.1 RHA Program Plan. The RHA Program Plan shall include the program's organizational structure for observance and execution of hardness assurance tasks. The RHA Program Plan shall address subcontractor flow down of parts hardness assurance requirements and the methodology for validation of radiation specification levels and processes from all suppliers. This shall include the role of the procuring activity in the overall RHA program.

The RHA Program Plan shall include detailed modeling of the mission environment(s), with consideration of the overall system specifications, to allow for full system functionality before, during, and after nuclear events, and specifically determine piece part radiation test levels (see D.2.4). The expected natural radiation environment (trapped particle environment, galactic cosmic ray environment, solar flare environment, etc.) and man-made radiation environment (nuclear weapons, etc.) shall be characterized for the application and shall be defined in the system specification. Atmospheric radiation environment effects shall be addressed in accordance with IEC 62396.

The RHA Program Plan shall address all phases of hardware design, production, test, storage, and surveillance. It shall define the radiation hardness assurance techniques to be used within the initial design, parts selection, parts procurement, parts characterization, production, validation, fielding, and maintenance of each system and subsystem.

The RHA Program Plan includes the RHA Test approach for all microelectronic assemblies, semiconductors, and passive components including resistors, capacitors, cables, and printed wiring boards (PWBs). The RHA Program Plan may consist of a combined test and analysis program to verify the capability of the system to perform as intended in both natural and man-made radiation environments. The plan shall further define the radiation environment at the piece part level, to allow components and PWBs to be procured, tested, and screened to these required levels. When High-Altitude Electromagnetic Pulse (HEMP) is required in accordance with the

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system specification, the RHA Program Plan shall identify required testing in accordance with MIL-STD-188-125-1 and MIL-STD-188-125-2.

In addition, the RHA Program Plan shall identify Radiation Transport Analysis, laboratory radiation sources, and design alternatives (e.g., shielding, circumvention, and other hardening approaches). System level hardness shall be validated by radiation testing of samples from each piece part production lot to validate survivability. RHA testing requirements for semiconductors are described in TABLE D-I. Industry standard microelectronics screening techniques will be used to ensure operation and survival of the fielded system in its application environment. The procuring activity shall approve the contractor PMP containing the RHA Program Plan before beginning the piece part selection process and the procuring activity disposition process.

D.2.2 Specification of Radiation Environment. The system specification defines the expected environment. For example, during peacetime, a space-based asset (satellite) must operate in a trapped particle environment, galactic cosmic ray (heavy ion) environment, and solar flare environment while successfully performing its mission. In addition, for mission critical space assets required to survive exposure to man-made nuclear events, the system design is required to survive the nuclear event and remain operational after each nuclear event in accordance with the National Space Security Office policy.

External radiation environment, system shielding and hardware/part shielding effects are analyzed to determine the maximum radiation levels seen by each microcircuit.

D.2.3 Radiation Transport Analysis. The RHA Program Plan includes radiation transport calculations to define the actual environment at the electronics subassembly and piece part level. These calculations are the basis for defining detailed test requirements identified in the device' source control drawing. Applicable contractor source control drawings shall be approved by the procuring activity and shall include the following as a minimum:

a. Radiation test methods.

(1) MIL-STD-750, Test Methods for Semiconductor Devices (Methods 1017, 1019, 1032, 1080, 3478, 5001)

(2) MIL-STD-883, Test Methods and Procedures for Microelectronics (Methods 1017, 1019, 1020, 1021, 1023, 5004, 5005, 5010)

(3) ASTM Subcommittee F01.11 on Nuclear and Space Radiation Effects Methods F448, F615M, F744M, F773M, F980, F996, F1190, F1192, F1262M, F1263, F1467, F1892, F1893

(4) JESD57, Test Procedures for the Measurement of Single-Event Effects in Semiconductor Devices from Heavy Ion Irradiation

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(5) JESD89, Measurement and Reporting of Alpha Particle and Terrestrial Cosmic Ray-Induced Soft Errors in Semiconductor Devices

(6) JEP133, Guide for the Production and Acquisition of Radiation-Hardness-Assured Multichip Modules and Hybrid Microcircuits

(7) TIA-455-64 (FOTP-64), Procedure for Measuring Radiation-Induced Attenuation in Optical Fibers and Optical Cables

b. Except for standard microcircuit drawing (SMD) specified RHA parts, contractor prepared drawings shall call out sample size and sampling statistics used in lot acceptance.

c. Radiation type, source and dose/exposure level.

d. End point test, pre- and post-radiation test requirements, and acceptance criteria.

e. Data reporting and analysis.

f. Special radiation tests such as electrical or radiation screening tests.

Where nuclear weapon radiation environments apply, system design specifications will include transport models that best describe the threat, to include the operate/survive/recovery requirements. Using these environments (total ionizing dose, particle energy fluences spectra, etc.), dose transport codes are developed and used to create detailed dose-depth curves. This information is used to estimate dose and fluence levels that apply inside each system box, electronic piece part, and package. As the design process evolves, a more accurate mechanical model of the system is developed and the radiation environment flow down to each location is estimated with greater accuracy. Predicted radiation levels, as modeled for each piece part at each PWB location, will be the basis for test requirements provided in device SCDs.

In addition, the radiation transport calculations shall model High-Altitude Electromagnetic Pulse (HEMP)/Dispersive Electromagnetic Pulse (DEMP) effects for all exposed devices, solar arrays, antennas, cables, and boxes as applicable. Input/output protection devices and hardware interface circuits are evaluated for potential burnout. Hardening and shielding techniques are established to protect from Internal Electromagnetic Pulse (IEMP), Systems-Generated Electromagnetic Pulse (SGEMP), etc. The HEMP/DEMP hardening and testing plans are included as part of the RHA Program Plan.

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Radiation transport models and calculations shall include Thermo-Mechanical Response (TMR) for all exposed surfaces (i.e. structures, paints, mirror coatings) and components for systems in categories A and B.

D.2.4 RHA Testing. RHA piece part test is performed in a number of separate radiation environments, as defined in TABLE D-I. As dictated by mission requirements, other environments and nuclear threats may be identified for specialized testing. The Radiation Transport Analysis as described in D.2.3 determines each environment's basic test level. A single system test requirement, based on the worst-case location may be selected, but multiple requirements for different locations are also acceptable.

The basic radiation test levels selected represent the worst-case environments for the particular system. For the total ionizing dose, and all dose rate and displacement damage environments, the basic test level is doubled (also called a 2x Radiation Design Margin, or 2x RDM) to account for variability in part response and dosimetry error. Radiation Design Margin (RDM) guidance is provided in MIL-STD-1766B Appendix E Table 2 (only). For the purpose of this document RDM is defined as:

$$Radiation\ (Hardness) Design\ Margin = \frac{Lowest\ Observed\ Failure\ Level}{Specified\ Radiation\ Level}$$

The basic test level with the 2x RDM is the actual test requirement imposed on the piece part for these environments. Simple over test margin is not applicable for Single Event Effects (SEE) testing, and the environment specified in the system specification applicable at the time of contract start (for example it might be the "worst case day" specified in CRÈME-96) shall be used to define the actual test levels for all SEE test.

Where denoted by a "(10)" in TABLE D-I, for parts where a 10x RDM can be proven by test data, the procuring activity may allow one time test of this part, when vendor, design and process does not change.

TABLE D-I. Radiation hardness assurance testing requirements for semiconductors.

Test Requirement 2/	**Equipment Category (as defined in 4.1.2, Equipment Categories and Definitions)**				
	A	**B**	**C**	**D**	**E 1/**
Total Ionizing Dose (TID)	L (10)	L (10)	L (10)	L (10)	
Dose Rate Upset, Latchup, Survivability, and Operate-Through	L (10)	L (10)	L (10)	L (10)	
Single Event Effects (SEE) and Latchup from Heavy Ions and Protons	O	O			

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Test Requirement 2/	Equipment Category (as defined in 4.1.2, Equipment Categories and Definitions)				
	A	B	C	D	E 1/
Single Event Effects (SEE) and Latchup from Neutrons	O	O	O		
Displacement Damage from Neutrons	O(T)	O(T)			
Displacement Damage from Protons	O(T)				

L = Lot testing is required at 2x RDM.

O = One time testing is allowed at 2x RDM if vendor, design, and process do not change.

10 = One time testing may be approved by the procuring activity, if radiation test results show 10x RDM and vendor, design, and process do not change. A lesser margin may be approved by the procuring activity if mission environments and system specifications allow a reduction.

T = Displacement damage testing need not be performed on process-proven technologies (i.e. non-DRAM CMOS).

1/ Radiation hardness assurance testing is not required for Category E, if minimal radiation exposure is predicted and system maintenance can be accomplished without loss of mission performance.

2/ Radiation testing is not required for hardness non-critical (HNC) items (see D.2.5).

The RHA Program Plan includes the generic test requirements for microelectronic devices and integrated circuits. The plan identifies how each developer and their suppliers will control electronic component selection and verify the radiation hardness level of each subsystem. The plan will include the program's approach for compliance with TABLE D-I, to ensure that all mission critical microelectronics meet or exceed the following:

a. At least 2x RDM for total ionizing dose, dose rate effects, and displacement damage requirements

b. Single Event Latchup immunity to a Linear Energy Transfer (LET) of at least 60 MeV-mg/cm^2

c. SEE performance to system specifications in all applicable environments (Single Event Latch up, Single Event Functional Interrupt, Single Event Burnout, Single-Event Gate Rupture, etc.) for all relevant particles (protons, neutrons, and heavy ions) For SEE heavy-ion tests, one part from each lot date code shall undergo angle testing with no less than two angles in roll direction and no less than two angles in tilt direction.

Recommended test sample sizes are 5-8 devices from each lot date code (plus two control) in each radiation environment. For example, if one device lot requires testing in 7 unique radiation environments, as many as 70 test samples (per lot) may be required to validate the performance.

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A failure of one (1) critical electrical parameter during or after radiation testing requires rejection of the entire lot. Hybrids and multi-chip modules are expensive; therefore, radiation testing at the lowest level of assembly shall be considered. All failures that occur during radiation testing shall be identified to the Program Failure Review Board (FRB) and procuring activity.

Functional and parametric operation of electronic piece parts is to be verified through electrical testing before and after (pre- and post-) irradiations.

All radiation testing shall be performed after device burn-in, to reduce pre-irradiation elevated temperature stress (PETS) effects from affecting the piece part response. Careful attention to the production of and qualification of hybrid circuits is necessary to meet this requirement.

All radiation testing shall be performed at/near room/laboratory temperature with the exception of latchup testing at elevated temperature. For designs that normally operate at extreme temperatures (i.e. cryogenic), radiation testing shall be performed at those operating extremes. Extreme temperatures are defined as component (case) temperatures that normally operate above 125°C or below -55°C.

The developer shall maintain a radiation effects database of electronic piece parts to allow for tracking of all system electronics. Lot traceability shall be established from procurement, through radiation testing, to actual placement in PWBs and subsystem. The database will verify testing status for each procurement lot, radiation tests performed on each lot, actual radiation levels verified on each lot, and approval for use.

If commercial parts are used that require qualification for radiation hardness, and the manufacturer does not provide design change notification, the developer shall validate the radiation performance with lot sample testing in each radiation environment.

In selecting semiconductors for use, off-the-shelf radiation hardened parts are recommended over commercial parts that require qualification. Radiation qualified processes and vendors are also recommended. Devices manufactured on insulating substrates (i.e. silicon-on-insulator, or SOI) are recommended for use in high dose rate and operate-through applications.

D.2.4.1 Total Ionizing Dose. TID performance shall be verified with lot sample testing on packaged devices from each production lot and/or date code using Co-60 or Cs-137 sources. Testing shall be performed in accordance with Test Method 1019 of MIL-STD-883 or MIL-STD-750, as applicable.

For space-based missions exposed to total ionizing dose rates of less than 30 mrad(Si)/s, use MIL-STD-883, Test Method 1019 for bipolar linear ICs with potential Enhanced Low Dose Rate Sensitivity (ELDRS) effects.

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D.2.4.2 Dose Rate Effects. Dose-rate effects shall be verified with lot sample testing on each production lot and/or date code and performed in accordance with MIL-STD-883 Test Methods 1021 and 1023.

Latchup effects shall be verified on each production lot and/or date code with lot sample testing and performed per MIL-STD-883 Test Method 1020 at the highest junction temperature predicted by the design. If initial latchup characterization and circuit modeling shows no potential for radiation-induced latchup (i.e. the circuit contains no parasitic 4-layer elements), latchup testing can be eliminated.

Several radiation test methods are required for evaluation of power MOSFET devices including electrical dose rate testing to MIL-STD-750 Test Method 3478.

D.2.4.3 Single Event Effects and Displacement Damage. SEE testing shall be performed in accordance with ASTM F1192 and EIA/JESD 57. Several radiation test methods are required for evaluation of power MOSFET devices including single event burnout and gate rupture testing to MIL-STD-750 Test Method 1080.

Single event effects and displacement damage effects shall be verified once per part type, during initial part qualification and each time the vendor, design, layout (mask revision level), or process changes.

D.2.5 Use of Hardness Non-Critical Parts and Materials. In order for a part or material to be designated as a hardness non-critical (HNC) item, the part or material shall demonstrate a large design margin, or absence of a critical radiation failure criterion, such that repeated radiation testing is not needed. Active components shall demonstrate, through initial lot screening, a radiation design margin greater than 10x in all environments to be designated for HNC approval. Procuring activity approval is required for designation of any active component (semiconductors, diodes, etc.) as a HNC part. Active components shall be HNC recertified (with radiation testing) if the mask revision, manufacturing process, or vendor is changed. Destructive physical analysis (DPA), lot traceability, and design change/revision certifications are required to maintain HNC status and determine the need for retesting of HNC active components.

When passive component requirements, with appropriate shielding factors, are below the International Traffic in Arms Regulation (ITAR) Radiation Environment Export Control Levels for electronics {ITAR, Category XV, sub-paragraphs (d)(1), (d)(2), and (d)(3)}, then passive components (including resistors, capacitors, inductors, connectors) and basic construction materials (including optical components, epoxy, plastics, rubber, organics, etc.) can be designated as a HNC part or material. HNC parts and materials are not required to undergo screening for radiation effects. In this case, the radiation screening exemption for passive

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components does not apply to active electronic components (including transistors, diodes, integrated circuits, etc.).

D.2.5.1 Special Considerations. Extreme care shall be taken when choosing certain types of passive components and construction materials for use in radiation environments. Special attention shall be given to the following:

a. Prompt conductivity of capacitors used in high dose rate applications.

b. Darkening and prompt response of optical fibers and glass when exposed to high total ionizing dose and dose rate environments.

c. Breakdown and embrittlement of insulating materials (e.g., Teflon®, potting compounds, transformer potting materials, epoxy, Mylar®, oil, butyl, silicones, grease, nylon, paper) and lubricating materials when exposed to high total ionizing dose environments.

d. Changes to discrete resistor and quartz crystal properties when exposed to high total ionizing dose and dose rate environments.

e. Changes to electrolytic, plastic, and paper capacitors used in neutron environments.

f. Nuclear spallation products emitted from some high atomic number packaging and shielding materials (i.e. total ionizing dose shields, package lids) which cause single- event upsets in cosmic particle environments.

g. If a passive part or basic construction material has no known radiation data, it shall be characterized (one-time test) to at least 10x RDM in critical environments, even if the system meets the limits noted in D.2.5.

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OUTGASSING

E.1 SCOPE

E.1.1 Scope. This appendix defines the requirements for material outgassing. Material outgassing is defined as the emanation of volatile materials, organic or inorganic, under vacuum or non-vacuum conditions resulting in a mass loss and/or material condensation on nearby surfaces. For the purpose of this document, outgassing and offgassing are terms often used interchangeably. Outgassing refers to volatiles released under vacuum conditions, and offgassing refers to volatiles released under near-atmospheric conditions. The procedures established herein are intended to reduce the number of outgassing related failures and help ensure long term reliability.

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

E.2 REQUIREMENTS

E.2.1 Material Outgassing Requirements. When required by the procuring activity, all polymeric and organic materials shall be tested for outgassing in accordance with ASTM E595 and the results documented on the approved materials lists. Extra attention shall be paid to combinations of materials in closed compartments, where even a small amount of outgassing may reach dangerous concentrations in time.

E.2.1.1 Corrosive/Reactive Products. Materials selected for use in hardware shall not liberate corrosive or reactive fumes under any conditions encountered during storage, shipment or service. Special consideration shall be given to materials, such as insulation on wire, which may be exposed to overheating and resultant outgassing or breakdown. Some examples include acid emitting liquid or vapor, room temperature vulcanizing (RTV) silicones, and Hydrogen Fluoride emission from crosslinked ethylene-tetrafluoroethylene (ETFE) insulation.

E.2.1.2 Non-Corrosive/Reactive Products. Materials shall not emit non-corrosive/reactive products where such products will affect the operation of equipment exposed to these products (e.g., condensation on optics).

E.2.2 Determination of Acceptable Levels of Outgassing. Determination of acceptable levels of outgassed product shall be based on contamination sensitivity of each subsystem. For example, optic systems and guidance systems may have different requirements than external containers. Materials used in EEEE and mechanical parts, shall be screened for outgassing based on operating conditions and impact on the mission. Established material outgassing data shall be verified and made available to the procuring activity.

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Material outgassing shall be in accordance with ASTM E595. Materials that have a Total Mass Loss (TML) less than 1.00% and a Collected Volatile Condensable Mass (CVCM) less than 0.10% are considered acceptable. Materials not meeting this may be "baked out" in a thermal vacuum chamber to achieve the desired limits if it is verified that such bakeout causes no degradation of other properties or performance of the material or associated assembly.

Utilization of a material based on bakeout requires the approval of the procuring activity. For common TML and CVCM material values, refer to the Materials and Processes Technical Information Service (MAPTIS) of the Marshall Space Flight Center (MSFC). Data listed in NASA RP-1124, *Outgassing Data for Selecting Spacecraft Materials*, for applicable materials may be used in lieu of actual testing. Use of outgassing rating systems that provide equivalent characteristics to MAPTIS may be submitted to the procuring activity for approval.

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COUNTERFEIT PARTS AND MATERIALS

F.1 SCOPE

F.1.1 Scope. This appendix defines requirements for counterfeit parts and materials. The procedures established herein are intended to prevent, detect, report, and contain suspect counterfeit parts and materials.

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

F.2 REQUIREMENTS

F.2.1 Counterfeit Prevention. Documented procedures shall ensure that use of counterfeit parts and materials is avoided, and that potential counterfeit parts and materials are controlled to not impact system performance. See SAE AS5553 and SAE AS6174 for additional guidance.

F.2.2 Authorized Sources. All parts and materials shall only be procured from the Original Equipment Manufacturers (OEMs) or its franchised/authorized distributor, and shall come with a Certificate of Conformance (C of C) and supply chain traceability for all purchases.

F.2.3 Preventing Counterfeit Parts and Materials. The procedures as defined below shall be performed to minimize the risk of receiving counterfeit parts and materials:

a. Shall maximize availability of authentic, originally designed, and qualified parts throughout the product's life cycle, including management of parts obsolescence.

b. Shall assess potential sources of supply to minimize the risk of receiving counterfeit parts or materials.

c. Shall maintain a listing of approved suppliers with documented criteria for approval and removal of suppliers from the list.

d. Shall have purchasing procedures which require the selection of parts and materials from Original Component Manufacturers (OCMs) or authorized suppliers.

e. Shall have purchasing procedures which confirm whether a selected supplier is authorized for each purchase.

f. Shall use government or industry services such as GIDEP and other commercially available services to identify part or supplier quality or authenticity problems.

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g. Shall define minimum inspection and test requirements for parts being procured from unauthorized suppliers (see F.2.4), and shall ensure that in-house, third-party, and supplier inspection and test procedures and facilities comply with these requirements.

h. Shall flow the requirements above to subcontractors.

i. Shall train personnel in these counterfeit avoidance and detection practices.

j. Shall have a counterfeit control plan to be approved by the customer that covers these items.

k. Shall test components for authenticity through a government approved plan commensurate with the risk level and component type.

l. Shall receive customer approval before use in hardware.

F.2.4 Detecting Counterfeit Parts and Materials. Appropriate test methods shall be used to detect potential counterfeit parts and materials. TABLE F-I provides minimal requirements for inspection and test of electronic components bought from unauthorized suppliers. Tailoring of the tests or inspections must be noted in the unauthorized supplier purchase report. The Percent Defective Allowable (PDA) shall be defined for screening and acceptance of parts and materials from unauthorized suppliers that experience test failures during authenticity testing.

Mechanical components bought from unauthorized suppliers shall be inspected for indicators that the parts may be counterfeit. Examples of counterfeit mechanical parts indicators are:

a. Logos or trademarks that do not match the manufacturer's logo or trademark.

b. Documentation errors, misspellings, or inconsistencies.

c. Altered labels or tags.

d. Altered or unexplained markings, stamping, moldings, or engravings.

e. Improper surface treatment, or repainting/recoating.

f. Oil stains, overheated areas, wear, signs of disassembly, or other indicators of usage on parts represented as new.

Suggested tests for counterfeit mechanical parts include, but are not limited to:

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a. Liquid penetrant inspection for surface defects (non-porous materials only).

b. Magnetic particle inspection for surface or below-surface defects (iron and ferroelectric material parts only).

c. Ultrasonic inspection for internal defects.

d. Eddy current inspection for coating thickness, conductivity, or wear inspection on used parts (metallic only).

e. Radiological inspection for internal defects.

f. Destructive tests such as shear, compression, cross-section, and corrosion.

TABLE F-I. Inspection and test of electronic components.

Test/Inspection (4/, 5/)	**Destructive?**	**Test Difficulty [Value] (6/,7/)**	**Applies To…**	**Indicators**	**Comments (Notes)**
Documentation Check	No	Low [High]	All parts.	Spelling and grammatical errors, inaccuracies, omissions.	For detecting fake documentation. Refer to IDEA-STD-1010. (1/)
Bar Code Check	No	Low [Med]	All parts.	Discrepancy between bar code label and human- readable equivalent.	For detecting fake packaging. Refer to IDEA-STD-1010. (1/)
Visual Inspection	No	Med [High]	All parts.	Inconsistencie s in appearance, poor quality, defects, multiple lot date codes.	For detecting used, refurbished, or remarked parts. Refer to IDEA-STD-1010. (2/)

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Test/Inspection (4/, 5/)	Destructive?	Test Difficulty [Value] (6/,7/)	Applies To…	Indicators	Comments (Notes)
Marking Permanency (Mineral Spirits and Alcohol)	No	Low [High]	ICs and other marked plastic, ceramic, and metal packaged components.	Removal of ink marking.	For detecting remarked parts. Refer to MIL-STD-883, Method 2015, Solvent Solution a. (3/,5/,8/)
Surface Finish Permanency (Acetone)	No	Low [High]	ICs and other marked plastic, ceramic, and metal packaged components.	Removal of coating from part, sanding marks. Removal of ink marking is not cause for rejection.	For detecting blacktopped parts. Refer to IDEA-STD-1010. (3/,5/,8/)
Surface Finish Permanency (Other)	Yes	Med [High]	ICs and other marked plastic, ceramic, and metal packaged components.	Removal of coating from part, sanding marks. Removal of ink marking is not cause for rejection.	For detecting blacktopped parts (Heated Aggressive Solvent, e.g. Dyna-Solve 750). (3/, 5/ ,8/)
X-Ray Fluorescence (Radiological)	No	Med [Med]	Components requiring tin-lead plated terminations.	Finishes not compliant with the part specification (primarily lead (Pb) content).	For detecting retinned or remarked parts. (3/,5/)
X-Ray (Radiological)	No	Med [High]	Components with a die, leadframe, or other internally identifiable	Inconsistent die size or leadframe.	For detecting incorrect die or wrong parts. (3/,5/)

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Test/Inspection (4/, 5/)	Destructive?	Test Difficulty [Value] (6/,7/)	Applies To…	Indicators	Comments (Notes)
Scanning Acoustic Microscopy (SAM)	No	High [High]	Plastic encapsulated components	Evidence of thermal stress (delamination).	For detecting signs of uncontrolled thermal stress damage or partially sanded part markings. (3/,5/)
Die Verification (Decapsulation)	Yes	High [High]	Components with a semiconductor die.	Inconsistent die markings or disagreement with known good part.	For detecting incorrect die or wrong parts. (3/,5/)

1/ This inspection or test, when applicable, shall be performed on all documentation sources (certificates of conformance, reels, boxes, bags, etc.).

2/ This inspection or test, when applicable, shall be performed on all parts.

3/ This inspection or test, when applicable, shall be performed on at least three parts from each lot date code if feasible. If lot date code size is small (<10 parts), testing on one part per lot date code is acceptable.

4/ Parts shall be removed from random locations within the packaging. Sometimes authentic parts are placed in the most easily accessible locations.

5/ Multiple tests can be performed on the same parts for efficiency. The order of testing can be varied. 6/ Test Difficulty notes:

Low – Test can be cheaply performed with minimally trained personnel.

Med – Test can be performed with equipment commonly found in a basic test laboratory. Some level of expertise is required to perform the test or interpret the results.

High – Test requires equipment not commonly found in a basic test laboratory, or significant development work may be required.

7/ Test Value notes:

Low – Test results are not a solid indicator of component authenticity.

Med – The test method is somewhat good at detecting counterfeit parts. The detection method is not easily replaced by other less expensive tests.

High – The test method can frequently detect counterfeit parts that may not be readily detectable by other methods. Failing results are a strong indicator of a potential counterfeit part.

8/ Extreme caution shall be exercised when using chemical solvents. These solvents may have a flash point below the test temperature (e.g., acetone = -20°C, DynaSolve 750 = 41°C). Consult appropriate Material Safety Data Sheet (MSDS) before use of chemical solvent.

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F.2.5 Reporting Suspect Counterfeit Parts and Materials. The customer shall be notified of a confirmed or suspect counterfeit part or material, and the actions taken to identify, contain, and impound all product from the lot. The original manufacturer, and supplier if applicable, shall also be contacted. An ALERT to the Government-Industry Data Exchange Program (GIDEP) shall be initiated and submitted within 60 days of knowledge of the counterfeit part or material. The appropriate parties shall be notified to document the case for legal action if required (e.g., contracting officer, DoD Office of Inspector General).

F.2.6 Containing Suspect Counterfeit Parts and Materials. Suspect counterfeit parts shall be quarantined with all other items of the same lot. All potential users or hardware items with the suspect part or material, and contain product which has this suspect product, pending confirmation of the part or material's authenticity shall be identified and located. Confirmed counterfeit material shall be provided to investigative agencies for ongoing investigation or prosecution. The counterfeit product shall not be scrapped or otherwise disposed of without approval from investigative authorities. Confirmed counterfeit product shall not be returned or handled in a way which would allow its resale or reuse. Further guidance may be found in the following references:

a. FAR Clauses 27.201-2(b), 32.1009, and 33.209, DFAR 252.246-7003, FAR 52.203-13, FAR 52.211-5 and the FY12 National Defense Authorization Act (NDAA).

b. IDEA-STD-1010, *Acceptability of Electronic Components Distributed in the Open Market*, Independent Distributors of Electronics Association (IDEA).

c. SAE TB-0003, Counterfeit Parts & Materials Risk Mitigation, SAE International.

d. SAE AS5553, Fraudulent/Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition, SAE International.

e. IEC TS 62668-1, Process Management for Avionics – Counterfeit Prevention – Part 1, Avoiding the use of counterfeit, fraudulent and recycled electronic components, International Electrotechnical Commission (IEC).

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OBSOLESCENCE

G.1 SCOPE

G.1.1 Scope. This appendix defines requirements for parts obsolescence. The procedures established herein are intended to minimize a Diminishing Manufacturing Sources and Material Shortages (DMSMS) issue. DMSMS issues are not confined to piece parts or devices; obsolescence may occur at the part, module, component, equipment, or system level. Ultimately, DMSMS issues affect materiel readiness and operational availability, which, in turn, affect both combat operations and safety.

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

G.2 REQUIREMENTS

G.2.1 Obsolescence Requirements. Documented procedures shall ensure that a proactive obsolescence management approach is established and maintained that meets the criteria of SAE STD-0016. The obsolescence management plan shall be approved by the procuring activity and shall address the following considerations:

a. Specify the infrastructure established for the obsolescence management process to include data management, personnel resources, processes, management reports, and financial resources.

b. Processes through which the production status of electronic (and other targeted components) is monitored using Commercial Predictive Tools, direct manufacturer contact, GIDEP, and other sources. Attention shall be applied to determining where to focus obsolescence management efforts.

c. Methodologies as to how to measure and prioritize the operation impacts of the obsolescence risks.

d. Methodologies for analyzing alternate approaches for resolving obsolescence issues in order to find the preferred resolution.

e. Finally, considerations for obsolescence resolution implementation including which data to track such as type of resolution, cost of resolution, and impact of resolution.

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Further guidance may be found in the following reference:

a. SD-22, Diminishing Manufacturing Sources and Material Shortages (DMSMS) Guidebook, Defense Standardization Program Office

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INCOMING INSPECTION

H.1 SCOPE

H.1.1 Scope. This appendix defines requirements for incoming inspection and associated documentation. The procedures established herein are intended to ensure the high quality of parts and materials used.

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

H.2 REQUIREMENTS

H.2.1 Incoming Inspection Requirements. Requirements shall be established and maintained for incoming inspections and associated documentation. Incoming tests and inspections, including destructive physical analysis (DPA), of parts and materials shall be performed to ensure that they meet the requirements of the procurement specification. For categories A, B, C, and T, a database shall be developed and maintained that captures all relevant data for received parts, to include, lot date code, purchase order requirements, and Certificate of Conformance (C of C) data for the life of the program. The incoming inspection and testing of parts and materials shall be conducted in accordance with documented procedures. The plan shall address the following tests and inspections as shown in TABLE H-I For parts procured from Independent Distributors, see TABLE F-I.

TABLE H-I. PM&P incoming inspection requirements.

PM&P Incoming Inspection Requirement	EEE Parts	Mechanical Parts	Materials
Part identification and packaging requirements	X	X	X
Evidence of damage	X	X	X
Supplier inspection, verification, and data requirements	X	X	X
Certificate of Conformance (C of C)	X	X	X
External Visual	X	X	X
Destructive Physical Analysis (DPA)	X		
Particle Impact Noise Detection (PIND) Categories A-C and T only	X		
X-Ray Fluorescence (XRF) or equivalent, as part of the receiving inspection sampling plan, to identify coating or material discrepancies such as pure tin plating	X		
Material analysis, as part of the receiving inspection sampling plan, to determine proper material characteristics and to verify		X	X

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PM&P Incoming Inspection Requirement	EEE Parts	Mechanical Parts	Materials
Certificate of Conformance, (examples: Fourier Transform Infrared (FTIR), XRF, ASTM, SAE testing, and/or Rockwell hardness)			

H.2.2 Destructive Physical Analysis. For Category A and B hardware, DPA shall be performed on one device per received lot date code of non-standard microcircuits, hybrids, multichip modules, semiconductors, stacked capacitors, and custom devices. For hardware Categories A and B, three devices from each lot date code of received microcircuits, hybrids, semiconductors, stacked capacitors, custom devices, and connectors shall be held for life of fielded component. For hardware Category T, one device from each lot date code of EEEE devices shall be held for life of fielded component. Variation of the DPA sample size requirements shall be approved by the procuring activity. For Category D hardware, DPA may be required by the procuring activity when failure history or other concerns warrant further examination of the device. Standard parts do not require DPA unless they are purchased from an unauthorized supplier. DPA shall be performed in accordance with MIL-STD-1580. Use of other DPA procedures requires procuring activity approval. DPA per MIL-STD-1580 is not a counterfeit detection test by itself.

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CONCLUDING MATERIAL

Custodian:	Preparing activity:
Army - MI	OSD – SO
Air Force - 11	(Project STDZ-2023-001)
Navy - SH	

Review activities:

Army - AV

Air Force - 19, 71, 85

DLA - CC

OT - MDA

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you shall verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.

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