BY ORDER OF THE COMMANDER

SMC Standard SMC-S-011
13 June 2008

Supersedes:
New issue

Air Force Space Command

SPACE AND MISSILE SYSTEMS CENTER STANDARD

PARTS, MATERIALS, AND PROCESSES CONTROL PROGRAM FOR EXPENDABLE LAUNCH VEHICLES

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

FOREWORD

1. This standard defines the Government's requirements and expectations for contractor performance in defense system acquisitions and technology developments.

2. This new-issue SMC standard comprises the text of The Aerospace Corporation report number TOR-98(1412)-1, Rev A.

3. Beneficial comments (recommendations, changes, additions, deletions, etc.) and any pertinent data that may be of use in improving this standard should be forwarded to the following addressee using the Standardization Document Improvement Proposal appearing at the end of this document or by letter:

Division Chief, SMC/EAE
SPACE AND MISSILE SYSTEMS CENTER
Air Force Space Command
483 N. Aviation Blvd.
El Segundo, CA 90245

4. This standard has been approved for use on all Space and Missile Systems Center/Air Force Program Executive Office - Space development, acquisition, and sustainment contracts.

James Horejsi, Col, USAF
SMC Chief Engineer

CONTENTS

PAGE

PAGE

PAGE

SECTION 1

SCOPE

1.1 PURPOSE

This document establishes the requirements for the preparation, implementation, and operation of a parts, materials, and processes control program for use during the design, development, and production of expendable launch vehicles (ELV). The implementation of these requirements is intended to:

a. Assure integrated management of the selection, application, procurement, control, and standardization of parts, materials, and processes (PMP).

b. Improve the reliability of program PMP to reduce PMP failures at all levels of assembly and test.

c. Reduce program life cycle cost.

d. Improve procurement and test of small quantities of parts and materials that meet system requirements

1.2 APPLICATION

This document is intended for use in acquisition contracts for launch vehicle programs. The document should be cited in the contract schedule or the statement of work. The document defines the minimum acceptable requirements for ELV applications and as such shall not be tailored ***except where allowed by the PMPCB as specified herein***. The requirements are intended to be used to coordinate at the program level the selection, application, management, and procurement of PMP throughout the design, development, and production cycles of an acquisition.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 2

APPLICABLE DOCUMENTS

2.1 COMPLIANCE DOCUMENTS

Unless otherwise specified, the following specifications, standards, and handbooks of the revision in effect at the time of invitation to bid to the Government acquisition activity form part of this document to the extent specified herein. Changes to the revision level of the specifications, standards, and handbooks listed below shall be incorporated on new procurements of both Government Qualified and Non-Government Qualified Products as specified by the document preparing activity at the time of the document change. ***Piece parts and materials shall be acceptable for program use to depletion provided they meet the requirements of the revisions in effect at the date of manufacture.***

MILITARY SPECIFICATIONS

MIL-C-17	Cables, Radio Frequency, Flexible and Semirigid, General Specification for
MIL-PRF-20	Capacitors, Fixed, Ceramic Dielectric (Temperature Compensating), Established and Non-Established Reliability, General Specification for
MIL-PRF-27	Transformer and Inductor (Audio, Power, and High Power Pulse), General Specification for
MIL-PRF-123	Capacitors, Fixed, Ceramic Dielectric, (Temperature Stable and General Purpose), High Reliability, General Specification for
MIL-PRF-3098	Crystal Unit, Quartz, General Specification for
MIL-C-3655	Connector, Plug and Receptacle, Electrical (Coaxial Series Twin), and Associated Fittings, General Specification for
MIL-R-5757	Relays, Electromagnetic, General Specification for
MIL-PRF-6106	Relay, Electromagnetic (Including Established Reliability (ER) Types), General Specification for
MIL-PRF-9395	Switches, Pressure, (Absolute, Gage and Differential), General Specification for
MIL-S-13949	Plastic Sheet, Metal-Clad (For Printed Wiring Boards), General Specification for

MIL-PRF-15305 Coil, Fixed and Variable, Radio Frequency, General Specification for

MIL-PRF-19500 Semiconductor Devices, General Specification for

MIL-PRF-19978 Capacitors, Fixed, Plastic (or Paper-plastic) Dielectric, (Hermetically Sealed, in Metal, Ceramic, or Glass Cases) Established and Non-established Reliability, General Specification for

MIL-PRF-21038 Transformer, Pulse, Low Power, General Specification for

MIL-W-22759 Wire, Electric, Fluoropolymer-Insulated, Copper or Copper Alloy

MIL-PRF-23269 Capacitors, Fixed, Glass Dielectric, Established Reliability, General Specification for

MIL-PRF-23419 Fuse, Instrument Type, General Specification for

MIL-PRF-23648 Thermistor (Thermally Sensitive Resistor), Insulated, General Specification for

MIL-PRF-24236 Switches, Thermostatic, (Metallic and Bimetallic), General Specification for

MIL-C-26482 Connector, Electrical, (Circular, Miniature, Quick Disconnect, Environment Resisting) Receptacles and Plugs, General Specification for

MIL-PRF-28861 Filters and Capacitors, Radio Frequency/Electromagnetic Interference Suppression, General Specification for

MIL-PRF-38534 Hybrid Microcircuits, General Specification for

MIL-PRF-38535 Integrated Circuits (Microcircuits) Manufacturing, General Specification for

MIL-PRF-39003 Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability, General Specification for

MIL-PRF-39005 Resistor, Fixed, Wirewound (Accurate), Established Reliability, General Specification for

MIL-PRF-39006 Capacitors, Fixed Electrolytic (Nonsolid Electrolyte), Tantalum, Established Reliability, General Specification for

MIL-PRF-39007 Resistor, Fixed, Wirewound (Power Type), Established Reliability, General Specification for

MIL-PRF-39009 Resistor, Fixed, Wirewound (Power Type, Chassis Mounted), Established Reliability, General Specification for

MIL-PRF-39010 Coil, Fixed, Radio Frequency, Molded, Established Reliability, General Specification for

MIL-PRF-39012 Connector, Coaxial, Radio Frequency, General Specification for

MIL-PRF-39014 Capacitors, Fixed, Ceramic Dielectric (General Purpose), Established Reliability, General Specification for

MIL-PRF-39015 Resistor, Variable, Wirewound (Lead Screw Actuated), Established Reliability, General Specification for

MIL-PRF-39016 Relay, Electromagnetic, Established Reliability, General Specification for

MIL-PRF-39017 Resistor, Fixed Film (Insulated), Established Reliability, General Specification for

MIL-C-39029 Contact, Electrical Connector, General Specification for

MIL-PRF-39035 Resistor, Variable, Non-wirewound (Adjustment Type), Established Reliability, General Specification for

MIL-PRF-55182 Resistor, Fixed, Film, Established Reliability, General Specification for

MIL-DTL-55302 Connector, Printed Circuit Subassembly and Accessories

MIL-PRF-55310 Oscillators, Crystal, General Specification for

MIL-PRF-55342 Resistor, Fixed, Film, Chip, Established Reliability, General Specification for

MIL-PRF-55365 Capacitor, Chip Fixed Tantalum, Established Reliability

MIL-PRF-55681 Capacitors, Chip, Multiple Layer, Fixed, Encapsulated, Ceramic Dielectric, Established Reliability, General Specification for

MIL-W-81044 Wire, Electric, Crosslinked Polyalkene, Crosslinked Alkane-imide Polymer or Polyaralene Insulated, Copper of Copper Alloy

MIL-W-81381 Wire, Electric, Polyimide - Insulated, Copper or Copper Alloy

MIL-PRF-83401 Resistor Networks, Fixed, Film, General Specification for

MIL-PRF-83421 Capacitors, Fixed, Supermetallized, Plastic Film Dielectric, (DC, AC, or DC and AC), Hermetically Sealed in Metal Cases, Established Reliability

MIL-PRF-83723 Connector, Electrical, (Circular, Environment Resisting), Receptacle and Plugs, General Specification for

MIL-PRF-83733 Connector, Electrical, Miniature, Rectangular Type, Rack to Panel, Environment Resisting, 200°C Total Continuous Operating Temperature, General Specification for

MIL-PRF-87164 Capacitors, Fixed, Mica Dielectric, High Reliability, General Specification for

MIL-PRF-87217 Capacitors, Fixed, Supermetallized Plastic Film Dielectric, Direct Current for Low Energy, High Impedance Applications, Hermetically Sealed in Metal Cases, Established Reliability, General Specification for

MILITARY STANDARDS

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts

MIL-STD-750 Test Methods for Semiconductor Devices

MIL-STD-883 Test Methods and Procedures for Microelectronics

MIL-STD-981 Design, Manufacturing, and Quality Standards for Custom Electromagnetic Devices for Space Applications

MIL-STD-1580 Destructive Physical Analysis for Space Quality Parts

MIL-STD-1686 Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices) (Metric)

MILITARY HANDBOOKS

MIL-HDBK-198 Capacitor, Selection and Use of

MIL-HDBK-199 Resistor, Selection and Use of

MIL-HDBK-217 Reliability Prediction of Electronic Equipment

DOD-HDBK-263 Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, and Equipment

MIL-HDBK-279 Total Dose Hardness Assurance Guidelines for Semiconductor Devices and Microcircuits

MIL-HDBK-280 Neutron Hardness Assurance Guidelines for Semiconductor Devices and Microcircuits

MIL-HDBK-454 Standard General Requirements for Electronic Equipment

MIL-HDBK-1331 Parameters to be Controlled for the Specification of Microcircuits

MIL-HDBK-339 Custom Large Scale Integrated Circuit Development and Acquisition for Space Vehicles

(Copies of specifications, standards, handbooks, drawings, and publications required by contractors in connection with specified acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

OTHER MILITARY DOCUMENTS

AFSCP 800-27 Parts Derating Guidelines; Department of the Air Force, Air Force Systems Command (AFSC) Pamphlet 800-27

Application for copies should be addressed to: Department of the Air Force, Headquarters Air Force Systems Command, Andrews Air Force Base, DC 20334

NASA PUBLICATIONS

TM X-64755 Guidelines for the Selection and Application of Tantalum Electrolytic Capacitors in Highly Reliable Equipment

Application for copies should be addressed to: National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161

MSFC-STD-355 Radiographic Inspection of Electronic Parts

Application for copies should be addressed to: Marshall Space Flight Center, Document Repository (AS24D), Huntsville, AL 35812

NHB 5300.4 Requirements for Soldered Electrical Connections (3A-1)

2.2 GUIDANCE DOCUMENTS

MILITARY SPECIFICATIONS

MIL-B-121	Barrier Material, Greaseproofed, Waterproofed, Flexible
MIL-B-131	Barrier Materials, Water Vapor Proof, Flexible, Heat-Sealable
J-W-1177	Wire, Magnet, Electrical, General Specification
MIL-C-5015	Connector, Electrical, Circular Threaded, AN Type, General Specification for
MIL-T-5021	Tests, Aircraft, and Missile Welding Operators' Qualification
MIL-H-6088	Heat Treatment of Aluminum Alloys
MIL-H-6875	Heat Treatment of Steels (Aircraft Practice), Process for
MIL-C-7438	Core Material, Aluminum, for Sandwich Construction
MIL-B-7883	Brazing of Steels, Copper, Copper Alloys, Nickel Alloys, Aluminum and Aluminum Alloys
MIL-W-8939	Welding, Resistance, Electronic Circuit Modules
MIL-T-9047	Titanium and Titanium Alloy Bars and Forging Stock
MIL-A-9067	Adhesive Bonding, Process and Inspection, Requirements for
MIL-C-15305	Coil, Fixed and Variable, Radio Frequency, General Specification for
MIL-A-21180	Aluminum Alloy Castings, High Strength
MIL-B-22191	Barrier Material, Transparent, Flexible, Heat Sealable
MIL-C-24308	Connector, Electric, Rectangular, Miniature Polarized Shell, Rack and Panel, General Specification for
MIL-C-27500	Cable, Electrical Shielded and Unshielded, Aerospace
MIL-P-28809	Printed Wiring Assemblies
MIL-M-38510	Microcircuits, General Specification for

MIL-C-38999 Connector, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breach Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for

MIL-R-39008 Resistor, Fixed, Composition (Insulated), Established Reliability, General Specification for

MIL-S-45743 Soldering, Manual Type, High Reliability Electrical and Electronic Equipment

MIL-I-46058 Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)

MIL-A-46106 Adhesives - Sealants, Silicone, RTV, One-component

MIL-A-46146 Adhesives - Sealants, Silicone, RTV, Noncorrosive (For use with sensitive metals and equipment)

MIL-I-46058 Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)

MIL-I-46843 Printed Wiring Assemblies

MIL-S-46844 Solder Bath Soldering of Printed Wiring Assemblies

MIL-P-50884 Printed Wiring, Flexible and Rigid-Flex

MIL-P-55110 Printed Wiring Boards, General Specification for

MIL-H-81200 Heat Treatment of Titanium and Titanium Alloys

MIL-B-81705 Barrier Materials, Flexible, Electrostatic-Free, Water Vapor Proof, Heat Sealable

MIL-A-83377 Adhesive Bonding (Structural) for Aerospace and Other Systems, Requirements for

MIL-R-87254 Resistor, Fixed, Film, High Reliability, General Specification for

MILITARY STANDARDS

MIL-STD-401 General Test Methods, Sandwich Construction and Core Materials

MIL-STD-403 Preparation for and Installation of Rivets and Screws, Rocket and Missile Structures

MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-275	Printed Wiring for Electronic Equipment
MIL-STD-976	Certification Requirements for JAN Microcircuits
MIL-STD-1132	Switches and Associated Hardware, Selection and Use of
MIL-STD-1346	Relays, Selection and Application
MIL-STD-1353	Electrical Connectors and Associated Hardware, Selection and Use of
MIL-STD-1521	Technical Reviews and Audits for Systems, Equipment, and Computer Software
MIL-STD-1772	Certification Requirements for Hybrid Microcircuit Facilities and Lines
MIL-STD-1522	Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems
MIL-STD-1523	Age Controls of Age-sensitive Elastomeric Material (for Aerospace Applications)
MIL-STD-1540	Test Requirements for Space Vehicles
MIL-STD-1595	Qualification of Aircraft, Missile, and Aerospace Fusion Welders
MIL-STD-2073	DOD Material Procedures for Development and Application of Packaging Requirements
MIL-STD-2154	Inspection, Ultrasonic, Wrought Metals, Process for

MILITARY HANDBOOKS

MIL-HDBK-5	Metallic Materials and Elements for Aerospace Vehicle Structures
MIL-HDBK-17	Polymer Matrix Composites, Volume 1, Guidelines
MIL-HDBK-23	Structural Sandwich Composites

(Copies of specifications, standards, handbooks, drawings, and publications required by contractors in connection with specified acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

FEDERAL STANDARDS

FED-STD-209 Clean Room and Work Station Requirements, Controlled Environment

NASA PUBLICATIONS

MSFC-SPEC-250 Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification for

MSFC-SPEC-504 Specification: Welding Aluminum Alloys

MSFC-SPEC-522 Design Criteria for Controlling Stress Corrosion Cracking

Application for copies should be addressed to: Marshall Space Flight Center, Document Repository (AS24D), Huntsville, AL 35812

INDUSTRY SPECIFICATIONS

ASTM-E595-84 Total Mass Loss and Collected Volatile Condensable Materials From Outgassing in a Vacuum Environment, Standard Test Method for

AMS-2770 Heat Treatment of Aluminum Alloy Parts

IPC-2221/2223 Flexible and Rigid-Flex Wiring for Electronic Equipment, Design Requirements for

IPC-J-STD-001 Requirements for Soldered Electrical and Electronic Assemblies

NEMA-MW1000 Wire, Magnet, Electrical, General Specification

SAE AMS2422 Gold Plating, Electrodeposited

SAE AS-9100 Quality Program Requirements

SAE-AS-50881 Wiring, Aerospace Vehicle

2.3 ORDER OF PRECEDENCE

In the event of a conflict between the text of this document and the references cited herein, the text of this document shall take precedence. Nothing in this document, however, shall supersede applicable laws and regulations.

SECTION 3

DEFINITIONS AND ACRONYMS

3.1 DEFINITIONS

3.1.1 Catastrophic Electronic Part Failures. A catastrophic failure shall be defined as any open or short or any parametric measurement which exceeds its specified limits by 100% or more. The PMPCB may define a tighter requirement based upon the device application.

3.1.2 Categories of Contractor. A contractor for the extent of this document shall be defined as a producer of modules or higher level items of equipment. A contractor that provides items to another contractor shall be identified as a subcontractor. If only one major contractor is responsible directly to the Government acquisition activity, that contractor shall be identified as the prime contractor and shall be responsible for managing the program Parts, Materials, and Processes Control Program. If two or more contractors are responsible directly to the Government acquisition activity, those contractors shall be identified as associate contractors. The Government acquisition activity may designate one associate contractor as responsible for managing the program Parts, Materials, and Processes Control Program. In this document, when the term contractor is used, it applies to the prime, the associate, or the subcontractor, whichever is applicable.

3.1.3 Categories of Electronic Components.

3.1.3.1 Category I. Any component that is defined as both mission critical and single string or is part of the flight termination system.

3.1.3.2 Category II. Any component that is defined as either non-mission critical or redundant excluding flight termination system components.

3.1.4 Component. A component is an assembly of two or more parts which in their assembled form combine to perform a vehicle level function. A component is replaceable as a unit and, through proper disassembly, is subject to repair and rework. Examples of assemblies classified as components are actuators, valves, batteries, electrical harnesses, and individual electronic boxes.

3.1.5 Connector/Pins. A connector shall consist of the connector shell, insert, and contacts.

3.1.6 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 their authority as delegated by the contracting officer.

3.1.7 ***Critical Non-electronic Part or Material. Any one non-electronic part or material in any one application which with one single failure would cause loss of primary mission objectives or flight safety requirements.***

3.1.8 Custom Part. A Custom Part is an electronic part procured to a non-military specification. Active custom electronic parts shall be built, tested, and qualified in full accordance with the minimum Custom processing and screening requirements specified in Sections IV (Microcircuits), V (Hybrids), and VI (Transistors and Diodes) of Appendix B and Tables D-1 through D-4 (Relays) of Appendix D. Custom parts will look similar to JANS/Class S parts with the contractor acquisition activity performing those tasks specified in Appendix B and Appendix D on the Custom product that DESC normally performs on the Space Quality product.

3.1.9 Electronic Component. An electronic component is a component, as defined in paragraph 3.1.4, which provides electrical signals to or receives electrical signals from other components on the vehicle or on the ground.

3.1.10 Electronic Parts. For the purposes of this document, electronic parts shall be defined as all electronic, electromechanical, electro-optical and electrical (EEE) parts.

3.1.11 Established Reliability. Established reliability (ER) codes are assigned to certain military specification, QPL'd parts based upon continuous sample testing of each lot date code. Test results are expressed as either an Exponential or a Weibull failure rate level. For the purposes of this document, Exponential failure rate "S" shall be equivalent to Weibull failure rates "E", "D", "C", and "B".

3.1.12 Expendable Launch Vehicle Quality PMP Baseline. For the purposes of this document the ELV Quality PMP Baseline is defined as:

a. Semiconductors (transistors and diodes) procured to:

   1. MIL-PRF-19500, Appendix E, Table IV, JANS.

   2. The Custom processing and screening requirements called out in Section VI (Tables B-6a through B-6d) of Appendix B.

   3. MIL-PRF-19500, Appendix E, Table IV, JANTXV, PIND & XRAY, listed on the QPL, and upscreened to the requirements of Section III (Tables B-3a through B-3c) of Appendix B.

b. Microcircuits procured to:

   1. The detailed specifications of MIL-PRF-38535, Class V.

   2. The Custom processing and screening requirements called out in Section IV (Tables B-4a through B-4d) of Appendix B.

3. The detailed specifications of MIL-PRF-38535, Class Q, listed on the applicable specification's QPL/QML, and upscreened to the requirements of Section I (Tables B-1a through B-1c) of Appendix B.

c. Hybrids procured to:

1. The detailed specifications of MIL-PRF-38534, Appendix C. The manufacturing facility shall be certified to MIL-STD-1772.

2. The custom processing and screening requirements called out in Section V (Tables B5-a through B5-d) of Appendix B. The manufacturing facility shall be certified to MIL-STD-1772.

3. The detailed specifications of MIL-PRF-38534, listed on the QPL, and upscreened to the requirements called out in Section II (Tables B2-a through B2-c) of Appendix B. The manufacturing facility shall be certified to MIL-STD-1772.

d. Relays procured to:

1. The custom processing and screening requirements called out in Appendix D, Tables D-1 through D-4.

2. The detailed specifications of MIL-PRF-39016, failure rate level "P" or better, and listed on the applicable specification's QPL.

e. Magnetic devices manufactured and screened in accordance with MIL-PRF- 27, MIL-STD-981, Class S, with the exceptions noted herein, MIL-PRF-21038, or MIL-PRF-39010, whichever is applicable.

f. Resistors***/Thermistors*** procured to:

1. The detailed specification of MIL-PRF-55182 and listed on the applicable QPL.

2. The detailed specifications of MIL-PRF-39005, MIL-PRF-39007, MIL-PRF-39009, MIL-PRF-55182, MIL-PRF-55342, ***or MIL-PRF-83401,*** Exponential failure rate "S" or "R".

3. ***The detailed specifications of MIL-PRF-23648 and listed on the applicable QPL.***

g. Capacitors procured to:

1. The detailed specifications of MIL-PRF-123, MIL-PRF-49467, MIL-PRF-87164, or MIL-PRF-39003/10, failure rate "C", and listed on the applicable QPL.

2. The detailed specification of MIL-PRF-23269, MIL-PRF-39003, MIL-PRF-39006, MIL-PRF-55365, MIL-PRF-83421, Exponential failure rate "S" or "R" or Weibull failure rate "E", "D", "C", or "B".

h. Wire and cable constructions listed in Appendix E.

i. Connectors manufactured and screened in accordance with MIL-C-3655, MIL-C-5015, MIL-C-24308, MIL-C-26482, MIL-C-38999, MIL-PRF-39012, MIL-DTL-55302, MIL-PRF-83723, or MIL-PRF-83733, whichever is applicable.

j. Crystal Oscillators manufactured and screened in accordance with MIL-PRF-3098 or MIL-PRF-55310.

k. Fuses manufactured and screened in accordance with MIL-PRF-23419.

l. Filters *manufactured and screened in accordance with the Class B requirements of MIL-PRF-28861, with the exception that all piece parts utilized in the filter meet the requirements of the ELV quality PMP baseline.*

m. Materials and processes listed in the approved Parts, Materials, and Processes Selection List (PMPSL) for unlimited use.

n. Materials and processes which meet the requirements or guidelines specified in Appendix A.

o. Non-EEE parts listed in the PMPSL for unlimited use and/or manufactured to any military specification listed in the Department of Defense Index of Specifications and Standards (DODISS).

3.1.13 Heritage Design Components. For purposes of PMP requirements only, all components that are not defined as new design and that have been previously used in an Atlas, Delta, Titan, IUS, or Centaur class launch vehicle shall be considered heritage design.

3.1.14 Inspection (Upscreening) Lot. For the purposes of testing to be performed by the contractor acquisition activity only, an inspection lot shall be defined as a group of parts of the same device type with the same lot date code produced by the same manufacturer and procured at one time. Inspection lots of resistors and capacitors may contain different resistance or capacitance values built with the same lot date code. For device types requiring 100% screening and lot

acceptance testing, Percent Defective Allowable and Lot Tolerance Percent Defective shall be applied across the entire inspection lot.

3.1.15 Lot Acceptance Testing (LAT). Testing performed, where specified, on a sample of each inspection lot after 100% screening has been successfully completed to assure that the device and lot quality conforms with the requirements of the applicable procurement document.

3.1.16 Lot Date Code. A unique device type lot date code is defined as the four digit manufacturer's date code, and all prefixes and suffixes.

3.1.17 Lot Rejection. Lot rejection is the failure of an inspection lot to meet one or more of the screening and acceptance criteria specified herein. Lot failures shall be submitted to the PMPCB for further technical evaluation, if further consideration is requested. Where one-time automatic resubmission or retesting is specified herein, that action may be taken without PMPCB evaluation or approval.

3.1.18 Manufacturing Baseline. The manufacturing baseline is an engineering drawing(s), normally in the form of a flow chart, of the sequence of manufacturing operations necessary to produce a specific part, including all process specifications and revisions, lot travelers, and the construction analysis.

3.1.19 Material. Material is a metallic or nonmetallic element, alloy, mixture, or compound used in a manufacturing operation which becomes a permanent portion of the manufactured item.

3.1.20 Material Lot. A lot for material refers to material produced as a single batch or in a single continuous operation or production cycle and offered for acceptance at any one time.

3.1.21 Mission Critical Component. Any system/circuit installed on an ELV whose failure could cause loss of primary mission objectives or flight safety requirements.

3.1.22 Modified Design *Component*. For purposes of PMP requirements only, when any modification changes a component to the extent that some form of requalification, other than qualification by similarity, is required, the hardware modified, not the entire component, shall be considered modified design hardware.

3.1.23 Monitor. Monitoring shall be defined as physically witnessing tests. Monitoring shall be performed, as a minimum, on a sample basis.

3.1.24 New Design Component. For purposes of PMP requirements only, any component not previously qualified to Atlas, Delta, Titan, Centaur, or Inertial Upper Stage (IUS) class launch vehicle requirements or not previously flown on an Atlas, Delta, Titan, Centaur, or IUS class launch vehicle shall be considered new design.

3.1.25 Non-Mission Critical Component. Any system/circuit installed on an ELV whose failure could not cause loss of primary mission objectives or flight safety requirements.

3.1.26 Off-the-Shelf Item. An off-the-shelf item is a part or component which has been developed and produced to military or commercial standards and specifications and is readily available for delivery from an industrial source. The internal configuration of off-the-shelf items is typically not controlled by the buyer.

3.1.27 Parts, Materials, and Processes Control Board (PMPCB). The PMPCB is a formal organization established by this document to assist the contractor in managing and controlling and the acquisition activity in overseeing the selection, application, procurement, and documentation of parts, materials, and processes used in equipment, systems, or subsystems.

3.1.28 Parts, Materials, and Processes Control Board (PMPCB) Action Form. The PMPCB action form is a one page document utilized to submit and track PMPCB decisions requiring Government PMPCB member approval. As a minimum, the PMPCB action form contains a log number, description of request, justification for the request, and signature and comment blocks for Government disposition. A sample action form is included in Appendix K. The exact format of the form will be as approved by the PMPCB.

3.1.29 Parts, Materials, and Processes Selection List (PMPSL). The PMPSL is a list of all parts, materials, and processes which are approved for new and modified designs in a specific contract.

3.1.30 Piece Part. A piece part is one piece, or two or more pieces joined together, which are not normally subjected to disassembly without destruction or impairment of its designed use. For the purposes of this document, all uses of the term "part" shall mean "piece part".

3.1.31 Process. A process is an operation, treatment, or procedure used during a step in the manufacture of a material, part, or assembly.

3.1.32 Product Baseline Record. The product baseline record is a listing of all process/manufacturing documents, including revision level and date, used in the manufacture/assembly of the part.

3.1.33 Production Lot (Electronic Parts). A production lot of electronic parts shall be as defined in the appropriate military specifications. All parts in the same production lot shall be segregated by lot date code in accordance with the applicable specifications.

3.1.34 Production Lot (Non-electronic Parts). A production lot shall consist of parts of the same type, of the same physical dimensions, manufactured from the same material (the same heat treat lot of material where applicable), and processed as one batch in one continuous run and submitted for the manufacturer's final inspection at the same time.

3.1.35 Redundant System/Circuit. Any system/circuit, consisting of two independent paths performing the same function, which can function *within the required performance limits* with the failure of either but not both paths shall be considered redundant.

3.1.36 Single String System/Circuit. Any system/circuit which cannot be defined as redundant shall be considered single string.

3.1.37 Screening Lot. Subset of an inspection (upscreening) lot split for the convenience of 100% screening.

3.1.38 Space Quality Part. A Space Quality part is an electronic part that is built, tested, qualified, and procured in full accordance with the space quality level requirements as specified in the part's general and detailed military specification and is listed on the appropriate military specification's Qualified Products List (QPL) or Qualified Manufacturers List (QML). A list of designators for space quality parts for the applicable specifications is shown below:

a. MIL-PRF-123 - All QPL'd devices
b. MIL-PRF-19500 - JANS
c. MIL-PRF-28861 - Class S
d. MIL-PRF-38510 - Class S
e. MIL-PRF-38534 - Class K
f. MIL-PRF-38535 - Class V
g. MIL-PRF-39003 - All /10, failure rate level C, QPL'd devices
h. MIL-PRF-87164 - All QPL'd devices
i. MIL-PRF-87217 - All /1, /3, and /4 QPL'd devices
j. MIL-PRF-87254 - All QPL'd devices
k. MIL-STD-981 - Class S with exceptions noted herein

3.1.39 Supplier/Vendor. Any organization that provides parts or components to other contractors for use in higher order assemblies and is not considered a subcontractor.

3.2 ACRONYMS

3.2.1 AQL - Acceptable Quality Level

3.2.2 CDRL - Contract Data Requirements List

3.2.3 DPA - Destructive Physical Analysis

3.2.4 EEE - Electronic, Electromechanical, Electro-optical, and Electrical

3.2.5 ELV - Expendable Launch Vehicle

3.2.6 ER - Established Reliability

3.2.7 ESD - Electrostatic Discharge

3.2.8 IUS - Inertial Upper Stage

3.2.9 LAT - Lot Acceptance Test

3.2.10 LTPD - Lot Tolerance Percent Defective

3.2.11 MUA - Material Usage Agreement

3.2.12 OEM - Original Equipment Manufacturer

3.2.13 PAR - Part Approval Request

3.2.14 PDA - Percent Defective Allowable

3.2.15 PMP - Parts, Materials, and Processes

3.2.16 PMPCB - Parts, Materials, and Processes Control Board

3.2.17 PMPSL - Parts, Materials, and Processes Selection List

3.2.18 QML - Qualified Manufacturers List

3.2.19 QPL - Qualified Products List

3.2.20 SCD - Source Control Drawing

3.2.21 SPWG - Space Parts Working Group

SECTION 4

REQUIREMENTS

4.1 PARTS, MATERIALS, AND PROCESSES CONTROL PROGRAM PLANNING

The contractor shall establish a parts, materials, and processes control program in accordance with the requirements of this document.

4.1.1 Parts, Materials, and Processes Control Program Plan(s). The parts, materials, and processes control program shall be documented in a plan(s) (See Appendix K for sample content) prepared by the contractor identified and tasked by the Government acquisition activity to plan, manage, and coordinate the program level PMP. The plan shall be comprehensive and shall describe how the contractor's effort is to be organized, managed, and conducted to meet the requirements of this document. The plan shall also address how the contractor ensures the flow down of the applicable parts, materials, and processes control program requirements to all the applicable subcontractors and suppliers/vendors. Individual topics or subordinate plans may be prepared as separate documents and incorporated by reference into the overall parts, materials, and processes control program plan. Existing contractor nonproprietary in-house documentation may be used and referenced in the plan when applicable. The use of this existing documentation is encouraged. Contractor documents referenced in the plan shall be made available for review by the Government acquisition activity upon request.

The parts, materials, and processes control program plan shall address the following major topics:

a. A PMPCB operating procedure , including membership, membership responsibilities in supporting PMPCB meetings, preparing PMP documentation, and providing timely information on and resolution of PMP problems, membership authority, PMP review procedures, PMP approval procedures, and plans for updating the operating procedure. The contractor may selectively establish more than one control board based upon the product types, parts, materials, and processes. Each control board shall have a single focal point who shall be subordinate to the PMPCB chairman. The responsibilities and authority of each board shall be clearly defined within the PMP Control Program Plan.

b. Definition of the contents of the PMPSL and procedures for updating, approving, and ensuring the appropriate distribution of the PMPSL.

c. Inventory control plan in accordance with paragraph 4.5.11.

d. Application and derating documents to meet program derating policy and the requirements stated herein.

e. Plans and procedures for manufacturer and subcontractor surveillance and auditing, where applicable.

f. Plans and procedures for qualification of PMP and qualification updating.

g. Policies and procedures to ensure that design engineers select PMP described by the ELV Quality PMP Baseline to the maximum extent possible.

h. Plans and procedures for conducting destructive physical analysis of piece parts, where required, and related review and approval procedures.

i. Suspect Parts & Materials Control Program per paragraph 4.5.14.

j. Program integration of PMP requirements, reliability requirements, and quality control efforts. Include methods for coordination between the PMPCB, Failure Review Board or similar Quality Board, Material Review Board, and other applicable boards or groups.

k. Definition of the authority of the PMPCB as it relates to various groups within the prime, associate, and subcontractor organizations.

l. Radiation Hardness Assurance Program per Appendix J, if applicable.

m. Plans and procedures to meet the electrostatic discharge protection requirements of DOD-STD-1686 for PMP.

n. Plans and procedures for contamination control of critical surfaces of piece parts and materials during shipping, storage, manufacturing, and handling.

o. Plans and procedures for review and disposition of PARs, MUAs, and PMPCB Action Forms, including resolution of disputed interpretations of requirements.

p. Descriptions and definitions of general requirements, standard clauses, format requirements, and content outlines of upscreening and Custom S drawings.

q. Ground rules defining conditions which necessitate the revision and resubmittal of a previously approved PAR or MUA.

r. Plans and procedures for conducting failure analysis, where required, and related review and approval procedures.

4.2 PARTS, MATERIALS, AND PROCESSES CONTROL BOARD(S) (PMPCB)

A Parts, Materials, and Processes Control Board(s) (PMPCB) shall be implemented by the contractor who is identified and tasked by the Government acquisition activity to plan, manage, and coordinate at the program level, the selection, application, and procurement requirements of all PMP. PMPCB findings and decisions shall be within the contractual scope of this document and the contract and shall be implemented by all applicable contractors. The Government acquisition activity shall have the right of disapproval of PMPCB decisions.

4.2.1 Membership. The PMPCB membership shall include at least one member from each contractor and each appropriate subcontractor. However, representation at individual meetings shall be based upon subject matter and topics scheduled on the agenda and any special walk-in items. The Government acquisition activity shall be represented by an active member on the PMPCB. Other members may be designated by the Government acquisition activity and/or the Chairman of the PMPCB. Each member shall be capable of being supported in technical matters as required. Each member shall have the authority to commit his organization or company to PMPCB decisions which are within the scope of this document.

4.2.2 Delegation. The authority to conduct PMPCBs may be delegated by the PMPCB to major subcontractors. Each major subcontractor granted this delegation shall supply the prime PMPCB with meeting minutes (See Appendix K for sample content) documenting their decisions in a timely manner. This information shall be made available to the Government acquisition activity. The prime PMPCB and Government acquisition activity shall retain the right of disapproval of decisions made at all delegated PMPCBs.

4.2.3 PMPCB Meeting Schedules. PMPCB meetings shall be held as follows:

a. A post-award PMPCB organizational meeting shall be convened by the contractor designated the program PMPCB manager. The chairman of the PMPCB shall coordinate the date and location of the meeting with the Government acquisition activity, and inform proposed members and representatives of the schedule. This meeting is intended to establish initial working relationships, responsibilities, and procedures for implementation of the PMP Control Program. This initial meeting shall also be used as a forum to present and answer any questions regarding the requirements of the PMP control program. This meeting may be held in conjunction with other scheduled contract review meetings.

b. Subsequent PMPCB meetings shall be held as necessary to implement the PMP program in a timely manner consistent with other program activities and schedules. Meetings shall be held quarterly or as designated by the PMPCB Chairman. These meetings shall address a full PMP program agenda as agreed to by the PMPCB.

c. Special PMPCB meetings may be called by the PMPCB chairman to discuss special agenda items which require expeditious resolution. Adequate notification must be provided to all the PMPCB members and representatives.

4.2.4 PMPCB Responsibilities.

a. The PMPCB Chairman shall establish PMPCB operating procedures in accordance with this document. These operating procedures shall be approved by the PMPCB.

b. The PMPCB Chairman shall ensure the establishment and maintenance of a program PMPSL. The PMPCB Chairman shall coordinate the identification and applicable data for candidate PMP proposed for the PMPSL. The PMPCB shall review and approve Part Approval Requests (PAR) and Material Usage Agreements (MUA) and the supporting data, including qualification and evaluation plans.

c. The PMPCB Chairman shall ensure the selection and use of PMP meeting the ELV Quality PMP Baseline to the maximum extent practicable. The PMPCB chairman shall ensure that the responsible PMP engineering functions are involved up-front in the design process to both maximize the use of Space Quality parts and to standardize PMP usage wherever possible.

d. The PMPCB Chairman shall ensure the procurement of PMP to the orders of precedence specified in Appendix L.

e. The PMPCB shall ensure compliance with the PMP requirements of this document. This shall include the review of custom specifications for compliance to the requirements specified herein.

f. The PMPCB shall ensure that the derating for electronic parts used in new or modified design hardware meets the requirements of this document and the system requirements. The PMPCB shall evaluate and approve any exceptions to this derating policy.

g. The PMPCB shall ensure that the derating policies used for heritage design hardware meet system requirements.

h. The PMPCB shall ensure the establishment of destructive physical analysis (DPA) policies, procedures, and reporting formats. ***The PMPCB shall review and approve all DPA policies and procedures for compliance with Program requirements.*** A standard DPA policy, procedure, and reporting format for use by all contractors and subcontractors, using MIL-STD-1580 as a guideline, is highly encouraged. Problem DPA findings and summary reports shall be reviewed by the PMPCB on a regular basis.

i. The PMPCB shall ensure the review of the results of receiving inspection, destructive physical analysis, Material Review Board actions, failure analyses, and problems pertaining to PMP, including those identified in the field. PMP problem areas shall be presented at all PMPCB meetings for the PMPCB's review and approval.

j. The PMPCB shall ensure the timely identification of long lead procurement items.

k. The PMPCB shall ensure the identification and configuration control of those changes required in PMP specifications necessary to meet the equipment, system, or subsystem requirements.

l. The PMPCB shall ensure the review and approval of all substitute part lists.

For PRODUCTION ASSEMBLIES, the PMPCB shall ensure that substitute parts meet the technical requirements of this document as a minimum. Exceptions shall require Government acquisition activity approval.

For QUALIFICATION ASSEMBLIES, the PMPCB shall ensure that the substitute part is the same device type in form, fit and function as the part to be used in the production assemblies, with only the quality level being lower. Approval of the use of these substitute parts by the Government acquisition activity does not imply acceptance of risk by the Government acquisition activity. The contractor shall assume all risks inherent in the use of these substitute parts.

m. The PMPCB shall ensure the review and approval of all contracted screening and DPA facilities. All screening and DPA facilities shall be reviewed prior to first contract award from the contractor acquisition activity and subsequently, as a minimum, on a yearly basis, if further usage of the approved facility is requested.

n. ***The PMPCB shall annually issue an official list of approved screening and DPA facilities to all contractors.***

o. The PMPCB shall ensure the timely review of all Action Forms, assigning numbers and maintaining a status summary which shall be distributed at all regular PMPCB meetings. The PMPCB shall send a copy of the closed PMPCB Action Form to all contractors affected by the decision. When requested in writing, the PMPCB shall also supply copies of any other PMPCB Action Forms.

4.2.5 PMPCB Authority. The PMPCB shall have the authority to make both technical and programmatic decisions that fall within the scope of this document. Where specified herein, PMPCB decisions shall be documented on a PMPCB Action Form and submitted to the Government acquisition activity designated members of the PMPCB, in a timely manner, for review and disposition. ***Government disposition shall be completed in a mutually agreed upon time-frame.***

For records clarity, each PMPCB Action Form shall be numbered and request the approval of one issue, PAR, or MUA only.

4.2.6 Responsibilities of the Program PMP Contractor. The contractor designated by the Government acquisition activity as responsible for the PMP Control Program shall:

a. Provide the PMPCB chairman, conduct PMPCB meetings, prepare and distribute PMPCB meeting notices, agenda (See Appendix K for sample content), and meeting minutes (See Appendix K for sample content), and manage the PMPCB.

4.3 MANAGEMENT OF PMP SELECTION

The contractor shall manage the selection of PMP in accordance with the criteria specified in this document. After contract award, the contractor shall develop a Parts, Materials, and Processes Selection List (PMPSL) to be used on the program in their design and manufacturing. ***The approved PMPSL shall be provided to each subcontractor no later than the first preliminary design review.***

4.3.1 PMP Selection for Systems Designs. PMP shall be selected to meet the requirements of the system application; however, design preference shall be given to Space Quality parts and materials and processes that are described by the ELV Quality PMP Baseline.

4.3.1.1 Electronic Part Selection. Electronic parts ***used in new, heritage, or modified hardware*** shall meet the requirements of the ELV Quality PMP Baseline. Parts selected that do not meet the requirements of the ELV Quality Baseline shall be submitted to the PMPCB on a PAR. A PMPCB action form shall be generated for every PAR approved by the PMPCB and forwarded to the Government PMPCB representatives for disposition. For ***Category II*** systems/circuits, JANTXV and Class B parts upscreened to the requirements of Appendix B with the exception that LAT is not performed do not require a PAR. All open PARs and PARs over which there are concerns shall be clearly identified at all design reviews with justification for their selection and use. The Design Review package, in accordance with the requirements of MIL-STD-1521, shall include a list of all approved PARs included in the parts list. This list need not be presented in the formal review.

For ***Category I*** systems/circuits, the responsible engineering function or subcontractor shall be required to brief the PMPCB, throughout the design process, on the technical rationale for the selection of non-Space Quality active electronic parts. The PMPCB shall ensure through these briefings that Space Quality parts are used to the maximum extent possible.

4.3.1.2 Material and Processes Selection. The contractor shall limit the number of different materials and processes by selecting, wherever possible, materials and processes for new design from the existing PMPSL approved by the Government acquisition activity. The selection of materials and processes for new or modified designs shall be the result of design studies which address:

a. Operational requirements

b. Material or process performance

Metallic Materials:

1). Acceptable initial flaw sizes, defects, and tolerances associated with the materials and manufacturing processes during fabrication and assembly.

2). Relevant mechanical properties as identified in MIL-HDBK-5 or other acceptable source as approved by the PMPCB.

3). Stability under environmental conditions, aging characteristics, fracture toughness, and crack growth (da/dn) under the service stresses

Non-Metallic Materials:

1). Compatibility with environmental conditions.

2). Specification controls over composition and processing.

3). Material's shelf-life and aging characteristics.

c. Manufacturing capabilities

d. Safety margins

e. Inspection criteria

Materials and processes already approved for unlimited program use through the PMPSL shall be acceptable for use in new components or modified design hardware if available data (flight history, production history, etc) provides clear evidence that the material is suitable for the proposed application. All materials and processes which meet the requirements or guidelines specified in Appendix A shall also be considered as approved for use in new components and modified design hardware. Materials and processes not meeting either criteria shall require the submission of a MUA, with supporting data, to the PMPCB. A PMPCB action form shall be generated for every MUA approved by the PMPCB and forwarded to the Government PMPCB representatives for disposition. All open MUAs and MUAs over which there are concerns shall be clearly identified at all design reviews with justification for their selection and use. The Design Review package, in accordance with the requirements of MIL-STD-1521, shall include a list of all approved MUAs included in the parts list, but this list need not be presented in the formal review.

4.3.1.3. Prohibited Parts and Materials. The part types and materials listed in Appendix F shall not be used in new components or modified design hardware except as noted. These items are listed because data has shown them to be reliability suspect.

4.3.2 PMP Selection Approval. The contractor shall use the following PMP review and approval procedures for PMP to be selected and listed on the PMPSL:

a. PMP included in the ELV Quality PMP Baseline shall be considered approved for use. For inspection lots of parts used in only Category II boxes, lot acceptance testing during the upscreen of Class B, Class K, and JANTXV parts in accordance with Appendix B need not be performed.

b. Parts not defined by paragraphs a and proposed for inclusion in the PMPSL shall require the submission of a Part Approval Request (PAR) with supporting data to the PMPCB for approval.

c. Materials and processes not defined by paragraph a and proposed for inclusion in the PMPSL shall require the submission of a Material Usage Agreement (MUA) with supporting data to the PMPCB for approval.

4.3.3 Parts, Materials, and Processes Selection List (PMPSL). The PMPSL shall be organized to delineate and distinguish between approved parts, approved materials, and approved processes. The PMPSL shall be approved by the PMPCB and submitted through the Contract Data Requirements List (CDRL). Each PMP listing shall contain, as a minimum, the following information:

a. Generic part number (manufacturer's designation) or military specification number, slash sheet number and/or dash number, whichever is applicable.

b. Contractor PMP ***specification*** number

c. Noun description

d. Approved, proposed, and selected sources. In the case of QPL/QML parts, list a preferred source, if applicable.

e. Applicable usage restrictions

4.3.4 Changes to the PMPSL. Subsequent changes to the PMPSL, as required to support the contractor's design efforts, shall be approved by the PMPCB and submitted through the Contract Data Requirements List (CDRL).

4.3.5 PMPSL Records. Records of the program PMPSL shall be maintained and kept for the life of the program. The records shall include as a minimum the following:

a. The latest edition of the PMPSL

b. Proposed PMP. This is the PMP for which approval action is pending.

c. Addition or deletion actions.

d. Disapproved PMP, including information on applicable reasons for disapproval and the date of disapproval. This is the PMP that has been disapproved for program use.

4.3.6 Part Approval Request (PAR). A PAR shall be submitted to the PMPCB when required as described by paragraph 4.3.2c. A PAR shall consist of the PMPCB Action Form as the cover sheet with all necessary supplemental data attached. Supplemental data required with this request includes as a minimum the following:

a. Justification for the proposed applications.

b. Identification of relevant GIDEP Alerts, and other relevant Alerts.

c. Availability, including approved, proposed, and selected sources.

d. Description of how the technical requirements are met, including qualification. Include any appropriate test data.

e. Process methods, data, and required quality control provisions, if applicable.

4.3.7 Material Usage Agreement (MUA). A MUA shall be submitted to the PMPCB when required as described by paragraph 4.3.2d. A MUA shall consist of the PMPCB Action Form as the cover sheet with all necessary supplemental data attached. Supplemental data required with this request includes as a minimum the following:

a. Justification for the proposed applications.

b. Identification of relevant GIDEP Alerts, and other relevant Alerts.

c. Availability, including approved, proposed, and selected sources.

d. Description of how the technical requirements are met; including qualification. Include any appropriate test data.

e. Process methods, data, and required quality control provisions, if applicable.

4.3.8 As-designed Parts and Materials List. As the program progresses, the PMPCB may convert the PMPSL to an as-designed parts and materials list which shall indicate the final parts and materials selected. Parts and materials approved for program use, but not actually used in the equipment, system, or subsystem, shall not be included on this as-designed list.

4.4 MANAGEMENT OF PART AND MATERIAL PROCUREMENT

All parts and materials shall be procured directly from the manufacturer, whenever possible, or procured from an authorized distributor. The selection of suppliers shall be based on criteria that includes factors to ensure that the required quality and reliability requirements can be met. Parts and materials procured from an authorized distributor shall be traceable to the manufacturer and shall be accompanied by a written certification by lot date code of specification compliance furnished by the manufacturer with each procurement. The PMPCB shall ensure the review of the contractor's source surveillance planning to verify that it meets the requirements of this document.

4.4.1 New Design Components. PMP used in new design components shall be compliant to the requirements specified herein.

4.4.2 Heritage Design Components. ***Electronic parts*** used in heritage design components shall ***be compliant to the requirements specified herein***. ***Nonelectronic parts and materials and processes*** used in heritage design components shall be compliant with the component's heritage requirements as a minimum. ***Nonelectronic parts and materials and processes*** used in any of the component's hardware classified as modified design hardware shall be compliant to the requirements specified herein. Management of PMP Quality Assurance for heritage design hardware shall be in accordance with the requirements of paragraph 4.5 and subsequent subparagraphs.

4.4.3 Off-The-Shelf Equipment. When off-the-shelf equipment is proposed for use, it shall be reviewed and approved by the PMPCB. A PMPCB action form shall be generated for each piece of equipment defined as off-the-shelf by the PMPCB and forwarded to the Government PMPCB representatives for disposition. ***Tracking systems shall not be procured as off-the-shelf. Instrumentation components whose failure would result in loss of all flight instrumentation data shall not be procured as off-the-shelf.***

4.4.4 Electronic Parts Procurement Order of Precedence. The procurement order of precedence for electronic parts shall be in accordance with Appendix L.

4.4.5 Electronic Part Manufacturer/Screening Surveillance (Monitoring).

4.4.5.1 Custom Parts. The contractor shall arrange for the surveillance of:

a. Integrated Circuits
b. Semiconductor Devices
c. Hybrid Devices
d. Relays

procured to Source Control Drawings (SCDs) at the manufacturer. The contractor shall participate in pre-encapsulation visual inspections and monitor board loading and checkout, final electricals, and either burn-in on or burn-in off as a minimum. The contractor is encouraged to monitor all remaining electrical testing wherever possible. The contractor shall be responsible for authorizing shipment of the electronic parts from the manufacturer.

4.4.5.2 Upscreened Parts. The contractor shall arrange for the surveillance of:

a. Integrated Circuits
b. Semiconductor Devices
c. Hybrid Devices

upscreened to meet the requirements of this document at the screening facility. The contractor shall monitor board loading and checkout, final electricals, and either burn-in on or burn-in off as a minimum. The contractor is encouraged to monitor all remaining electrical testing wherever possible. The contractor shall be responsible for authorizing shipment from the screening facility.

4.4.6 Manufacturing Baseline. All custom electronic parts shall be procured to a manufacturing baseline. ***For custom active electronic parts, the manufacturing baseline shall be in accordance with the applicable tables of Appendix B.***

4.4.7 DESC Space Quality Operating Stock. An Operating Stock has been initiated by the Defense Logistics Agency to facilitate the procurement of Space Quality electronic parts. For parts in stock and on order, this reduces procurement lead times and allows small quantity ordering by the contractor while retaining the cost benefits of large quantity procurements. In support of this program, the contractor shall:

a. Forecast and supply the Government acquisition activity with projected electronic part requirements for Space Quality device types on a yearly basis.

b. Supply the Government acquisition activity with the following information necessary to obtain authorization to use the JAN Class S Operating Stock:

1) Company address

2) Freight/Receiving address

3) Billing address

4) Department of Defense Activity Address Code (DODAAC), if known.

4.4.8 Space Parts Working Group (SPWG). The SPWG is a combined Government acquisition activity/contractor group designed to facilitate the transfer of technical information regarding the use of applicable PMP specifications and standards. This technical input is critical in identifying to the Government acquisition activity those specification changes necessary to make a specification usable. The Government acquisition activity is responsible for requesting action from the military activity responsible for that specification to expedite appropriate changes. The SPWG is also a forum for the development of future PMP policy for ELV and space systems. The contractor is highly encouraged to support SPWG meetings held once a year as a minimum, usually in the Spring, in the local vicinity of Space Systems Division.

4.5 MANAGEMENT OF PMP QUALITY ASSURANCE

The contractor shall implement PMP quality assurance procedures which meet the requirements of this document to ensure parts and materials procured and processes used meet system requirements, both at the time of receipt, during production, and over the lifetime of the hardware.

4.5.1 General Workmanship. General workmanship shall be in accordance with the requirements of MIL-STD-454, Requirement 9 and/or other workmanship requirements as specified in the applicable specifications and standards.

4.5.2 Rework/Repair of Electronic Parts. Rework of Electronic parts shall be in accordance with each general or detailed requirement of the applicable military specification with the exception that delidding custom electronic parts for the purpose of repair/rework is not allowed ***without the specific approval of the PMPCB. Delidding approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition***.

4.5.3 Reuse of Parts and Materials. Parts and materials which have been permanently installed in an assembly using soldering, alloying, or other fuzing techniques, and are then removed from the assembly for any reason, shall not be used again in any item of flight hardware, without specific approval of the PMPCB. Part reuse approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

4.5.4 PMP Qualification.

4.5.4.1 General. All PMP, including any processes developed to accomplish rework or retrofit, shall require qualification for program use. Only qualified PMP shall be used on flight hardware.

4.5.4.2 Electronic Part Qualification. Electronic parts not included in the ELV quality baseline shall be qualified to the requirements specified in the applicable specifications and standards for the device type. The contractor, through the PMPCB, shall prepare and submit for PMPCB approval a qualification plan and procedure for those electronic parts for which deviations from the qualification requirements specified in Appendix B for custom active devices or the applicable device specification for non-QPL electronic devices are requested. Following PMPCB approval, these qualification plans shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition. The qualification plan shall identify all conditions and testing necessary to meet the program and mission reliability requirements and show adequate margin over expected operating conditions. This item may be satisfied by submission of the SCD. Manufacturers generic data may be used, if approved by the PMPCB.

4.5.4.3 Materials and Processes Qualification. Materials and Process qualification shall be the result of design studies performed during the selection process as required by paragraph 4.3.1.2

and system testing.

4.5.5 Incoming Inspection Requirements. Each contractor shall perform, or be responsible for performing, applicable incoming testing and inspections of parts and materials to ensure that they meet the requirements of the procurement specifications. Unless previously accomplished or witnessed and accepted by contractor field personnel, incoming testing and inspections shall be accomplished upon receipt of the parts or materials.

4.5.5.1 Incoming Inspection of Electronic Parts. As a minimum, incoming inspection of all electronic parts shall consist of the following:

a. Sample external inspection, with an Acceptable Quality Level (AQL) of 1% in accordance with MIL-STD-105, at 3X magnification (minimum), for such things as permanent and legible marking, body finish, lead finish, insulation, lead straightness, excessive material, misalignment, dimensions, and any visual or mechanical defect.

b. A destructive physical analysis (DPA), independent of the manufacturer, on each inspection lot in accordance with MIL-STD-1580 or an equivalent PMPCB approved procedure. The minimum DPA sample size shall be five (5) devices, except as explicitly noted herein. The DPA sample size may be reduced based upon device cost and lot size considerations with PMPCB approval. DPA sample reductions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition. With PMPCB approval, the contractor may use an independent destructive physical analysis previously performed on the same production lot date code as evidence for the quality of the lot, in lieu of performing another destructive physical analysis. The PMPCB shall evaluate the independent destructive physical analysis procedures for their applicability in proving the quality of this lot for space applications. A DPA performed by the manufacturer of the part does not constitute an independent DPA and therefore does not satisfy this requirement.

The following device types shall require a DPA:

1). Integrated circuits - Appendix L, Para 2.1a, third order of precedence parts, and Para 2.1b, second order of precedence parts shall require a double sample size DPA.
2). Semiconductor devices - Appendix L, Para 2.1a, third order of precedence parts, and Para 2.1b, second order of precedence parts shall require a double sample size DPA.
3). Filters
4). Magnetic components - ***2 samples minimum***
5). Capacitors - Perform a DPA on one capacitance value from each production lot.
6). Resistors - Perform a DPA on one resistance value from each production lot.

7). Inductors
8). Hybrid devices - ***3 samples minimum***
9). Passive networks
10). Relays - ***2 samples minimum***
11). Bimetallic thermal switches
12). Connectors/Pins - ***2 samples per family type, minimum***
13). Crystals/Oscillators - ***2 samples minimum***

c. For relays other than those meeting the requirements of Appendix D:

1). Perform a residual gas analysis on two samples in accordance with MIL-STD-883, Method 1018. Water content shall be 1,000 parts per million (ppm) maximum at 100°C.

2). For relays with a high noise signature, perform an asynchronous miss test per notes 2/ and 5/ of Appendix D, Table D-2, on the entire lot.

d. For Space Quality active electronic parts:

1). Electrical testing at -55°C, 25°C, and 125°C, to an LTPD of 2 (116 devices with 0 failures), is encouraged.

e. Data accompanying all parts shall be reviewed to determine the acceptability of received parts.

4.5.5.2 Incoming Inspection of Materials and Non-electronic Parts. As a minimum, incoming inspection of materials shall consist of at least one of the following:

a. Sample analysis or testing of significant physical and mechanical properties of received material.

b. Review of the data accompanying the lot, specifically the Certificate of Compliance and/or the Certificate of Analyses, to insure that the material meets all specified requirements.

4.5.6 Upscreening and DPA Facilities. The contractor, identified and tasked by the acquisition activity to plan, manage, and coordinate the selection, procurement, and application of all PMP at the program level, shall maintain a listing of acceptable upscreening and DPA facilities. Only facilities or laboratories listed shall be used. This listing and any subsequent changes to this listing shall be submitted to the PMPCB for approval.

4.5.7 Electronic Part Configuration Control. The contractor shall plan for and assess the physical characteristics of all electronic parts requiring destructive physical analysis for the purpose of identifying any changes in the materials used, construction, or configuration of the parts. As a minimum, the contractor shall use manufacturer data and initial destructive physical analysis

findings to baseline the physical characteristics of the parts, and then compare subsequent destructive physical analysis findings to that initial baseline.

4.5.8 Failure Analysis.

4.5.8.1 Failures During Electronic Part Screening (Lots Presented for Flight Usage). Failure analysis shall be performed as a minimum on electronic part catastrophic failures experienced during and after the first device burn-in, whether Power or High Temperature Reverse Bias, in upscreening or custom screening and during receiving inspection. Failures shall be analyzed to the extent necessary to understand the failure mode, cause, and relationship of the failure to the generic lot the failed part came from. In the case of lot-related type failures, failures shall be analyzed to the extent necessary to develop screens to detect the failure mechanism and/or corrective actions to eliminate/reduce its occurrence. Corrective action shall be determined and implemented, as applicable. The results of failure analysis, shall be submitted to the PMPCB for review. Catastrophically failed parts and failure analysis reports shall be retrievable for the duration of the contract. Contractors shall report catastrophic failures of electronic parts procured from the DESC JAN Class S Operating Stock Program to DESC, the PMPCB, and the Government acquisition activity. Contractors are strongly encouraged to report catastrophic failures of Space Quality electronic parts procured from other sources to DESC, the PMPCB, and the Government acquisition activity.

4.5.8.2 Failures During Assembly and Test. Failure analysis shall be performed as a minimum on part and material failures experienced during assembly level acceptance testing. Failures shall be analyzed to the extent necessary to understand the failure mode and cause and the relation of the failure to the generic lot the failed part or material came from. In the case of lot-related type failures, failures shall be analyzed to the extent necessary to develop screens to detect the failure mechanism and/or corrective actions to eliminate/reduce its occurrence. Corrective action shall be determined and implemented, as applicable. The results of failure analysis, shall be submitted to the PMPCB for review. This requirement may be satisfied by submission of Failure Review Board, or similar board, meeting minutes. The contractor is encouraged to conduct a failure analysis on all PMP related failures.

Failures attributed to processes shall be recorded and analyzed to identify the cause of the failure and the need for corrective action. All such data and the corrective actions taken shall be submitted to the PMPCB for review. This requirement may be satisfied by submission of Failure Review Board, or similar board, meeting minutes.

4.5.9 Data Requirements. The following subparagraphs specify the data packages the contractor acquisition activity shall procure, as a minimum. In cases where the device type requires two or more different data packages, the data packages shall be combined by lot date code to facilitate data retrieval. All data packages shall be retained for the life of the contract ***or until the entire inspection lot is flown, whichever is sooner***.

4.5.9.1 Custom Active Electronic Parts. The contractor shall procure a data package for all active electronic devices manufactured to Source Control Drawings. The data package shall include, as a minimum, the following data items from the manufacturer:

a. Certificate of Compliance with the applicable standards and specifications
b. Process flow diagram
c. Product baseline record (Note: This item may be satisfied by a detailed process flow diagram that includes references to the applicable process/manufacturing documents and revision levels.)
d. Engineering drawings of the part
e. Acceptance/Qualification test reports
f. Attribute summary
g. Actual completed lot traveler
h. Read and record data for each serial number device submitted to electrical testing
i. Failure analysis report(s), if applicable

The contractor shall require the manufacturer to retain all screening failures until final lot data acceptance.

4.5.9.2 Upscreening. The contractor shall procure a data package for all electronic devices upscreened to meet the requirements of this document. The data package shall include, as a minimum, the following data from the screening facility:

a. Actual completed lot traveler
b. Attribute summary
c. Read and record data for each serial number device submitted to electrical testing
d. Failure summary
e. Failure analysis report(s), if applicable

All failures during upscreening shall be segregated and clearly marked as failures and shipped to the contractor. Failed devices shall be retained by the contractor for the life of the contract ***or until the entire inspection lot is flown, whichever is sooner***. Failed devices from lots dispositioned as scrap need not be retained.

4.5.9.3 Military Specification Parts. The contractor shall procure a data package for all parts manufactured to military standards and specifications as follows:

a. For electronic parts:

1. Non-Space Quality. The data package shall include the following data from the part supplier:

a. A Certificate of Compliance with the applicable standards and specifications, traceable to the part manufacturer.

2. Space Quality. The data package shall include the following data from the part supplier:

a. A Certificate of Compliance with the applicable standards and specifications, traceable to the part manufacturer.

b. Attribute summary

b. For non-electronic parts, the data package shall consist of the Certificate of Compliance with the applicable standards and specifications, traceable to the part manufacturer.

4.5.9.4 Destructive Physical Analysis (DPA). The contractor shall generate a data package for all part types requiring a DPA. The data package shall include the following data items from the DPA facility:

a. DPA report

All DPA samples shall be returned to the contractor and retained for the life of the contract ***or until the entire inspection lot is flown, whichever is sooner***.

4.5.10 Traceability and Lot Control. The contractor shall be capable of tracing electronic parts and critical non-electronic parts and materials to their manufacturer and lot identifications (lot date code or batch designation). Similarly, given a lot date code or batch number, the contractor shall be capable of determining the unique ***component*** by serial number (and dash number) at the lowest assembly level in which the part or material is installed.

4.5.11 Inventory Control. The contractor is highly encouraged to implement a first-in, first-out (FIFO) inventory control system. Inventory control policies and procedures shall be addressed in the PMP Control Program Plan.

4.5.12 Preservation and Packaging. Preservation, packaging, and packing of parts and materials shall be in accordance with both the item and the system requirements. MIL-STD-2073 should be used as a guide in the development of part and material packaging.

4.5.12.1 Electrostatic Discharge Sensitive (ESD) Parts. All parts which are subject to degradation by electrostatic discharge shall be marked, packaged, and handled in accordance with the approved ESD procedure referenced in paragraph 4.1.1m.

4.5.13 Handling and Storage. Handling and storage procedures shall be instituted to prevent part and material degradation. The following criteria shall be used as a minimum for establishing handling and storage procedures for parts and materials:

a. Environmental controls, such as temperature, humidity, contamination, and pressure.

b. Measures (Procedures) and facilities to segregate and protect parts and materials routed to different locations in-house and to outside sources (for processing) such as, to the materials review crib, or to a laboratory for inspection, or returned to the manufacturer for replacement.

c. Control measures to limit personnel access to parts and materials during receiving inspection, screening, and storage.

d. Provisions for protective cushioning, where required, on transportation containers to protect against accidental dropping or dislodging during transit, on storage area shelves, and in storage containers.

e. Non-degrading bench surfaces on which parts and materials are handled. Typical handling operations include kit organization, assembly, inspection, and test.

f. Provisions for protection of parts susceptible to damage by electrostatic discharge.

The contractor is encouraged to institute similar procedures for the handling and storage of higher order assemblies into which parts and materials are installed.

4.5.14 Suspect Parts and Materials Control Program. The PMPCB shall ensure the review and evaluation of Government Industry Data Exchange Program Alerts (GIDEP ALERTS) and industry problem alert bulletins in a timely manner. The PMPCB shall ensure that suspect parts and materials are not selected for designs or procured for use. The PMPCB chairman shall ensure that GIDEP ALERTS are generated where applicable on rejected parts and materials. The PMPCB shall ensure the evaluation of the impact of suspect parts or materials already in-stock and/or in system equipment on system performance and reliability and the notification of the Government acquisition activity of:

a. The use of the defective part or material

b. The evaluation of the impact

The above may be accomplished through the monthly submittal of Response to Alert/Safe Alert (See Appendix K for sample content).

Parts and materials indicated as suspect in any GIDEP ALERT shall not be approved for use or listed on the PMPSL unless the indicated defects or failures have been corrected or identified and controlled.

4.6 MANAGEMENT OF PART AND MATERIAL APPLICATION

4.6.1 Electronic Part Derating. The PMPCB shall ensure the establishment of derating policies that meet system requirements. Derating policies shall address degradation sensitive parameters and maximum rated variations expected over the program mission life. Policies shall also include derating due to radiation effects, where applicable. The PMPCB shall also ensure that electronic parts used in new and modified design hardware meet the derating criteria specified in Appendix G. Exceptions to the derating requirements may be approved by the PMPCB if the worst case operating value exceeds the derated value specified in Appendix G by 20% or less. Derating exceptions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition. Use of electronic parts whose worst case operating values are greater than 20% above the applicable derated value shall require Government acquisition activity approval. The derating for items not explicitly covered in Appendix G shall be submitted to the PMPCB for review and approval. Following PMPCB approval, derating for these items shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

4.6.2 Radiation Hardness. The contractor, when explicitly required by contract, shall develop and conduct a radiation hardness assurance program in accordance with Appendix J for all radiation hardness critical parts and materials to meet the radiation hardness assurance requirements of the system. The hardness assurance program shall ensure:

a. Radiation environments for parts are specified.

b. Radiation hardness assurance requirements and appropriate test methods are identified and included in the appropriate procurement specifications.

c. Radiation hardness assurance representatives support the PMPCB, when necessary.

The radiation hardness assurance program plan shall be documented and referenced in the Parts, Materials, and Processes Control Program Plan. All radiation hardness assurance design documentation shall be provided to the PMPCB for review and approval prior to the Preliminary Design Review.

APPENDIX A

MATERIAL AND PROCESS GUIDELINES AND REQUIREMENTS

CONTENTS

CONTENTS

SECTION 1

SCOPE

1 APPLICATION

The technical requirements of this appendix are divided into two sections; Section 2, compliance items, and Section 3, guidelines. The contractor shall comply with the requirements of Section 2. The contractor is encouraged to use the requirements specified in Section 3 as a guide in the selection of materials and processes used in new design components and modified design hardware.

SECTION 2

REQUIREMENTS

2.1 PROCESS REQUIREMENTS

2.1.1 Product Fabrication Specification. The contractor shall establish manufacturing documentation which clearly designates each step of the manufacturing process which his production staff will be required to use in preparation of shop direction sheets. This documentation will also provide for and specify control of all incoming material, control of all in-shop handling, use in manufacturing of parts, shop environmental controls, quality control inspection procedures, identification of what to inspect and establishment of acceptable defect limits in each case. This practice will continue through the entire manufacturing process, including curing of the part, removal from tool, trimming, drilling for installation and final acceptance inspection.

2.1.2 Soldering. Soldering of piece parts to printed wiring boards shall be performed in accordance with the requirements of NHB 5300.4(3A-2), MIL-STD-2000 (General Requirements Paragraph 4 and Subparagraphs), or MIL-S-45743. Wave soldering shall be performed in accordance with the requirements of MIL-S-46844.

2.1.2.1 Solderability. All electronic piece parts that require soldering shall be tinned prior to use. All piece parts with gold-plated leads that require soldering shall be double-dip tinned prior to use. ***A single 5 second dip in solder when using a flow solder source shall be acceptable in lieu of double-dip tinning.*** All terminals, solder cups, and other hardware that is gold-plated in the area to be soldered shall have the gold removed prior to use.

2.1.3 Component Mounting. Piece parts shall be mounted on printed wiring boards in accordance with the requirements of MIL-STD-275 or MIL-S-45743. Stacking of components and placement of multiple leads in the same plated thru-hole are prohibited.

2.2 NON-METALLIC MATERIAL REQUIREMENTS

2.2.1 Outgassing. Organic/polymeric materials used in upper stage compartments which are not hermetically sealed with a maximum leakage of 5×10^{-4} cc/sec of helium, when tested in accordance with MIL-STD-1540, Method II, at a pressure of 1×10^{-5} Torr, shall have a maximum total mass loss (TML) of 1.0% of the original specimen mass and a maximum collected volatile condensable material (CVCM) content of 0.1% of the original specimen mass when tested in accordance with ASTM-E-595. Exceptions to these requirements shall be approved by the PMPCB.

2.2.2 Electrical Insulation. Vinyl and polyvinylchloride shall not be used as insulation on wiring or as sleeving because of their fungus nutrient characteristics and the dangers of

outgassing during storage. These organics give off corrosive vapors which actively attack metals, plastics, elastomers, and insulation. Outgassing proceeds under normal room temperature conditions but is accelerated by high temperature or low pressure, and is most serious in closed containers. Satisfactory insulation includes Polytetrafluorethane, FEP Teflon, Kel-F, Polyimide, Polyamide (nylon), Polyurethane, Polycarbonate, Polyethylene, Polyalkene, Polyethyleneterephthalate, Polyolefin, Polysulfone, and Silicone sleeving in all grades. Where materials other than these are required, fungus resistant classes shall be specified and their performance established by testing per MIL-STD-810. Caution must be exercised in the use of teflon covered, silver plated copper wire because of possible corrosion at pin holes. Obtaining adhesion when potting or encapsulating teflon insulated wire is difficult. Teflon coated wire, both PTFE and FEP, may "cold flow" when installed under stress, against sharp edges, and in sharp bend configurations resulting in shorting failures. Use of unsupported teflon insulated wire shall require PMPCB approval.

2.2.3 Tape. Tapes shall be selected which are both non-corrosive and within the outgassing requirements of paragraph 2.2.1.

2.2.4 Printed Wiring Boards. Printed Wiring Boards shall be designed, fabricated, and tested in accordance with the requirements of Appendix C of this document.

2.2.5 Conformal Coatings. Materials used to conformal coat PWBs shall be in accordance with requirements of MIL-I-46058.

SECTION 3

GUIDELINES

3.1 PROCESS GUIDELINES

3.1.1 Fastener Installation. The installation of mechanical fasteners and associated parts should meet the requirements of MSFC-SPEC-250. Rivets should be installed in accordance with the requirements of MIL-STD-403.

3.1.2 Fracture Control. Program required fracture control plans and/or requirements shall be reviewed by the PMPCB for applicability to PMP specifications and inspections. MIL-STD-1522 should be used as a guide in the design and test of pressure vessels.

3.1.3 Adhesive Bonding. Structural bonding should meet the requirements of MIL-A-83377. Structural component bonds, except for high temperature nozzle bonds, shall be tested under simulated service conditions, using tag-end test specimens and/or co-processed samples when possible to demonstrate that the materials and processes selected will provide the desired properties for the entire life of the component. When thermal cycling testing is required, the rate of temperature change of the first three test cycles shall be equal to the expected rate of temperature change in service. Structural bonding procedures shall be available for PMPCB review upon request.

3.1.4 Welding. Resistance welding of electronic circuit modules should meet the requirements of MIL-W-8939. Training and certification of personnel and machine qualification are required every six months, or as approved by the PMPCB. The design selection of parent materials and weld methods shall be based upon consideration of the weldments, including adjacent heat affected zones, as they affect the operational capability of the parts concerned. Welding procedures and supplies shall be selected to provide the required weld quality, to utilize the minimum weld energy input possible, and to protect the heated material from contaminants. The suitability of the equipment, processes, welding supplies and supplementary treatments selected shall be demonstrated through qualification testing of welded specimens which represent the materials and joint configuration of production parts. Welding operators should be qualified in accordance with MIL-STD-1595. The contractor shall provide the necessary training and qualification requirements to certify each operator and the applicable welding equipment for specific tasks required on critical space flight hardware such as pressure vessels, tubing, and other primary structural components. All welding processes in primary structural and pressure applications shall be available for PMPCB review upon request. The contractor training and certification requirements, including appropriate weld schedules and procedures, are subject to review and approval of the PMPCB.

3.1.4.1 Weld Repair. Weld repairs shall be minimized by discriminatory selection of acceptable methods, procedures, and specifications. Weld repair is limited to the repair 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 review. Documentation shall include, as a minimum, weld procedures and schedules, location of the repair, nature of the problem, and appropriate inspection requirements for acceptance. The quality of repair welds shall be confirmed by 100% inspection of both surface and subsurface, using visual, dimensional, and nondestructive radiography techniques, as applicable. The repair of welds in high performance or critical parts using nonstandard repair procedures is unacceptable unless reviewed and approved by the PMPCB.

3.1.4.2 Weld Filler Metal. Weld rod or wire used as filler metal on structural parts shall be fully certified and documented for composition, type, heat number, manufacturer/supplier, etc., as required to provide positive traceability to the end use item. In addition, qualitative analysis and nondestructive testing shall be conducted on segments of each filler or wire as necessary to assure that the correct filler metal is used on each specific critical welding task. Quantitative analyses of weld filler metal on a lot basis will be considered acceptable provided that each structural weldment is subjected to simulated service testing or proof loading prior to acceptance.

3.1.4.3 Aluminum Welding. The welding of aluminum alloys for high strength applications should meet the requirements of MSFC-SPEC-504. Alternate welding specifications are allowed only if sufficient data is available to substantiate that the specification is satisfactory for the intended application. Supporting data for the use of alternate welding specifications shall be available for review by the PMPCB upon request.

3.1.4.4 Brazing. Brazing should meet the requirements of MIL-B-7883. 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 shall be designed for shear loading and shall not be relied upon for strength in tension for structural parts.

3.1.5 Forming and straightening. Forming and straightening operations performed on sheet metal, plate extrusions and forgings shall be limited to processes which:

a. Do not result in detrimental residual stresses or losses in mechanical properties on structurally critical parts.

b. Do not lead to stress corrosion sensitivity of the part.

Shot peen forming is permissible.

The contractor shall maintain adequate controls and supportive data which substantiate that the employed forming and straightening processes meet the foregoing requirements.

3.1.6 Forgings. Because mechanical properties are maximum in the direction of material flow during forging, forging techniques shall be used that produce an internal grain flow pattern such that the direction of flow in all stressed areas is essentially parallel to the principle tensile stresses. The grain flow pattern shall be essentially free from reentrant and sharply folded flow lines. After the forging technique, including degree of working, is established, the first production forging shall be sectioned to show the grain flow patterns and to determine mechanical properties at control areas. The procedure shall be repeated after any change in the forging technique. The information gained from this effort shall be utilized to redesign the forging as necessary. These data and results of tests on redesign shall be retained by the contractor and be available for PMPCB review.

3.1.7 Castings. Aluminum alloy castings for electronic boxes and other structural applications should meet the requirements of MIL-A-21180.

3.1.8 Sandwich Assemblies. Aluminum honeycomb core sandwich assemblies should use MIL-C-7438 perforated core. All sandwich assemblies shall be designed to prevent entrance and entrapment of water or other contaminants in the core structure. External venting or perforation which could allow moisture to enter shall not be used without the approval of the PMPCB. Sandwich assemblies should satisfy the requirements of MIL-HDBK-23. Test methods for sandwich constructions should be in accordance with MIL-STD-401. A non-metallic core may be used in structural applications where technically advantageous. Non-metallic structural sandwich assemblies shall be subjected to a special test program which will demonstrate the assemblies capability to withstand qualification environments.

3.2 METALLIC MATERIAL GUIDELINES

MIL-HDBK-5, Government material specifications, or other widely accepted industry specifications shall be used as the basic document for defining strength allowables and other mechanical and physical properties for metallic materials. When data is not contained in any of the above referenced documents, contractor allowables developed in accordance with MIL-HDBK-5 may be used with approval of the PMPCB. The contractor shall meet the metallic materials requirements specified herein as a minimum.

3.2.1 Corrosion

3.2.1.1 Corrosion Prevention and Control. All parts, assemblies, and equipment, including spares, shall be finished to provide protection from corrosion. The contractor is encouraged to use MSFC-SPEC-250 as a guide. The contractor shall apply acceptable corrosion prevention and control measures and ensure that they are properly integrated during system definition, engineering development, design, production and operational phases.

3.2.1.2 Stress Corrosion. Some high strength 2000 and 7000 series aluminum alloys and high strength alloy steels are subject to stress corrosion cracking. As a general criteria, MSFC-

SPEC-522 should be used as a guide for controlling stress corrosion cracking in design and material selection. Alloys and heat treatments which result in a high resistance to stress corrosion cracking shall be utilized in all structural load carrying applications. Particular emphasis shall be focused in the area of design, fabrication, and installation of parts to prevent the sustained surface tensile stresses from exceeding the stress corrosion threshold limitations for the particular material and grain-flow orientation. Stress corrosion threshold values are determined by actual testing as described in paragraph 3.2.1.2.3. Test results have indicated that stress corrosion can be avoided by following the guidelines specified in paragraphs 3.2.1.2.1 and 3.2.1.2.2.

3.2.1.2.1 Steel Alloys. The assembly stresses of low alloy steels, heat treated above 200 ksi UTS should not exceed the stress corrosion threshold limitation for the particular material and grain-flow orientation.

3.2.1.2.2 Aluminum Alloys. Aluminum alloys or tempers should not be used where the assembly stresses are greater than the stress corrosion threshold for that alloy, temper and grain-flow orientation. Alloys with a stress corrosion threshold, in any grain direction, less than 25 ksi are prohibited, except as specified for sheet material in paragraph 3.2.2.

3.2.1.2.3 Other Metals. For those materials which have no stress corrosion data or use history, the contractor shall develop and utilize threshold values similar to those listed above for other metals, based on the material's ability to withstand exposure to alternate immersion tests in 3.5% sodium chloride solution (10 minute immersion and 50 minute drying time) for 180 days without cracking as detectable by Class AA ultrasonic inspection in conformance with MIL-STD-2154 or for 30 days without cracking as detectable by sectioning and metallographic examination or salt spray when tested un accordance with ASTM-13117 (168 hours for aluminum alloys and 336 hours for steel alloys) without cracking. This data shall be retained by the contractor and be available for PMPCB review.

3.2.2 Aluminum. In structural applications requiring the selection of aluminum alloys, maximum use shall be made of those alloys, heat treatments, and coatings which minimize susceptibility to pitting and general, intergranular and stress corrosion. Aluminum alloys 2020-T6, 7079-T6, and 7178-T6 shall not be used for structural applications unless specifically approved by the PMPCB. The use of 7075-T6, 2024-T3, 2024-T4, and 2014-T6 sheet (less than 0.25 inches thick) material is allowed only in the case where the short transverse loads (design, fitup, thermal, and residual) are below acceptable stress corrosion limits and that proven corrosion protection systems are provided. Other forms of 7075 shall be heat-treated to the -T73 temper. The following alloys and heat treatments shall not be used in applications where the temperature exceeds 150°F; 5083-H32, -H38; 5086-H34, -H38; and 5456-H32, -H38.

Heat treatment of aluminum alloy piece parts should meet the requirements of AMS-2770. Use of heat treatments not included in AMS-2770 should require sufficient test data to conclusively prove that the specific heat treatment improves the mechanical and/or physical properties of specific aluminum alloys without altering susceptibility to degradation.

3.2.3 Steel. Special consideration shall be given when using high strength steels heat-treated at or above 180 ksi ultimate tensile strength (UTS). These steels are subject to delayed failure mechanisms, such as those caused by contaminating elements introduced during processing. Also, the effect of low temperature on reducing high strength steel toughness and ductility should be considered. Steels heat-treated to strength levels at or above 200 ksi UTS shall require specific approval of the PMPCB for the particular application.

Steel parts should be heat-treated to meet the requirements of MIL-H-6875. All high strength steel parts heat-treated at or above 180 ksi UTS shall include appropriate test coupons or specimens from the same material as used in production parts, which will accompany the parts through the entire fabrication cycle to assure that desired properties are obtained. When acid cleaning baths or plating processes are used, parts shall be baked afterwards at 375°F for not less than 23 hours following such processes to alleviate potential hydrogen embrittlement problems. Heat treatments not included in MIL-H-6875 may be used if sufficient test data is available to conclusively prove that the heat treatment improves the mechanical and/or physical properties of the specific steel without altering susceptibility to degradation. This data shall be retained by the contractor and be available for review by the PMPCB upon request. Materials tempered at temperatures below 375°F shall require specific PMPCB approval.

The drilling of holes, including beveling and spot facing, in martensitic steel hardened to 180 ksi UTS or above shall be avoided. When such drilling, machining, reaming, or grinding is unavoidable, carbide tipped tooling and other techniques necessary to provide smooth surface finishes and avoid formation of untempered martensite shall be used. 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 grinding operations.

The ends of the holes shall be deburred by a method which has been demonstrated to not cause untempered martensite. Either metallurgical testing or an etching procedure shall be used to determine the presence of untempered martensite.

3.2.4 Corrosion-Resistant Steel. Unstabilized austenitic steels may be used in assemblies where temperatures during processing do not exceed 700°F. Welded assemblies ,except for the stabilized or low carbon grades 321, 347, 316L, and 304L, shall be solution heat treated after welding .

3.2.5 Precipitation Hardened Stainless Steel. All precipitation hardened steel parts shall be aged at temperatures of 1000°F and above. Exceptions may be made for particular applications for those steels, such as 17-7PH, which develop maximum resistance to stress corrosion with certain aging treatments below 1000°F. Precipitation hardened steels should also conform to the requirements specified in paragraph 3.2.1.2, Stress Corrosion.

3.2.6 Titanium. Most titanium alloys have limited hardenability with section size and should not be used in sections which exceed their specified hardenability limits. The variation of mechanical properties with section size as heat treated is shown in Table II of MIL-T-9047. For candidate titanium alloys other than those listed in MIL-T-9047, similar information shall be

obtained by the contractor prior to final selection. This data shall be retained by the contractor and be available for PMPCB review upon request. The surfaces of titanium parts shall be machined or chemically milled to eliminate all contaminated zones formed during processing. Silver plated self-locking nuts may be used with titanium and titanium alloy bolts and screws in structural applications where operating temperatures will not exceed 600°F. Heat treatment of titanium and titanium alloy parts should meet the requirements of SAE-AMS H-81200B.

Care shall be exercised to ensure that cleaning fluids and other chemicals used on titanium are not detrimental to performance. Surface contaminants which can induce stress corrosion, hydrogen embrittlement, or reduce fracture toughness include, hydrochloric acid, cadmium, silver, chlorinated cutting oils and solvents, methyl alcohol, mercury, and components containing mercury. With the exception of silver plated nuts, the use of these substances on titanium is prohibited.

Since titanium alloys are susceptible to the reduction of fatigue life by fretting at interfaces between titanium alloys or titanium and other metal parts, structural applications of titanium shall be designed to avoid fretting.

3.2.7 Magnesium. Magnesium alloys shall not be used except in areas where minimal exposure to corrosive environments can be expected and high reliability protection systems can be maintained. Magnesium alloys shall not be used for primary structures, or in other areas subject to wear, abuse, foreign object damage, abrasion, erosion, or possible fluid or moisture entrapment.

3.2.8 Beryllium. Beryllium and beryllium alloys shall be restricted to applications in which their properties offer definite performance advantages. Additionally, the capability of beryllium parts to provide reliable service and predictable life must be demonstrated by preproduction tests under simulated service conditions, including any expected corrosive environments. Design of beryllium parts shall include consideration of its low impact resistance, the notch sensitivity, particularly at low temperatures, directional material properties (anisotropy), and sensitivity to surface finish requirements. Items containing beryllium and beryllium alloys shall be clearly marked as containing these materials, with a warning calling attention to the hazards of machining and handling beryllium.

3.2.9 Mercury. Mercury and many compounds containing mercury can cause accelerated stress cracking of aluminum and titanium alloys. The use of temperature sensing devices, electrical devices, and any other devices containing mercury shall be prohibited on installed equipment and in items used during fabrication of space flight structures and subsystems. Protected mercury vapor lamps used in the fluorescent penetrant inspection of flight parts are exempt from this requirement.

3.2.10 Other Metals. The contractor shall meet the requirements specified in his own internal Material Management Plan for metallic materials not specifically covered in this appendix.

3.3 NON-METALLIC MATERIAL GUIDELINES

3.3.1 Organic Resins. The organic matrix (binder, resin, plastic and matrix are interchangeable terms) of conventional or advanced composites can be thermoset or thermoplastic. A thermoset composite is processed to a product form by a chemical reaction known as cure. The curing reaction can be facilitated by heat and/or pressure, as in an autoclave cure, or by other means such as radio frequency or radiation exposure.
A thermoplastic composite is physically processed to a product form by a softening transition at the melting temperature, with subsequent processing such as deformation forming or injection molding.

3.3.2 Conventional Composites. Glass fiber reinforced plastic materials usually find aerospace applications in radomes and primary and secondary structures. Glass fiber, either continuous or chopped, can be used to reinforce any number of various organic resins. The many aspects of materials and processes for conventional composites are discussed in MIL-HDBK-17, which should be used as a guide for the selection of conventional composites.

3.3.3 Advanced Composites. Advanced composites consist of an organic matrix reinforced by high modulus and/or high strength, relative to fiberglass, fibers. The fiber reinforcement takes the form of continuous unidirectional filaments, woven fabric , chopped fibers, etc. Fiber materials include boron, carbon, aromatic polymide, etc. DOD/NASA Structural Composites Fabrication Guide should be used in the processing and production of advanced composite materials and structures. Guidance in the effective utilization of advanced composite materials and design concepts in aerospace structures can be found in the DOD/NASA Advanced Composites Design Guide, Vol I -Vol IV.

3.3.4 Elastomeric Materials. Elastomeric materials in contact with Hydrazine shall be restricted to AF-E-332 and AF-E-411 as defined by Air Force Materials Lab report TR71-59, Part II. Use of other elastomeric materials including insulation, liner, bladder and seal materials shall require the approval of the PMPCB. Elastomeric compounds shall have adequate resistance to aging, low temperature, ozone, heat aging, polymer reversion, working fluids, lubricants, and propellants to meet system requirements.

3.3.4.1 Cured Elastomers. Cured elastomers which are age sensitive should be controlled according to MIL-STD-1523. All cured elastomeric materials shall be cure dated either on the item itself or on the packaging. Cured elastomeric materials should be protected from sunlight, fuel, oil, water, dust, and ozone. The storage temperature should not exceed 100°F (38°C) and shall not exceed 125°F (55°C).

3.3.4.2 Uncured Elastomers. Materials which are procured in a uncured state, such as sealants and potting compounds, shall be held in controlled temperature storage with a temperature not to exceed 80°F (26°C) and appropriate humidity controls. Materials requiring reduced temperature storage should be avoided if possible because of the added burden of

reduced temperature storage and the likelihood that this storage temperature will not be maintained at all times. When chosen, materials requiring storage at reduced temperatures should be stored according to manufacturer recommendations. Maximum storage times shall be determined and controlled. Most polysulfide sealants can be stored for at least 9 months at less than 80°F (26°C) without suffering degradation which would make them unsuitable for use. If materials exceed their storage life, suitable tests shall be conducted to ensure the material is adequate for use.

3.3.4.3 Silicone Elastomers. Some one-part silicone products liberate acetic acid during cure. This includes commercial adhesives and sealants as well as those meeting MIL-S-46106. Since these materials can cause corrosion of electronic materials, these materials shall not be used to pot, seal, embed, or encapsulate and shall not be used on or near avionics, electronics, or electrical equipment. These materials have, however, performed well in many applications and may be used in applications other than electronic providing proper precautions are taken. When these products are used, processing should be in accordance with the requirements of MIL-S-46106.

There are one-part silicone sealants available which are non-corrosive. These materials liberate alcohol during cure and are covered by MIL-A-46146. These materials do not cure as quickly nor always adhere as well as the acetic acid liberating materials. It is suggested, however, that the alcohol liberating sealants be used in preference to the acetic acid liberating sealants. Appropriate laboratory testing should be performed in order to verify the adequacy of the material used.

3.3.5 Foamed Plastics. Foamed plastics shall not be used for metal skin reinforcement in structural components nor as a core material in sandwich structural components other than all plastic sandwich parts, low density filler putties, or syntactic foams.

3.3.6 Glass Fiber Reinforced Plastics. Glass fiber reinforced plastic parts should be designed using the guidelines of MIL-HDBK-17.

3.3.7 Lubricants. NASA SP-8063 should be used as a guide in the design and application of lubricants for space flight systems and components.

3.3.8 Adhesives, Sealants, and Coatings. Silicone adhesives and sealants subjected to cryogenic temperatures shall display secondary transition (glass transition) below -100°F. Silicon grease shall not be used as a thermal couplant except in sealed assemblies. The application of other adhesives, including high temperature bonding types, shall require PMPCB approval.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B

MICROCIRCUIT, HYBRID, AND SEMICONDUCTOR UPSCREENING AND CUSTOM PROCESSING REQUIREMENTS

SECTION I
MIL-PRF-38535 CLASS B MICROCIRCUIT UPSCREENING

TABLE B-1a

UPSCREENING (TEST 100%), TEST METHODS OF MIL-STD-883

SCREEN	METHOD	REQUIREMENTS 1/
1. Prescreen electricals 3/ & 8/	5005	YLN of 2% 10/ Optional but encouraged
2. Particle Impact Noise Detection (PIND)	2020	2/
3. Serialization		100%
4. Radiographic	2012	Optional
5. Pre-HTRB electrical parameters 3/ & 8/		Read and record at 25°C
6. High Temperature Reverse Bias (HTRB) burn-in 7/ & 9/	1015	Test condition A or C, 48 hours minimum at +150°C or the device maximum operating limit, whichever is lower
7. Post HTRB electricals and deltas 3/ & 8/		Read and record at 25°C within 16 hours of removal from bias. Percent Defective Allowable: First Pass: 5% or 1, whichever is greater 5/ Second Pass: 3% or 1, whichever is greater 6/
8. Power Burn-in test 9/	1015 4/	160 hours minimum at +125°C

TABLE B-1a UPSCREENING (Con't)

SCREEN	METHOD	REQUIREMENTS 1/
9. Post burn-in electrical parameters and deltas 3/ & 8/		Read and record at 25°C within 96 hours of removal from bias. Percent Defective Allowable: First Pass: 5% or 1, whichever is greater 5/ Second Pass: 3% or 1, whichever is greater 6/
10. Final Electricals 3/ & 8/ a. Static Tests Subgroups 1, 2, and 3 of Table I, Method 5005 b. Dynamic Tests Subgroups 4, 5, and 6 - or - Subgroups 7 and 8 of Table I, Method 5005 c. Switching Tests Subgroup 9 of Table I, Method 5005	 5005 5005 5005	All failures must be data logged Electrical testing performed at step 9 does not need to be repeated
11. Seal test (a) Fine (b) Gross	1014	Reject criteria per test method
12. External Visual	2009	100%

Notes:

1/ Except as stated below, the requirements shall be per Class S of the applicable MIL-M-38510 detail specifications

Notes (Con't):

2/ Test condition A, multiple pass criteria of MIL-STD-883, Method 2020

3/ Parameters as called out in MIL-STD-883, Method 5004 for Class S and:

a. The Class S slash sheet if released.
b. The Class B slash sheet if released.
c. The most similar Class S family device slash sheet if there is no detail Class S slash sheet.
d. The most similar Class B family device slash sheet if there is no detail Class B slash sheet.

4/ Test condition as specified in the applicable detailed slash sheet as determined in note 3/ above. Test conditions A, B, C, and F of Method 1015 shall not apply.

5/ The lot may be automatically resubmitted to a second Power Burn-in or HTRB one-time only without the necessity for MRB approval if the PDA does not exceed 20%. A PDA of greater than 20% shall require lot rejection.

6/ A PDA of greater than 3% on the Power Burn-in or HTRB resubmittal shall require lot rejection.

7/ HTRB shall be performed when specified in the applicable MIL-M-38510 detail slash sheet, as determined in note 3/ above, and for certain MOS, linear, and other microcircuits where surface sensitivity is of concern.

8/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 3/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future upgrade screening.

9/ The order in which Power urn-in and HTRB are performed may be switched at the contractor's option.

10/ Perform group A, subgroups 1 and 7. This test is designed to evaluate lots for continued upscreening or return to the vendor. A yield loss notification (YLN) of 2% should be imposed as a flag for PMPCB review and disposition.

TABLE B-1b

LOT ACCEPTANCE TESTING (SAMPLE AS SPECIFIED), TEST METHODS OF MIL-STD-883

SUBGROUP	METHOD	REQUIREMENTS 11/
Subgroup 1		3 devices sampled with 0 failures or 5 devices sampled with 1 failure
(b) Internal water-vapor content 5/	1018	5,000 ppm max water content at 100°C
Subgroup 5		LTPD = 10 over subgroup 5 9/
(a) Electrical measurements 1/ & 2/ a. Subgroups 1, 2, and 3 of Table I, Method 5005	5005	Read and record
(b) Steady state life 4/ & 10/	1005	1000 hours minimum at +125°C
(c) Electrical measurements and deltas 1/ & 2/ a. Subgroups 1, 2, and 3 of Table I, Method 5005	5005	Read and record 8/
Subgroup 6		LTPD = 15 over subgroup 6 9/
(b) Temp cycling 3/	1010	Condition C, 100 cycles minimum
(c) Constant acceleration 6/	2001	Test condition E, Y_1 orientation only
(d) Seal - fine and gross 7/	1014	Reject criteria per test method
(e) Electrical measurements 1/, 2/ & 7/ a. Subgroup 1 of Table I, Method 5005	5005	Read and record 9/

Notes:

1/ Parameters as called out in MIL-STD-883, Method 5005 and:

a. The Class S slash sheet if released.
b. The Class B slash sheet if released.
c. The most similar Class S family device slash sheet if there is no detail Class S slash sheet.
d. The most similar Class B family device slash sheet if there is no detail Class B slash sheet.

Notes (Con't):

2/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 1/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future upgrade screening.

3/ Temperature cycling may be performed as part of 100% testing with 10 thermal cycles performed to test Condition C of MIL-STD-883, Method 1010.

4/ A 340 hour intermittent operating life test per MIL-STD-883, Method 1006, and the applicable slash sheet may be performed in lieu of steady state life.

5/ Internal water-vapor testing may be performed as part of the DPA.

6/ Constant acceleration may be performed as part of 100% testing. If performed as part of 100% testing, constant acceleration shall be performed prior to seal leak testing.

7/ Seal leak and electrical testing need not be performed if thermal cycling and constant acceleration are performed as part of 100% screening.

8/ Life test samples tested at temperatures below the maximum specified junction temperature, meeting all specified acceptance criteria, and not subjected to the destructive testing of Subgroup 1, test (b), Internal Water Vapor and/or Subgroup 6, test (a), Temp cycling may be used in flight hardware with PMPCB approval.

9/ Reference Appendix H for the number of samples required for each specified LTPD. Resubmission of a failed lot shall be permitted one time only. The resubmission sample size shall be the sample size called out in the next lower LTPD for the number of failures experienced during the first submission with zero additional failures or larger sample sizes at the same lower LTPD with total failures between the first and second submission as specified. Parts passing the first test shall not be included in the resubmission sample without PMPCB approval.

10/ Test condition as specified in the applicable detailed slash sheet as determined in note 1/ above. Test conditions A, B, C, and F of Method 1005 shall not apply.

11/ Post burn-in electrical rejects from the same inspection lot may be used for all subgroups when end-point measurements are not required.

TABLE B-1c

Destructive Physical Analysis (DPA)

DPA per MIL-STD-1580 1/ or approved procedure	Sample size per paragraph 4.5.5.1b. All anomalies shall be dispositioned as acceptable or rejectable.
Internal water-vapor content 2/	Per MIL-STD-883, Method 1018. 3 devices sampled with 0 failures or 5 devices sampled with 1 failure. 5,000 ppm max water content at 100°C

Notes:

1/ DPA may be performed anytime after part receipt.

2/ Internal water-vapor may be performed as part of Lot Acceptance Testing.

SECTION II
MIL-PRF-38534 CLASS H HYBRID UPSCREENING

TABLE B-2a

UPSCREENING (TEST 100%), TEST METHODS OF MIL-STD-883

SCREEN	METHOD	REQUIREMENTS 1/
1. Prescreen electricals 3/ & 7/	5005	YLN of 2% 8/ Optional but encouraged.
2. Particle Impact Noise Detection (PIND)	2020	2/
3. Serialization		100%
4. Radiographic	2012	2 views
5. Pre burn-in electrical parameters 3/ & 7/		Read and record at 25°C
6. Power Burn-in test 4/	1015	160 hours at +125°C
7. Post burn-in electricals and deltas 3/ & 7/		Read and record at 25°C within 96 hours of removal from bias. Percent Defective Allowable: First Pass: 2% or 1, whichever is greater 5/ Second Pass: 1.5% or 1, whichever is greater 6/
8. Final Electricals 3/ & 7/ a. Static Tests Subgroups 1, 2, and 3 of Table X, Method 5008	5008	All failures must be data logged Electrical testing performed at step 7 does not need to be repeated

TABLE B-2a UPSCREENING (Con't)

SCREEN	METHOD	REQUIREMENTS 1/
b. Dynamic Tests Subgroups 4, 5, and 6 of Table X, Method 5008 - or - Functional Tests Subgroups 7 and 8 of Table X, Method 5008	5008	
c. Switching Tests Subgroups 9, 10, and 11 of Table X, Method 5008	5008	
9. Seal test (a) Fine (b) Gross	1014	Reject criteria per test method
10. External Visual	2009	100%

Notes:

1/ Except as stated below, the requirements shall be per Class K of applicable MIL-PRF-38534E detail specifications.

2/ Test condition A, multiple pass criteria of MIL-STD-883, Method 2020

3/ Parameters as called out in MIL-STD-883, Method 5008 for Class K and:

a. The Class K slash sheet if released.

b. The Class H slash sheet if released.

c. The most similar Class K family device slash sheet if there is no detail Class K slash sheet.

d. The most similar Class H family device slash sheet if there is no detail Class H slash sheet.

4/ Test condition as specified in the applicable detailed slash sheet as determined in note 3/ above. Test conditions A, B, C, and F of Method 1015 shall not apply.

5/ The lot may be automatically resubmitted to a second Power Burn-in one-time only without the necessity for MRB approval if the PDA does not exceed 10%. A PDA of greater than 10% shall require lot rejection.

6/ A PDA of greater than 1.5% on the Power Burn-in resubmittal shall require lot rejection.

Notes (Con't):

7/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 3/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future upgrade screening.

8/ Perform group A, subgroups 1 and 4. This test is designed to evaluate lots for continued upscreening or return to the vendor. A yield loss notification (YLN) of 2% should be imposed as a flag for PMPCB review and disposition.

TABLE B-2b

LOT ACCEPTANCE TESTING (SAMPLE AS SPECIFIED), TEST METHODS OF MIL-STD-883

SUBGROUP	METHOD	REQUIREMENTS 11/
Subgroup 1		3 devices sampled with 0 failures or 5 devices sampled with 1 failure
(b) Internal water-vapor content 4/	1018	3,000 ppm max water content at 100°C
Subgroup 2		15 devices sampled with zero failures 5/ & 6/
(a) Electrical measurements 1/ & 2/ a. Subgroups 1, 2, and 3 of Table X, Method 5008	5008	Read and record
(b) Steady state life 3/ & 10/	1005	1000 hours minimum at +125°C
(c) Electrical measurements and deltas 1/ & 2/ a. Subgroups 1, 2, and 3 of Table X, Method 5008	5008	Read and record 5/
Subgroup 3		15 devices sampled with zero failures 6/
(b) Temp cycling 7/	1010	Condition C, 20 cycles minimum
(c) Constant acceleration 8/	2001	Y_1 orientation only
(d) Seal - fine and gross 9/	1014	Reject criteria per test method
(e) Electrical measurements 1/ and 2/ a. Subgroups 1, 2, and 3 of Table X, Method 5008	5008	Read and record

Notes:

1/ Parameters as called out in MIL-STD-883, Method 5008 for Class K and:
   a. The Class K slash sheet if released.
   b. The Class H slash sheet if released.
   c. The most similar Class K family device slash sheet if there is no detail Class K slash sheet.
   d. The most similar Class H family device slash sheet if there is no detail Class H slash sheet.

2/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 1/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future upgrade screening.

3/ A 340 hour intermittent operating life test per MIL-STD-883, Method 1006 and the applicable slash sheet may be performed in lieu of steady state life.

4/ Internal water-vapor testing may be performed as part of the DPA.

5/ Life test samples tested at temperatures below the maximum specified junction temperature, meeting all acceptance criteria, and not subjected to the destructive testing of Subgroup 1, test (b), Internal Water Vapor, and/or Subgroup 3, test (b), Temperature Cycling may be used in flight hardware with PMPCB approval.

6/ Resubmission of a failed lot shall be permitted one time only using double the sample size with zero failures allowed. Parts passing the first test shall not be included in the resubmission sample without PMPCB approval.

7/ Temperature cycling may be performed as part of 100% testing with 10 thermal cycles performed to test Condition C of MIL-STD-883, Method 1010.

8/ Constant acceleration may be performed as part of 100% testing. If performed as part of 100% testing, constant acceleration shall be performed prior to seal leak testing.

9/ Seal leak and electrical testing need not be performed if thermal cycling and constant acceleration are performed as part of 100% screening.

10/ Test condition as specified in the applicable detailed slash sheet as determined in note 1/ above. Test conditions A, B, C, and F of Method 1005 shall not apply.

11/ Post burn-in electrical rejects from the same inspection lot may be used for all subgroups when end-point measurements are not required.

TABLE B-2c

Destructive Physical Analysis (DPA)

DPA per MIL-STD-1580 1/ or approved procedure	Sample size per paragraph 4.5.5.1b. All anomalies shall be dispositioned as acceptable or rejectable.
Internal water-vapor content 2/	Per MIL-STD-883, Method 1018. 3 devices sampled with 0 failures or 5 devices sampled with 1 failure. 5,000 ppm max water content at 100°C

Notes:

1/ ***DPA may be performed anytime after part receipt.***
2/ Internal water-vapor may be performed as part of Lot Acceptance Testing.

SECTION III
MIL-PRF-19500 JANTXV TRANSISTOR AND DIODE UPSCREENING

TABLE B-3a

UPSCREENING (TEST 100%), TEST METHODS OF MIL-STD-750

SCREEN	METHOD	REQUIREMENTS 1/
1. Prescreen electricals 3/ & 9/		YLN of 2% 11/ Optional but encouraged.
2. Particle Impact Noise Detection (PIND) 6/	2020	Per MIL-STD-883. 2/
3. Serialization		100%
4. Pre HTRB electrical parameters 3/ & 9/		Read and record at 25°C
5. High temperature reverse bias burn-in 10/ & 12/ Reverse bias burn-in (for transistors) (bipolar) Reverse bias burn-in (for diodes and rectifiers)	1039 1038	48 hours minimum at +150°C or the devices maximum operating limit, whichever is lower and at the minimum applied voltage as follows: Transistor - 80% of rated V_{CB} (bipolar) or V_{GS} (FET and MFET) Diodes (except zeners of 10 volts or less) and rectifiers - rated < 10 amps at T_C > 100°C - 80% of rated V_B
6. Interim electricals and deltas 3/ & 9/		Read and record at 25°C within 16 hours of removal of bias. Percent Defective Allowable: First Pass: 5% or 1, whichever is greater 4/ Second Pass: 3% or 1, whichever is greater 5/

TABLE B-3a UPSCREENING (Con't)

SCREEN	METHOD	REQUIREMENTS 1/
7. Power burn-in 13/ Burn-in (for transistors) Burn-in (for diodes and rectifiers)	 1039 1038	160 hours minimum per the applicable slash sheet
8. Post burn-in electrical parameters and deltas 3/ & 9/	–	Read and record at 25°C within 96 hours of removal of bias. Percent Defective Allowable: First Pass: 5% or 1, whichever is greater 4/ Second Pass: 3% or 1, whichever is greater 5/
9. Final electricals 3/ & 9/ a. Static Tests Subgroups 2 and 3 of Table III of MIL-PRF-19500 b. Dynamic Tests Subgroups 4 and 7 of Table III of MIL-PRF-19500		All failures must be data logged Electrical testing performed at step 8 does not need to be repeated.
10. Radiography	2076	Optional
11. Seal test (a) Fine 7/ & 8/ (b) Gross	1071	 (a) Test conditions G or H, max leak rate = 5 X 10^{-8} atm cc/s except 5 X 10^{-7} atm cc/s for devices with internal cavity > 0.3 cc (b) Test conditions A, C, D, E, or F
12. External visual examination	2071	100%

Notes:

1/ Except as stated below, the requirements shall be per the JANS requirements of the applicable MIL-PRF-19500 detail specifications
2/ Test condition A, multiple pass criteria of MIL-PRF-19500
3/ Parameters as called out in MIL-PRF-19500, Table II, JANS Requirements and:
   a. The JANS slash sheet if released
   b. The JANTXV slash sheet if released
   c. The most similar JANS family device slash sheet if there is no detail JANS slash sheet
   d. The most similar JANTXV family device slash sheet if there is no detail JANTXV slash sheet.
4/ The lot may be automatically resubmitted to a second Power Burn-in or HTRB one-time only without the necessity for MRB approval if the PDA does not exceed 20%. A PDA of greater than 20% shall require lot rejection.
5/ A PDA of greater than 3% on the Power Burn-in or HTRB resubmittal shall require lot rejection.
6/ For all devices with an internal cavity.
7/ Omit this test for painted glass diodes.
8/ Omit this test for metallurgically bonded, double plug diodes.
9/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 1/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future upgrade screening.
10/ The order in which Power Burn-in and HTRB are performed may be switched at the contractor's option.
11/ Perform group A, subgroups 2 and 4. This test is designed to evaluate lots for continued upscreening or return to the vendor. A yield loss notification (YLN) of 2% should be imposed as a flag for PMPCB review and disposition.
12/ Test Condition A of the appropriate test method shall apply.
13/ Test Condition B of the appropriate test method shall apply.

TABLE B-3b

LOT ACCEPTANCE TESTING (SAMPLE AS SPECIFIED), TEST METHODS OF MIL-STD-750

SUBGROUP	METHOD	REQUIREMENTS
Subgroup 1		3 devices sampled with 0 failures or 5 devices sampled with 1 failure
(a) MIL-M-38510, Method 5005 Internal water-vapor content 4/	1018 of MIL-STD -883	On cavity devices only. 5000 ppm max water content at 100°C
Subgroup 4		LTPD = 10 over subgroup 4 8/
(a) Electrical measurements 1/ & 2/ a. Subgroups 2 and 3 of Table III of MIL-PRF-19500		Read and record
(b) Intermittent Operating Life	1037	340 hours per the applicable slash sheet
(c) Electrical measurements and Deltas 1/ & 2/ a. Subgroups 2 and 3 Table III of MIL-PRF-19500		Read and record
Subgroup 3		LTPD = 15 over subgroup 3 8/
(a) Temp cycling 3/	1051	Condition C3, 100 cycles minimum
(b) Constant acceleration 5/ & 9/	2006	Y_1 orientation only
(c) Seal - fine and gross 6/	1071	Reject criteria per test method
(d) Electrical measurements 1/, 2/ & 6/ a. Subgroup 2 of Table III of MIL-PRF-19500		Read and record

Notes:

1/ Parameters as called out in MIL-PRF-19500, Table IVa and:
   a. The JANS slash sheet if released.
   b. The JANTXV slash sheet if released.
   c. The most similar JANS family device slash sheet if there is no detail JANS slash sheet.
   d. The most similar JANTXV family device slash sheet if there is no detail JANTXV slash sheet.

2/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 1/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future upgrade screening.

3/ Temperature cycling may be performed as part of 100% testing with 20 thermal cycles performed to test Condition C of MIL-STD-750, Method 1051.

4/ Internal water-vapor may be performed as part of the DPA.

5/ Constant acceleration may be performed as part of 100% screening. If constant acceleration is performed as part of 100% screening, it shall be performed prior to seal leak testing.

6/ Seal leak and electrical testing need not be performed if temperature cycling and constant acceleration are performed as part of 100% screening.

7/ Life test samples tested at temperatures below the maximum specified junction temperature, meeting all acceptance criteria, and not submitted to the destructive testing of Subgroup 1, test (a), Internal Water Vapor, or Subgroup 3, test (a), Temperature Cycling may be used in flight hardware with PMPCB approval.

8/ Reference Appendix H for the number of samples required for each specified LTPD. Resubmission of a failed lot shall be permitted one time only. The resubmission sample size shall be the sample size called out in the next lower LTPD for the number of failures experienced during the first submission with zero additional failures or larger sample sizes at the same lower LTPD with total failures between the first and second submission as specified. Parts passing the first test shall not be included in the resubmission sample without PMPCB approval.

9/ Omit this test for non-cavity devices.

TABLE B-3c

Destructive Physical Analysis (DPA)

DPA per MIL-STD-1580 1/ or approved procedure	Sample size per paragraph 4.5.5.1b. All anomalies shall be dispositioned as acceptable or rejectable.
Internal water-vapor content 2/ & 3/	Per MIL-STD-883, Method 1018. 3 devices sampled with 0 failures or 5 devices sampled with 1 failure. 5,000 ppm max water content at 100°C

Notes:

1/ DPA may be performed anytime after part receipt

2/ Internal water-vapor may be performed as part of Lot Acceptance Testing.

3/ Do not perform on glass body or double plug solid construction diodes

SECTION IV
MICROCIRCUIT CUSTOM REQUIREMENTS

TABLE B-4a

PROCESSING PER MIL-M-38510, CLASS S REQUIREMENTS EXCEPT AS NOTED

PROCESS	REQUIREMENT
1. Manufacturing Baseline	
a. Process Specifications	As approved by the contractor acquisition activity. Process revision level shall be under the purchaser's configuration control.
b. Lot Traveler	Per MIL-M-38510 for Class S devices. The lot traveler shall be approved by the contractor acquisition activity. Process revision level shall be under the purchaser's configuration control.
c. As-built Construction Analysis	Decap internal visual. Visual criteria in accordance with qualified design. 1 device for each lot.
d. 4 Wafer Lots per Date Code maximum	
e. Wafer Traceability	Per MIL-M-38510 for Class S devices.
2. Rework	Per MIL-M-38510 for Class S devices. Delidding is permitted only with the approval of the PMPCB.
3. Design & Construction	Per MIL-M-38510 for Class S devices.
4. Processing Surveillance	In-process testing monitored by the contractor acquisition activity.
a. Wafer Acceptance (SEM)	Per MIL-STD-883, Method 5007
b. Die Shear	Per MIL-STD-883, Method 2019 for the applicable die size
c. Bond Pull	Per MIL-STD-883, Method 2023 1/ Lot failure criteria of MIL-M-38510
d. Pre-cap Visual Inspection	Per MIL-STD-883, Method 2010, Condition A, 100%

Notes:

1/ When an automatic bonder in used, sample destructive bond pull may be performed in lieu of 100% nondestructive bond pull. Sample destructive bond pull shall be per the following requirements:

a. MIL-STD-883, Method 2011, failure criteria of Method 2011, Table I
b. 100% destructive bond pull on three devices at the beginning and end of each shift and after any interruptions greater than 15 minutes in the production flow.
c. 100% destructive bond pull on three devices every two hours. The three devices shall be randomly selected from the prior two hour production period. Acceptance of product bonded during the prior two hour period shall be contingent upon this three piece sample passing the criteria of Method 2011.

TABLE B-4b

SCREENING (TEST 100%), TEST METHODS OF MIL-STD-883

SCREEN	METHOD	REQUIREMENTS 1/
1. Temperature Cycling	1010	10 cycles to Condition C
2. Constant Acceleration	2001	Test Condition E, Y_1 orientation only
3. Particle Impact Noise Detection (PIND)	2020	2/
4. Serialization		100%
5. Radiographic	2012	Optional
6. Pre burn-in electrical parameters 3/ & 8/		Read and record at 25°C
7. Power Burn-in test	1015 4/	240 hours minimum at +125°C
8. Interim (post burn-in) electrical parameters and deltas 3/ & 8/		Read and record at 25°C within 96 hours of removal from bias. Percent Defective Allowable: First Pass: 5% or 1, whichever is greater 5/ Second Pass: 3% or 1, whichever is greater 6/
9. High Temperature Reverse Bias (HTRB) burn-in 7/	1015	Test condition A or C, 72 hours minimum at +150°C or the device maximum operating limit, whichever is lower.

TABLE B-4b SCREENING (Con't)

SCREEN	METHOD	REQUIREMENTS 1/
10. Post HTRB electricals and deltas 3/ & 8/		Read and record at 25°C within 16 hours of removal from bias. Percent Defective Allowable: First Pass: 5% or 1, whichever is greater 5/ Second Pass: 3% or 1, whichever is greater 6/
11. Final Electricals 3/ & 8/		Read and record Electrical testing performed in step 10 need not be repeated.
a.. Static Tests Subgroups 1, 2, and 3 of Table I, Method 5005	5005	
b. Dynamic/Functional Tests Subgroups 4, 5, and 6 - or - Subgroups 7 and 8 of Table I, Method 5005	5005	
c. Switching Tests Subgroup 9 of Table I, Method 5005	5005	
12. Seal test (a) Fine (b) Gross	1014	Reject criteria per test method
13. External Visual	2009	100%

Notes:

1/ Except as stated below, the requirements shall be per Class S of the applicable MIL-M-38510 detail specifications

2/ Test condition A, multiple pass criteria of MIL-STD-883, Method 2020

3/ Parameters as called out in MIL-STD-883, Method 5004 for Class S devices and the most similar Class S family device slash sheet if there is no detail Class S slash sheet or the most similar Class B family device slash sheet if there is no similar Class S family device slash sheet.

4/ Test condition as specified in the applicable detailed slash sheet as determined in note 3/ above. Test conditions A, B, C, and F of Method 1015 shall not apply.

5/ The lot may be automatically resubmitted to a second Power Burn-in or HTRB one-time only without the necessity for MRB approval if the PDA does not exceed 20%. A PDA of greater than 20% shall require lot rejection.

6/ A PDA of greater than 3% on the Power Burn-in or HTRB resubmittal shall require lot rejection.

7/ HTRB shall be performed when specified in the applicable MIL-M-38510 detail slash sheet, as determined in note 3/ above, and for certain MOS, linear, and other microcircuits where surface sensitivity is of concern.

8/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 3/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future screening.

TABLE B-4c

LOT ACCEPTANCE TESTING (SAMPLE AS SPECIFIED), TEST METHODS OF MIL-STD-883

SUBGROUP	METHOD	REQUIREMENTS 7/ & 9/
Subgroup 1		Device samples as called out below
(a) Physical dimensions	2016	2(0)
(b) Internal water-vapor content 4/	1018	5,000 ppm max water content at 100°C 3(0) or 5(1)
Subgroup 2		Device samples as called out below
(a) Resistance to solvents	2015	4 devices sampled with 0 failures
Subgroup 3		LTPD = 10 for subgroup 3 8/
Solderability	2003 or 2022	
Subgroup 4		2 devices sampled with 0 failures
(a) Lead Integrity	2004	Test Condition B_2
(b) Seal a. Fine b. Gross	1014 2024	Reject criteria per test method.
(c) Lid Torque 5/		
Subgroup 5		LTPD = 5 over subgroup 5 8/
(a) Electrical measurements 1/ & 2/ a. Subgroups 1, 2, and 3 of Table I, Method 5005	5005	Read and record
(b) Steady state life 3/ & 6/	1005	1000 hours minimum at +125°C
(c) Electrical measurements and deltas 1/ & 2/ a. Subgroups 1, 2, and 3 of Table I, Method 5005	5005	Read and record

TABLE B-4c LOT ACCEPTANCE TESTING (Con't)

SUBGROUP	METHOD	REQUIREMENTS 7/ & 9/
Subgroup 6		LTPD = 15 over subgroup 6 8/
(a) Thermal Shock	1011	Condition B, 15 cycles min
(b) Temp cycling	1010	Condition C, 100 cycles minimum
(c) Mechanical shock	2002	Condition B min Condition A min
(d) Vibration, variable frequency	2007	Test condition E, Y_1 orientation only
(e) Constant acceleration	2001	Reject criteria per test method.
(f) Seal a. fine b. gross	1014	Read and record
(g) Electrical measurements 1/ & 2/ a. Subgroup 1 of Table I, Method 5005	5005	

Notes:

1/ Parameters as called out in MIL-STD-883, Method 5004 for Class S devices and the most similar Class S family device slash sheet if there is no detail Class S slash sheet or the most similar Class B family device slash sheet if there is no similar Class S family device slash sheet.

2/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 1/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future screening.

3/ A 340 hour intermittent operating life test per MIL-STD-883, Method 1006 and the applicable slash sheet may be performed in lieu of steady state life.

4/ Internal water-vapor may be performed as part of the DPA.

5/ Lid torque shall be performed on glass-frit sealed devices only.

6/ Test condition as specified in the applicable detailed slash sheet as determined in note 1/ above. Test conditions A, B, C, and F of Method 1015 shall not apply.

Notes (Con't):

7/ Life test samples tested at temperatures below the maximum specified junction temperature, physical dimension samples, and resistance to solvents samples meeting all acceptance criteria and not submitted to the destructive testing of Subgroups 1(b), 2(b), 3, 4(a), 4(c), or 6(b) may be used in flight hardware with the approval of the PMPCB.

8/ Reference Appendix I for the number of samples required for each specified LTPD. Resubmission of a failed lot shall be permitted one time only. The resubmission sample size shall be the sample size called out in the next lower LTPD for the number of failures experienced during the first submission with zero additional failures or larger sample sizes at the same lower LTPD with total failures between the first and second submission as specified. Parts passing the first test shall not be included in the resubmission sample without PMPCB approval.

9/ Post burn-in electrical rejects from the same inspection lot may be used for all subgroups when end-point measurements are not required.

TABLE B-4d

Destructive Physical Analysis (DPA)

DPA per MIL-STD-1580 1/ or approved procedure	Sample size per paragraph 4.5.5.1b. All anomalies shall be dispositioned as acceptable or rejectable.

Notes:

1/ ***DPA may be performed anytime after part encapsulation.***

SECTION V
HYBRID CUSTOM REQUIREMENTS

TABLE B-5a

PROCESSING PER MIL-PRF-38534, CLASS K REQUIREMENTS EXCEPT AS NOTED

PROCESS	REQUIREMENT
1. Manufacturing Baseline	
a. Process Specifications	As approved by the contractor acquisition activity. Process revision level shall be under the purchaser's configuration control.
b. Lot Traveler	Per MIL-PRF-38534 for Class K devices. The lot traveler shall be approved by the contractor acquisition activity. Process revision level shall be under the purchaser's configuration control.
c. As-built Construction Analysis	Decap internal visual. Visual criteria in accordance with qualified design. 1 device for each lot.
e. Traceability	Per MIL-PRF-38534 for Class K devices. Traceability to the wafer lot which each semiconductor and microcircuit element originated.from
2. Rework	Per MIL-PRF-38534 for Class K devices. Delidding for the purpose of rework/repair, compound bonding, and seal rework are permitted only with the approval of the PMPCB.
3. Design & Construction	Per MIL-PRF-38534 for Class K devices.
a. Element evaluation	Per MIL-STD-883, Method 5008 for Class K devices.
4. Processing Surveillance	In-process testing monitored by the contractor acquisition activity
a. Data Review	Review of substrate lot acceptance and element evaluation results
b. Die Shear	Per MIL-STD-883, Method 2019 for the applicable die size 22 die shears with 0 failures on each of 2 devices
c. Bond Pull	Per MIL-STD-883, Method 2023 1/ Lot failure criteria of MIL-M-38510
d. Pre-cap Visual Inspection	Per MIL-STD-883, Method 2014, 100%

Notes:

1/ When an automatic bonder in used, sample destructive bond pull may be performed in lieu of 100% nondestructive bond pull. Samples used for testing may be non-flight parts or a representative coupon. Sample destructive bond pull shall be per the following requirements:

a. MIL-STD-883, Method 2011, failure criteria of Method 2011, Table I
b. Destructive bond pull on one device to a LTPD of 5 at the beginning and end of each shift.
c. Destructive bond pull on one device to a LTPD of 5 every two hours. The device shall be randomly selected from the prior two hour production period. Acceptance of product bonded during the prior two hour period shall be contingent upon this one piece sample passing the criteria of Method 2011.

TABLE B-5b
SCREENING (TEST 100%), TEST METHODS OF MIL-STD-883

SCREEN	METHOD	REQUIREMENTS 1/
1. Temperature Cycling	1010	10 cycles to Condition C
2. Constant Acceleration	2001	Y_1 orientation only
3. Particle Impact Noise Detection (PIND)	2020	2/
4. Serialization		100%
5. Radiographic	2012	Optional
6. Pre burn-in electrical parameters 3/ & 7/		Read and record at 25°C
7. Power Burn-in test	1015 4/	160 hours minimum at +125°C
8. Interim (post burn-in) electrical parameters and deltas 3/ & 7/		Read and record at 25°C within 96 hours of removal from bias. No Percent Defective Allowable is imposed. Remove all failed devices. from the lot.
9. Power Burn-in test	1015 4/	160 hours minimum at +125°C
10. Post burn-in electricals and deltas 3/ & 7/		Read and record at 25°C within 96 hours of removal from bias. Percent Defective Allowable: First Pass: 2% or 1, whichever is greater 5/ Second Pass: 1.5% or 1, whichever is greater 6/

TABLE B-5b SCREENING (Con't)

SCREEN	METHOD	REQUIREMENTS 1/
11. Final Electricals 3/ & 7/		Read and record
a. Static Tests of Table X, Method 5008 Subgroups 1, 2, and 3	5008	Electrical testing performed in step 10 need not be repeated.
b. Dynamic/Functional Tests Subgroups 4, 5, and 6 - or - Subgroups 7 and 8 of Table X, Method 5008	5008	
c. Switching Tests Subgroups 9, 10, and 11 of Table X, Method 5008	5008	
12. Seal test (a) Fine (b) Gross	1014	Reject criteria per test method
13. External Visual	2009	100%

Notes:

1/ Except as stated below, the requirements shall be per Class K of the applicable MIL-H-38534 detail specifications.

2/ Test condition A, multiple pass criteria of MIL-STD-883, Method 2020

3/ Parameters as called out in MIL-STD-883, Method 5008 for Class K devices and the most similar Class K family device slash sheet if there is no detail Class K slash sheet or the most similar Class H family device slash sheet if there is no similar Class K family device slash sheet.

4/ Test condition as specified in the applicable detailed slash sheet as determined in note 3/ above. Test conditions A, B, C, and F of Method 1015 shall not apply.

5/ The lot may be automatically resubmitted to a second Power Burn-in one-time only without the necessity for MRB approval if the PDA does not exceed 10%. A PDA of greater than 10% shall require lot rejection.

6/ A PDA of greater than 1.5% on the Power Burn-in or HTRB resubmittal shall require lot rejection.

7/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 3/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future screening.

TABLE B-5c

LOT ACCEPTANCE TESTING (SAMPLE AS SPECIFIED), TEST METHODS OF MIL-STD-883

SUBGROUP	METHOD	REQUIREMENTS 6/ & 8/
Subgroup 1		Device samples as called out below
(a) Physical dimensions	2016	2 devices sampled with 0 failures
(b) Internal water-vapor content 4/	1018	3,000 ppm max water content at 100°C 3 devices sampled with 0 failures or 5 devices sampled with 1 failure
Subgroup 2		Device samples as called out below
(a) Resistance to solvents	2015	4 devices sampled with 0 failures
Subgroup 3 Solderability	2003 or 2022	1 device sampled with 0 failures
Subgroup 4		1 device sampled with 0 failures
(a) Lead Integrity	2004	Test Condition B_2
(b) Seal a. Fine b. Gross	1014	Reject criteria per test method
Subgroup 5		15 devices sampled with 0 failures 7/
(a) Electrical measurements 1/ & 2/ a. Subgroups 1, 2, and 3 of Table X, Method 5008	5008	Read and record
(b) Steady state life 3/ & 5/	1005	1000 hours minimum at +125°C
(c) Electrical measurements and deltas 1/ & 2/ a. Subgroups 1, 2, and 3 of Table X, Method 5008	5008	Read and record

TABLE B-5c LOT ACCEPTANCE TESTING (Con't)

SUBGROUP	METHOD	REQUIREMENTS 6/ & 8/
Subgroup 6		15 devices sampled with 0 failures 7/
(a) Thermal shock	1011	Condition B, 15 cycles min
(b) Temp cycling	1010	Condition C, 20 cycles minimum
(c) Constant acceleration	2001	Y_1 orientation only
(d) Seal a. fine b. gross	1014	Reject criteria per test method
(e) Electrical measurements 1/ & 2/ a. Subgroups 1, 2, and 3 Table X, Method 5008	5008	Read and record

Notes:

1/ Parameters as called out in MIL-STD-883, Method 5008 for Class K devices and the most similar Class K family device slash sheet if there is no detail Class K slash sheet or the most similar Class H family device slash sheet if there is no similar Class K family device slash sheet.

2/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 1/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future screening.

3/ A 340 hour intermittent operating life test per MIL-STD-883, Method 1006, and the applicable slash sheet may be performed in lieu of steady state life.

4/ Internal water-vapor may be performed as part of the DPA.

5/ Test condition as specified in the applicable detailed slash sheet as determined in note 1/ above. Test conditions A, B, and F of Method 1005 shall not apply.

6/ Life test samples tested at temperatures below the maximum specified junction temperature, physical dimension samples, and resistance to solvents samples meeting all acceptance criteria and not submitted to the destructive testing of Subgroups 1(b), 2(b), 3, 4(a), 4(c), or 6(b) may be used in flight hardware with the approval of the PMPCB.

7/ Resubmission of a failed lot shall be permitted one time only using double the sample size with 0 failures allowed. Parts passing the first test shall not be included in the resubmission sample without PMPCB approval.

8/ Post burn-in electrical rejects from the same inspection lot may be used for all subgroups when end-point measurements are not required.

TABLE B-5d

Destructive Physical Analysis (DPA)

DPA per MIL-STD-1580 1/ or approved procedure	Sample size per paragraph 4.5.5.1b. All anomalies shall be dispositioned as acceptable or rejectable.

Notes:

1/ ***DPA may be performed anytime after part encapsulation.***

TABLE VI
TRANSISTOR AND DIODE CUSTOM PROCESSING

TABLE B-6a

PROCESSING PER MIL-PRF-19500, JANS REQUIREMENTS EXCEPT AS NOTED

PROCESS	REQUIREMENT
1. Manufacturing Baseline	
a. Process Specifications	As approved by the contractor acquisition activity. Process revision level shall be under the purchaser's configuration control.
b. Lot Traveler	Per MIL-PRF-19500 for JANS devices. The lot traveler shall be approved by the contractor acquisition activity. The revision level shall be under the purchaser's configuration control.
c. As-built Construction Analysis	Decap internal visual. Visual criteria in accordance with qualified design. 1 device for each lot.
d. Single Wafer Lot Date Code	Per MIL-PRF-19500 for JANS devices
e. Wafer Traceability	Per MIL-PRF-19500 for JANS devices
2. Rework	Per MIL-PRF-19500 for JANS devices. Delidding is permitted only with the approval of the PMPCB.
3. Design & Construction	Per MIL-PRF-19500 for JANS devices. Use of non-metallurgical bonding techniques for diodes with PMPCB approval.
4. Processing Surveillance	In-process testing monitored by the contractor acquisition activity.
a. Wafer Acceptance (SEM)	Per MIL-STD-750, Method 2077, 100% (For devices with expanded contact metallization only)
b. Die Shear	Per MIL-STD-750, Method 2017
c. Bond Pull	Per MIL-STD-883, Method 2023 1/
d. Pre-cap Visual Inspection	Per MIL-STD-750, Method 2075, 100%

Notes:

1/ When an automatic bonder in used, sample destructive bond pull may be performed in lieu of 100% nondestructive bond pull. Sample destructive bond pull shall be per the following requirements:

a. MIL-STD-883, Method 2011, failure criteria of Method 2011, Table I
b. 100% destructive bond pull on three devices at the beginning and end of each shift and after any interruptions greater than 15 minutes in the production flow.
c. 100% destructive bond pull on three devices every two hours. The three devices shall be randomly selected from the prior two hour production period. Acceptance of product bonded during the prior two hour period shall be contingent upon this three piece sample passing the criteria of Method 2011.

TABLE B-6b

SCREENING (TEST 100%), TEST METHODS OF MIL-STD-750

SCREEN	METHOD	REQUIREMENTS 1/
1. High Temp Life (Stabilization Bake)	1032	24 hours minimum at maximum rated storage temperature
2. Temperature cycling	1051	Condition C, 10 cycles
3. Constant acceleration 14/	2006	Test condition E, Y_1 orientation only
4. Particle Impact Noise Detection (PIND) 6/	2020	Per MIL-STD-883. 2/
5. Instability shock test (axial lead diodes only) 10/		
a. Forward instability shock test (FIST)	2081	
b. Backward instability shock test (BIST)	2082	
c. Thermal response 11/	1051	10 Cycles
6. Serialization		100%
7. Pre burn-in electrical measurements 3/ & 9/		Read and record at 25°C
8. Power burn-in 13/		240 hours minimum per the applicable slash sheet
Burn-in (for transistors)	1039	
Burn-in (for diodes and rectifiers)	1038	

TABLE B-6b SCREENING (Con't)

SCREEN	METHOD	REQUIREMENTS 1/
9. Interim (post burn-in) electrical measurements and deltas 3/ & 9/		Read and record at 25°C within 96 hours of removal of bias. Percent Defective Allowable: First Pass: 5% or 1, whichever is greater 4/ Second Pass: 3% or 1, whichever is greater 5/
10. High temperature reverse bias burn-in 12/		48 hours minimum at +150°C or the devices maximum operating limit, whichever is lower and at the minimum applied voltage as follows:
Reverse bias burn-in (for transistors)	1039	Transistor - 80% of rated V_{CB} (bipolar) or V_{GS} (FET and MFET)
Reverse bias burn-in (for diodes and rectifiers)	1038	Diodes (except zeners of 10 volts or less) and rectifiers - rated < 10 amps at T_C > 100°C - 80% of rated V_B
11. Post HTRB electricals and deltas 3/ & 9/		Read and record at 25°C within 12 hours of removal of bias. Percent Defective Allowable: First Pass: 5% or 1, whichever is greater 4/ Second Pass: 3% or 1, whichever is greater 5/

TABLE B-6b SCREENING (Con't)

SCREEN	METHOD	REQUIREMENTS 1/
12. Final electricals 3/ & 9/ a. Static Tests Subgroups 2 and 3 of Table II of MIL-PRF-19500 b. Dynamic Tests Subgroups 4 and 7 of Table II of MIL-PRF-19500		Read and record Electrical testing performed at step 11 need not be repeated.
13. Radiography	2076	Optional
14. Seal test (a) Fine 7/ & 8/ (b) Gross	1071	 (a) Test conditions G or H, max leak rate = 5 X 10^{-8} atm cc/s except 5 X 10^{-7} atm cc/s for devices with internal cavity > 0.3 cc (b) Test conditions A, C, D, E, or F
15. External visual examination	2071	100%

Notes:

1/ Except as stated below, the requirements shall be per the JANS requirements of the applicable MIL-S-19500 detail specifications.
2/ Test condition A, multiple pass criteria of MIL-PRF-19500.
3/ Parameters as called out in MIL-PRF-19500, Table II and the most similar JANS family device slash sheet if there is no detail JANS slash sheet or the most similar JANTXV family device slash sheet if there is no similar JANS family device slash sheet.
4/ The lot may be automatically resubmitted to a second Power Burn-in or HTRB one-time only without the necessity for MRB approval if the PDA does not exceed 20%. A PDA of greater than 20% shall require lot rejection.
5/ A PDA of greater than 3% on the Power Burn-in or HTRB resubmittal shall require lot rejection.

Notes (Con't):

6/ For all devices with an internal cavity.
7/ Omit this test for painted glass diodes.
8/ Omit this test for metallurgically bonded, double plug diodes.
9/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 3/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future screening.
10/ Omit both the BIST and the FIST tests for metallurgically bonded double plug or stud-mounted diodes. Omit the FIST test for temperature compensated reference diodes.
11/ A thermal response test shall be performed on metallurgically bonded devices only. Perform this test in accordance with MIL-STD-750, Method 1051, but with power applied to the devices. Monitor the devices for any intermittents during the temperature cycling.
12/ Test Condition A of the appropriate test method shall apply.
13/ Test Condition B of the appropriate test method shall apply.
14/ Omit this test for non-cavity devices.

TABLE B-6c

LOT ACCEPTANCE TESTING (SAMPLE AS SPECIFIED), TEST METHODS OF MIL-STD-750

SUBGROUP	METHOD	REQUIREMENTS 5/ & 6/
Subgroup 1		Device samples as called out below
(a) Physical dimensions	2066	2 devices sampled with 0 failures
(b) Internal water-vapor content 3/ & 7/	1018	Per MIL-STD-883, Method 1018. On cavity devices only. 5000 ppm max internal wator vapor at 100°C. 3 devices sampled with 0 failures or 5 devices sampled with 1 failure.
Subgroup 2		LTPD = 15 over subgroup 2 4/
(a) Solderability	2026	
(b) Resistance to solvents	1022	
Subgroup 3		LTPD = 10 over subgroup 3 4/
(a) Temp cycling	1051	Condition C3, 100 cycles minimum
(b) Terminal strength	2036	
(c) Mechanical shock	2016	
(d) Vibration, variable frequency	2056	
(e) Constant acceleration	2006	Test condition E, Y_1 orientation only
(f) Seal a. fine b. gross	1071	Method per MIL-STD-750. criteria per test method.
(g) Electrical measurements 1/ & 2/ a. Subgroups 2 and 3 of Table III of MIL-PRF-19500		Read and record
Subgroup 4		LTPD = 10 over subgroup 4 4/
(a) Intermittent operating life	1037	340 hours per the applicable slash sheet

LOT ACCEPTANCE TESTING (Con't)

SUBGROUP	METHOD	REQUIREMENTS 5/ & 6/
Subgroup 4 (Con't) (b) Electrical measurements and deltas 1/ & 2/ a. Subgroups 2 and 3 of Table III of MIL-PRF-19500		Read and record
Subgroup 6 (a) Thermal resistance	3131	LTPD = 10 over subgroup 6 4/

Notes:

1/ Parameters as called out in MIL-PRF-19500, Table IVa and the most similar JANS family device slash sheet if there is no detail JANS slash sheet or the most similar JANTXV family device slash sheet if there is no similar JANS family device slash sheet.

2/ Two correlation samples shall be used to verify functionality of all Automatic Test Equipment (ATE) and bench testing equipment. Correlation units shall be tested prior to any electrical testing. All parameters specified in the applicable detail slash sheet, as determined in note 1/ above, shall be read and recorded. If correlation units are not available, they may be removed from the lot being processed. Correlation units shall be controlled by the contractor for future screening.

3/ Internal water-vapor may be performed as part of the DPA.

4/ Reference Appendix I to determine the appropriate number of samples for the specified LTPD. Resubmission of a failed lot shall be permitted one time only. The resubmission sample size shall be the sample size called out in the next lower LTPD for the number of failures experienced during the first submission with zero additional failures or larger sample sizes at the same lower LTPD with total failures between the first and second submission as specified. Parts passing the first test shall not be included in the resubmission sample without PMPCB approval.

5/ Life test samples tested at temperatures below the maximum specified junction temperature, physical dimension samples, solderability samples, resistance to solvents samples, and thermal resistance samples meeting all acceptance criteria and not submitted to the destructive testing of Subgroups 1(b), 3(a), 3(b), 3(c), 3(d), or 4(c) may be used in flight hardware with PMPCB approval.

6/ Post burn-in electrical rejects from the same inspection lot may be used for all subgroups when end-point measurements are not required.

7/ Omit this test for glass body and double plug solid construction diodes.

TABLE B-6d

Destructive Physical Analysis (DPA)

DPA per MIL-STD-1580 1/ or approved procedure	Sample size per paragraph 4.5.5.1b. All anomalies shall be dispositioned as acceptable or rejectable.

Notes:

1/ ***DPA may be performed anytime after part encapsulation.***

APPENDIX C

PRINTED WIRING BOARD MANUFACTURING AND SCREENING REQUIREMENTS

1. APPLICATION

Where practical, rigid printed wiring boards with plated through holes shall be used to interconnect electronic parts. Part mounting shall allow visual inspection of all solder joints on both sides of the board.

2. DESIGN AND CONSTRUCTION

The following specifications and standards shall apply to printed wiring boards and assemblies:

MIL-HDBK-454	Standard General Requirements for Electronic Equipment
MIL-STD-2000	Standard Requirements for Soldered Electrical and Electronic Assemblies
MIL-S-13949	Plastic Sheet, Metal-Clad (For Printed Wiring Boards), General Specification for
MIL-C-28809A	Printed Wiring Assemblies
MIL-I-46058	Insulating Compound, Electrical (For Coating Printed Circuit Assemblies)
MIL-P-50884	Printed Wiring, Flexible, and Rigid-Flex
MIL-P-55110	Printed Wiring Boards
IPC-S-804	Solderability Test Methods for Printed Wiring Boards
IPC J-STD-001	Requirements for Soldered Electrical and Electronic Assemblies
ANSI/IPC DW-425-82/11	Design and End Product Requirements for Discrete Wiring Boards
NHB 5300.4 (3A-1)	Requirements for Soldered Electrical Connections

2.1 Rigid Printed Wiring and Printed Wiring Boards. Rigid printed wiring and printed wiring boards (PWBs), single-sided, double-sided, and multilayer, shall be in accordance with the requirements of MIL-P-55110 and IPC 2221 and 2222. The materials used for single-sided, double-sided, and multilayer printed wiring boards shall be in accordance with the requirements of MIL-S-13949. Rigid printed circuit boards with plated through holes shall be in accordance with the requirements of MIL-P-55110 and IPC 2221 and 2222, except for the following:

a. Etchback ***is required and shall be performed in accordance with the detail requirements of MIL-P-55110.***

b. Wherever possible, flame-retardant material, type GF or GI, shall be used.

c. 100% electrical testing at the bare board level on multilayer PWBs is required.

d. Drilled holes: The number of holes to be plated-through that are drilled per one drill bit shall be 1000 holes maximum or as approved by the PMPCB. When necessary, drill life can be extended to allow completion of an entire board plus test coupon.

e. Drill Changes: All drill bit changes shall be documented. The use of resharpened drill bits is prohibited.

f. Tin-Lead Plating: Tin-Lead plating thickness shall be 0.0003 inches minimum. Plating thickness shall be verified using Coupon C in accordance with IPC 2221 and 2222. There shall be no solder plate on any surface which is to be laminated to an insulator, metal frame, or stiffener.

g. Fusing: After solder plating and other processes, unless otherwise specified on the Source Control Drawing (SCD), the printed wiring board shall be fused. The manufacturer shall be limited to one fusing operation, whether or not the fusing process heats one or both sides of the board. The fuse time and temperature shall be recorded. After fusing, the solder coating shall be homogeneous, shall completely cover the conductors without pitting or pinholing, and shall show no non-wet areas. Side walls of the conductors do not have to be solder coated. Touch-up is permitted, but must be documented.

h. Ductility: A method for monitoring copper plating baths shall be used to insure that measured elongation of as-plated copper from the bath meets or exceeds 12%.

i. Process Control Coupons: The use of process control coupons to provide immediate feedback to the printed wiring board manufacturer on the stability of his processes is encouraged.

j. Deliverable Coupons: ***The number and locations of deliverable coupons shall be in accordance with the detail specification of MIL-P-55110.***

k. Coupon Marking: Each coupon ***or test strip*** shall be suitably marked to retain traceability.

l. Storage and Retrievability: All deliverable coupons shall be stored for the life of the contract ***or until the entire inspection lot is flown, whichever is sooner.***

2.2 Multilayer Printed Circuit Boards. When multilayer printed circuit boards are used, the copper surfaces on all inner layers to be laminated shall be treated or primed prior to lamination to increase the laminate bonding. A copper oxidation technique is an acceptable treatment prior to lamination. Multilayer printed circuit boards shall be configured to equalize, to the greatest extent possible, the distribution of conductive areas in a layer and the distribution of conductive areas among layers. Large conductive areas such as ground planes should be positioned close to the board midpoint thickness. When more than one ground plane is required, they should be in layers that are equidistant from the midpoint thickness.

2.3 Flexible and Rigid-Flex Wiring. Flexible and rigid-flex printed wiring shall be in accordance with the requirements of MIL-P-50884.

2.4 Discrete Wiring Boards. Discrete wiring boards with plated through holes shall be in accordance with the requirements of ANSI/IPC-DW-425-82/11. Discrete wiring boards shall not be used in flight hardware without PMPCB approval.

2.5 Printed Wiring Board Size. Whenever cost and technical requirements permit, standard rigid PWB sizes should be used. These standard sizes will facilitate the development and use of standardized insertion and extraction tools. Standard board sizes and thicknesses are shown in figure 17-1 of MIL-HDBK-454 with their corresponding extractor hole sizes and locations.

2.6 Printed Wiring Board Modifications. The number of allowable cuts and jumpers for a single PWB through production and test shall be in accordance with the requirements of MIL-C-28809 with the exception that drill outs shall be performed per a PMPCB approved procedure and limited to a total of 10 drillouts per printed wiring assembly.

3. QUALITY ASSURANCE

3.1 Screening (100%). Manufacturer screening and in-process inspection shall be in accordance with the requirements of MIL-P-55110. The contractor acquisition activity shall conduct a data review at the time of board receipt to insure that these requirements have been met. 100% electrical continuity testing at receiving inspection or verified by qualified contractor

field personnel at the manufacturer is required at the bare board level on multilayer PWBs. Deliverable coupons shall be tested in accordance with IPC 2221 and 2222.

3.2 Lot Conformance Testing. Manufacturer lot conformance tests shall be in accordance with the requirements of MIL-P-55110. All deliverable coupons shall be inspected to verify that all applicable requirements have been met.

APPENDIX D

CUSTOM RELAY REQUIREMENTS

CUSTOM RELAY REQUIREMENTS

TABLE D-1
PROCESSING

PROCESS	REQUIREMENT
1. Manufacturing Baseline	
a. Process Specifications	As approved by the contractor acquisition activity. Process revision level shall be under the purchaser's configuration control.
b. Lot Traveler	The lot traveler(s) shall be approved by the contractor acquisition activity. The revision level shall be under the purchaser's configuration control. The lot traveler(s) shall contain all data obtained during the screening, lot acceptance, and DPA testing.
2. Rework	None permitted after device seal.
3. Design & Construction	Per MIL-PRF-39016 or MIL-PRF-6106, whichever is applicable, for hermetically sealed devices. Semiconductors and microcircuits used internally shall meet the requirements of the ELV Quality Baseline.
4. Processing Surveillance	Monitored by the contractor acquisition activity.
a. Pre-cap Visual	100% inspection. Inspection guidelines per paragraph 1.1 and inspection criteria per paragraph 1.2 of this Appendix.
b. Cleaning and small particle inspection	Per the contractor activity approved procedure

TABLE D-2

SCREENING ***FOR RELAYS DESIGNED AND BUILT IN ACCORDANCE WITH*** MIL-PRF-39016, TEST METHOD AS CALLED OUT IN THE REFERENCED PARAGRAPH OF MIL-PRF-39016

SCREEN	METHOD	REQUIREMENTS 5/
1. Vibration (Sinusoidal)	4.8.11.1	Per para 3.14 of MIL-PRF-39016
2. Vibration (Random)	1/	Per para 3.14 of MIL-PRF-39016
3. Insulation resistance	4.8.6	Para 3.9 of MIL-PRF-39016
4. Dielectric withstanding voltage	4.8.7	Para 3.10 of MIL-PRF-39016
5. Electrical measurements 3/		Read and record. Parameter values as specified in para 3.11 of MIL-PRF-39016 and the applicable slash sheet or SCD
6. Operational reliability	4/	Per para 3.39 of MIL-PRF-6106
7. Asynchronous Miss Test	2/	
8. Insulation resistance	4.8.6	Para 3.9 of MIL-PRF-39016
9. Dielectric withstanding voltage	4.8.7	Para 3.10 of MIL-PRF-39016
10. Electrical measurements 3/		Read and record. Parameter values as specified in para 3.11 of MIL-PRF-39016 and the applicable slash sheet or SCD
11. Seal	4.8.5	No leakage in excess of 1×10^{-8} atm cm^3/s
12. External visual	4.8.1	100% for materials and workmanship

Notes:

1/ Perform per the general requirements of MIL-PRF-39016, para 4.8.11.2, using MIL-STD-202, Method 214, Test Condition II with the following exceptions:

a. Determine the PSD level according to each individual relay application.
b. Mounting fixtures shall not affect the PSD by more than ± 3dB.
c. Vibrate in 3 orthogonal planes (determined by normal mounting means).
d. Vibrate for 3 minutes in each plane for each armature position (energized and deenergized) or for each position (set and reset) for latching relays.
e. Monitor contacts using Circuit B of MIL-STD-202, Method 310.

Notes (Con't):

2/ Vibrate the relay with a 10g peak sine wave at a fixed frequency of 10Hz for 3 minutes. The axis of vibration shall be perpendicular to the motion of the contacts. Operate the relay at 9.9Hz while the relay is being vibrated, monitoring the relay for any misses. Relays with misses shall be rejected and removed from the production lot.

3/ The following parameters, as applicable, shall be read and recorded:

a. Operate, release, and hold voltages
b. Operate and release times
c. Contact bounce
d. Contact voltage drop (resistance)
e. Coil resistance
f. Coil transient voltage
g. Reverse polarity protection
h. Neutral screen (differential voltage) - test per MIL-PRF-39016 and with each coil at rated voltage with a plus 5 and a minus 5 volt differential from rated voltage on the opposing coil.

Basic test methods as called out in para 4.8.8 of MIL-PRF-39016.

4/ Perform as described in 4.7.30 of MIL-PRF-6106 with the following exceptions:

a. Subject the relays to five temperature cycles instead of three. The fifth cycle shall be performed in accordance with the requirements specified for the third cycle.
b. For relays with coil wire gauge 44 AWG or smaller, monitor coil continuity with 350 microamperes during the low temperature step of the first four cycles. Any discontinuity shall be classified as a failure.

5/ A Percent Defective Allowable (PDA) in excess of 10% across any one test and/or in excess of 20% across all screening shall require lot rejection.

TABLE D-3

SCREENING ***FOR RELAYS DESIGNED AND BUILT IN ACCORDANCE WITH*** MIL-PRF-6106, TEST METHOD AS CALLED OUT IN THE REFERENCED PARAGRAPH OF MIL-R-6016

SCREEN	METHOD	REQUIREMENTS 6/
1. Vibration (Sinusoidal)	4.7.27 4/	Para 3.16 of MIL-PRF-6106
2. Vibration (Random)	1/	Per para 3.14 of MIL-PRF-39016
3. Insulation resistance	4.7.5	Per para 3.11 of MIL-PRF-6106
4. Dielectric withstanding voltage	4.7.6	Per para 3.12 of MIL-PRF-6106
5. Electrical measurements 3/		Read and record. Parameter values as specified in section 3, Requirements, of MIL-PRF-6106 and the applicable slash sheet or SCD
6. Asynchronous Miss	2/	
7. Operational reliability	5/	Per para 3.39 of MIL-PRF-6106
8. Insulation resistance	4.7.5	Per para 3.11 of MIL-PRF-6106
9. Dielectric withstanding voltage	4.7.6	Per para 3.12 of MIL-PRF-6106
10. Electrical measurements 3/		Read and record. Parameter values as specified in section 3, Requirements, of MIL-R-6016 and the applicable slash sheet or SCD
11. Seal	4.7.28	Relays larger than 2 in^3 - no leakage in excess of 1 x 10^{-6} atm cm^3/s All others - no leakage in excess of 1 x 10^{-8} atm cm^3/s
12. External visual	4.7.1	100% for materials and workmanship

Notes:

1/ Perform per the general requirements of MIL-PRF-39016, para 4.8.11.2, using MIL-STD-202, Method 214, Test Condition II with the following exceptions:

a. Determine the PSD level according to each individual relay application.
b. Mounting fixtures shall not affect the PSD by more than ± 3dB.
c. Vibrate in 3 orthogonal planes (determined by normal mounting means).
d. Vibrate for 3 minutes in each plane for each armature position (energized and de-energized) or for each position (set and reset) for latching relays.
e. Monitor contacts using Circuit B of MIL-STD-202, Method 310.

Notes (Con't):

2/ Vibrate the relay with a 10g peak sine wave at a fixed frequency of 10Hz for 3 minutes. The axis of vibration shall be perpendicular to the motion of the contacts. Operate the relay at 9.9Hz while the relay is being vibrated, monitoring the relay for any misses. Relays with misses shall be rejected and removed from the production lot.

3/ The following parameters, as applicable, shall be read and recorded:

a. Operate, release, and hold voltages
b. Operate and release times
c. Contact bounce
d. Contact voltage drop (resistance)
e. Coil resistance
f. Coil transient voltage
g. Reverse polarity protection
h. Neutral screen (differential voltage) - test per MIL-PRF-39016 and with each coil at rated voltage with a plus 5 and a minus 5 volt differential from rated voltage on the opposing coil.

Basic test methods as called out in para 4.7 of MIL-PRF-6106.

4/ Perform test method per established reliability (ER) requirements.

5/ Perform as described in 4.7.30 of MIL-PRF-6106 with the following exceptions:

a. Subject the relays to five temperature cycles instead of three. The fifth cycle shall be performed in accordance with the requirements specified for the third cycle.
b. For relays with coil wire gauge 44 AWG or smaller, monitor coil continuity with 350 microamperes during the low temperature step of the first four cycles. Any discontinuity shall be classified as a failure.

6/ A Percent Defective Allowable (PDA) in excess of 10% across any one test and/or in excess of 20% across all screening shall require lot rejection.

TABLE D-4

LOT ACCEPTANCE ***FOR RELAYS DESIGNED AND BUILT IN ACCORDANCE WITH*** MIL-PRF-39016, TEST METHOD AS CALLED OUT IN THE REFERENCED PARAGRAPH OF MIL-PRF-39106

SUBGROUP	METHOD	REQUIREMENTS 5/
Subgroup 1		
(a) Physical dimensions		2 devices sampled with 0 failures 4/
(b) Internal Water-Vapor 1/	1018 of MIL-STD-883	1,000 ppm max water content at 100°C 3 devices with 0 failures or 5 devices sampled with 1 failure
(c) Solderability	4.8.4	2 devices sampled with 0 failures
(d) Resistance to solvents	4.8.22	5 devices sampled with 0 failures per para 3.25 of MIL-PRF-39016
(e) Terminal strength 1/	4.8.13	2 devices sampled with 0 failures per para 3.16 of MIL-PRF-39016
Subgroup 2		LTPD = 10 3/
(a) Life	4.8.20	Para 3.23 of MIL-PRF-39016
(b) Insulation resistance	4.8.6	Para 3.9 of MIL-PRF-39016
(c) Dielectric withstanding voltage	4.8.7	Para 3.10 of MIL-PRF-39016
(d) Electrical measurements 2/		Read and record. Parameter values as specified in para 3.11 of MIL-PRF-39016 and the applicable slash sheet or SCD
(e) Seal	4.8.5	No leakage in excess of 1×10^{-8} atm cm^3/s
(f) External visual	4.8.1	5/

Notes:

1/ Internal water vapor and terminal strength may be performed as part of the DPA.

Notes (Con't):

2/ The following parameters, as applicable, shall be read and recorded:
- a. Operate, release, and hold voltages
- b. Operate and release times
- c. Contact bounce
- d. Contact voltage drop (resistance)
- e. Coil resistance
- f. Coil transient voltage
- g. Reverse polarity protection
- h. Neutral screen (differential voltage) - test per MIL-PRF-39016 and with each coil at rated voltage with a plus 5 and a minus 5 volt differential from rated voltage on the opposing coil.

Basic test methods as called out in para 4.8.8 of MIL-PRF-39016.

3/ Reference Appendix I to determine the appropriate number of samples for the specified LTPD. Resubmission of a failed lot shall be permitted one time only. The resubmission sample size shall be the sample size called out in the next lower LTPD. Parts passing the first test shall not be included in the resubmittal samples without PMPCB approval.

4/ Inspect per the applicable slash sheet or source control drawing as applicable.

5/ Test samples meeting all acceptance criteria and not subjected to the destructive testing of test 1(b) and 1(e) may be used in flight hardware with PMPCB approval.

TABLE D-5

LOT ACCEPTANCE ***FOR RELAYS DESIGNED AND BUILT IN ACCORDANCE WITH*** MIL-PRF-6106, TEST METHOD AS CALLED OUT IN THE REFERENCED PARAGRAPH OF MIL-PRF-6106

SUBGROUP	METHOD	REQUIREMENTS 6/
(a) Physical dimensions		2 devices sampled with 0 failures 5/
(b) Internal Water-Vapor 1/	1018 of MIL-STD-883	1,000 ppm max water content at 100°C 3 devices with 0 failures or 5 devices sampled with 1 failure
(c) Solderability	4.8.4 3/	2 devices sampled with 0 failures
(d) Resistance to solvents	4.8.22 3/	2 devices sampled with 0 failures per para 3.25 of MIL-PRF-39016
(e) Terminal strength 1/	4.7.11	Para 3.18 of MIL-PRF-6106
Subgroup 2		LTPD = 10 4/
(a) Life	4.7.26	Para 3.28 of MIL-PRF-6106
(b) Insulation resistance	4.7.5	Per para 3.11 of MIL-PRF-6106
(c) Dielectric withstanding voltage	4.7.6	Per para 3.12 of MIL-PRF-6106
(d) Electrical measurements 2/		Read and record. Parameter values as specified in section 3, Requirements, of MIL-PRF-6106 and the applicable slash sheet or SCD
(e) Seal	4.7.28	Relays larger than 2 in^3 - no leakage in excess of 1 x 10^{-6} atm cm^3/s
(f) External visual 5/	4.7.1	All others - no leakage in excess of 1 x 10^{-8} atm cm^3/s

Notes:

1/ Internal water vapor and terminal strength may be performed as part of the DPA.

2/ The following parameters, as applicable, shall be read and recorded:

a. Operate, release, and hold voltages
b. Operate and release times
c. Contact bounce
d. Contact voltage drop (resistance)
e. Coil resistance
f. Coil transient voltage
g. Reverse polarity protection
h. Neutral screen (differential voltage) - test per MIL-PRF-39016 and with each coil at rated voltage with a plus 5 and a minus 5 volt differential from rated voltage on the opposing coil.

Basic test methods as called out in para 4.7 of MIL-PRF-6106.

3/ Test method and requirements per the applicable paragraphs of MIL-PRF-39016.

4/ Reference Appendix I to determine the appropriate number of samples for the specified LTPD. Resubmission of a failed lot shall be permitted one time only. The resubmission sample size shall be the sample size called out in the next lower LTPD. Parts passing the first test shall not be included in the resubmittal samples without PMPCB approval.

5/ Inspect per the applicable slash sheet or source control drawing as applicable.

6/ Test samples meeting all acceptance criteria and not subjected to the destructive testing of test 1(b) and 1(e) may be used in flight hardware with PMPCB approval.

TABLE D-6
Destructive Physical Analysis (DPA)

DPA per MIL-STD-1580 or approved procedure	Sample size per paragraph 4.5.5.1b. All anomalies shall be dispositioned as acceptable or rejectable.

1. Pre-cap Visual Inspection. A visual examination shall be performed on 100% of the relays prior to final cleaning and assembly in the can. The examination shall be performed at the specified magnification in paragraph 1.1 or at a greater magnification when necessary to verify product integrity.

1.1 Required Inspections. The following visual inspections, as a minimum, shall be performed to verify product integrity. Failure criteria shall be as specified in paragraph 1.2 or, if not specified, shall be consistent with good engineering practices.

a. Inspect the moving contact assembly at 20x magnification for proper installation and position. The springs shall clear all adjacent parts for both positions of the armature. Inspect support brackets for the moving contact assembly for cracks and loose fractures.

b. Inspect the contact surfaces at 10x magnification for:

1. Scratches, burrs and cracked or peeling plating in contact mating areas.

2. Proper alignment for both armature positions.

Inspect the contact surfaces at 20x magnification for:

1. Fibrous and other contaminants.

2. Tool marks on the underside of contact supports

3. Weld splatter on the contact terminals.

c. Inspect the coil for the following at 10x magnification for the following:

1. Poor coil lead welds. Inspect for evidence or weld on each coil lead wire. Follow by probing the weld area to verify that each coil lead wire is attached to the terminal.

2. Inspect at 10x for proper lead coil dress. Ensure clearance to all moving and conductive surfaces. Coil leads shall not be kinked and shall not be stretched tight from coil to coil lead post.

3. Loose or frayed teflon insulation.

Inspect the coil at 20x magnification for the following:

1. Weld splatter at the coil terminals.

2. Nicks in the coil wire due to the stripping of the insulation.

d. Inspect the armature and pole piece gap at 20x magnification for weld splatter and contamination.

e. Inspect the header at 10x magnification for unacceptable tool marks and weld splatter, acceptable glass seals, cracked or peeling plating, and proper alignment of the header and the frame.

1.2 Visual Inspection Failure Criteria.

1.2.1 Weld splatter. Weld splatter or weld expulsion balls observed under 20x magnification shall be acceptable if the balls are capable of withstanding a probing force of 150 grams applied using an approved force gauge calibrated for a range of 125 to 150 grams pressure force. The manufacturer, under the supervision of the contractor acquisition activity's source surveillance personnel, shall perform this testing if acceptance of the relay is desired. Each suspect weld may be probed one time only during pre-cap.

1.2.2 Scratches. Scratches or tool marks which are wholly below the surface of the metal are acceptable. Burrs protruding above the surface are not acceptable.

1.2.3 Cracks. Cracks in the header pin glass seals that extend from the pin or outer edge for more than one-third the radius of the seal are not acceptable. This criterion is not applicable to glass seals less than 0.1 inch in diameter.

1.2.4 Teflon. Teflon strands that are not physically attached or affixed to the teflon coil wrap or coil lead insulation are unacceptable. Teflon strands that are physically attached or affixed, but are of sufficient length or location that they can interfere with the normal operation of the relay are also unacceptable.

APPENDIX E

ELV QUALITY BASELINE WIRE CONSTRUCTIONS

1 UNLIMITED USE CONSTRUCTIONS

The following wire constructions are included in the ELV quality PMP baseline for unlimited use:

Specification	Title/Construction
MIL-W-22759/16	Wire, Electric, Fluoropolymer-Insulated, Extruded ETFE, Medium Weight, Tin-Coated Copper Conductor, 600 Volt, 150°C
MIL-W-22759/17	Wire, Electric, Fluoropolymer-Insulated, Extruded ETFE, Medium Weight, Silver-Coated High-Strength Copper Alloy Conductor, 600 Volt, 150°C
MIL-W-22759/18	Wire, Electric, Fluoropolymer-Insulated, Extruded ETFE, Light Weight, Tin-coated Copper Conductor, 600 Volt, 150°C
MIL-W-22759/19	Wire, Electric, Fluoropolymer-Insulated, Extruded ETFE, Light Weight, Silver Coated High-Strength Copper Alloy Conductor, 600 Volt, 150°C
MIL-W-22759/32	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Light Weight, Tin-Coated Copper, 600 Volt, 150°C
MIL-W-22759/33	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Light Weight, Silver-Coated High-Strength Copper Alloy, 600 Volt, 200°C
MIL-W-22759/34	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Normal Weight, Tin-Coated Copper, 600 Volt, 150°C
MIL-W-22759/35	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Normal Weight, Silver-Coated High-Strength Copper Alloy, 600 Volt, 200°C
MIL-W-22759/41	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Normal Weight, Nickel-Coated Copper, 600 Volt, 200°C
MIL-W-22759/42	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Normal Weight, Nickel-Coated High-Strength Copper Alloy, 600 Volt, 200°C
MIL-W-22759/43	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Normal Weight, Silver-Coated Copper, 600 Volt, 200°C
MIL-W-22759/44	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Light Weight, Nickel-Coated Copper, 600 Volt, 200°C

MIL-W-22759/45	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Light Weight, Nickel-Coated Copper, 600 Volt, 200°C
MIL-W-22759/46	Wire, Electric, Fluoropolymer-Insulated, Crosslinked Modified ETFE, Light Weight, Nickel-Coated High Strength Copper Alloy, 600 Volt, 200°C
MIL-W-81381/7	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Light Weight, Nickel-Coated Copper Conductor, 600 Volts, 200°C, Nominal 5.8 MIL Wall
MIL-W-81381/8	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Light Weight, Nickel-Coated Copper Conductor, 600 Volts, 200°C, Nominal 5.8 MIL Wall
MIL-W-81381/9	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Light Weight, Silver-Coated High Strength Copper Alloy Conductor, 600 Volts, 200°C, Nominal 5.8 MIL Wall
MIL-W-81381/10	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Light Weight, Nickel-Coated High-Strength Copper Alloy Conductor, 600 Volts, 200°C, Nominal 5.8 MIL Wall
MIL-W-81381/11	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Medium Weight, Silver-Coated Copper Conductor, 600 Volts, 200°C, Nominal 8.4 or 15.4 MIL Wall
MIL-W-81381/12	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Medium Weight, Nickel-Coated Copper Conductor, 600 Volts, 200°C, Nominal 8.4 or 15.4 MIL Wall
MIL-W-81381/13	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Medium Weight, Silver-Coated High-Strength Copper Alloy Conductor, 600 Volts, 200°C, Nominal 8.2 or 8.4 MIL Wall
MIL-W-81381/14	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Medium Weight, Nickel-Coated High-Strength Copper Alloy Conductor, 600 Volts, 200°C, Nominal 8.2 or 8.4 MIL Wall
MIL-W-81381/17	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Light Weight, Silver-Coated Copper, 600 Volts, 200°C, Nominal 4.6 MIL Wall
MIL-W-81381/19	Wire, Electric, Fluorocarbon/Polyimide-Insulated, Light Weight, Silver-Coated High-Strength Copper Alloy Conductor, 600 Volts, 200°C, Nominal 4.6 MIL Wall

2 LIMITED USE CONSTRUCTIONS

The following wire constructions are included in the ELV quality PMP baseline for wiring internal to electrical boxes only:

Specification	Title/Construction
MIL-W-22759/28	Wire, Electric, Fluoropolymer-Insulated, Extruded TFE, Polyimide-Coated, Silver-Coated Copper Conductor, 600 Volt
MIL-W-22759/29	Wire, Electric, Fluoropolymer-Insulated, Extruded TFE, Polyimide-Coated, Nickel-Coated Copper Conductor, 600 Volt
MIL-W-22759/30	Wire, Electric, Fluoropolymer-Insulated, Extruded TFE, Polyimide-Coated, Silver-Coated High-Strength Copper Alloy Conductor, 600 Volt
MIL-W-22759/31	Wire, Electric, Fluoropolymer-Insulated, Extruded TFE, Polyimide-Coated, Nickel-Coated High-Strength Copper Alloy Conductor, 600 Volt

The following wire constructions are included in the ELV quality PMP baseline for wiring internal to magnetic and inductive parts.

Specification	***Title/Construction***
NEMA-MW1000	***Wire, Magnet, Electrical, General Specification***

APPENDIX F

PROHIBITED PARTS AND MATERIALS

1 PROHIBITED MATERIALS

a. Conformal coatings that do not meet MIL-STD-275 for printed circuit assemblies

b. Corrosive (acetic acid evolving) silicone sealants, adhesives, and coatings are prohibited from use on electronic or electrical equipment

c. Items with exposed surfaces of cadmium or zinc shall not be used in upper stages without PMPCB approval. Exceptions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

d. Polyvinyl chloride.

e. Mechanical parts, mounting hardware, optical components, electronic parts, their packages and leads shall have neither internal nor external surfaces coated with zinc (Zn), cadmium (Cd), or pure tin (Sn) or tin alloy containing less than three percent lead (Pb). This prohibition also applies to shielding mesh tapes, terminal lugs, brackets, and housings for flight hardware, and/or critical ground equipment designed for launch support. The only exceptions are completely insulated wire products where tin (Sn) is only used during the drawing process.

2 PROHIBITED PARTS

2.1 Prohibited Electronic Parts

2.1.1 Prohibited Capacitors

a. CLR 65 (MIL-PRF-39006/9) silver-cased wet tantalum slug capacitors

b. Mica capacitors per specifications other than MIL-PRF-87164

c. Glass capacitor styles CYR41, 42, 43, 51, 52, and 53

d. Aluminum electrolytic capacitors

e. Variable capacitors without PMPCB approval. Exceptions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

2.1.2 Prohibited Diodes

a. Diodes in hot-welded cans

b. All plastic encapsulated types

c. Non-glassivated or non-passivated semiconductor devices without PMPCB approval. Exceptions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

d. Devices with gold/aluminum bonds at the die

e. Point contact (whisker) diodes without PMPCB approval. Exceptions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

2.1.3 Prohibited Filters

a. EMI/RF filters with tubular ceramic elements

2.1.4 Prohibited Fuses

a. All fuses requiring fuse holders

b. Non-hermetic fuses

2.1.5 Prohibited Relays

a. Plug-in types

b. Solder-sealed relays

2.1.6 Prohibited Resistors

a. All hollow glass or hollow ceramic core devices

b. Carbon composition resistors without PMPCB approval. Exceptions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

c. Variable resistors without PMPCB approval. Exceptions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

2.1.7 Prohibited Thyristors

a. All plastic encapsulated types

2.1.8 Prohibited Transistors

a. All plastic encapsulated types
b. Non-glassivated or non-passivated semiconductor types without PMPCB approval. Exceptions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

c. Devices with gold/aluminum bonds at the die

2.1.9 Prohibited Microcircuits/Hybrids

a. All plastic encapsulated devices

b. Devices with gold/aluminum bonds at the die, excluding hybrids

2.1.10 Prohibited Wire Construction

a. Unsupported, teflon insulated wire without PMPCB approval. Exceptions approved by the PMPCB shall be documented on a PMPCB action form and forwarded to the Government PMPCB representatives for disposition.

2.1.11 Prohibited Crystals

a. Plug-in types

2.2 Prohibited Non-Electronic Parts

2.2.1 Prohibited Attach Hardware

a. B-Nuts used with flared tubing

APPENDIX G

ELECTRONIC PIECE PART DERATING REQUIREMENTS

CONTENTS

CONTENTS (Con't)

1. CAPACITORS

1.1 Military Specification Capacitor Types

TABLE 1-1 CAPACITORS, MIL-SPEC LISTING (FOR REFERENCE)

DIELECTRIC MATERIAL	MIL-SPEC	STYLE
Ceramic	MIL-PRF-39014	CKR
Ceramic	MIL-PRF-20	CCR
Ceramic	MIL-PRF-123	CKS
Ceramic, High Voltage	MIL-PRF-20	---
Ceramic Chip	MIL-PRF-55681	CDR
Mica	MIL-PRF-87164	CMS
Glass, Porcelain	MIL-PRF-23269	CYR
Supermetallized Film	MIL-PRF-83421	CRH
Supermetallized Film (Low Energy Application)	MIL-PRF-87217	CHS
Plastic Film; Metallized & Nonmetallized	MIL-PRF-19978	CQR
Tantalum Foil	MIL-PRF-39006	CLR
Solid Tantalum	MIL-PRF-39003	CSR
Solid Tantalum, Low Impedance Applications	MIL-PRF-39003/10	CSS
Solid Tantalum Chip	MIL-PRF-55365	CWR
Variable, Air, Piston, Type	MIL-PRF-14409 1/	P
Variable, Glass or Ceramic	MIL-PRF-14409 1/	---
Wet Tantalum-Tantalum	MIL-PRF-39006/22 2/	CLR 79

NOTES:

1/ Variable capacitors should only be used where absolutely necessary. Their design is such that they are non-hermetic, easily damaged by excessive installation soldering and have a limited adjustment life.

2/ Only tantalum-tantalum construction (style CLR79) manufactured by a QPL/QML source with a double seal is approved for wet tantalum construction in expendable launch vehicle applications.

1.2 General Requirements. The normal maximum operating temperature for all capacitors shall not be greater than shown in the derating curves for the applied stress or 10°C less than maximum rated temperature, whichever is less. The longevity and reliability of capacitors are increased by operation below their rated temperature limits and below their rated voltage, both AC and DC.

1.3 Capacitor Reliability Application Derating Guidelines

TABLE 1-2 CAPACITOR DERATING 9/

TYPE	PARAMETER	MAXIMUM STRESS RATIO	COMMENTS
Ceramic	Voltage	0.50 4/	0.70 WC 5/
Ceramic Chip	Voltage	0.50 4/	0.70 WC 5/
Feed Through Capacitor	See EMI Filters		
Glass	Voltage	Figure 1-1	
Supermetallized Film CRH	Voltage	0.50 to 85°C max.	0.65 WC to 85°C max.
Supermetallized Film, & Nonmetallized Film, CHS, CQR	Voltage	0.50 to 85°C max.	0.65 WC to 85°C max. 6/
Mica	Voltage	Figure 1-2	
Porcelain	Voltage	Figure 1-1	
Tantalum Foil	Voltage	Figure 1-3	2/
Tantalum Solid	Voltage	Figure 1-4	1/ & 7/
Solid Tantalum Chip	Voltage	Figure 1-4 8/	1/
Wet Tantalum-Tantalum	Voltage	Figure 1-5	2/
Variable	Voltage	0.5	0.70 WC 3/

NOTES:

1/ At least 0.1 ohms/volt series resistance or equivalent current limit of 10 amps shall be provided for solid tantalum and tantalum chip capacitors. Parallel tantalum capacitors do not require separate series resistors for each capacitor.

2/ Temperature rise due to ripple current shall not result in an operating temperature exceeding 85°C.

NOTES (Con't):

3/ Use only after PMPCB review and approval

4/ 0.5 to 85°C, decreasing to 0.30 at +125°C

5/ 0.7 to 85°C, decreasing to 0.50 at +125°C

6/ Linearly decrease voltage to zero at 100°C

7/ Special assembly and test procedures are required to ensure that tantalum capacitors are installed in accordance with the correct polarity.

8/ The maximum surge voltage shall not exceed the steady state rated voltage.

1.4 *Use of Derating Curves (Figs 1-1 through 1-5). To determine the maximum permitted operating voltage from the following figures:*

- *determine the maximum part temperature at the location where the capacitor will be mounted. The maximum temperature is the sum of the part ambient temperature, which is the acceptance test temperature plus the temperature rise from the component baseplate to the part location, and the part operational temperature, which is a function of the applied voltage.*

- *find the maximum temperature on the X-axis, and read the Voltage Stress Ratio upper limit from the Region I curve. The voltage stress ratio is determined by dividing the maximum voltage across the capacitor in its intended circuit application by the manufacturer's maximum voltage rating.*

- *Any combination of part temperature and voltage stress ratio that lies in Region I shall be considered approved for that application. Any combination that lies in Region III shall be considered disapproved for the intended application. Combinations falling in Region II shall be identified, analyzed to assure that the part application meets mission requirements, and presented to the PMPCB for approval.*

Combinations falling 20% or less above the Region I curve shall be documented on a PMPCB Action Form and forwarded to the Government PMPCB representatives for approval. Combinations greater than 20% above the Region I curve shall require acquisition activity approval.

Figure 1-1 Glass, Porcelain (CYR)

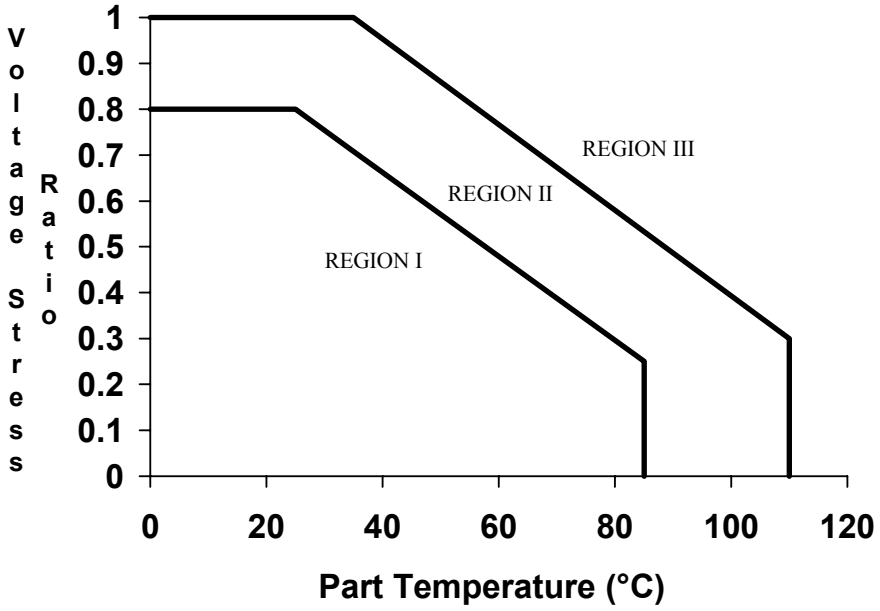


Figure 1-2 Mica (CMS)

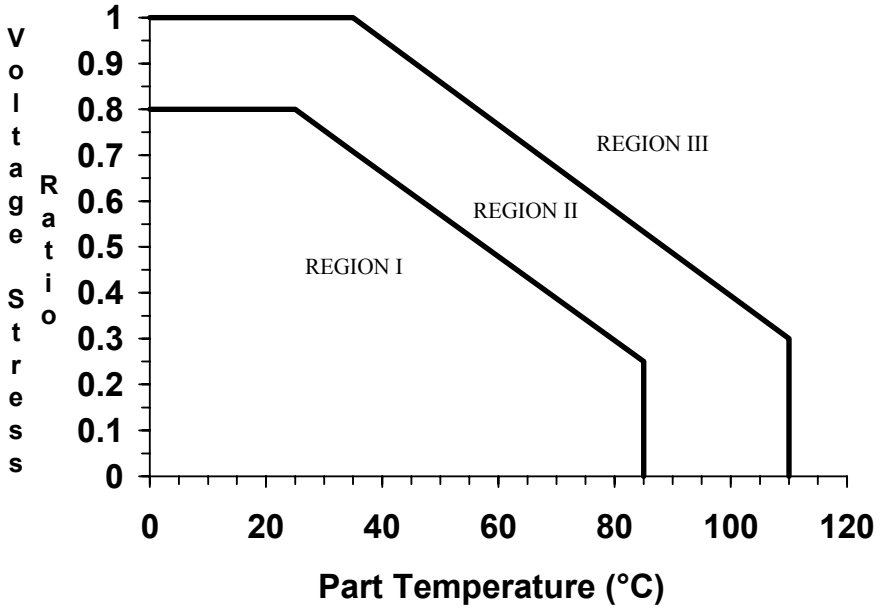


Figure 1-3 Tantalum Foil (CLR 25, 27, 35, 37)

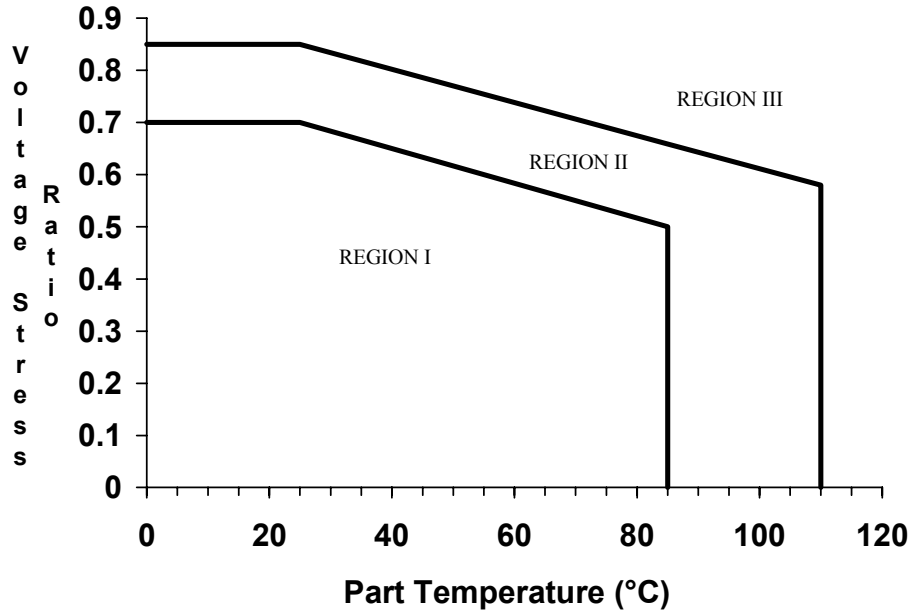


Figure 1-4 Solid Tantalum (CSR, CSS)

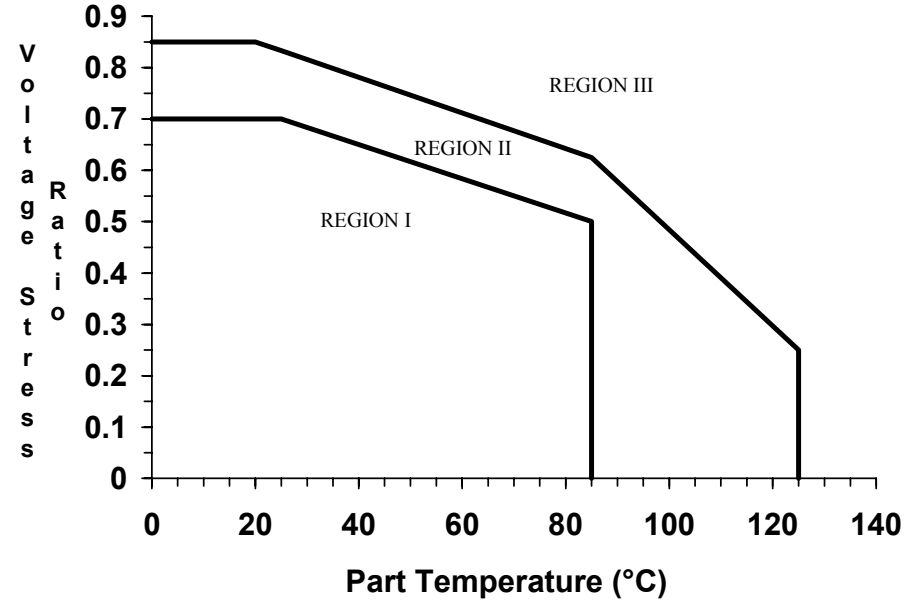
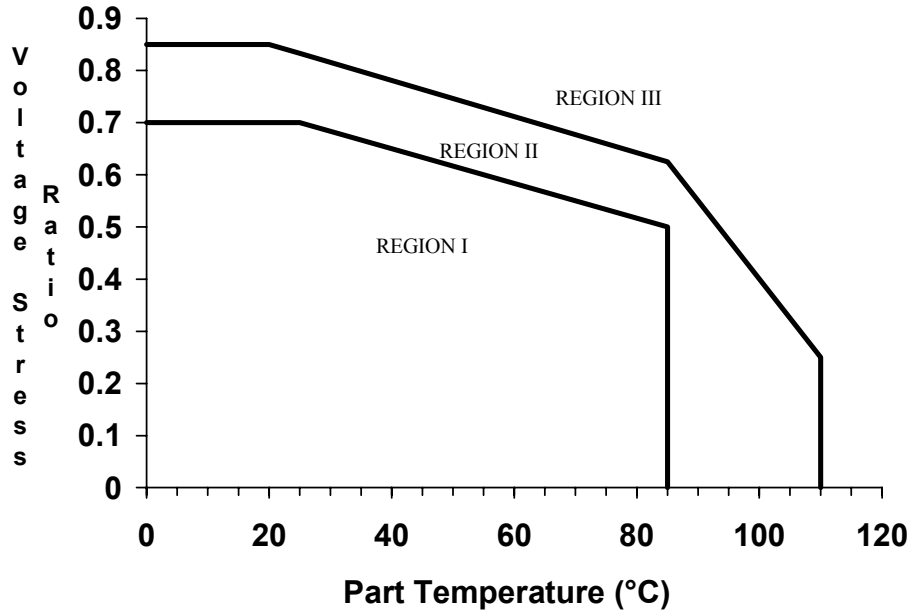


Figure 1-5 Wet Tantalum-Tantalum (CLR 79)



2. CONNECTORS

2.1 Connectors Reliability Application Derating Guidelines

TABLE 2-1 CONNECTORS

TYPE	PARAMETER	MAXIMUM STRESS RATIO	COMMENTS 1/, 2/, 3/
ALL	Current	0.50 of rating	When pins are connected in parallel to increase current capacity, each pin shall have the capability of conducting (within the derating criteria) 25% more current than the calculated equally divided current to compensate for "current hogging".
	Voltage	0.50 of rating	The maximum voltage stress ratio derating should be multiplied by the sea level rated working voltage to obtain the maximum voltage to be applied between the pin and the case. This provides a safe working voltage for high altitude or space applications.
	Temperature	Not to exceed: T(max-dielectric) - 50°C	The maximum hot spot temperature shall be at least 50°C below the maximum rated temperature of the connector dielectric material.

NOTES:

1/ Within the constraints of this table, use TABLE 2-2 as a guide for contact and wire sizes.

2/ For block connectors and crimp connections, the current derating is the same as TABLE 17-1 for the single wire.

3/ Power connector failure risks should be minimized by requiring that power and return lines be separated by at least one unassigned connector pin to reduce short circuit risk.

TABLE 2-2 CONNECTOR DERATING

NUMBER of CONTACTS USED in the CONNECTOR	CONTACT SIZE	MAXIMUM DERATED CURRENT (AMPS) for CONTACT WIRE SIZE (AWG) 1/							MAXIMUM VOLTAGE
		16	18	20	22	24	26	28	
1 to 4	16	13.0	9.2	6.5					
1 to 4	20			6.0	4.5	3.3			
1 to 4	22				4.5	3.3	2.5	1.8	50 percent of the rated sea level Dielectric Withstanding Voltage (DWV) between the pin and case for all contact sizes.
5 to 14	16	9.0	7.0	5.0					
5 to 14	20			5.0	3.5	2.7			
5 to 14	22				3.5	2.7	1.9	1.4	
15 or more	16	6.5	5.0	3.7					
15 or more	20			3.7	2.5	2.0			
15 or more	22				2.5	2.0	1.4	1.0	

NOTES:

1/ Connector derating must also comply with the "per pin" derating of Table 2-1.

3. CRYSTALS

3.1 Crystal Reliability Application Derating Guidelines

TABLE 3-1 CRYSTALS

TYPE	PARAMETER	MAXIMUM STRESS RATIO	COMMENTS
ALL	Current (Drive Level)	0.50	50% drive current equals 25% drive power.

4. DIODES

4.1 Diode Reliability Application Derating Guidelines

TABLE 4-1 DIODE
(SWITCHING, SMALL SIGNAL, RECTIFIER, AND TRANSIENT SUPPRESSORS)

PARAMETER	MAXIMUM STRESS RATIO		
	SWITCHING, SMALL SIGNAL	RECTIFIER	TRANSIENT SUPPRESSOR
Power	0.50 (0.70 WC) 2/	0.65 (0.70 WC) 2/	0.75
Voltage, DC or repetitive pulse	0.75 2/	0.75 2/	----
Voltage Transients 1/	0.85 2/	0.85 2/	0.75
Forward Current	0.50 2/	0.75 (0.85 WC) 2/	
Surge Current	0.50 2/	0.75 (0.85 WC) 3/	
Junction temperature	125°C, or 20°C less than the manufacturer's rating 4/	125°C. or 20°C less than the manufacturer's rating 4/	125°C, or 20°C less than the manufacturer's rating 4/

NOTES FOR TABLE 4-1:
1/ Worst case turn-on or repetitive transient
2/ Of maximum rating
3/ Of surge rating
4/ Whichever is lower

TABLE 4-2 DIODE
(STEP RECOVERY, VARACTOR, and VARICAP)

PARAMETER	MAXIMUM STRESS RATIO
Power	0.50 (0.70 WC)
Voltage, DC or Repetitive pulse	0.75 2/
Voltage Transients 1/	0.80 2/
Forward Current	0.75 2/
Junction temperature	125°C, or 20°C less than the manufacturer's rating 4/

TABLE 4-3 ZENER DIODE (REFERENCE AND REGULATOR)

PARAMETER		MAXIMUM STRESS RATIO
Reference Zener		
	Power	0.50 (0.85 WC) 2/
	Junction Temperature	125°C, or 20°C less than the manufacturer's rating 4/, 5/, & 6/
Regulator Zener		
	Power	0.50 (0.75 WC) 2/, 6/
	Junction Temperature	125°C, or 20°C less than the manufacturer's rating 4/, 6/

NOTES FOR TABLES 4-2 AND 4-3:

1/ Worst case turn-on or repetitive transient

2/ Of maximum rating

4/ Whichever is lower

5/ Note that temperature compensated reference diodes must be operated at the manufacturer's specified current to optimize temperature compensation.

6/ The zener current shall be limited to no more than $I_Z = I_{Z\ nominal} + .05\ (I_{Z\ maximum} - I_{Z\ nominal})$ but do not derate to the point where the device is operating at the knee.

TABLE 4-4 DIODE, SHOTTKY BARRIER

PARAMETER	MAXIMUM STRESS RATIO
Power	0.75 (0.85 WC)
Voltage, DC or repetitive pulse	0.75 2/
Voltage transients 1/	0.80 2/
Junction temperature	125°C, or 20°C less than the manufacturer's rating 4/

TABLE 4-5 DIODE (TUNNEL, GERMANIUM) 7/

PARAMETER	MAXIMUM STRESS RATIO
Power	0.50 (0.70 WC)
Voltage, DC or repetitive pulse	0.70 2/
Voltage transients	0.80 2/
Junction temperature	125°C, or 20°C less than the manufacturer's rating 4/

NOTES FOR TABLES 4-4 AND 4-5:

1/ Worst case turn-on or repetitive transient
2/ Of maximum rating
4/ Whichever is lower
7/ Germanium diodes are not recommended for new or modified designs.

TABLE 4-6 DIODE (PHOTO, LED)

PARAMETER	MAXIMUM STRESS RATIO
Current	0.50 (0.70 WC)
Junction temperature	125°C, or 20°C less than the manufacturer's rating 4/

NOTES FOR TABLE 4-6:
4/ Whichever is lower

5. EMI FILTERS

5.1 EMI Filter Reliability Application Derating Guidelines

TABLE 5-1 EMI FILTERS

TYPE	PARAMETER	MAXIMUM STRESS RATIO
ALL	Voltage	0.50 of rating
	Current	0.75 of rating
	Temperature	Case 85°C maximum

6. FUSES

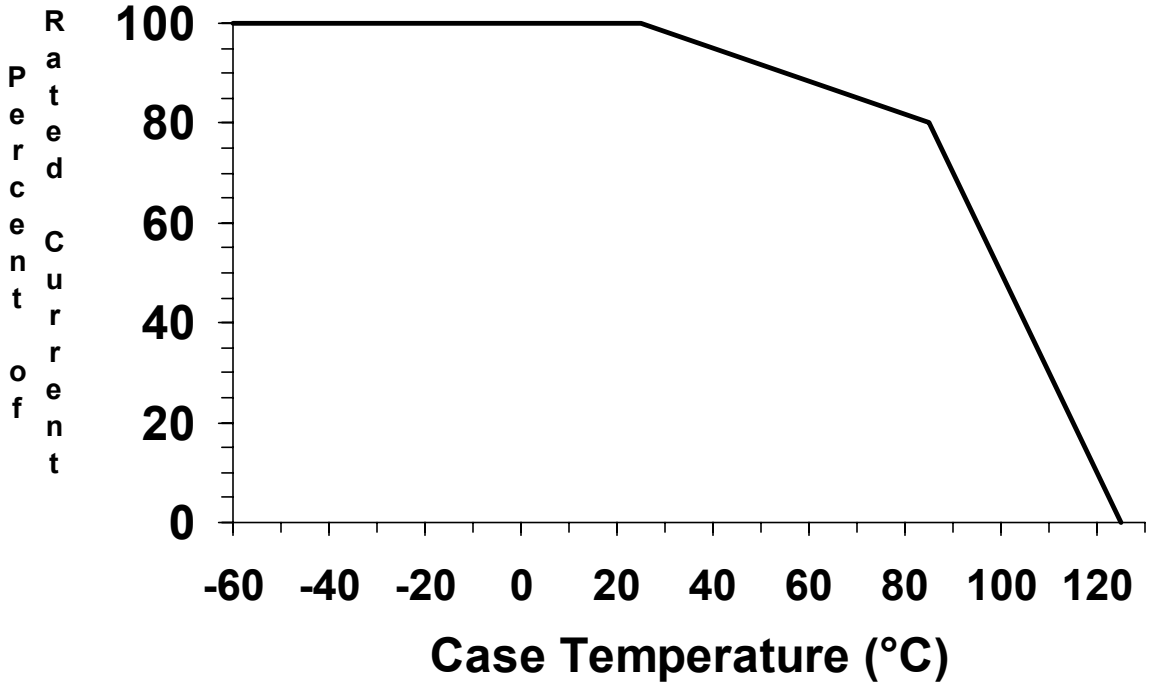
6.1 Fuse Reliability Application Derating Guidelines

TABLE 6-1 FUSE DERATING

TYPE	PARAMETER	MAXIMUM STRESS RATIO	COMMENTS 1/, 2/, 3/
Solid Body	Current	0.75 of rating	Multiply 0.75 by the additional derating of Figure 6-1 to compensate for temperature.
Glass Fuses 1/			Manufacturer's current ratings are temperature dependent.
1/8 amp 2/	Current	0.25 of rating	
1/4 amp 2/	Current	0.30 of rating	Derating factors are based on data from fuses mounted on printed circuit boards and conformally coated. The derating criteria allows for possible loss of pressure which lowers the blow current rating and allows for a decrease of current capability with time.
3/8 amp 2/	Current	0.35 or rating	
1/2 amp 2/	Current	0.40 of rating	
1 amp	Current	0.45 of rating	
2 amp or greater	Current	0.50 of rating	
Fusible resistors	Current	Consult Reliability Engineering	Above 25°C, the derating factor decreases an additional 0.5% for each degree C above 25°C. In the event a non-standard fuse size is required, use the next highest rated fuse size.

NOTES:
1/ Glass fuses are derated for reliability and to allow for air loss in vacuum.
2/ Shall not be used on new or modified designs without PMPCB approval.

Figure 6-1 Solid Body Fuse Additional Derating for Temperature



7. INDUCTORS & TRANSFORMERS

7.1 Inductor and Transformer Reliability Application Derating Guidelines

TABLE 7-1 INDUCTORS AND TRANSFORMERS

TYPE	PARAMETER	MAXIMUM STRESS RATIO	COMMENTS 1/, 2/, 3/
All	Current	0.50 of rating	2/
	Voltage	0.50 of rating	Inductors: As established , per MIL-C-39010, MIL-PRF-27, or MIL-PRF-21038 (as applicable) for Dielectric Withstanding Voltage (DWV), induced voltage and corona voltage. Transformers: As established per MIL-PRF-27 or MIL-PRF-21038 for DWV, induced voltage, and corona voltage.
	Temperature (Inductors)	1/ and 4/	Classes per MIL-PRF-39010 or MIL-PRF-27 as appropriate. 3/
	Temperature (Transformers)	1/ and 5/	Classes per MIL-PRF-27 or MIL-PRF-21038 as appropriate. 3/

NOTES:

1/ Insulation rated at less than 150°C shall not be used. The maximum operating temperature of the device shall be at least 30°C lower than the maximum temperature of the item with the lowest maximum temperature. This may be the core material, the insulation of the magnet, etc.

2/ Current rating for each winding shall be less than or equal to the rating for a bundle of wires of the same AWG size as the wire used for the winding (see TABLE 17-1 WIRE DERATING).

3/ The permitted maximum temperature stress is defined as the worst case temperature resulting from the combined effects of hot spot temperature, the ambient and/or base plate temperature, and the temperature rise resulting from joule heating.

NOTES (Con't):

4/ Maximum operating temperature equals ambient temperature plus temperature rise +10°C (allowance for hot spot). Compute temperature rise as follows:

Inductor temperature rise (°C) = $((R-r)/r)(T+234.5^{*})$

Where:

R = winding resistance under load**
r = no-load winding resistance at ambient temperature T (°C)
T = maximum ambient temperature (°C) at time of power shutoff

* This factor is for copper wire, but varies for different wire materials

** For accurate results, this measurement must be made in a vacuum to simulate actual operating conditions.

5/ Maximum operating temperature equals ambient temperature plus temperature rise + 10°C (allowance for hot spot). Compute temperature rise as follows:

Transformer temperature rise (°C) = $((R-r)/r)(t+234.5^{*})-(T-t)$

Where:

R = winding resistance under load**
r = no-load winding resistance at ambient temperature T (°C)
t = specified initial ambient temperature (°C)
T = maximum ambient temperature (°C) at time of power shutoff. (T) shall not differ from (t) by more than +5°C.

* This factor is for copper wire, but varies for different wire materials.

** For accurate results, this measurement must be made in a vacuum to simulate actual operating conditions.

8. INTEGRATED CIRCUITS

8.1 Derating Criteria for Digital Integrated Circuits

TABLE 8-1 INTEGRATED CIRCUIT, CMOS, TTL

PARAMETER	MAXIMUM STRESS RATIO	COMMENTS
Voltage, Input	May not exceed supply voltage applied to IC	1/
Voltage, Supply DIGITAL Turn on Operational	 Transient peaks shall not exceed the absolute maximum value. Per manufacturer's recommended operational voltages	
Fanout	Derate by one load or to 80% (90% WC) of maximum rating, whichever is greater.	Not applicable to single fanout devices.
Current, Load	0.80 (0.90 WC) 2/	Not applicable to single fanout devices.
Propagation delay	1.1	Worst case only
Power	0.80 (0.90 WC)	
Junction or Hot Spot Temperature	125°C or 20°C less than the manufacturer's rating	Whichever is lower

NOTES:

1/ For parts that are designed to accept an input voltage that is greater that the IC supply voltage, the maximum stress shall be 10% or more below the part manufacturer's maximum specified rating.

2/ The derating for all outputs of digital devices must be calculated for both high and low output states.

8.2 Derating Criteria for Linear, Op Amp, Comparator Devices

TABLE 8-2 INTEGRATED CIRCUIT, LINEAR, OP AMP, COMPARATOR 1/

PARAMETER	MAXIMUM STRESS RATIO	COMMENTS
Power	0.75 (0.85 WC)	
Voltage, Input	0.70 (0.80 WC) of max. rating	2/
Operating Frequency (Applications)	0.75 (0.85 WC) of max. rating	
Transients	Transient peaks shall not exceed the absolute maximum value.	
Gain (Applications)	0.75 (0.85 WC) of max. rating	
Voltage, Supply	0.90 of maximum rating	Not to exceed the manufacturer's recommended operating voltage in WC.
Current, Output	0.75 (0.85WC) of max. rating	Of rated value, or 0.75 of the current limited value.
Junction or Hot Spot Temperature	125°C or 20°C less than the manufacturer's rating.	Whichever is lower

NOTES:

1/ In general, the 10% minimum/maximum margin applies to operational characteristics for the device, such as usable gain bandwidth, propagation delay, etc.

2/ Of the maximum rated supply voltage applied to the IC and/or of the rated differential input voltage. The input voltage shall not exceed the applied supply voltage.

8.3 Derating Criteria for Linear Voltage Regulator ICs

TABLE 8-4 INTEGRATED CIRCUIT, LINEAR VOLTAGE REGULATOR

PARAMETER	MAXIMUM STRESS RATIO	COMMENTS
Power	0.80 (0.85 WC)	The controlling factor for voltage regulators is the input-output voltage differential which shall be limited to 80% of the max. rated (Vin-Vout).
Voltage, Input	0.80 (0.85 WC)	
Current, Input	0.80 (0.90 WC)	
Current, Output	0.75 (0.85 WC)	
Transients	Transient peaks shall not exceed absolute maximum values	
Junction or Hot Spot Temperature	125°C or 20°C less than manufacturer's rating	Whichever is lower

8.4 Hybrids Chip and Wire

8.4.1 Derating Criteria for Hybrids Chip and Wire Devices. Integrated circuit hybrids shall be designed so that discrete piece parts and deposited resistors meet the derating requirements of this document.

8.4.2 Internal Wire. Maximum design current for any given internal wire or ribbon used in a Hybrid Microcircuit is dependent upon the conductor material and the wire diameter and is equal to 50% of the value determined by the equation $I=Kd^{3/2}$. The constant (K) is dependent upon the composition of the wire or ribbon as shown.

TABLE 8-4 VALUES FOR K

CONDUCTOR MATERIAL	K VALUES FOR CONDUCTOR LENGTH, L	
	L $\leq$ 0.040"	L > 0.040"
Aluminum	22,000	15,200
Gold	30,000	20,500
Copper	30,000	20,500
Silver	15,000	10,500
All others	9,000	6,300

8.5 Derating Criteria (Integrated Circuits, Other). For large scale integrated circuits, microcircuit chips for hybrids, and integrated circuit part types not specifically addressed in the preceding material, apply appropriate linear and/or digital criteria from the appropriate derating tables. For devices which are partially digital and partially linear, the linear device derating factors shall apply to the linear portion of the device and the digital device derating factors shall apply to the digital portion.

9. MOTORS

9.1 Derating Criteria

TABLE 9-1 MOTOR DERATING

TEMPERATURE

Motor parts and materials shall be subject to the same temperature restrictions as inductors. Specifically:

1. Maximum temperature (hot spot, ambient + temperature rise) Class A, 105°C, and Class B, 125°C; classes per MIL-C-15305.

2. Insulation rated at less than 105°C shall not be used.

In general, no part or material shall operate at a temperature greater than 30°C below the manufacturer's rated temperature for the part or material.

BEARING LOAD: 75% maximum of rated value.

Note that motor loading directly affects electrical stress and lifetime. Motor loading at operating speed shall be sufficiently derated from maximum rated torque so as to comply with the above temperature guidelines.

WIRE

Restrictions on wire size shall apply to motor windings and leads. (See Table 17-1)

LIFETIME DERATING

Motor lifetime in space applications will be determined by such factors as bearing lubrication, motor loading, and electrical stress. These factors shall be derated to 25% or less of their predicted capability under the application conditions.

10. PRINTED WIRING BOARDS

10.1 Derating Criteria. The minimum conductor width for both single and multi-layer copper foil printed wiring boards (PWBs) is a function of required circuit current.

Two sets of plots are provided. The first set (Figures 10-1 and 10-2) plots the current carrying capability of the etched foil versus the cross sectional area required for a 10°C temperature rise in the trace. This rise ensures minimal component heating. The second set (Figures 10-3 and 10-4) plots the copper trace width versus the cross sectional area for four thicknesses of foil. The curves provided appear in FULL and EXPANDED scales to improve accuracy. The FULL scale covers the current range up to 7 amperes and a trace cross section up to 700 square mils. The EXPANDED scale covers the current range up to 1.8 amperes and a cross section up to 100 square mils.

10.2 Use of Derating Curves.

1. Enter the Current versus Area plot at the current required by the circuit and determine the cross sectional area.

2. Enter the Width versus Area plot of the same horizontal scale for the weight of copper foil used and determine the minimum trace width required.

10.3 Additional Factors.

1. Reliability review or approval is required for higher current densities than shown herein.

2. This information does not take into account the voltage drop between points on the PWB. The circuit designer must determine what is acceptable.

3. These curves are based upon IPC-D-275, Type 3, multilayer PWBs with inside traces, but apply to all PWBs in space as there is no air cooling.

4. The curves include an industry standard 10% margin on the allowed current per trace to allow for variations in etching copper thickness and conductor width.

5. Where under etching becomes significant, the trace cross sectional area will be reduced as will its current carrying capability. A wider trace should be used in this case.

6. The effect of components on the trace temperature rise has not been included.

7. These charts are for single conductors. For groups of similar, closely spaced, parallel conductors, the temperature rise may be found by summing the currents and summing the cross sectional areas as though the group were only one wire.

8. These curves apply to copper traces without overplating.

Figure 10-1 Conductor Current vs. Cross Sectional Area - Full

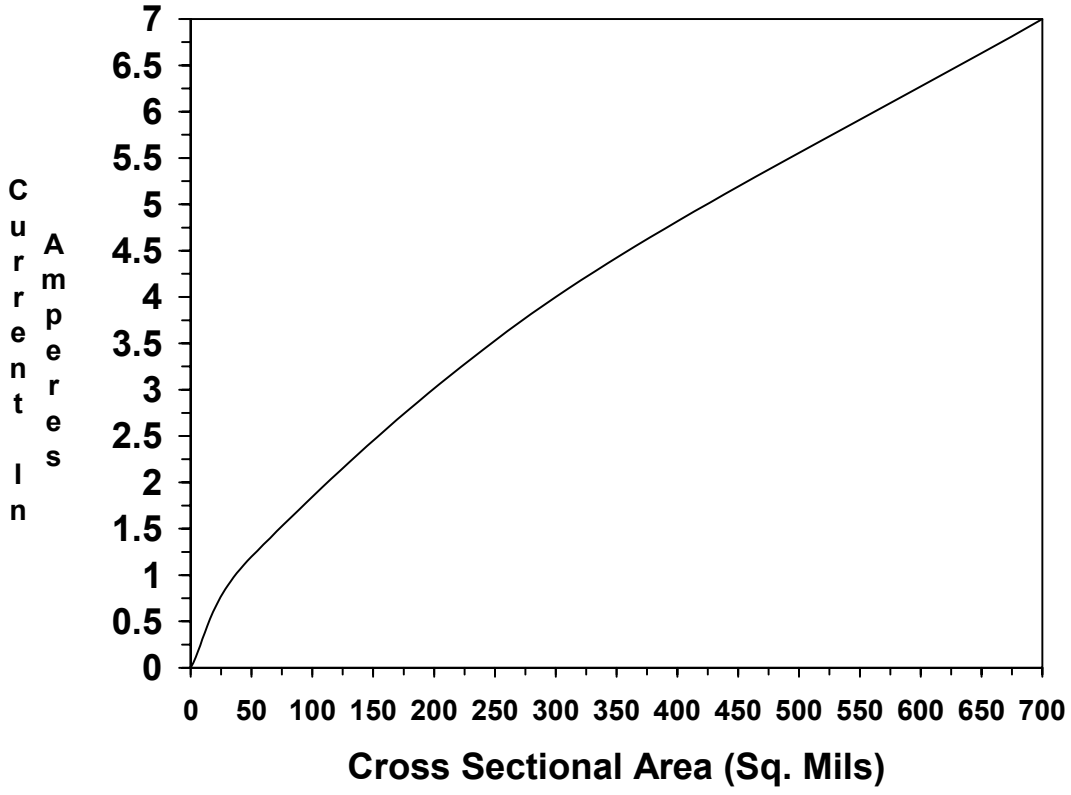
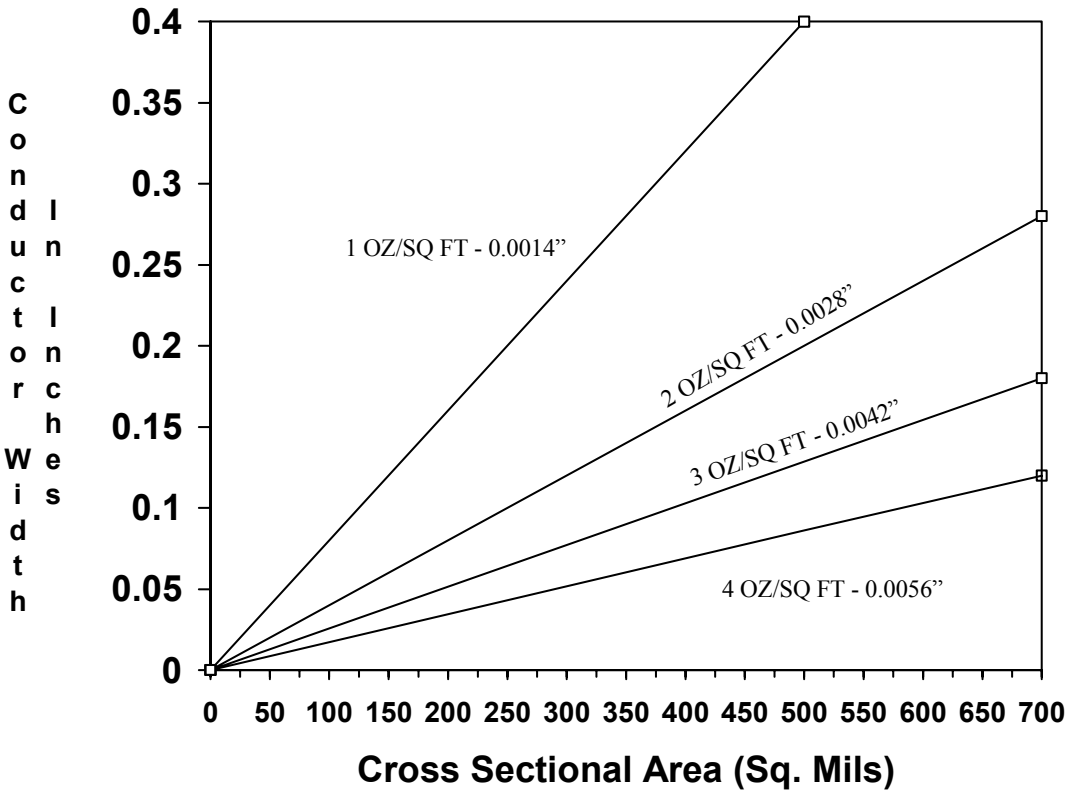


Figure 10-2 Conductor Width vs. Cross Sectional Area



11. RELAYS

11.1 Derating Criteria

TABLE 11-1 RELAY DERATING (See Notes 1/ Through 8/)

RELAY LOAD TYPE	CONTACT CURRENT MAXIMUM STRESS	COIL VOLTAGE	
		MINIMUM ALLOWABLE	MAXIMUM ALLOWABLE
Resistive	0.75 of resistive load rating	1.1 of must-operate voltage at +125° C rating	0.9 of maximum rated voltage
Inductive	0.50 of inductive load rating, or 0.40 of resistive load rating if inductive load rating is not specified	1.1 of must-operate voltage at +125° C rating	0.9 of maximum rated voltage
Motor	0.5 of motor load rating, or 0.20 of resistive load rating if motor load rating is not specified	1.1 of must-operate voltage at +125° C rating	0.9 of maximum rated voltage
Filament	0.10 of resistive load rating	1.1 of must-operate voltage at +125° C	0.9 of maximum rated voltage
Capacitive or in-rush type load	Series resistance shall be used with any capacitive load to insure that currents do not exceed derated levels for resistive loads.	1.1 of must-operate voltage at +125° C rating	0.9 of maximum rated voltage

NOTES:

1/ Maximum number of operations shall be 50% of rated life when relay is used with resistive loads, and 25% of rated life when used with inductive loads. Relay actuations performed during pre-flight testing shall be included as a portion of the permitted maximum number of relay operations.

2/ Suppression of induced transient voltage spikes is typically recommended to minimize effects on circuits/devices used to drive relay coils. Back-to-back zener diodes, or a zener diode with a blocking diode, across the coil are effective techniques. These techniques minimize degradation to contact life which can occur because of longer drop-out times for the suppressed coil. Bifilar wound coils are another option. If used, they should not require additional external suppression.

NOTES (Con't)

3/ For loads other than those specified in the above table, the stress on the relay contacts shall be no greater than 75% of the manufacturer's rating for the type of load specified.

4/ Contacts can be paralleled for redundancy. However, paralleled contacts should not be used as a means to increase contact current rating over the value specified for a single current. This restriction is necessary because there is no guarantee that parallel contacts will open and close simultaneously. Therefore, a single contact must be capable or carrying the entire load.

5/ Relays used to switch resistive loads at an appreciable distance from the relay contacts (such as in a spacecraft harness) may, in fact, be switching a load with significant inductance (the harness) in series with the load resistance. Each case shall be examined separately to determine the amount of inductance. If the amount of inductance as defined by the equation $L=.0001R_L$ in MIL-PRF-6106 is exceeded, the relay contact load shall be considered to be inductive. In these cases, the contacts shall be derated using the inductive derating rather than the resistive derating.

6/ Arc suppression techniques for the relay contacts are not recommended for use in spacecraft designs to provide higher than the derated current value in Table 11-1, since failure of the arc suppression circuit increases the risk of relay contact failure. Instead, relay contacts of a higher rating that can withstand the surge current during switching should be used.

7/ Relay contacts can safely carry more current than they can switch. For purposes of derating, the "carry-only" load shall not exceed 90% of the rated "carry-only" load.

8/ Relay coil voltages should not be derated. Relay coils should be operated at their specified nominal voltage level. Since operation exactly at the specified nominal voltage is not always possible. There are some upper and lower tolerance limits for coil voltage. Table 11-1 defines those limits which will ensure proper relay operation. The minimum actuation voltage supplied to the relay coil should never be less then 110% of the smallest voltage which will operate the relay at its maximum related temperature. The voltage supplied to the coil should never be greater than 90% of the specified maximum voltage rating for the coil over the specified temperature range.

12. RESISTORS

TABLE 12-1 MIL-SPEC LISTING (FOR REFERENCE)

RESISTOR TYPE	MIL-SPEC	STYLE
Fixed, Carbon (Insulated) Composition	MIL-R-39008	RCR
Fixed Film (Insulated)	MIL-PRF-39017	RLR
Fixed Film Resistor Chips	MIL-PRF-55342	RM, RMO
Fixed Film	MIL-PRF-55182	RNC
Fixed Film, Precision	MIL-PRF-55182	RNR 1/
Fixed Film, High Voltage	MIL-PRF-55182	
Fixed, Wire Wound (Accurate)	MIL-PRF-39005	RBR
Fixed, Wire Wound (Pwr Type)	MIL-PRF-39007	RWR
Fixed, Wire Wound Power Type Chassis Mounted	MIL-PRF-39009	RER
Pill Resistor (Stripline)	MIL-R-10509	
Resistance Network	MIL-PRF-83401	RZ, RZO
Thermistor	MIL-PRF-23648	RTH
Variable, Nonwire Wound 2/ (Adjustment Type)	MIL-PRF-39035	RJR
Variable, Nonwire Wound (2) (Lead Screw Actuated)	MIL-PRF-39015	RTR

NOTES:
1/ For solder only applications, not for welding.
2/ Not recommended for space usage.

12.1 Derating Criteria

TABLE 12-2 RESISTOR DERATING

TYPE	PARAMETER	MAXIMUM STRESS RATIO 11/
Carbon Composition	Power	Figure 12-1 1/
Metal Film RLR RNC	 Power Power	 Figure 12-2 1/ Figure 12-3 1/
Film, Chip - RMO	Power	0.50 (0.75 WC) 2/ & 9/
Film Resistance Network	Power	0.50 (0.75 WC) 2/ & 9/
Wire Wound Accurate - RBR	Power	Figure 12-4 1/, 8/, & 10/
Wire Wound Power - RWR	Power	Figure 12-5 1/ & 4/
Wire Wound Power - RER Chassis Mounted	Power	Figure 12-5 1/ & 4/
Deposited (Thick Film as Part of a Hybrid Substrate)	Power	0.50 3/
Inconel Foil Heaters or Deposited Heaters on Kapton	Power	0.50 6/
Thermistors Positive Temperature Compensating	Power	0.50
Thermistors Negative Temperature Compensating	Power	0.50 5/
Microwave Loads, Isolators, Circulators (Pill Resistors)	Power	0.50 7/

NOTES:

1/ For discrete resistors, the voltage shall not exceed 50% of rated voltage. Where a specific voltage rating has not been stated, the nominal rated voltage shall be determined from E = Square Root of (PR). When the voltage is applied in short pulses so that the average power of the resistor is less than 50% of the manufacturer's rating, this voltage derating may be the controlling derating factor. Average pulse power is defined by:

$$P_{average} = P(t/T)$$

Where:

P = pulse power, calculated from E^2/R
E = amplitude of the pulses
R = impedance across which the pulses appear
t = pulse width or duration in seconds
T = cycle width or duration in seconds

For nonrepetitive pulses, the resistor's thermal time constant in the particular application shall be determined and the pulse power limited to a value that does not result in a temperature rise at the resistor surface which is greater than the temperature rise that would result from the applied derated DC power level.

2/ Power rating shall be determined from the maximum hot spot temperature and a calculation of the thermal resistance from the element to the equipment mounting surface. Above 70°C, linearly reduce the power derating factor from 0.50 at +70°C to zero at +125°C.

3/ Deposited resistors:
Dimensions are determined by required resistance value and the resistivity of the ink used. Power rating for DuPont Birox 1400 series inks is 100 watts per square inch. The total power dissipated on a substrate, however, shall not exceed 4 watts per square inch and the voltage shall not exceed 1500 volts per inch of length. Consult the appropriate specification for other inks.

4/ For chassis-mounted applications, resistor body temperature (hot spot) shall not exceed 140°C.

5/ Current limiting resistors or other methods shall be used to prevent thermal runaway. The 50% power stress ratio applies to +25°C. Derate linearly to zero milliwatts at +125°C (or the appropriate zero power temperature for the thermistor used.)

6/ 50% derating applies only if low thermal resistance exists between the heater and the heatsink. Higher derating (dissipating less power) is required if there is no heat sink, or if the thermal resistance to the heat sink is not low.

7/ This is 50% of the manufacturer's maximum power rating for the component (such as an isolator or circulator) at maximum acceptance temperature with the maximum power reflected into load that will still permit the circuit to function.

Notes (Cont.)

8/ These resistors are susceptible to absorption of water vapor and can exhibit a positive or negative (usually positive) shift of resistance of 30 to 70 parts per million.

9/ Under relatively low humidity conditions, film chip resistors (particularly those of smaller base size with high sheet resistance films) are subject to electrostatic discharge (ESD) and sudden shifts in resistance and in the temperature coefficient of resistance. Precautions against ESD are necessary in packaging and handling.

10/ The RBR resistors are designed as precision resistors. They are physically larger than RWR resistors for the same wattage rating which enables them to be used at higher power stress ratios than RWR resistors while maintaining their accuracy.

11/ The resistor derating guidelines account for the vacuum environment of space and are based on the maximum allowable resistor body hot spot temperature for lead mounted resistors in vacuum, except for RER and inconel foil heater resistors, which are based on chassis mounting.

12.2 Use of Derating Curves (Figs. 12-1 through 12-5). To determine the maximum permitted operating power from the following figures:

- Determine the maximum temperature at the location where the resistor will be mounted. The maximum temperature is the sum of the part ambient temperature, which is the acceptance test temperature plus the temperature rise from the component baseplate to the part location, and the part operational temperature, which is a function of the power applied.

- Find that maximum temperature on the X axis, and read the Power Stress Ratio upper limit from the Region I curve. The power stress ratio is determined by dividing the maximum power across the resistor in its intended circuit application by the manufacturer's maximum power rating.

- *Any combination of part temperature and power stress ratio that lies in Region I shall be considered approved for that application. Any combination that lies in Region III shall be considered disapproved for the intended application. Combinations falling in Region II shall be identified, analyzed to assure that the part application meets mission requirements, and presented to the PMPCB for approval. Combinations falling 20% or less above the Region I curve shall be documented on a PMPCB Action Form and forwarded to the Government PMPCB representatives for approval. Combinations greater than 20% above the Region I curve shall require acquisition activity approval.*

Figure 12-1 Carbon Composition Resistor (RCR)

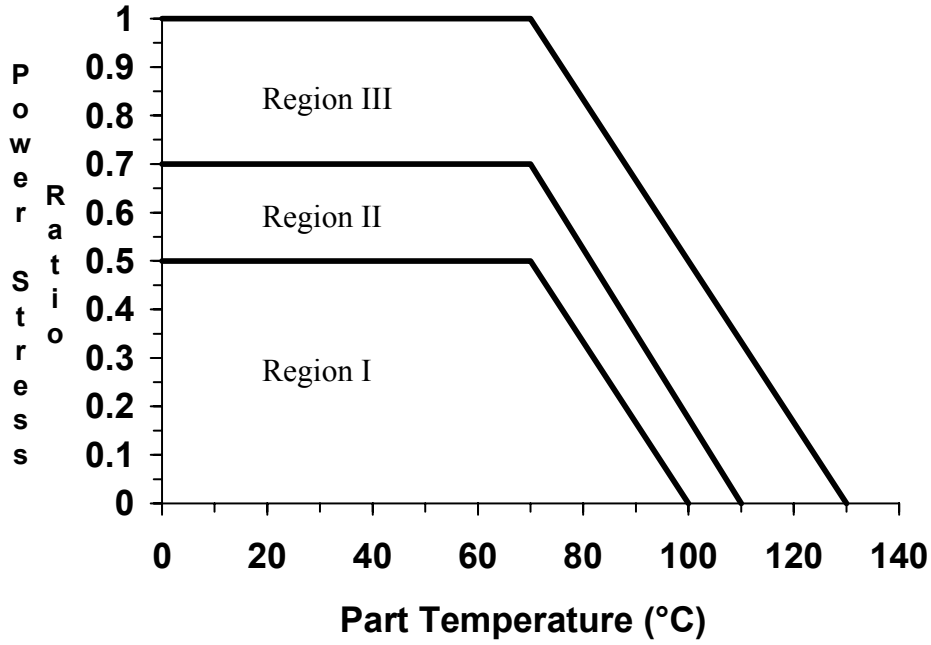


Figure 12-2 Metal Film Resistor (RLR)

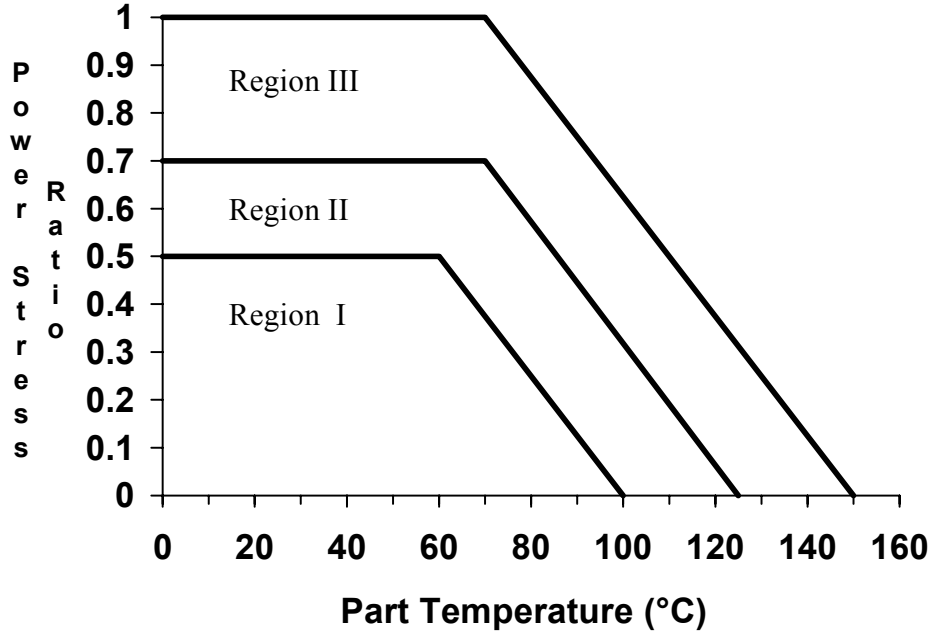


Figure 12-3 Metal Film Resistor (RNC, RNR)

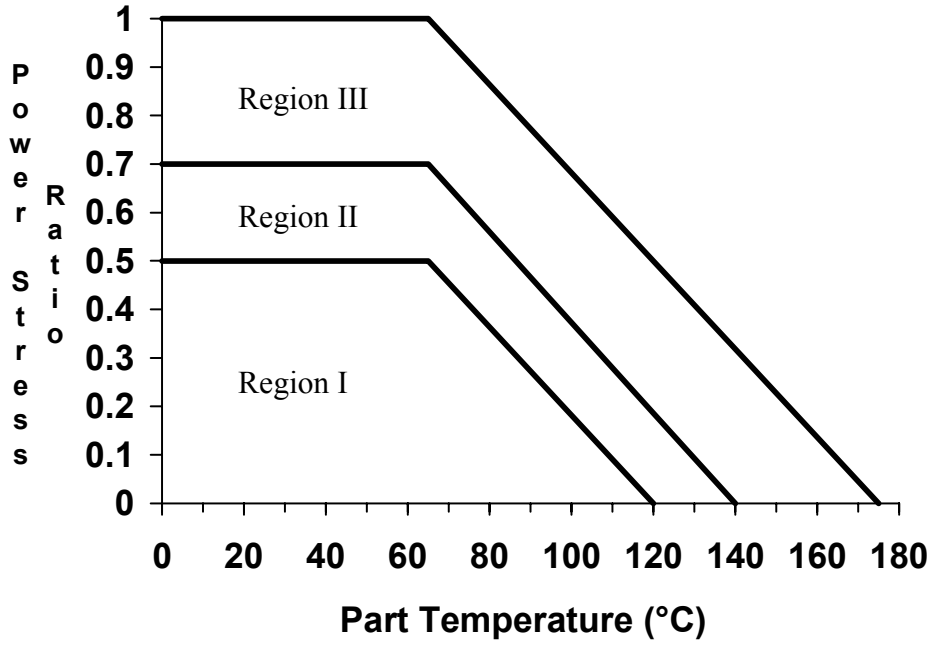


Figure 12-4 Wire Wound Accurate Resistor (RBR)

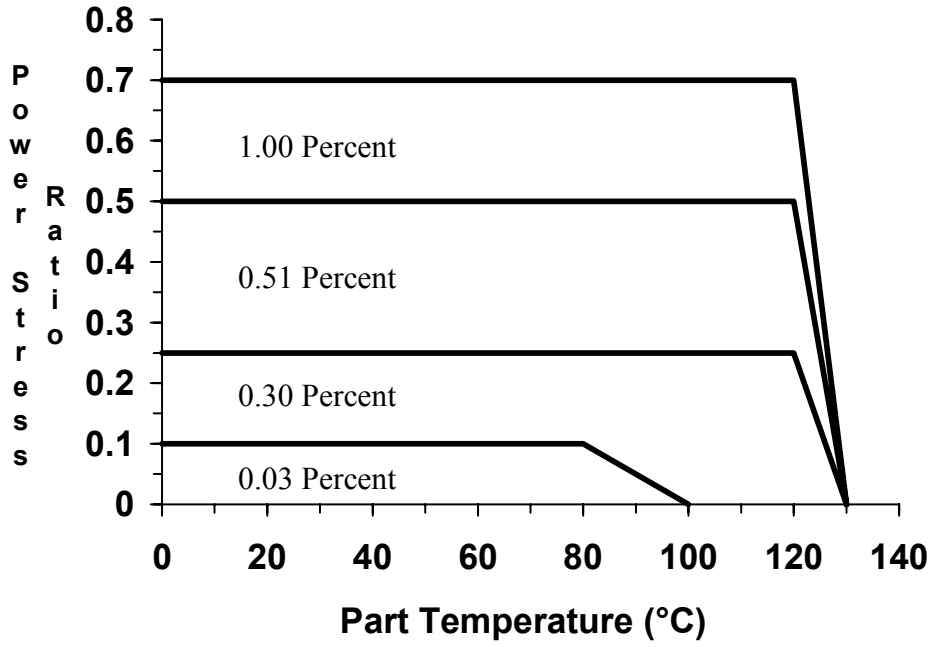
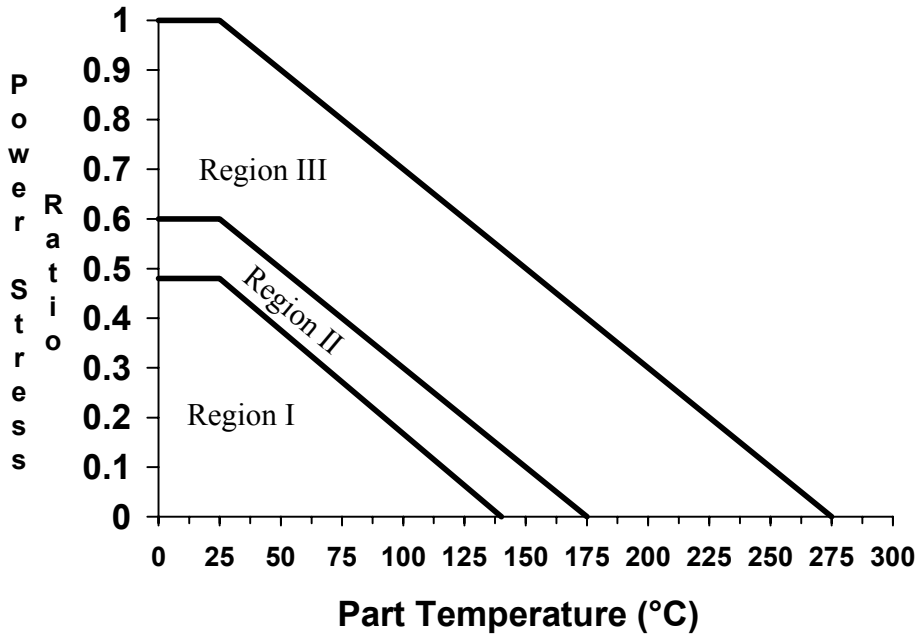


Figure 12-5 Wire Wound Power Resistor (RWR, RER)



13. SLIP RINGS

13.1 Derating Criteria. The maximum current in the slip ring shall not exceed 50% of the designed current carrying capability of the slip ring. In addition, slip rings shall be designed so that when 50% of the rated current is being carried, the temperature rise of the slip rings shall not exceed 50°C rise above ambient.

14. SUBSTRATES

14.1 Derating Criteria. Alumina substrates shall be derated to 50% of the manufacturer's dielectric withstanding voltage.

15. SWITCHES

15.1 Switch Derating Criteria. The derating requirements for switches is essentially the same as for relay contacts. The notes below table 11-1 that refer to relay contacts also apply to switches.

Thermal switches per MIL-PRF-24236 are not recommended for space application. Where they must be used, the contacts shall be derated as stated above and proper configurations of series and parallel redundancy shall be employed. In addition, a +4°C minimum dead band shall be required and a temperature rate of change equal to or greater than 0.11 °C/minute shall be used. If these conditions can not be met, solid-state thermal controls shall be used.

16. TRANSISTORS

16.1 Derating Criteria

TABLE 16-1 Transistor, Bipolar, JFET

PARAMETER	MAXIMUM STRESS RATIO	COMMENTS
Power	0.50 (0.60 WC) 1/	
Voltage	0.75 of maximum rating 2/	
Voltage Transients	0.85 of maximum ratings	Worst case turn-on or repetitive transient
Current	0.75 (0.85 WC)	
Junction Temperature	125°C or 20°C less than the manufacturer's rating.	Whichever is lower.

TABLE 16-2 Transistor, GaAs FET

TYPE	PARAMETER	MAXIMUM STRESS RATIO	COMMENTS
GaAs FET Low Noise	Voltage	0.75	
	Current	0.90 3/ & 4/	
	Power, Channel	0.50	
	Temperature, Channel	125°C or 20°C less than the manufacturer's rating.	Whichever is lower.
GaAs FET Power	Voltage	0.75	
	Current	0.90 3/ & 4/	
	Temperature, Channel	125°C or 20°C less than the manufacturer's rating.	Whichever is lower.

TABLE 16-3 MOSFET, Small Signal and Power

PARAMETER	MAXIMUM STRESS RATIO	COMMENTS
Voltage, Gate to Source, V_{GS}	0.75	
Channel Power	0.5	
Channel Current	0.9 3/ & 4/	
Breakdown Voltage, V_{BGSS}	0.75	
Temperature, Channel	125°C or 20°C less than the manufacturer's rating.	Whichever is lower

Notes for Tables 16-1, -2, and -3:

1/ Usable power at a given case temperature can be found from

$$P = (T_{Jmax} - T_C)/\phi_{JC}$$

Where:

T_{Jmax} is the maximum allowed junction temperature

T_C is the device case temperature

ϕ_{JC} is the thermal resistance from junction to case

2/ Voltage derating applies to device voltages such as V_{CBO}, V_{EBO}, and V_{CEX}.

3/ Where maximum I_{DS} rating is not specified, the upper I_{DSS} rating will apply.

4/ Devices may be tested briefly with I_{DS} not to exceed the maximum rated value. Forward gate current shall be 0.90 or less of rating, or zero if not specified.

17. WIRE AND CABLE

17.1 Derating criteria

TABLE 17-1 WIRE DERATING 1/, 2/

WIRE SIZE AWG#	MAXIMUM APPLIED CURRENT (AMPS)		COMMENTS
	BUNDLE/CABLE	SINGLE WIRE	
30	0.7	1.3	Current ratings for bundles are based on bundles of 15 or more wires at 70°C in a hard vacuum. For smaller bundles the allowable current may be proportionally increased as the bundle approaches a single wire.
28	1.0	1.8	
26	1.4	2.5	
24	2.0	3.3	
22	2.5	4.5	Ratings are based on polyalkene insulated copper wire.
20	3.7	6.5	
18	5.0	9.2	
16	6.5	13.0	
14	8.5	19.0	
12	11.5	25.0	
10	16.5	33.0	
8	23.0	44.0	

NOTES:

1/ Use of wire smaller than AWG# 30 is not recommended. However, if wire smaller than AWG# 30 must be used, the maximum current rating for a single wire is 2.63 milliamps per circular mil (3.348 mA/sq. mil) of cross-sectional area. Wire smaller than AWG# 36 shall require reliability review and PMPCB approval prior to use and shall not be used in critical application.

2/ The current in wires terminated in or run through connectors may be restricted further than indicated above by virtue of the connector contact size. See section 2.1 Connector Derating Criteria, Tables 2-1 and 2-2.

APPENDIX H

GENERAL SAMPLING PLAN

TABLE C-I. LTPD sampling plans 1/ 2/

Minimum size of sample to be tested to assure, with a 90 percent confidence, that a lot having percent-defective equal to the specified LTPD will not be accepted (single sample).

Max. Percent Defective (LTPD) or λ	50	30	20	15	10	7	5	3	2	1.5	1	0.7	0.5	0.3	0.2	0.15	0.1
Acceptance Number (c) (r = c + 1)	Minimum Sample Sizes (For device-hours required for life test, multiply by 1000)																
0	5 (1.03)	8 (0.64)	11 (0.46)	15 (0.34)	22 (0.23)	32 (0.16)	45 (0.11)	76 (0.07)	116 (0.04)	153 (0.03)	231 (0.02)	328 (0.02)	461 (0.01)	767 (0.007)	1152 (0.005)	1534 (0.003)	2303 (0.002)
1	8 (4.4)	13 (2.7)	18 (2.0)	25 (1.4)	38 (0.94)	55 (0.65)	77 (0.46)	120 (0.28)	195 (0.18)	258 (0.14)	390 (0.09)	555 (0.06)	778 (0.045)	1296 (0.027)	1946 (0.018)	2592 (0.013)	3891 (0.009)
2	11 (7.4)	18 (4.5)	25 (3.4)	34 (2.34)	52 (1.6)	75 (1.1)	105 (0.78)	170 (0.47)	266 (0.31)	354 (0.23)	533 (0.15)	759 (0.11)	1065 (0.080)	1773 (0.045)	2662 (0.031)	3547 (0.022)	5323 (0.015)
3	13 (10.5)	22 (6.2)	32 (4.4)	43 (3.2)	65 (2.1)	94 (1.5)	132 (1.0)	221 (0.62)	333 (0.41)	444 (0.31)	668 (0.20)	953 (0.14)	1337 (0.10)	2226 (0.062)	3341 (0.041)	4452 (0.031)	6681 (0.018)
4	16 (12.3)	27 (7.3)	38 (5.3)	52 (3.9)	78 (2.6)	113 (1.8)	158 (1.3)	265 (0.75)	398 (0.50)	531 (0.37)	798 (0.25)	1140 (0.17)	1599 (0.12)	2663 (0.074)	3997 (0.049)	5327 (0.037)	7994 (0.025)
5	19 (13.8)	31 (8.4)	45 (6.0)	60 (4.4)	91 (2.9)	131 (2.0)	184 (1.4)	308 (0.85)	462 (0.57)	617 (0.42)	927 (0.28)	1323 (0.20)	1855 (0.14)	3090 (0.085)	4638 (0.056)	6181 (0.042)	9275 (0.028)
6	21 (15.6)	35 (9.4)	51 (6.6)	68 (4.9)	104 (3.2)	149 (2.2)	209 (1.6)	349 (0.94)	528 (0.62)	706 (0.47)	1054 (0.31)	1503 (0.22)	2107 (0.155)	3509 (0.093)	5267 (0.062)	7019 (0.047)	10533 (0.031)
7	24 (16.6)	39 (10.2)	57 (7.2)	77 (5.3)	116 (3.5)	166 (2.4)	234 (1.7)	390 (1.0)	589 (0.67)	783 (0.51)	1178 (0.34)	1680 (0.24)	2355 (0.17)	3922 (0.101)	5883 (0.067)	7845 (0.051)	11771 (0.034)
8	26 (18.1)	43 (10.9)	63 (7.7)	85 (5.6)	128 (3.7)	184 (2.6)	258 (1.8)	431 (1.1)	648 (0.72)	864 (0.54)	1300 (0.36)	1854 (0.25)	2599 (0.18)	4329 (0.108)	6498 (0.072)	8660 (0.054)	12995 (0.036)
9	28 (19.4)	47 (11.5)	69 (8.1)	93 (6.0)	140 (3.9)	201 (2.7)	282 (1.9)	471 (1.2)	709 (0.77)	945 (0.58)	1421 (0.38)	2027 (0.27)	2842 (0.19)	4733 (0.114)	7103 (0.077)	9468 (0.057)	14206 (0.038)
10	31 (19.9)	51 (12.1)	75 (8.4)	100 (6.3)	152 (4.1)	218 (2.9)	306 (2.0)	511 (1.2)	770 (0.80)	1025 (0.60)	1541 (0.40)	2199 (0.28)	3082 (0.20)	5133 (0.120)	7704 (0.080)	10268 (0.060)	15407 (0.040)
11	33 (21.0)	54 (12.8)	83 (8.3)	111 (6.2)	166 (4.2)	238 (2.9)	332 (2.1)	555 (1.2)	832 (0.83)	1109 (0.62)	1664 (0.42)	2378 (0.29)	3329 (0.21)	5546 (0.12)	8319 (0.083)	11092 (0.062)	16638 (0.042)
12	36 (21.4)	59 (13.0)	89 (8.6)	119 (6.5)	178 (4.3)	254 (3.0)	356 (2.2)	594 (1.3)	890 (0.86)	1187 (0.65)	1781 (0.43)	2544 (0.3)	3562 (0.22)	5936 (0.13)	8904 (0.086)	11872 (0.065)	17808 (0.043)
13	38 (22.3)	63 (13.4)	95 (8.9)	126 (6.7)	190 (4.5)	271 (3.1)	379 (2.26)	632 (1.3)	948 (0.89)	1264 (0.67)	1896 (0.44)	2709 (0.31)	3793 (0.22)	6321 (0.134)	9482 (0.089)	12643 (0.067)	18964 (0.045)
14	40 (23.1)	67 (13.8)	101 (9.2)	134 (6.9)	201 (4.6)	288 (3.2)	403 (2.3)	672 (1.4)	1007 (0.92)	1343 (0.69)	2015 (0.46)	2878 (0.32)	4029 (0.23)	6716 (0.138)	10075 (0.092)	13431 (0.069)	20146 (0.046)
15	43 (23.3)	71 (14.1)	107 (9.4)	142 (7.1)	213 (4.7)	305 (3.3)	426 (2.36)	711 (1.41)	1066 (0.94)	1422 (0.71)	2133 (0.47)	3046 (0.33)	4265 (0.235)	7108 (0.141)	10662 (0.094)	14216 (0.070)	21324 (0.047)
16	45 (24.1)	74 (14.6)	112 (9.7)	150 (7.2)	225 (4.8)	321 (3.37)	450 (2.41)	750 (1.44)	1124 (0.96)	1499 (0.72)	2249 (0.48)	3212 (0.337)	4497 (0.241)	7496 (0.144)	11244 (0.096)	14992 (0.072)	22487 (0.048)
17	47 (24.7)	79 (14.7)	118 (9.86)	158 (7.36)	236 (4.93)	338 (3.44)	473 (2.46)	788 (1.48)	1182 (0.98)	1576 (0.74)	2364 (0.49)	3377 (0.344)	4728 (0.246)	7880 (0.148)	11819 (0.098)	15759 (0.074)	23639 (0.049)
18	50 (24.9)	83 (15.0)	124 (10.0)	165 (7.54)	248 (5.02)	354 (3.51)	496 (2.51)	826 (1.51)	1239 (1.0)	1652 (0.75)	2478 (0.50)	3540 (0.351)	4956 (0.251)	8260 (0.151)	12390 (0.100)	16520 (0.075)	24780 (0.050)
19	52 (25.5)	86 (15.4)	130 (10.2)	173 (7.76)	259 (5.12)	370 (3.58)	518 (2.60)	864 (1.53)	1296 (1.02)	1728 (0.77)	2591 (0.52)	3702 (0.358)	5183 (0.256)	8638 (0.153)	12957 (0.102)	17276 (0.077)	25914 (0.051)
20	54 (26.1)	90 (15.6)	135 (10.4)	180 (7.82)	271 (5.19)	386 (3.65)	541 (2.60)	902 (1.56)	1353 (1.04)	1803 (0.78)	2705 (0.52)	3864 (0.364)	5410 (0.260)	9017 (0.156)	13526 (0.104)	18034 (0.078)	27051 (0.052)
25	65 (27.0)	109 (16.1)	163 (10.8)	217 (8.08)	326 (5.38)	466 (3.76)	652 (2.69)	1086 (1.61)	1629 (1.08)	2173 (0.807)	3259 (0.538)	4656 (0.376)	6518 (0.269)	10863 (0.161)	16295 (0.108)	21726 (0.081)	32589 (0.054)

1/ Sample sizes are based upon the Poisson exponential binomial limit.

2/ The minimum quality (approximate AQL) required to accept on the average) 19 of 20lots is shown in parenthesis for information only.

APPENDIX I

SMALL LOT SAMPLING PLAN FOR CUSTOM S DEVICES

Small Lot Sampling Plan for Custom S Devices

Lot Size

Specified LTPD 1/	Less than 25	25-60	61-120	121-240	241-500	Greater than 500
2	21(0) or 34(1)	29(0) or 48(1)	41(0) or 68(1)	58(0) or 97(1)	82(0) or 137(1)	116(0) or 195(1)
3	14(0) or 22(1)	19(0) or 32(1)	27(0) or 45(1)	38(0) or 63(1)	54(0) or 90(1)	76(0) or 129(1)
5	8(0) or 13(1)	12(0) or 19(1)	16(0) or 27(1)	23(0) or 38(1)	32(0) or 53(1)	45(0) or 77(1)
7	6(0) or 10(1)	8(0) or 13(1)	12(0) or 19(1)	16(0) or 27(1)	23(0) or 38(1)	32(0) or 55(1)
10	4(0) or 7(1)	6(0) or 12(1)	8(0) or 13(1)	11(0) or 18(1)	16(0) or 28(1)	22(0) or 38(1)
15	3(0) or 5(1)	4(0) or 7(1)	6(0) or 10(1)	8(0) or 13(1)	11(0) or 18(1)	15(0) or 25(1)
20	3(0) or 5(1)	3(0) or 5(1)	4(0) or 7(1)	6(0) or 10(1)	8(0) or 13(1)	11(0) or 18(1)

NOTES:

1/ Select the appropriate reduced sample size based upon the specified LTPD and ti size.

APPENDIX J

RADIATION HARDNESS ASSURANCE

Radiation Hardness Assurance Requirements

1. SCOPE

This appendix provides the detailed requirements for managing the radiation hardness assurance of piece parts.

2. HARDNESS ASSURANCE PROGRAM

The contractor shall develop and implement a radiation hardness assurance program for all piece parts requiring some level of radiation hardening, during the design and production of the launch vehicle. The hardness assurance tasks shall include:

a. Development of radiation hardness assurance requirements where applicable.

b. Presentation of radiation hardness assurance issues at the preliminary and critical design reviews for the applicable hardware.

c. Presentations at PMPCB meetings when applicable.

d. Development of radiation hardness assurance design documentation.

2.1 Hardness Assurance Requirements. When radiation hardness assured parts, quality levels Class S or Class B for parts built to MIL-M-3 85 1 0 or JANS and JANTXV for parts built to MIL-PRF-19500 and -radiation levels M, D, R, or H, are unavailable to meet the specified radiation environments, the contractor shall develop detailed specifications or source control documents (SCDS) to procure the piece parts. All technical requirements for radiation hardness shall be included in the detailed specifications or SCD, either directly stated or by reference to other documents. These requirements shall include:

a. Radiation test methods and test circuits.

b. Sample size and sampling method.

c. Radiation types and specification level.

d. Pre- and post-radiation response parameters and failure criteria

e. Required confidence level (C) and survival probability (P).

f. Dosimetry requirements, if applicable.

g. Special radiation tests such as electrical or radiation screening tests.

In addition, the procurement paper should also include a list of the approved radiation test facilities, the data reporting and analysis requirements, and the failure analysis requirements.

2.2 Hardness Assurance Design Documentation. The contractor shall prepare hardness assurance design documentation for each applicable subsystem which details all radiation analyses and test data for all required radiation hard piece parts. This documentation shall include:

a. Identification of all circuits that require piece parts with some level of radiation hardness.

b. Circuit schematic, functional description, pin-out, operating conditions, and application of each circuit identified above.

c. Specification of the worst case radiation environment that the piece parts will see in this circuit.

d. Design margin between the worst-case circuit requirements and the degradation, if applicable, of the piece parts due to radiation.

e. Results of hardness verification analyses and tests.

f. Testability requirements, including a description of any hardness assurance test chips.

g. List of critical design and processing parameters necessary to meet radiation environments.

h. Radiation hardness lot acceptability criteria and test results.

2.3 Preliminary and Critical Design Reviews. The contractor shall ensure that all system design decisions that affect radiation hardness assurance of piece parts are made with the concurrence of the PNTCB. In addition, the PUTCB shall ensure that the hardness assurance design documentation and the detailed piece part specifications are appropriately modified, if necessary, to incorporate any hardness assurance decisions made at the preliminary and critical design reviews.

2.4 Hardness Assurance for Custom Large Scale Integrated Circuits (LSIC). The PMPCB shall ensure that the following tasks are included during the design and construction of custom LSI devices:

a. Designer and manufacturer capability audits.

b. Feasibility assessment performed by the contractor during the conceptual design phase.

c. Design requirements for hardness assurance testability.

d. Radiation critical **layout** rules and circuit design considerations.

e. Critical procedure and process requirements during wafer fabrication and assembly.

Additional requirements for custom LSI devices are detailed in MIL-HDBK-339.

3. HARDNESS ASSURANCE VERIFICATION

3.1 Hardness Verification Analyses. The contractor shall perform and document radiation analyses of all circuits with some level of radiation hardness to ensure that the piece parts used in the circuit are capable of meeting the hardness assurance requirements.

3.2 Radiation Characterization Tests. The contractor shall conduct radiation characterization of all radiation hardened piece parts in the specified radiation environments. The radiation characterization tests may be waived if existing databases are approved by the PMPCB. The radiation characterization tests shall consist of exposing the test sample to increasing radiation levels until the parametric or the functional failure value for the device has been reached. All failure values shall be based on both a worst case circuit analysis and the applicable device specifications.

APPENDIX K

DATA ITEM DESCRIPTIONS

Titan PMPCB Action Form	Number:
	Issue Date:
Military Specification Part No:	Date Code:
Selected Item Drawing Number:	Quantity:
Program:	
End Item Drawing:	
Problem Description:	
Proposed Solution:	
PMPCB Disposition: ☐ Approved ☐ Approved with Comments ☐ Disapprove	

PMPCB Chairman:	PMP Engineering:	Mission Success: (Not required for NSPARS)
SMC:	Aerospace Corporation:	

Delta Program PMPCB Action Form			Log Number:
			IPT:
			Date:
1) Subject:			
2) Description of Request:			
3) Enclosures:			
4) Justification:			
5) Contractor:		6) Contract Number:	7) Reply Need Date:
8) Submitted by:	9) Phone:	10) Date:	11) Expedite Requested

Actions:

To affected members review and provide disposition/comments as appropriate.
Due Date: _____

Failure to provide disposition response within 2 weeks from due date shall be considered as concurrence and disposition shall be applied accordingly.

Dispositions:

Affected :	Date	Applicable	Not Applicable	Info Only
PMPCB Chairman:	_____ /_____	☐	☐	☐
AF/SMC Rep:	_____/_____	☐	☐	☐
Aerospace Rep:	_____/_____	☐	☐	☐
NASA Rep:	_____/_____	☐	☐	☐
Other	_____/_____	☐	☐	☐

Comments:

Copies To:	Chairman:	Date:

SPCB Action Form	No:
Centaur ☐ Atlas ☐	Date:
Part Number:	Generic:
Vendor Name:	Date Code:
Next Assembly:	End Item:
Vendor P/N:	"Make From" (If Applicable)
Problem Description:	
Proposed Solution:	
Disposition/ Condition of Acceptance:	

SPCB Chairman:		Aerospace Corporation Rep:
		USAF SMC Rep:

APPENDIX L

ELECTRONIC PART PROCUREMENT ORDER OF PRECEDENCE

SECTION 1

SCOPE

1 PURPOSE AND APPLICATION

This appendix defines the procurement order of precedence to be utilized for the purchase of electronic parts. These requirements are to be applied to purchases only and not to parts in stock. Parts in stock may be used to depletion.

SECTION 2

REQUIREMENTS

2. PROCUREMENT ORDER OF PRECEDENCE

2.1 Semiconductors and Microcircuits. The part selection orders of precedence for single string and redundant circuitry are shown below:

a. *Category I* Electronic Systems/Circuits. The procurement order of precedence for *category I* systems/circuits shall be as follows in the order shown:

FIRST: Space Quality parts listed on the applicable QPL/QML shall be procured. If procured Space Quality parts will not be delivered in time to meet the production schedule, *the contractor may go to the second order of precedence for a number of substitute devices limited by the PMPCB to those necessary to avoid schedule impact or assembly interruptions.*

SECOND: If parts described by the first order of precedence are physically unobtainable, parts described by this second order of precedence shall be procured. The second order of precedence shall include:

Custom parts built to the minimum processing requirements and screened to the minimum screening requirements specified in Appendix B for the applicable device type,

- or -

JANTXV and Class B parts listed on the QPL and up-screened to the minimum up-screening requirements specified in Appendix B for the applicable device type. Although either selection is acceptable, the selections are listed in their preferred order.

THIRD: If parts described by the first and second orders of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of third order of precedence parts. Parts described by this third order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB.

Parts procured that meet DESC, MIL-STD-883 Para 1.2.1, or other requirements shall first be brought up to JANTXV or Class B requirements (with the exception of internal visual) before up-screening to the requirements specified in Appendix B for the applicable device type. ***A part procured to less than JANTX or Class B requirements shall be compared, in detail, to the nearest equivalent or most similar JANTXV or Class B specification. If differences are identified, only those tests and inspections, which have not already been performed on the lower level parts need to be performed in order to bring the parts up to the JANTXV or Class B level.*** **The first inspection (up-screening) lot of each device type shall be subjected to the general JANS/Class S part qualification requirements for the applicable device type.**

b. ***Category II*** Electronic Systems/Circuits. The procurement order of precedence for ***category II*** systems/circuits shall be as described below:

FIRST: Parts described by the first order of precedence shall be procured. The first order of precedence shall include:

Space Quality parts listed on the applicable QPL/QML.

- or -

Custom parts built to the minimum processing requirements and screened to the minimum screening requirements specified in Appendix B for the applicable device type,

- or -

JANTXV and Class B parts listed on the QPL and up-screened to the minimum upscreening requirements specified in Appendix B for the applicable device type. Lot Acceptance Testing (LAT) per Appendix B is not required.

Although any of the above selections are acceptable, they are listed in their preferred order.

Note: Parts procured from the above categories do not require a PAR.

SECOND: If parts described by the first order of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of these second order of precedence parts.

Parts described by this second order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The second order of precedence shall include:

Parts procured that meet DESC, MIL-STD-883 Para 1.2.1, or other requirements. *A part procured to less than JANTXV or Class B requirements shall be compared, in detail to the nearest equivalent or most similar JANTXV or Class B specification. If differences between the specifications are identified, only those tests and inspections which have not already been performed on the lower level parts need to be performed in order to bring the parts up to the JANTXV or Class B level.* The first inspection (up-screening) lot of each device type shall be subjected to the general JANS/Class S part qualification requirements for the applicable device type. Lot Acceptance Testing (LAT) per Appendix B is not required.

2.2 Resistors*/Thermistors*. The procurement order of precedence shall be as described below:

FIRST: Parts described by the first order of precedence parts shall be procured. The first order of precedence shall include:

Space Quality parts listed on the applicable QPL.

- or -

Parts manufactured in accordance with MIL-PRF-39005, MIL-PRF-39007, MIL-PRF-39009, MIL-PRF-39017, MIL-PRF-55182, MIL-PRF-55342, or MIL-PRF-83401, and listed on the applicable QPL for Exponential failure rate "S".

SECOND: If first order of precedence parts are not available to support schedule, second order of precedence parts shall be procured. The second order of precedence shall include:

Parts manufactured in accordance with MIL-PRF-39005, MIL-PRF-39007, MIL-PRF-39009, MIL-PRF-39017, MIL-PRF-55182, or MIL-PRF-55342 and listed on the applicable QPL for Exponential failure rate "R",

- or -

Parts manufactured in accordance with MIL-PRF-23648 and listed on the applicable QPL.

THIRD: If parts described by the two above orders of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of these third order of precedence parts. Third order of precedence parts shall not be procured unless a PAR has been submitted to the PMPCB for review and approval. The third order of precedence shall include:

All resistors*/thermistors* not described by the two orders of precedence above.

2.3 Capacitors. The procurement order of precedence shall be as described below:

FIRST: Parts described by the first order of precedence shall be procured. The first order of precedence shall include:

Space Quality parts listed on the applicable QPL.

- or -

Parts manufactured in accordance with MIL-PRF-20, MIL-PRF-19978, MIL-PRF-23269, MIL-PRF-39001, MIL-PRF-39003, MIL-PRF-39006, MIL-PRF-39014, MIL-PRF-55365, MIL-PRF-55681, or MIL-PRF-83421 and listed on the applicable QPL for Exponential failure rate "S" or Weibull failure rates "E", "D", "C", or "B".

SECOND: If first order of precedence parts are not available to support schedule, second order of precedence parts shall be procured. The second order of precedence shall include:

Parts manufactured in accordance with MIL-PRF-20, MIL-PRF-19978, MIL-PRF-23269, MIL-PRF-39001, MIL-PRF-39003, MIL-PRF-39006, MIL-PRF-39014, MIL-PRF-55365, MIL-PRF-55681, or MIL-PRF-83421 and listed on the applicable QPL for Exponential failure rate "R".

THIRD: If parts described by the two orders of precedence above are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for these third order of precedence parts. Third order of precedence parts shall not be procured unless a PAR has been submitted to the PMPCB for review and approval. The third order of precedence shall include:

All capacitors not described by the two orders of precedence above.

2.4 Printed Wiring Boards (PWB). The procurement order of precedence shall be as described below:

FIRST: PWBs described by the first order of precedence shall be procured. The first order of precedence shall include:

Printed Wiring Boards manufactured and screened in accordance with the requirements specified in Appendix C.

SECOND: If PWBs described by the first order of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain use of these second order of precedence PWBs. PWBs described by this second order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The second order of precedence shall include:

Printed Wiring Boards not described by the first order of precedence.

2.5 Relays. The procurement order of precedence shall be as described below:

FIRST: First order of precedence relays shall be procured. The first order of precedence shall include:

Relays manufactured and screened in accordance with the requirements specified in Appendix D.

- or -

Relays manufactured in accordance with MIL-PRF-39016 and listed on the QPL for failure rate "P" or "R". Use of failure rate "M" relays shall require PMPCB approval.

- or -

Type 1 (hermetic) relays manufactured to MIL-PRF-6106 and listed on the QPL for failure rate "P". Use of failure rate "M", "U", or "X" relays shall require PMPCB approval.

SECOND: If relays described by the first order of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain use of these second order of precedence parts. Relays described by this second order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The second order of precedence shall include:

Relays manufactured and screened to other requirements.

2.6 Wire. The procurement order of precedence shall be as described below:

FIRST: Wire described by the first order of precedence shall be procured. The first order of precedence shall include:

Wire constructions listed in Appendix E.

SECOND: If wire described by the first order of precedence is physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of these second order of precedence wire constructions. Wire constructions described by this second order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The second order of precedence shall include:

Wire constructions other than those listed in Appendix E.

2.7 Transformers. The procurement order of precedence shall be as described below:

FIRST: Transformers described by the first order of precedence shall be procured. The first order of precedence shall include:

Transformers manufactured and screened to MIL-STD-981, Class S with the exceptions that magnet wire shall conform to NEMA-JW1000 and that the manufacturer's quality system shall meet the requirements of SAE AS9100.

- or -

Transformers built and screened in accordance with MIL-PRF-27 or MIL-PRF-21038 and listed on the applicable QPL.

SECOND: If transformers described by the first order of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of these second order of precedence parts. Parts described by this second order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The second order of precedence shall include:

Transformers not described by the first order of precedence.

2.8 Inductors. The procurement order of precedence shall be as described below:

FIRST: Inductors described by the first order of precedence shall be procured. The first order of precedence shall include:

Inductors manufactured to MIL-STD-981, Class S, with the exceptions that magnet wire shall conform to NEMA-JW1000 and that the manufacturer's quality system shall meet the requirements of SAE AS9100.

- or -

Inductors built and screened in accordance with MIL-PRF-27 or MIL-PRF-39010 and listed on the applicable QPL.

SECOND: If inductors described by the first order of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of these second order of precedence parts. Parts described by this second order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The second order of precedence shall include:

Inductors not described by the first order of precedence.

2.9 Connectors. The procurement order of precedence shall be as described below:

FIRST: Connectors described by the first order of precedence shall be procured. The first order of precedence shall include:

Connectors manufactured to MIL-C-3655, MIL-C-5015, MIL-C-24308, MIL-C-26482, MIL-C-38999, MIL-PRF-39012, MIL-C-55302, MIL-PRF-83723, or MIL-PRF-83733 and listed on the applicable QPL.

SECOND: If connectors described by the first order of precedence are physically unobtainable, connectors described by the second order of precedence shall be procured. The second order of precedence shall include:

Connectors manufactured and screened to MIL-C-3655, MIL-C-5015, MIL-C-24308, MIL-C-26482, MIL-C-38999, MIL-PRF-39012, MIL-C-55302, MIL-PRF-83723, or MIL-PRF-83733.

THIRD: If connectors described by the first and second orders of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of these third order of precedence parts. Parts described by this third order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The third order of precedence shall include:

Connectors not described by the first or second order of precedence.

2.10 Fuses. The procurement order of precedence shall be as described below:

FIRST: Fuses described by the first order of precedence shall be procured. The First order of precedence shall include:

Fuses manufactured to MIL-PRF-23419 and listed on the QPL.

SECOND: If fuses described by the first order of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of these second order of precedence parts. Parts described by this second order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The second order of precedence shall include:

Fuses not described by the first order of precedence.

2.11 Crystal Oscillators. The procurement order of precedence shall be as described below:

FIRST: Crystal oscillators described by the first order of precedence shall be procured. The first order of precedence shall include:

Crystal oscillators manufactured to MIL-PRF-55310 and listed on the QPL.

SECOND: If crystal oscillators described by the first order of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of these second order of precedence parts. Parts described by this second order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The second order of precedence shall include:

Crystal oscillators not described by the first order of precedence.

2.12 Filters. The procurement order of precedence shall be as described below:

FIRST: Filters described by the first order of precedence shall be procured. The first order of precedence shall include:

Filters manufactured and screened in accordance with the Class B requirements of MIL-PRF-28861, except piece parts shall be selected in accordance with the orders of precedence delineated herein. The contractor shall submit a PAR for any filter which uses piece parts requiring PARs as delineated herein.

SECOND: If filters described by the first order of precedence are physically unobtainable, PARs may be submitted to the PMPCB to obtain approval for the use of these second order of precedence parts. Parts described by this second order of precedence shall not be procured unless a PAR has been submitted to and approved by the PMPCB. The second order of precedence shall include:

Filters not described by the first order of precedence.

SMC Standard Improvement Proposal

INSTRUCTIONS

1. Complete blocks 1 through 7. All blocks must be completed.
2. Send to the Preparing Activity specified in block 8.

NOTE: Do not be used to request copies of documents, or to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Comments submitted on this form do not constitute a commitment by the Preparing Activity to implement the suggestion; the Preparing Authority will coordinate a review of the comment and provide disposition to the comment submitter specified in Block 6.

SMC STANDARD CHANGE RECOMMENDATION:	**1. Document Number**	**2. Document Date**
3. Document Title		

4. Nature of Change
(Identify paragraph number; include proposed revision language and supporting data. Attach extra sheets as needed.)

5. Reason for Recommendation

6. Submitter Information

a. Name	**b. Organization**
c. Address	**d. Telephone**
e. E-mail address	**7. Date Submitted**

8. Preparing Activity

Space and Missile Systems Center
AIR FORCE SPACE COMMAND
483 N. Aviation Blvd.
El Segundo, CA 91245
Attention: SMC/EAE