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PROBLEM PARTS, AND RELATED MATERIALS AND PROCESSES

Problem Parts

a. Silver case wet slug tantalum.

Rationale: Cannot tolerate reverse voltage very well. Silver electroplating from the case on to and beneath the oxide layer increases current leakage paths, resulting in increased dissipation and internal heat rise, liberation of gasses, and catastrophic failure. The formulation of hydrogen and oxygen gasses at the electrodes creates excessive internal pressure, and can result in electrolyte leakage or bursting of the case.

b. Aluminum electrolytic capacitors

Rationale: Elastomer seal allows evaporation of electrolyte under long term storage or use conditions resulting in degradation of part. Use at high altitude or in a vacuum accelerates electrolyte evaporation. Non-hermetic construction makes parts susceptible to corrosion from some circuit board cleaning agents. Excessive ripple current causes heating, which accelerates evaporation of electrolyte.

c. Non-hermetic sealed plastic film capacitor

Rationale: Susceptible to insulation resistance failure from moisture introduced in humid environments or by board cleaning processes.

d. Relays not hermetically sealed, relays not solid state, and reed relays

Rationale: Reed Relays-Differentials of CTE in materials may lead to fracturing of the switches under temperature cycling inherent in aircraft application. Prohibition of reed relays dates back to the early 1970's due to the poor reliability reputation of these parts at that time. Current proposed usage should be evaluated in light of the current state of technology of these parts and the intended applications. Plastic Encapsulated Relays-Non-hermetic relays are not preferred for military applications due to the usual concerns of introduction of internal contaminants. Also see mechanized switches concerns.

e. Variable capacitors, resistors, and magnetic devices

Rationale: These parts are subject to contamination, oxidation, etc, resulting in parametric changes such as resistance drift. Designs requiring variations due to manufacturing or interface differences should use fixed value parts when the needed parameter is determined.

f. Passive components with failure rate level over 0.1% per 1000 hours

Rationale: Supplier quality and device reliability are suspect

g. Semiconductors not equivalent to or better then JANTX or AEC-Q101.

Rationale: These components should utilize known standards as much as possible. Other industry standards may be considered equivalent depending on the application such as aerospace or telecommunication documents and subject to customer agreement.

h. Microcircuits not equivalent to or better then QML/SMD or AEC-Q100.

Rationale: These components should utilize known standards as much as possible. Other industry standards may be considered equivalent depending on the application such as aerospace or telecommunication documents and subject to customer agreement.

i. Selenium rectifiers

Rationale: Degradation and reliability concerns

j. Thermo-compression bonded diodes, diodes that contain point whisker/wire conductors

Rationale: Less robust bonding method than metallurgical bonding.

k. Open type magnetic devices not environmentally protected

Rationale: Possible introduction of corrosive contamination during board cleaning operations, damage to windings and posts if not protected.

l. Sockets and socketed devices

Rationale: Insecure retention of parts. Possible intermittent contact in shock and vibration environments from fretting. Sockets in general are subject to oxidation between the leads and socket contacts

m. Circuit protection fuses

Rationale: Trip free circuit breakers and semiconductor/passive protection schemes are preferred. Reliability and maintenance concerns

n. Non-sealed miniature switches or connectors on circuit boards

Rationale: Introduction of contaminants during board cleaning processes.

o. Vacuum tubes except cathode-ray tubes

Rationale: Reliability and maintenance concern

p. Non-hermetic microcircuits and semiconductors without a customer approved selection and control process.

Rationale: Most non-hermetic parts are commercial/industrial grade and vary widely in construction, quality, and reliability and change without notice. Generally customer insight and participation in this process is highly desirable to evaluate parts for the application.

q. Parts and materials which will be used outside of the conditions identified in the vendor's specifications for the specific part or material (e.g. minimum temperature, maximum voltage, etc.)

Rationale: Can be a high liability risk. Can be a high reliability/performance risk if not characterized properly, use EIA 4899 for guidance. Complex devices may be very difficult to characterize and manage due to manufacturer non-disclosures.

r. Fiber inserts, sheet spring nuts, and sheet spring washers as locking devices.

Rationale: Vibration risks and shape retention issues for long-term reliability.

s. Mechanized switches.

Rationale: Generally a high failure rate item. Many switch internal mechanisms not proven for long-term reliable operation. Subject to moisture and contamination ingestion leading to shorts.

Contact oxidation can cause intermittent operation. Hot spot heating, arcing, and mechanical wear (fretting) all of which can lead to excessive oxidation, unreliable operation, and switch failure. Special lubricants can help for some applications.

t. Slide-on or snap-on BNC connectors
Rationale: Coupling integrity during severe environments; concerns for moisture and mechanical wear.

u. Parts not qualified for intended application life cycle environmental stress and duty cycle requirements.

Rationale: Parts without qualification data to support use in the application pose a significant risk of failing to meet the system requirements.

Problem Materials and processes; MIL-HDBK-1250 & MIL-STD-186 are for reference.

a. Aluminum alloys 2024-T3 or T4 (use T8 or 5000/6000 series)

Rationale: Subject to stress corrosion cracking.

b. Aluminum alloys 7001-T6, 7278-T6 and 7075-T6 (use T73 temper or 7050-T73)

Rationale: Subject to stress corrosion cracking.

c. Magnesium

Rationale: Corrodes easily and difficult to protect from corrosion. Flammability risk.

d. Precipitation hardening stainless steels in the H900, H950, or H1000 tempers (use H1025 or higher temper)

Rationale: Stress corrosion concerns.

e. Lubricants and greases or other materials, which contain graphite

Rationale: Graphite is a concern for corrosion (galvanic incompatibility with a variety of metals).

f. PVC plastics and PVC electrical insulation

Rationale: PCV-Subject to degradation from out-gassing and depletion of plasticizers, subject to acceleration by vacuum and/or high ambient temperatures. Flammable and gives off toxic fumes when burning. Plasticizer out-gassing may also introduce contamination source.

g. Corrosive type RTV adhesives/sealants (emit acetic acid during cure)

Rationale: Acetic acid is corrosive. Some RTVs revert under military use conditions.

h. Rubber that is susceptible to ozone damage

Rationale: Cracking, becomes ineffective seal or insulator

i. The use of silver-plated wire that has less than 40 micro inches of silver (and fails deterioration control tests per ASTM B 298). Still may have problem with certification and shelf life of bulk material.

Rationale: Red plague. Mitigated if wire is compliant to ASTM B 298 testing.

j. Wire with single polytetrafluoroethene insulation.

Rationale: Insulation cold flow concern. May be mitigated by wire routing and protection against sharp edges and pressure points on insulation. MIL-W-16878 is very loosely controlled spec (no QPL) and not a preferred choice.

k. Wire with fluoropolymer insulation, such as radiation cross-linked Ethylene-Tetrafluoroethylene (XL-ETFE).

Rationale: If stored in sealed plastic/metal bags or other enclosures for several months or longer corrosion can occur on metal surfaces and optics. Cristek 2003 data shows baking out is not enough to reduce risk.

l. Bare hook-up wire

Rationale: More susceptible to arcing, and handling/environment degradation if not coated.

m. Chromate conversion coating on aluminum, which fails 168-hours salt spray exposure per ASTM B 117)

Rationale: Corrosion concern

n. Cadmium or zinc plating without passivation

Rationale: Sublimes (vaporizes) easily at elevated temperatures especially in a vacuum or low pressures. Contamination concern, not an adequate corrosion resistance finish for most applications. Is considered an EPA toxic material

o. Gold plated electrical contacts without undercoating or with silver undercoating.

Rationale: Lack of underplating can allow purple plague (gold/aluminum intermetallics). 50 microinches underplate is considered minimum to prevent durability issues in most applications. Silver migrates easily.

p. Silver-plated electrical contacts

Rationale: Silver gets a contaminated (dirty) surface from reacting to gases/contamination in the air like sulfur. Silver migration issues, in the presence of moisture and an electric field silver migrates and can create short circuits (sometimes very rapidly. Reference Microelectronic Packaging Handbook, 1989, Tummala, Rao, soldering of silver-plated lugs and contacts is frequently a delicate operation because of the solubility of silver in tin due to silver scavenging.

q. Potting and foam materials that are reversion prone

Rationale: Out-gassing, corrosion, poor adhesion, and ineffective protectant

r. Bare corrodible metal surfaces and or galvanic metal couples with over 100mV potential difference with exceptions as allowed per MIL-STD-186.

Rationale: Galvanic corrosion concern.

s. Materials not inherently moisture and fungus resistant

Rationale: Materials are required to be non-nutritive to fungus. Contamination concern.

t. Nickel plated aluminum construction. Connector Limitations – Nickel-plated aluminum connectors are preferred parts for use in non-corrosive environments but are a concern for use in corrosive environments. Connectors with Cadmium type II or type III plating are preferred for use in corrosive environments. Interface of plated connector surfaces with dissimilar metals, and mating of Nickel-plated connectors with Cadmium plated connectors is prohibited.

Rationale: Nickel plated aluminum connectors are commonly available and the best low cost solution in non-corrosive environments. Cad plating is more corrosion resistant but is preferred only for corrosive environments due to toxicity concerns (see above concerns with nonpassivated cadmium). Use of dissimilar metals should be avoided due to galvanic corrosion concerns.

u. Polyamide insulated copper and copper alloy wire

Rationale: Kapton is susceptible to moisture degradation and subsequent arcing problems. However, Kapton insulation is commonly used in space applications and exoatmospheric systems due to limited radiation resistant insulating material. Preferred insulation is multilayer TFE/Kapton/TFE.

v. Class 1 ozone depleting chemicals (ODCs) and highly toxic chemicals

Rationale: Environmental laws, EPA regulated

w. Desiccants, organic or polymeric materials, such as lacquers, varnishes, coatings, adhesives, or greases inside cavity packages/housings with bare microcircuit and semiconductor die unless compliant to MIL-STD-883, method 5011 or equivalent industry specification.

Rationale: Potential for out-gassing and corrosion. Ineffective for long term harsh environments without adequate characterization.

x. Flammable materials

Rationale: Fire hazard, "flammable" is subjective, refer to UL, and OSHA definition levels.

y. Cotton and linen filler material in any electrical insulator without vacuum impregnation

Rationale: Very flammable material. Degradation of insulating properties over time.

z. Radioisotopes/radioactive materials except as allowed by AR 11-9.

Rationale: AR 11-9, The Army Radiation Safety Program allows some specific exceptions other wise they are safety concerns and require extensive accountability. OSHA and export regulated.

aa. Unalloyed tin coatings internal and external to Electrical, electronic, and electro-mechanical (EEE) parts/components and related hardware, except tin-plated electrical wire compliant to applicable military or industrial standards.

Rationale: Potential for tin whisker and tin pest. Must evaluate finish and application for risk mitigation for EEE applications especially terminals and leads.   Surfaces with tin should be coated with a tin alloy containing not less that 3% alloy. Applies to all piece part internal and external The restriction also includes plating or dipping over an existing pure tin finish, see GIDEP Alerts from 2003.

bb. Protective finishes and coatings not adequate for corrosion/deterioration protection in the intended application, and not utilizing MIL-STD-186 or equivalent as a reference for application and quality control of paints and finishes.
Rationale: MIL-STD-186 contains industry best practices for protecting components and materials for corrosion and deterioration control.

<u>Problem Design Practices For Electronic and Related Equipment, IPC-A-610 is for reference</u>

a. Printed wiring assemblies (PWAs) without conformal coatings.
Rationale: Protection of circuit card assemblies from exterior contaminants and handling. Shown to reduce component mounting fatigue during vibration and shock, must be compatible with rigid components like glass body diodes.

b. PWAs with stacked or piggybacked mounted components or components/leads using other components/leads for support or attachment.
Rationale: Difficulty with consistently mounting parts in "nonstandard" configurations leads to collateral damage. Serviceability issue, all components should be accessible for replacement without disturbing other components. Reliability concerns with degrading parts and attachment areas.

c. Jumper wires not detailed on the engineering drawing and approved by the customer.
Rationale: If too dense then reliability is an issue, can introduce EMI and noise into circuit, can cause performance problems if operators dont follow exact routing. Mounting process can easily degrade part and attach reliability.

d. Glass bodied components and magnetic elements not evaluated for coefficient of thermal expansion (CTE) matching to mounting substrate and to coating/staking materials, and not protected by buffer material when epoxy coatings are used.
Rationale: Breakage of components at low temperature, and temperature cycling in general. See 2003 GIDEPs for 4148 diodes.

e. Parts or components overhanging the edge of a PWA.
Rationale: Damage to parts. Possible installation interference.

f. Through-hole components mounted on both sides of a PWA.
Rationale: Susceptible to wave solder damage. Must be mounted by hand which is labor intensive and operator sensitive.

g. Large-bodied components mounted without adequate support and staking.
Rationale: Leads subject to damage or breakage under vibration environment.

h. High heat-dissipation components mounted without adequate heat sinks.
Rationale: Heat degrades surrounding components, creates hot spots and degrades reliability of most EEE components. Need to pay attention to surrounding materials and temperature sensitive parts and may require exotic cooling techniques. May be difficult to meet component derating guidelines. Refer to manufacturers application notes for best heat sinking.

i. Multiple leads or wires mounted in a single plated through hole.
Rationale: All components should be accessible for replacement without disturbing other components. Can be difficult to get a good solder joint and can easily degrade the integrity of the joint and the hole.

j. Crimped Aluminum electrical aircraft wire
Rationale: Due to high CTE of aluminum, thermal cycling causes loosing of crimps resulting in increased electrical resistance. Possible fire hazard from overheating at wire junctions due to corrosion of aluminum wire and increased junction resistance.