INCH-POUND

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SUPERSEDING
MIL-HDBK-1568(USAF)
18 July 1996
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NOTICE 2
18 July 1996

DEPARTMENT OF DEFENSE

DESIGN CRITERIA STANDARD

MATERIALS AND PROCESSES FOR
CORROSION PREVENTION AND CONTROL IN
AEROSPACE WEAPONS SYSTEMS

Reinstated after 12 August 2014 and may be used for new and existing designs and acquisitions.

AMSC 9478 AREA MFFP

FOREWORD

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

2. The purpose of this standard is to establish the requirements for materials, processes and techniques, and to identify the tasks required to implement an effective corrosion prevention and control program during the conceptual, validation, development and production phases of aerospace weapons systems.

3. Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, (Code 4L8000B120-3), Highway 547, Lakehurst, NJ 08733-5100, or emailed to michael.sikora@navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

4. For guidance on the technical content of this document, contact Commander, Naval Air Warfare Center, Aircraft Division, (Code 4.3), 48066 Shaw Road, 2188 Patuxent River, MD 20670.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLES

1. SCOPE

1.1 Scope. This standard establishes the requirements for materials, processes and techniques, and identifies the tasks required to implement an effective corrosion prevention and control program during the conceptual, validation, development and production phases of aerospace weapons systems. The intent is to minimize life cycle cost due to corrosion and to obtain improved reliability.

1.2 Purpose. The purpose of this standard is to provide a mechanism for implementation of sound materials selection practices and finish treatments during the design, development, production and operational cycles of aerospace weapons systems. This standard defines requirements to ensure establishment and implementation of a corrosion prevention and control plan and its accompanying finish specification as directed in Section 4. The corrosion prevention and control plan will set up operating procedures and the finish philosophies used in the systems. The finish specification will therefore be required to specify the detailed finish and coating systems to be used on the respective aerospace weapons system in accordance with the finish philosophies as approved in the corrosion prevention and control plan. This standard is derived from experience gained on protection of aerospace weapons systems against corrosion by the military services and industry. It represents technical guidance and requirements for incorporation in the corrosion prevention and control plan and finish specification.

1.3 Applicability. This standard is applicable for the Department of Defense procuring activities and their respective contractors involved in the design and procurement of aerospace weapons systems. The detailed corrosion control prevention and control plan and the finish specification applies to all elements of aerospace weapons systems, including spares. Materials and processes required for corrosion prevention and control in support equipment are covered in MIL-HDBK-808. Materials and Process Requirements for Weapons Systems are covered in MIL-HDBK-1587. This standard when used in conjunction with MIL-HDBK-808 and MIL-HDBK-1587 will result in reliable aerospace systems having a good balance between acquisition costs and life cycle cost.

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-5002	-	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems
MIL-DTL-5541	-	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-A-8625	-	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-S-8784	-	Sealing Compound, Low Adhesion, for Removable Panels and Fuel Tank Inspection Plates
MIL-F-18264	-	Finishes: Organic, Weapons System, Application And Control of
MIL-PRF-23377	-	Primer Coatings: Epoxy, High-Solids
MIL-M-38510	-	Microcircuits, General Specification for
MIL-DTL-38999	-	Connectors, Electrical, Circular, Miniature, High Density Quick Disconnect (Bayonet Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for
MIL-I-46058	-	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)
MIL-PRF-81733	-	Sealing and Coating Compound, Corrosion Inhibitive
MIL-DTL-83488	-	Coating, Aluminum, High Purity
MIL-PRF-85285	-	Coating: Polyurethane, Aircraft and Support Equipment
MIL-PRF-85582	-	Primer Coatings: Epoxy, Waterborne

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-7179	-	Finishes, Coatings and Sealants for the Protection of Aerospace Weapons Systems
MIL-STD-883	-	Microcircuits
MIL-STD-889	-	Dissimilar Metals
MIL-STD-1500	-	Cadmium-Titanium Plating, Low Embrittlement, Electrodeposition
MIL-STD-1530	-	Aircraft Structural Integrity Program (ASIP)
MIL-STD-2073-1	-	Standard Practice for Military Packaging

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-454	-	General Guidelines for Electronic Equipment
MIL-HDBK-1250	-	Corrosion Prevention and Deterioration Control In Electronic Components and Assemblies

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

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

ASTM INTERNATIONAL

ASTM A380	-	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM D1732	-	Standard Practices For Preparation of Magnesium Alloy Surfaces For Painting
ASTM G47	-	Standard Test Method for Determining Susceptibility to Stress Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products
ASTM G64	-	Standard Classification of Resistance to Stress Corrosion Cracking of Heat-Treatable Aluminum Alloys

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

SAE INTERNATIONAL

SAE AMS-QQ-N-290	-	Nickel Plating (Electrodeposited)
SAE AMS-QQ-P-416	-	Plating, Cadmium (Electrodeposited)
SAE AMS2430	-	Shot Peening, Automatic
SAE AMS2700	-	Passivation of Corrosion Resistant Steels
SAE AMS-M-3171	-	Magnesium Alloy, Processes for Pretreatment and Prevention of Corrosion on
SAE AMS3276	-	Sealing Compound, Integral Fuel Tanks and General Purpose, Intermittent Use To 360 °F (182 °C)
SAE AMS3284	-	Sealing Compound, Low Adhesion, for Removable Panels and Fuel Tank Inspection Plates
SAE AMS3374	-	Sealing Compound, Aircraft Firewall, Silicone
SAE AMS-S-8802	-	Sealing Compound, Temperature Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion
SAE AMS-C-8837	-	Coating, Cadmium (Vacuum Deposited)
SAE AMS-C-27725	-	Coating, Corrosion Preventative, Polyurethane for Aircraft Integral Fuel Tanks for Use to 250 °F (121 °C)
SAE AMS-C-83231	-	Coatings, Polyurethane, Rain Erosion Resistant for Exterior Aircraft and Missile Plastic Parts
SAE AMS-C-83445	-	Coating System, Polyurethane, Nonyellowing, White,

Rain Erosion Resistant, Thermally Reflective

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

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

3. DEFINITIONS. Not applicable.

4. GENERAL REQUIREMENTS

4.1 General requirements. A Corrosion Prevention and Control Plan shall define corrosion prevention and control requirements and considerations for system definition, design, engineering development, production and deployment phases, consistent with the design life of the system.

5. DETAIL REQUIREMENTS

5.1 Documentation. The following shall result from the implementation of the Corrosion Prevention and Control Program (see 6.3).

5.1.1 Corrosion prevention and control plan. The corrosion prevention and control plan shall describe the specific corrosion prevention and control measures to be implemented for the purpose of controlling corrosion. This corrosion prevention and control plan shall address only those materials and processes intended to be used in this specific aerospace weapons system being procured. This includes installation of Government furnished equipment.

5.1.2 Finish specification. The finish specification shall identify the specific organic and inorganic surface pretreatments and coatings intended to be used for protection against corrosion of the materials selected for the aerospace weapons system identified in the corrosion prevention control plan. After approval of the specification by the procuring activity, the requirements contained therein shall be included in all applicable production drawings.

5.2 Materials and process considerations in design.

5.2.1 Selection considerations. The primary consideration in the design and construction of aerospace weapons systems is the ability of the design to comply with structural and operational requirements. In addition, the aerospace weapons are expected to perform reliably and require minimum maintenance over a specified lifetime, which includes minimizing the rate of deterioration. Therefore, in the selection of materials and processing methods to satisfy system requirements, consideration shall also be given to those materials, processing methods and protective treatments which reduce failures due to deterioration. Deterioration modes that contribute to failures include, but are not limited to, pitting corrosion, galvanic corrosion, exfoliation corrosion, stress corrosion, corrosion fatigue, thermal embrittlement, fretting fatigue, oxidation, hydrogen embrittlement, weathering and fungus growth. In the entire design phase, attention shall be given to precautionary measures to minimize deterioration of individual parts and assemblies as well as the entire system. Required precautionary measures are specified in 5.2.2 through 5.2.4.

5.2.2 General design guidelines for corrosion prevention.

5.2.2.1 Exclusion of rain and airborne spray. The design of the system shall prevent water leaking into, or being driven into, any part of the system interior either on the ground or in flight. All windows, doors, panels, canopies, etc. shall be provided with scaling arrangements such that the entry of water is minimized when these items are correctly closed. Particular care shall be taken to prevent wetting of equipment, thermal insulation, and sound proofing materials. Recesses should be avoided so that moisture and solid matter cannot accumulate to initiate localized attack. Sealed floors shall be provided for galleys, toilets, and cockpits. Suitable drainage shall be provided for cockpits.

5.2.2.2 Ventilation. Ventilation shall prevent moisture retention and buildup.

5.2.2.3 Drainage. Drain holes shall be provided to prevent collection or entrapment of water or other unwanted fluid in areas where exclusion is impractical. Minimum diameter for all drains shall be 9.525mm (.375 inch) unless otherwise approved by the procuring activity. All designs shall include considerations for the prevention of water or fluid entrapment and ensure that drain holes are located to permit maximum drainage of accumulated fluids. Actual aircraft configuration and attitude shall be considered in addition to component design.

5.2.2.4 Dissimilar metals. Use of dissimilar metals, as specified in MIL-STD-889, in contact shall be limited to applications where similar metals cannot be used due to design requirements. When it is necessary to use dissimilar metals in contact, the metals shall be protected against galvanic corrosion. Galvanic corrosion can be minimized by interposition of a material that reduces the overall electrochemical potential of the joint or by interposition of an insulating or corrosion-inhibiting material. Composite materials containing graphite fibers shall be treated as graphite in MIL-STD-889.

5.2.3 Metallic materials.

5.2.3.1 Aluminum.

5.2.3.1.1 Alloy selection. The selection of aluminum alloys for structural application requires consideration of their resistance to stress-corrosion cracking (SCC). Maximum use shall be made of alloys and heat treatments that minimize susceptibility to SCC. Relative SCC ratings for high strength aluminum alloy products based on ASTM G64 and service experience are specified in table I. Although the ratings are based primarily on the results of standard corrosion tests, an experience factor can be substituted for those materials that have established service records. The ratings are given for the Short Transverse Grain Direction (STGD) since this is the most critical SCC condition in structural applications.

5.2.3.1.2 Aluminum alloy selection limitations. Mill product forms of aluminum alloys 2020, 7079, and 7178 in all temper conditions shall not be used for structural applications. The use of 7XXX-T6 aluminum alloys shall be limited to thicknesses not to exceed 6.35 mm (0.250 inch).

5.2.3.1.3 Maximum metal removal. Maximum metal removal from surfaces of non-stress relieved structural parts after final heat treatment shall not exceed 3.81 mm (0.150 inch) per side unless the final temper of condition has been demonstrated to have a stress-corrosion resistance of 173 MPa (25 ksi) or higher in the short transverse grain direction as determined by a 20 day alternate immersion test specified in ASTM G47. This requirement is applicable to 2000 and 7000 series alloys, but 30 days shall be used on 2000 series alloys. Stretch stress-relieved or compression stress-relieved aluminum products shall be used whenever possible. Maximum metal removal requirements are not intended to apply to mechanically stress-relieved products because of the low level of internal stresses resulting from mechanical stress-relieving.

TABLE I. Rating for resistance to SCC aluminum alloys in the short transverse grain direction (STDG).

Alloy and temper	Rolled plate	Rod and bar	Extruded shapes	Forgings
2014-T6	Low	Low	Low	Low
2024-T3, T4	Low	Low	Low	Low
2024-T6		High		Low
2024-T8	High	Very high	High	Intermediate
2124-T851	High			
2219-T351X, T37	Very high		Very high	Very high
2219-T6	Very high	Very high	Very high	Very high
6061-T6	Very high	Very high	Very high	Very high
7005-T53, T63			Low	Low
7039-T64	Low		Low	
7049-T74	Very high		High	High
7049-T76			Intermediate	
7149-T74			High	High
7050-T74	High		High	High
7050-T76	Intermediate	High	Intermediate	
7075-T6	Low	Low	Low	Low
7075-T736				High

TABLE I. Rating for resistance to SCC aluminum alloys in the short transverse grain direction (STDG) – Continued.

Alloy and temper	Rolled plate	Rod and bar	Extruded shapes	Forgings
7075-T74	Very High	Very High	Very High	Very High
7075-T76	Intermediate		Intermediate	
7175-T736			High	
7475-T6	Low			
7475-T73	Very High			
7475-T76	Intermediate			

All aluminum sheets used in external environments and interior corrosive environments shall be clad on both sides except where the design requires surface metal removal by machining, chemical milling, adhesive bonding or where alloys of the 1000, 3000, 5000, or 6000 series type are used.

5.2.3.1.4 Shot peening for stress corrosion resistance and fatigue life improvement. All critical surfaces of all structural forgings, machined plate and extrusions, where accessible after final machining and heat treatment, shall be completely shot peened in accordance with SAE AMS2430, ensuring 100 percent coverage as a minimum or placed in compression by other suitable means, except for alloys having a demonstrated stress corrosion resistance of 173 MPa (25 ksi) or higher in the short transverse direction and web areas under 2.03 mm (0.080 inch) thick where no short transverse grain is exposed by machining. Those areas of forgings requiring lapped, honed, or polished surface finishes for functional engineering requirements shall be shot peened prior to such subsequent surface finish operations. All aluminum products with an ASTM G47 stress corrosion threshold less than 173 MPa (25 ksi) shall, after shot peening, have essentially no residual surface tensile stresses in the final heat treated and machined condition. Attachment points for primary structure shall be shot peened for fatigue life improvement. Finish clean-up of shot peened surfaces as required for fit up shall not exceed 0.076 mm (0.003 inch) of surface removal for aluminum alloys.

5.2.3.1.5 Stress corrosion factor. High strength aluminum alloy parts shall be designed, manufactured, assembled, and installed so that sustained residual tensile stresses are minimized to prevent premature failures due to stress corrosion cracking.

5.2.3.2 Low alloy, high strength steels. All low alloy, high strength steel parts, 1241 MPa (180 ksi) ultimate tensile strength (UTS) and above, including fasteners, require corrosion preventative metallic coatings by a process proven to be nonembrittling to the alloy/heat treatment combination. Applicable metallic coatings and finishes are described in subsequent sections of this document.

5.2.3.2.1 Limitation on use of protective metallic coatings. Soft surface coatings such as cadmium, nickel-cadmium, and aluminum shall not be used for sliding or wear applications.

Cadmium plated surfaces shall not be used in applications where surface temperature exceeds 450 ºF (232 ºC). Cadmium shall not be used on functional fuel systems components that can come into contact with fuel during operations of the aircraft. Cadmium plated fasteners, used in areas where contact with fuel can occur, shall be overcoated with an approved fuel tank sealant and coating over the sealant. Chromium plating shall be considered an acceptable corrosion prevention for alloy steel wear surfaces only when the chrome plating is periodically lubricated (fluid or grease types only) or a 0.038 mm (0.0015 inch) minimum layer of nickel plating is applied under the chromium. All chromium plated steel parts used in fatigue application shall be shot peened prior to plating. Chromium plated surfaces shall not be used in applications where service temperatures exceed 700 ºF (371 ºC).

5.2.3.2.2 Stress corrosion factors. Alloy steel parts heat treated to 1241 MPa (180 ksi) UTS and above shall be designed, manufactured, assembled, and installed such that sustained residual surface tensile stresses shall be minimized to prevent premature failures due to stress corrosion cracking. The use of press or shrink fits, taper pins, clevis joints in which tightening of the bolt imposes a bending load on the female lugs, and straightening or assembly operations that result in sustained residual surface tensile stresses in these materials shall be avoided. In cases where such practices cannot be avoided, protective treatment such as stress relief heat treatments, optimum grain-flow orientation, wet installed (with a protective material) inserts and pins, and shot peening or similar surface working to minimize the hazard of stress-corrosion cracking or hydrogen embrittlement damage shall be applied.

5.2.3.3 Corrosion resistant steels. All corrosion resistant steels shall be passivated in accordance with SAE AMS2700 or ASTM A380. In addition, 400 series martensitic steel require coatings for protection against corrosion. Table II should be used as a guide in the selection of corrosion resistant steels for structural applications.

5.2.3.3.1 Corrosion resistant steels limitations. Precipitation hardening steels shall be aged at temperatures not less than 1000 ºF (538 ºC). Exception is made for castings which may be aged at 935 ºF ±15 ºF (501.5 ±9.4 ºC), for fasteners which may be used in the 950 condition, and for springs which have optimum properties at the CH 900 condition. Corrosion resistant maraging steels shall not be used in sustained load applications. Corrosion resistant 19-9DL and 431 steels shall not be used for any applications. Series 500 martensitic grade corrosion resistant steels shall not be used in the 700 ºF to 1100 ºF tempered condition. Unstabilized austenitic steels may be used up to 700 ºF (370 ºC). Only stabilized austenitic steels (321 and 347) shall be used above 698 ºF (370 ºC). All welded or brazed austenitic steel shall be solution heat treated after welding; however, welded 321 and 347, 304L and 316L may be used without heat treatment.

5.2.3.4 Titanium.

5.2.3.4.1 Surface considerations. The surfaces of titanium mill products (sheet, plate, bar, forging, casting and extrusion) shall be 100 percent machined, chemically milled, or pickled to remove all contaminated zones and layers formed while the material was at elevated temperature. This includes contamination as a result of mill processing, heat treating and elevated temperature forming operations.

5.2.3.4.2 Fretting. Titanium alloys are highly susceptible to the reduction of fatigue life by fretting at interfaces between titanium alloys or titanium and other metals. In any design where fretting is suspected, tests shall be made to determine whether such a condition exists. Design considerations shall be applied to minimize fretting in structural applications.

5.2.3.4.3 Special precautions. Titanium parts shall not be cadmium or silver plated. Cadmium plated clamps, tools, fixtures, and jibs shall not be used for fabrication or assembly of titanium components or structures.

TABLE II. Corrosion characteristics of corrosion resistant steels.

<table>
<tr><th>Class</th><th>Alloy</th><th>General corrosion resistance</th><th>Stress corrosion resistance</th></tr>
<tr><td rowspan="7">Austenitic</td><td>301</td><td>High</td><td>Very high</td></tr>
<tr><td>302</td><td>High</td><td>Very high</td></tr>
<tr><td>304</td><td>High</td><td>Very high</td></tr>
<tr><td>310</td><td>High</td><td>Very high</td></tr>
<tr><td>316</td><td>Very high</td><td>Very high</td></tr>
<tr><td>321</td><td>High</td><td>Very high</td></tr>
<tr><td>347</td><td>High</td><td>Very high</td></tr>
<tr><td rowspan="4">Martensitic</td><td>440C</td><td rowspan="4">Low to moderate - will develop superficial rust film with atmospheric exposure</td><td rowspan="4">Susceptibility varies significantly with composition, heat treatment and product form</td></tr>
<tr><td>420</td></tr>
<tr><td>410</td></tr>
<tr><td>416</td></tr>
<tr><td rowspan="11">Precipitation Hardening</td><td>21-6-9</td><td>Moderate</td><td rowspan="8">Susceptibility varies significantly with composition, heat treatment, and product form.</td></tr>
<tr><td>13-8Mo</td><td>Moderate</td></tr>
<tr><td>15-7Mo</td><td>Moderate</td></tr>
<tr><td>14-8Mo</td><td>Moderate</td></tr>
<tr><td>17-4PH</td><td>Moderate</td></tr>
<tr><td>15-5PH</td><td>Moderate</td></tr>
<tr><td>AM355</td><td>Moderate</td></tr>
<tr><td>AM350</td><td>Moderate</td></tr>
<tr><td>9Ni 4Co-0.20C</td><td>Moderate</td><td>Very high</td></tr>
<tr><td>9Ni 4Co-0.30C</td><td>Moderate</td><td>Very high</td></tr>
<tr><td>9Ni 4Co-0.45C</td><td>Moderate</td><td>Low</td></tr>
<tr><td>Other</td><td>A286</td><td>High</td><td>Very high</td></tr>
</table>

5.2.3.5 Magnesium. Magnesium alloys shall be used only with specific approval of the procuring activity.

5.2.3.6 Beryllium. In applications where beryllium is an approval material, consideration shall be given to protective coatings to protect parts against corrosion. All beryllium shall be used in a passivated condition by a process approved by the procuring activity.

5.2.3.7 Mercury. Mercury and many compounds containing mercury can cause accelerated stress cracking of brass, aluminum and titanium alloys. Mercury shall not be used where spillage can contact these materials.

5.2.3.8 Depleted uranium. The general finish for depleted uranium shall be nickel plate to in accordance with the requirements of SAE AMS-QQ-N-290 or aluminum coated in accordance with the requirements of MIL-DTL-83488, plus one coat of MIL-PRF-23377 Type I primer, thickness 0.015 to 0.023 mm (0.0006 to 0.0009 inch).

5.2.4 Insulating blankets. Where thermal/acoustical insulating blankets are required, they shall be either procured with a permanent baked on water repellent binder system or protected with sealant to prevent any moisture absorbed by the blanket from contacting the metal structure. The blankets shall be attached to the aircraft frame members and contact with aircraft skins shall be avoided. Blankets shall be easily removable to facilitate maintenance and inspection.

5.3 Corrosion prevention during manufacturing operations. Precautions shall be taken during manufacturing operations to maintain the integrity of corrosion prevention requirements and to prevent the introduction of corrosion or corrosive elements.

5.3.1 Cleaning. Cleaning of various types of metallic surfaces, prior to application of the surface treatments and coatings, shall be as specified in MIL-DTL-5002, using materials and processes which have no damaging effect on the metal, including freedom from pits, intergranular attack and significant etching. After cleaning, all parts shall be completely free of corrosion products, scale, paint, grease, oil, flux, and other foreign materials, including other metals, and shall be given the specific treatment immediately after cleaning. Particular care shall be exercised in the handling of parts to ensure that foreign metals are not inadvertently transferred, which may occur when steel is allowed to come into contact with zinc surfaces.

5.3.1.1 Titanium contamination. Care shall be taken to ensure that cleaning fluids and other chemicals are not used on titanium assemblies where entrapment can occur. Substances that are known to be contaminants and can produce stress corrosion cracking include:

a. Hydrochloric acid

b. Trichloroethylene/Trichloroethane

c. Carbon tetrachloride

d. All chlorides

e. Chlorinated cutting oil

f. Halogenated hydrocarbons

g. Methyl alcohol

5.3.2 Surface damage. Damage to any previously applied surface treatment or protective finish shall be repaired. Damage to surfaces that will become inaccessible because of mating with other parts shall be touched up prior to mating. Organic coatings used for repair shall be the same as those on the undamaged areas.

5.3.3 Marking pencils. Ordinary lead pencils containing graphite shall not be used to mark metal parts. Nongraphitic marking pencils shall be used.

5.3.4 Cleaning after assembly. All closed compartments shall be cleaned after assembly to remove debris such as metal chips, broken fasteners, and dust. Particular attention shall be given to ensure that drain holes are not blocked.

5.3.5 Protection of parts during storage and shipment. All parts and assemblies shall be given adequate protection to prevent corrosion and physical damage during temporary or long term storage and shipment. Packaging practices shall conform to MIL-STD-2073-1.

5.4 Inorganic finishes.

5.4.1 Detail requirements. Cleaning, surface treatments, and inorganic finishes for metallic surfaces of aerospace weapons systems parts shall be in accordance with MIL-DTL-5002. Those parts or surfaces or parts, located in corrosion susceptible areas that form exterior surfaces of the system, shall require chemical finishing to provide maximum corrosion resistance.

5.4.1.1 Aluminum. All nonclad parts made from 7000 series aluminum alloys shall be sulfuric acid anodized in accordance with MIL-A-8625, Type II or chromic acid anodized, in accordance with MIL-A-8625, Type IB, Type IC, or Type IIB. All nonclad parts made from 2000 series aluminum alloys shall be anodized in accordance with MIL-A-8625, Type I or II. Clad 2000 and 7000 series aluminum alloys may be anodized in accordance with MIL-A-8625, Type I or II, or shall have a chemical conversion coating in accordance with MIL-DTL-5541 as a minimum corrosion preventative coating. All 5000 and 6000 series aluminum alloys shall have a chemical conversion coating in accordance with MIL-DTL-5541 as a minimum corrosion preventative coating. For galvanic couples, anodized coatings are preferred due to their low electrical conditions.

5.4.1.2 Cadmium coatings. Cadmium coatings for all steel parts including fasteners shall have a minimum thickness of 0.008 mm (0.0003 inch) and shall be subsequently treated with a chromate conversion coating. High strength steels having an ultimate tensile strength of 1241 MPa (180 ksi) and above, shall be plated with MIL-STD-1500, the vacuum deposition process in accordance with SAE AMS-C-8837, or SAE AMS-QQ-P-416, Type II, Class 2.

5.4.1.3 Aluminum coatings. Aluminum coating per MIL-DTL-83488 or equivalent as approved by the procuring activity, may be considered acceptable alternative coatings to cadmium.

5.4.1.4 Magnesium. Magnesium alloys shall be treated in accordance with ASTM D1732 prior to painting. Hole(s) drilled after finishes have been applied shall be treated in accordance with SAE AMS-M-3171,Type VI. Parts, subsequent to anodizing, may be given a surface sealing treatment in accordance with SAE AMS-M-3171, Type VII.

5.5 Organic finishes.

5.5.1 Detail requirements. All finishes and coatings shall be in accordance with MIL-STD-7179.

5.5.1.1 Organic finishes and systems. The organic finishes or finish systems used shall provide the necessary protection against corrosion for all materials used in areas subjected to corrosive environments. All exterior paints and colors shall be consistent with thermal design requirements. The exterior paints and colors finish systems shall be MIL-PRF-85285 aliphatic polyurethane over MIL-PRF-23377, Type I or II, Class C1 or C2 or MIL-PRF-85582, Type I or II, Class C1 or C2 primer. This organic finish system is for temperature requirements to 350 ºF (177 ºC). All interior surfaces exposed to an exterior environment shall be considered as exterior finishes and shall be primed and top coated. Interior primer shall conform to MIL- PRF-23377, Type I, Class C1, or C2 or MIL-PRF-85582, Type I, C1, or C2 except in high temperature areas, the selected material shall be approved by the procuring activity. Integral fuel tank coatings shall meet the requirements of SAE AMS-C-27725. All exterior plastic parts that are subjected to rain or solid particle erosion shall be protected by coatings conforming to SAE AMS-C-83231 or SAE AMS-C-83445. Materials other than those specified herein shall not be used unless approval has been obtained by the procuring activity (see 6.5).

5.5.1.2 Organic finish applications. The MIL-PRF-85285 aliphatic polyurethane coating shall be applied in two coats to a thickness of 0.045 to 0.058 mm (0.0017 to 0.0023 inch), for an overall average total topcoat thickness of 0.51 mm (0.0020 inch). Primers in accordance with MIL-PRF-23377, Type I or II, Class C1 or C2 or MIL-PRF-85582, Type I or II, Class C1 or C2 shall be applied to a thickness of 0.015 to 0.023 mm (0.0006 to 0.0009 inch), for an overall average primer thickness of 0.020 mm (0.0008 inch). Organic finishes shall be applied in accordance with MIL-F-18264.

5.5.1.3 Magnesium surfaces. Magnesium surfaces shall receive two coats of primer and two coats of topcoat prior to assembly. All faying surfaces shall be sealed with a corrosion inhibiting sealant conforming to MIL-PRF-81733 and all fasteners shall be wet installed with MIL-PRF-81733 sealant or MIL-PRF-23377 primer.

5.6 Environmental sealing.

5.6.1 Detail requirements. All joints and seams located in exterior or internal corrosive environments, including those in landing gear wells, control surface vents, attachment wells and structure under fairings shall be faying surface sealed with sealant containing a chromate corrosion inhibitor conforming to MIL-PRF-81733 except when operational temperature exceeds 225 ºF (107 ºC). Those areas that operate at temperatures from 225 ºF (107 ºC) to 275 ºF (135 ºC), use sealant conforming to SAE AMS3276. For scaling areas that operate at 275 to 500 ºF (135 to 260 ºC) sealant conforming to SAE AMS3374 shall be used. Sealants used in integral fuel tanks shall conform to SAE AMS-S-8802 or SAE AMS3276. Removable panels and access doors shall be sealed, either by mechanical seals or separable faying surface sealants conforming to MIL-S-8784 or SAE AMS3284. High adhesion sealant such as SAE AMS-S-8802 or SAE AMS3276 may also be used for access door sealing provided a suitable parting agent is used on one surface.

5.7 Fastener installation.

5.7.1 Detail requirements. All permanently installed fasteners except as noted in 5.7.3 (all fasteners not normally removed for regular access or servicing) used in areas up to 225 ºF (107 ºC) shall be wet installed with either a corrosion inhibiting sealant conforming to MIL-PRF-81733 or an epoxy primer conforming to MIL-PRF-23377, Type I, Class C1, or C2, or a MIL-PRF-85582, Type I, Class C1 or C2 material that does not contain water. In high temperature areas exceeding 225 ºF (107 ºC), Type I, Class 1 or 2 epoxy primer or a sealant that is suitable for the thermal environment shall be used. Fasteners in integral fuel tanks shall be installed with wet sealant conforming to SAE AMS-S-8802 or SAE AMS3276. Sealant or corrosion inhibiting coatings other than those specified herein shall not be used unless approval has been obtained by the procuring activity.

5.7.2 Removable fasteners. Quick release fasteners and removable fasteners penetrating exterior surfaces, shall be designed and installed so as to provide a seal to prevent moisture or fluids from entering. Holes for these fasteners shall be primed with MIL-PRF-23377, Type I, Class C1 or C2, or MIL- PRF-85582, Type I, Class C1 or C2 epoxy primer and allowed to completely dry prior to installing the fastener.

5.7.3 Fasteners in titanium. Titanium, Monel, and stainless steel fasteners installed in titanium structures may be installed dry, unless sealing is required for liquid tightness, pressurization, or the fastener is also connected to aluminum.

5.7.4 Monel and stainless steel fastener. Monel fasteners or stainless steel fasteners shall be coated with cadmium or aluminum when used in contact with aluminum components.

5.7.5 Fasteners in graphite composites. Fastener materials for use in graphite composite structures shall be titanium or A286. Cadmium plated fasteners and aluminum fasteners shall not be used. Fasteners shall be wet installed using sealants as specified in 5.7.1.

5.7.6 Interference fit fasteners. Cadmium plated interference fit fasteners shall not be used in contact with titanium. Fastener holes for interference fit fasteners shall be primed with MIL-PRF-23377, Type I, Class 1 or 2 or MIL-PRF-85582, Type I, Class 2 and shall be completely dry prior to assembly.

5.8 Special considerations.

5.8.1 Cadmium plated parts. Cadmium plated parts such as press fit bushings shall not be used in contact with titanium components. Cadmium and silver plated parts and fasteners shall not be used in contact with titanium in applications where temperatures exceed 450 ºF (232 ºC). Titanium fasteners or components shall not be cadmium plated.

5.8.2 Engine corrosion susceptibility testing. Selected materials and coatings shall be corrosion tested under simulated engine environmental conditions appropriate to their final usage during operation, handling, and storage of the engine. A new or newly overhauled engine shall be selected for the corrosion susceptibility test. Prior to starting the test, the engine shall be disassembled and an inspection conducted to determine the condition of all parts normally exposed to atmospheric conditions. Detailed photographic coverage of these parts shall be used for comparison with post test conditions. The engine shall then be reassembled, pretest performance calibrated, and subject to 25 AMT cycles while being injected with a two percent of airflow weight spray solution, consisting of the following materials dissolved with distilled water to make one liter of salt spray solution.

Chemical designation	Quantity per liter of spray solution
NaC1 (c.p.)	23 grams
$Na_2SO_4 10H_2O$	8 grams
Stock solution	20 milliliters

The stock solution shall be composed of the following materials dissolved with distilled water to make one liter of stock solution:

Chemical designation	Quantity per liter of stock solution
KC1 (c.p.)	10 grams
KBr	45 grams
$MgC1_2$ $6H_2O$ (c.p.)	550 grams
$CaCl_2$ $6H_2O$ (c.p.)	110 grams

At specified intervals during the test, the engine shall be subjected to internal inspections to detect any evidence of corrosion or progression of corrosion of internal parts. Upon completion of the test, a performance check shall be conducted and the engine disassembled and inspected for evidence of corrosion. Detailed photographs shall be taken of all parts that show evidence of corrosion. Test specimen evidence of metallurgical analyses that completely characterizes the types of corrosion found shall be presented. The test results shall be considered satisfactory when the extent of corrosion is not of a magnitude that impairs structural integrity or component operation, or be a cause of significantly reducing performance, engine durability, or parts.

5.8.3 Electronic or avionics systems.

5.8.3.1 Cleaning of printed wiring boards (PWBs). All electronic systems shall be thoroughly cleaned to remove all contamination and solder flux prior to the application of conformal coatings and prior packaging. A cleanliness test shall be performed to verify the effectiveness of cleaning procedures.

5.8.3.2 Conformal coatings. All PWBs shall be conformally coated with a material specified in MIL-I-46058.

5.8.3.3 PWB orientation. PWBs shall be mounted in a vertical position with the connectors on a vertical edge where design permits.

5.8.3.4 Hermetic sealing. Electronic devices not specifically covered by MIL-M-38510 shall be hermetically sealed. Maintaining a maximum internal water vapor content of 500 parts per million (ppm) at 100 ºC when tested in accordance with MIL-STD-883, Method 1018.

5.8.3.5 Electrical connectors. All connectors meeting MIL-DTL-38999 shall be Class W.

5.8.3.6 General requirement. The technical baselines for design and construction of electronic equipment shall be in accordance to MIL-HDBK-454.

5.8.3.7 Electronic components and assemblies. Materials and processes shall withstand the attack of adverse environments during storage, shipment, and service. Guidance in the selection of materials and processes is specified in MIL-HDBK-1250.

6. NOTES

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

6.1 Intended use. This standard is intended to provide Department of Defense Program Offices with a document that provides timely and comprehensive consideration during systems design of corrosion prevention and control processes and of the lessons learned over the years from operational systems worldwide. System reliability and maintainability will be significantly improved by the use of this standard. It should be used in conjunction with MIL-HDBK-1587 in selection of materials and processes that will meet the requirements of the systems being designed in accordance with MIL-STD-1530.

6.2 Acquisition requirements. Acquisition documents should specify the title, number, and date of this standard.

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

DID Number	DID Title
DI-MFFP-81403	Corrosion Prevention and Control Plan
DI-MFFP-81402	Finish Specification Report

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

6.4 Subject term (key word) listing.

Cadmium plated
Metal finishes
Organic coatings
Sealants
Stress corrosion

6.5 Alternate finish. Justification data, including both laboratory and service experience, will be required for procuring activity approval.

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

CONCLUDING MATERIAL

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

Preparing activity:
Navy - AS
(Project MFFP-2014-006)

Review activities:
Navy - CH, EC, MC, OS, SA, SH, YD
Air Force - 20

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.