The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE INFORMATION REPORT

AIR4789

REV. A

Issued 1996-04
Revised 1996-11

Submitted for recognition as an American National Standard

AEROSPACE INFORMATION REPORT ON EVALUATING CORROSION TESTING OF ELECTRICAL CONNECTORS AND ACCESSORIES FOR THE PURPOSE OF QUALIFICATION

FOREWORD

Military electrical connectors and their associated accessories traditionally utilize aluminum alloy as the standard material for component parts such as shells and coupling nuts. This SAE Aerospace Information Report (AIR) provides information on evaluating the effects of corrosion testing aluminum alloy parts coated with cadmium and nickel plating.

INTRODUCTION

This document provides information and guidelines on electrical connectors and accessories with components manufactured from aluminum alloy and plated with conductive coating materials.

Electrical connectors having their shell components manufactured from aluminum alloy offer the user a reliable light weight part that is inherently electrically conductive. Aluminum alloy is a soft substrate alloy susceptible to wear. To improve the surface durability, the aluminum alloy is coated with lubricious conductive coatings, like cadmium or nickel to improve the surface wear and provide means of coloration free of oxides. Aluminum alloy provides excellent electrical conductivity and good thermal conductivity inherently, however aluminum is nonmagnetic. Nickel plating provides aluminum alloy a low permeable coating that reduces magnetic field intrusion and is electrically conductive. A combination of cadmium and nickel plating has become a standard finish for military connectors manufactured from aluminum alloy.

Corrosion occurs to aluminum alloy parts plated with cadmium or cadmium and nickel or nickel plating when subjected to environments that provide an electrolite to the galvanically dissimilar metals, when a hole or a pore provides a path through the plating to the aluminum substrate. Catastrophic erosion can occur to the aluminum part due to the aluminum sacrificing to the more noble plating materials.

Corrosion testing has been evaluated by subjectively determining if corrosion sites occur after salt fog testing described in MIL-STD-1344. Corrosion sites are acceptable if they do not effect performance. This document provides a method to objectively determine the effect to performance by definition of corrosion site size, quantity, and location to critical part elements.

1. SCOPE:

1.1 Scope:

This SAE Aerospace Information Report (AIR) establishes guidelines for evaluating the effects of corrosion testing of aluminum alloy connectors and accessories with cadmium or nickel plating.

1.2 Corrosion Classification:

Aluminum connectors and accessories covered by this document shall be of the following types and classes.

1.2.1 Types:

a. Type 1: Conductive, with electrical path surfaces
b. Type 2: Conductive, with nonelectrical path bodies

1.2.2 Classes:

a. Class 1: General duty, -65 to 175 °C
b. Class 2: General duty, -65 to 200 °C
c. Class 3: Space grade, -65 to 200 °C

1.3 Field of Application:

Aluminum connectors and accessories are intended for general use, where durability and electrical ground paths are desired.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and 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.

2.1 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 85-76	Standard Specification for Aluminum Alloy Die Castings
ASTM E 595-84	Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment, Test for
ASTM B 733-90	Standard Specification for Autocatalytic Nickel-Phosphorus Coating on Metals

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-I-17214	Indicator, Permeability, Low-Mu (Go-No-Go)
MIL-C-26074	Coatings, Electroless Nickel Requirement for
QQ-A-225	Aluminum and Aluminum Alloy Bar, Rod, Wire or Special Shapes; Rolled Drawn, or Cold Finished; General Specification for
QQ-P-416	Plating, Cadmium (Electrodeposited)
QQ-A-601	Aluminum Alloy Sand Castings
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-1344	Test Methods for Electrical Connectors

2.3 NASA Publications:

NASA Publication 1124 Outgassing Data for Selecting Materials

3. DISCUSSION:

3.1 General:

This document provides information and guidelines that may not be clearly defined in the military connector specifications for purposes of qualification testing and defines terms and technologies associated with the effects of corrosion testing of aluminum alloy connector and accessories with cadmium and/or nickel plating.

3.1.1 Application: Aluminum plated connector and accessory components are evaluated by salt fog testing to determine the magnitude of porosity sites and other surface defects inherent in application of cadmium and/or nickel finishes. It is the intent of this document to define an evaluation technique for the acceptability of cadmium and/or nickel finishes on aluminum alloy parts.

3.1.2 Classification: Aluminum plated connector and accessory components may be constructed from different alloys, such as wrought stock, QQ-A-225 or die cast alloy, ASTM B 85, or investment cast alloys, QQ-A-601, all having disparate properties, therefore it is essential for the user to determine the application requirements and select an alloy and finish that best meets their needs.

3.1.2 (Continued):

Example: Wrought alloys tend to be stable at temperatures up to 225 °C. Nickel plating tends to stress crack at temperatures exceeding 225 °C, therefore application requiring 200 °C, wrought alloys with nickel plating are good choices, whereas, cast alloys tend to stress relieve at temperatures above 195 °C, affecting the ability of nickel to adhere to the casting when exceeding 200 °C. Cadmium tends to outgass at temperatures above 175 °C and sublime in a vacuum environment, making cadmium plating a poor choice for space applications (see 1.2.2).

3.1.3 Corrosion Resistance: Aluminum components plated with cadmium and/or nickel have varying degrees of corrosion resistance. This is dependent on product classification and aluminum alloys used. Aluminum with cadmium plating will provide the user with significantly improved corrosion protection.

For example, see Table 1:

TABLE 1

	Aluminum With Cadmium	Aluminum With Nickel
Salt Spray per Method 1001 of MIL-STD-1344	1000 h	96 h

3.1.4 Temperature Realm: Aluminum alloy materials discussed in this document have different thermal properties. Temperature is a factor when considering aluminum alloy and plating selection and is the reason for having classifications (see 1.2).

3.1.4.1 Temperature: Temperature effects should be evaluated by continuous temperature testing in the product environment in lieu of short term temperature excursions. Short term excursion in the document is defined as minutes or less than 1 h. Continuous temperature is defined as life cycle or several hundred hours.

3.1.5 Class: Aluminum alloy connector described in this document are classified into two basic groups:

a. General duty: Class 1 and 2
b. Space grade: Class 3

3.1.5.1 General Duty: General duty connectors are designed to operate in severe environments typically associated with military defense electronic and weapon systems, and commercial aerospace applications.

3.1.5.2 Space Grade: Same as general duty, materials must meet the following requirements:

a. Permeability: MIL-I-17214
b. Vacuum stability: SP-R-0022
ASTM E 595-84

3.1.6 Conductive: Conductive type connectors and accessories used to provide a low electrical resistance path of 2.5 mΩ or less are used in applications such as: grounding and low resistance electrical bonding for EMI, RFI, EMP, HIRF shielding and indirect lightning strike grounding. Connector and accessories providing EMI/RFI shielding shall consider their shell bodies a critical area.

3.1.6.1 Conductive with Nonelectrical Paths: Cadmium and/or nickel plated aluminum connectors and accessories used in application where EMI/RFI shield grounding is not a requirement. Accessories that provide environmental sealing and strain relief, without EMI/RFI shield grounding is not required to provide a shell electrical path.

3.1.7 Critical Areas: Critical areas are design elements common in connector and accessory components, where corrosion sites would cause severe degradation to the performance of the part.

Critical areas: Threads, interlocking teeth, interlocking splines and keyways, interface or intermate surfaces, EMI shield termination surfaces.

3.1.7.1 Noncritical Areas: Noncritical areas are design elements where corrosion sites would have minimal effect to the performance of the part.

Noncritical areas: Knurls on coupling nut or bodies, strain relief bodies or saddle bars.

3.1.8 Corrosion Product: Corrosion product are defined as oxides created as a result of electrolitic erosion to the base aluminum alloy. Aluminum oxides appear as a white residue present on the plated surface. Cadmium oxides appear as a white residue on the plated surface and is not to be considered a corrosion product of the base aluminum alloy.

3.1.8.1 Corrosion Site: A corrosion site is defined as being usually circular in shape, exposing the aluminum substrate. The size of a corrosion site shall be defined by the major diameter with the longest straight line or chord that can be passed through the corrosion site. Blisters on the plating surface that are a result of salt fog exposed, shall be considered a corrosion site.

3.1.8.2 Corrosion Site Count: A corrosion site shall be measured and counted following salt fog exposure and rinse (see 3.2.2 and 4.2.1.1).

3.2 Test Samples:

The number of samples to be tested shall be determined by the individual specification.