AEROSYSTEMS

CORROSION PREVENTION AND CONTROL PROGRAM

TRAINING COURSE

FLEW SUEDE SHOES Elvis Presley’s abandoned private jet left to rust in New Mexico desert for 40 years sells for £216,000 at auction, February 2023

TRAINING SYLLABUS – INDEX OF PAGES

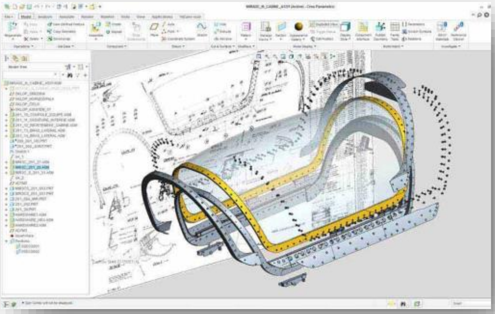
2 - SCOPE OF THE CPCP TRAINING

The **CPCP Corrosion Prevention and Control Program** Training will empower **Production Managers, Corrosion Control Managers, Quality Managers, Maintenance Managers, Designers and Engineers, Storage personnel, Operators and Control Operators** to Rectify and Prevent Corrosion damages to Aerospace Components.

Corrosion and its prevention are issues which impact on every industry.
Understanding how materials will react in their service environment is a crucial aspect of materials selection and appreciating how potential corrosion problems can be mitigated is an important part of the design process.
The knowledge gained from the course will enhance discussions between customers and suppliers and will assist engineers and designers when specifying materials.

2 - SCOPE OF THE CPCP TRAINING

Investigations during the past ten years have identified corrosion as a major factor electronics failure in the field. As much as 30% to 40% of civil/military avionic failures are due to the corrosion process. This is despite steady improvements in reliability of avionic systems fielded to date and outlines the need for an effective preventive maintenance program. The purpose of this program (and Training) is to ensure that corrosion prevention is taken into consideration in the design, manufacturing, and maintenance of aerospace components. This program will outline the steps to be taken to ensure that corrosion prevention is addressed during these processes.



- For the **Design Phase**, corrosion prevention should be taken into consideration when selecting the materials for the components. Certain materials are more resistant to corrosion and should be chosen if possible. Additionally, components should be designed in such a way that water or moisture cannot become trapped, as this can lead to corrosion.

- For the **Manufacturing Phase**, proper cleaning and coating techniques should be employed to ensure that components are protected from corrosion. Components should be properly cleaned prior to coating, and the coatings should be applied in such a way as to ensure that they are resistant to corrosion.

- For the **Maintenance Phase**, regular inspections should be conducted to check for corrosion and take necessary steps to prevent it. Additionally, components should be regularly serviced and maintained to ensure that they remain corrosion resistant.

By following this program, it is possible to ensure that corrosion prevention is taken into consideration during the design, manufacturing, and maintenance of aerospace components.

3 – What is a Corrosion Prevention and Control Program (CPCP)?

The service life of an aircraft is generally limited by metal fatigue caused by takeoff/landing and pressurization/depressurization cycles.
For the average jetliner, that can translate to 25-30 years in operation. But metal fatigue is not the only factor - **corrosion plays a role** too. In some cases, corrosion and fatigue can act together to accelerate damage to important structural components. The fatigue life is governed by the original design and by environmental stresses that cannot be avoided unless the plane isn't used at all. **Corrosion, on the other hand, can be at least minimized and controlled through the implementation of a good corrosion prevention and control plan.**


Corroded Connector

This training will review the elements of a corrosion control plan that can maximize an aircraft owner's return on investment while minimizing the risk of corrosion-induced failures.

Elements of a good corrosion control plan
A good corrosion prevention and control program starts with a good design. Without a corrosion-conscious design, the jobs of both the aircraft maintenance technician and the corrosion inspector are far more difficult. Good maintenance is an ongoing and critical process. Any plan to extend an aircraft's lifespan must include corrosion control maintenance. At regular intervals, **the aircraft and all its components must be inspected for corrosive damage** and a decision made about mitigation techniques, repair efforts, or in extreme cases, aircraft decommissioning.

A good CPCP will specify the inspection procedures and equipment to be used as well as the documentation that must be kept for each component. It involves selecting and following the appropriate existing standards and successfully obtaining all necessary certifications. Each of these elements of a good corrosion prevention and control plan is described in this training.

3 - What is a Corrosion Prevention and Control Program (CPCP)?

A corrosion prevention and control program (CPCP) is **a systematic approach to prevent and control corrosion in the Aircraft's Primary Structure.**

1) The **objective of a CPCP is to limit the deterioration due to corrosion** to a level necessary to maintain airworthiness and where necessary to restore the corrosion protection schemes for the structure.

2) A CPCP consists of a basic corrosion inspection task, task areas, defined corrosion levels, and compliance times (implementation thresholds and repeat intervals).

3) The CPCP also includes procedures to notify the competent authority and TCH of the findings and data associated with Level 2 and Level 3 corrosion and the actions taken to reduce future findings to Level 1 or better.

Note on Corrosion Levels

- **Level 1 Corrosion** is the damage occurring between successive inspections that is local and can be reworked/blended-out within allowable limits as defined by the manufacturer in a structural repair manual (SRM), service bulletin, etc.
- **Level 2 Corrosion** is damage occurring between successive inspections that require rework or blend-out that then exceeds the manufacturer's allowable limits, requiring a repair or complete/partial replacement of a principal structural element.
- **Level 3 Corrosion** is damage found during the first or subsequent inspection(s) which is determined by the operator to be a potential airworthiness concern requiring expeditious action.

4 - Regulatory Requirements for Corrosion Prevention and Control Programs

The Federal Aviation Administration (FAA) is the controlling authority over civil aviation in the USA. The FAA issued Airworthiness Directive 8300.12, Corrosion Prevention and Control Programs, in 1993. This document, except as superseded by updates, is the controlling authority over corrosion prevention and control programs in the USA. **The most recent major update is Advisory Circular 43-4B, Corrosion Control for Aircraft, published in 2018. This advisory reviews available information on detecting and remediating corrosion in aircraft structural and powerplant components.** It clarifies that corrosion prevention and control plans are the responsibility of the aircraft operator. For military equipment, 10 U.S.C. 2228 requires the Department of Defense (DoD) to develop and implement a long-term strategy to address the corrosion of its equipment and infrastructure. A key element of the DoD CPC strategy is programmatic and technical guidance is provided in the Corrosion Prevention and Control Planning Guidebook for Military Systems and Equipment.

Advisory Circular AC 43-4B

Operators must use the original equipment manufacturer's recommendations as their corrosion control program if the manufacturer has published one which, they can expand on if needed. If there is no plan available from the manufacturer, then the operator is free to implement their own corrosion maintenance program and document it in accordance with AC 43-4B. That circular is comprehensive in its review of:

- **The mechanisms and effects of corrosion**
- **Required maintenance and inspections**
- **Corrosion removal methods**
- **Acceptable limits of corrosion**
- **Handling of special corrosion problems**

These rules, along with manufacturers' own carefully developed mitigation procedures, help safeguard a bustling nation doing business from one end of the country to the other.

4 - Regulatory Requirements for Corrosion Prevention and Control Programs

- FAA Advisory Circular 43-4B, Corrosion Control for Aircraft, 2018
- FAA DOT/FAA/TC-16/13 Requirement for Corrosion Prevention and Control Program Study, 2016
- EASA International Maintenance Review Board Policy Board (IMRBPB)
- AMC4 CAMO.A.305(g) Personnel requirements (ED Decision 2020/002/R)
- DOD USA Department Of Defense Corrosion Prevention & Control (CPC) Source
- DOD USA Corrosion Prevention and Control Planning Guidebook for Military Systems and Equipment, 2022
- ISO 9223:2012 Corrosion of metals and alloys Corrosivity of atmospheres Classification, determination and estimation
- ISO 9226:2012 Corrosion of metals and alloys Corrosivity of atmospheres Determination of corrosion rate of standard specimens for the evaluation of corrosivity
- ISO/TC 156/WG4 ISOCORRAG International Atmospheric Exposure Program: Summary of Results
- IAQG AS/EN/JISQ 9100 Evaluation Guidance Material – Preservation
- AMMTIAC Corrosion Prevention and Control: A Program Management Guide for Selecting Materials, September 2006
- AOPA Pilot Resources - Aircraft Corrosion Guidelines
- RTCA DO160G Environmental Conditions and Test Procedures for Airborne Equipment
- MIL-STD-810 Department Of Defense Test Method Standard: Environmental Engineering Considerations and Laboratory Tests
- AIRBUS - Safety first #15, February 2013
- LHD 139 G2010X001AAW139 – EWIS Corrosion Prevention Campaign
- LHD 129 129G0000M005A - A129 BHC Corrosion Prevention Guidelines
- LHD AWPS003VA Application of Chromate Free Organic Corrosion Inhibiting Compounds

INTRODUCTION

Although, the word "corrosion" is most often associated with "rust" and the oxidation of other metals, the Congressional definition of corrosion (10 U.S.C. § 2228) is **"the deterioration of a material or its properties due to a reaction of that material with its chemical environment"**

It is inclusive of the deterioration of all materials, which can be caused through sun exposure, mold and mildew, wind, and other environmental elements.

DESCRIPTION

Understanding the scope of this definition requires an explanation of the "Science of Corrosion.“. Photos 1 and 2 provide two vivid examples of corrosion on metals.

ENVIRONMENTAL SEVERITY FACTORS INFLUENCING CORROSION

There are several environmental severity factors that influence corrosion. These include but are not limited to:

- Temperature
- Time of wetness and humidity
- Presence of chlorides
- pH
- Industrial pollutants
- UV radiation
- Microbiological activity

Example of Corrosion
Photo 1

Example of Corrosion
Photo 2

THE CORROSIVITY MAP

These factors influence the degradation of materials in multiple ways. None are the same, but the impact, unless mitigated, can be devastating.

Corrosion affects metals, wood, pavements, fabrics, roofs, and building systems.
The International Standards Organization (ISO) has a straight-forward approach to categorizing a region's corrosivity.

As shown on the ISO Corrosivity Map in Figure 1, coastal areas tend to represent a higher corrosion threat due to the presence of chlorides and moisture in the presence of heat.

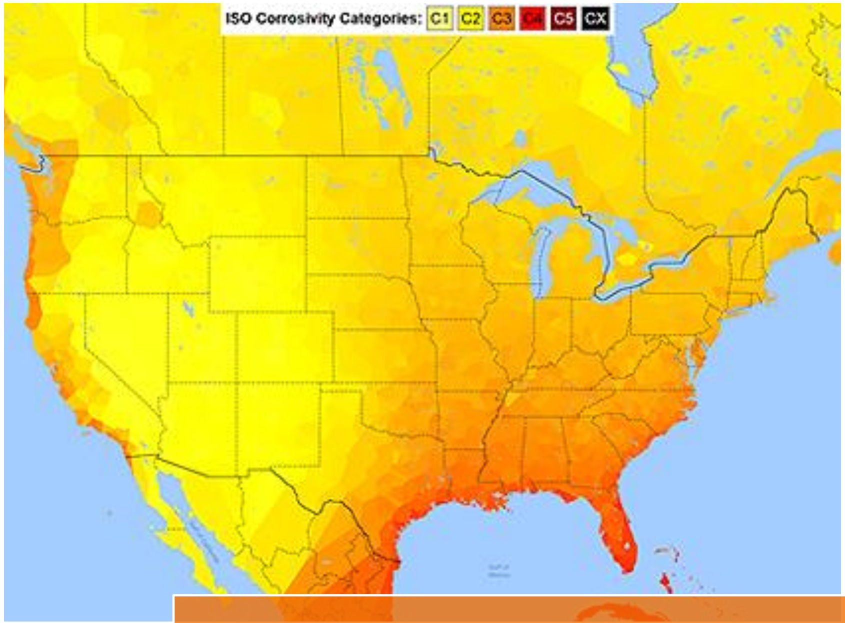


Figure 1: ISO Corrosivity Categories (U.S. ICCET Corrosivity Heat Map)
Photo credit: Map Data © 2016 Google, INEGI

While this is a good start to understanding the risks associated with environmental severity factors, local area considerations of climate, industrial impacts and intense solar exposures may result in higher corrosion rates than one would expect from only the presence of chlorides. It is prudent to investigate and understand environmental severity impacts for specific building and construction sites to establish the local corrosivity risk.

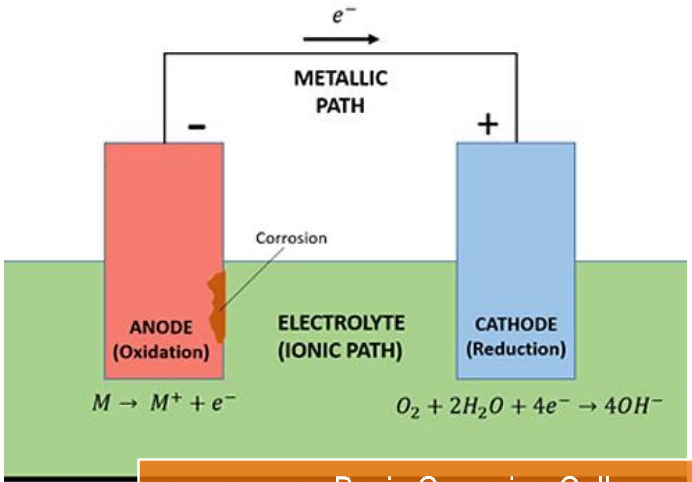
THE ELECTROCHEMICAL CELL AND CORROSION

Metallic corrosion results from the formation of an electrochemical cell. There are four fundamental components in an electrochemical corrosion cell: An anode, a cathode, an electron path (electrical connection) between the anode, cathode, and a conducting environment (electrolyte [see Figure]).

All four components must be present for corrosion to occur. Metal at the anode is oxidized, causing it to form a metal oxide, that is, to corrode. The electrons that are released as a result of this reaction travel to the cathode through the metallic path. The over-abundance of electrons at the cathode prevent it from corroding. The most common electrolyte mediums are water, soil, and chloride-contaminated concrete. The electron path is an electrical connection, usually with some amount of resistance. It can be internal to the metal itself or external such as a wire, direct connection, or other interconnecting metallic components.

The forms of corrosion in a given system depend on the materials, configuration, operation, and environment.

The types and extent of cathodic protection, coating, etc. depend upon the corrosion risk factors discussed in this webpage.



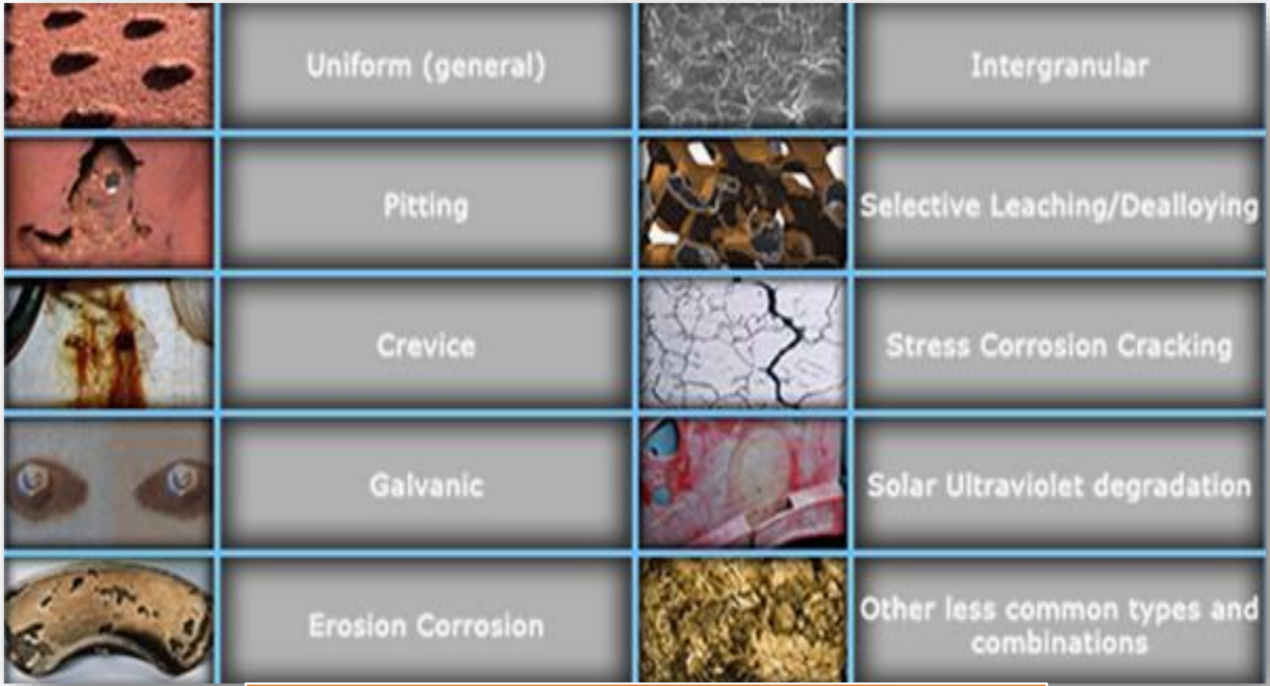
Basic Corrosion Cell
Diagram credit: D, CPO

IDENTIFYING AND RECOGNIZING COMMON FORMS OF CORROSION

The common forms of corrosion include:

- Uniform (General) corrosion
- Pitting
- Crevice
- Galvanic corrosion
- Erosion corrosion
- Intergranular
- Selective leaching/dealloying
- Stress corrosion cracking
- Solar ultraviolet degradation
- Other less frequent forms

(e.g., exfoliation, environmentally assisted cracking, corrosion fatigue)



Common Depictions of Corrosion
Photo credit: D, CPO

MAJOR FORMS OF CORROSION

Here is a summary description of the major forms of corrosion in almost any locale regardless of the environmental severity of the location:

- **Uniform (general)** is a form of corrosion that occurs uniformly over the entire exposed surface of a metal. Applying a barrier coating is one of the most common methods to mitigate this degradation
- **Pitting** is a form of localized corrosion that occurs when a corrosive medium attacks a metal at specific points and results in deep cavities in the metal
- **Crevice** is a form of corrosion that occurs when an electrolyte becomes trapped and stagnant in particular locations such as in joints, in corners, and under debris. It can be hard to find and extremely aggressive, causing high pitting rates and subsequent unexpected failures
- **Galvanic corrosion** results from the formation of a galvanic cell by the galvanic coupling of dissimilar metals (metals having different electrical potentials), which are exposed to an electrolyte. This form can be very aggressive, but it may also be one of the easiest to detect and prevent
- **Erosion corrosion** is due to the increased rate of deterioration and loss of a material from the combined effects of corrosion and the repeated motion of the surrounding environment. It is most often found in high-velocity areas or in fluids containing abrasive materials
- **Intergranular** is a form of corrosion that attacks grain boundaries in materials. It may occur as a result of a galvanic couple between differing phases within a material and may be prevented by avoiding susceptible alloy or heat treatments
- **Selective leaching or dealloying** is a localized form of corrosion where a particular constituent within a material is preferentially attacked and extracted from the material. Many copper alloys such as brasses and bronzes are susceptible alloys to this attack
- **Stress corrosion cracking (SCC)** is a cracking process involving the combined factors of a susceptible material, corrosive environment and a sustained tensile stress
- **Solar ultraviolet degradation** is the process by which organic-based polymers undergo photolytic and photo-oxidative reactions during exposure to solar UV radiation
- Other Types of Corrosion include: **Environmentally Assisted Cracking, Corrosion Fatigue** and **Alkali-silica reactions.**

RISKS OF CORROSION - REDUCING ACQUISITION RISK BY "DESIGNING IN" CORROSION RESISTANCE

Corrosion is a process that occurs when a material deteriorates due to its interaction with the surrounding environment in which an electrochemical reaction consumes the material through oxidation. **As a material corrosively deteriorates, its material properties likewise degrade.** The result of corrosion manifests itself as aircraft system or component failure at the worst or unsightly appearance at the best, and it's important to realize that corrosion occurs in nearly all aircraft systems and operating environments. **Corrosion can significantly impact readiness of aircraft systems if excessive maintenance is required to ensure continued safe operation.** Corrosion costs can be extensive and for complex systems combating its effects can take a great deal of time and expertise to correct. **Overall, the costs of combating corrosion are very high.**

Unfortunately, it is often the case that systems are designed to meet performance goals where strength, weight, thermal, and electrical requirements are primary technology considerations while other important attributes such as corrosion resistance and environmental compatibility receive far less attention. Without an upfront analysis to mitigate corrosion, problems often occur after the system has been implemented into service. Correcting unanticipated corrosion during the operational phase of the lifecycle can be very costly. In some cases it may be impossible to return the system to its original state without replacing problematic components or structures at great expense.
Developing new components and systems that are inherently corrosion resistant, either through the selection and use of corrosion resistant materials or, if appropriate, by employing corrosion preventative compounds and coatings, is one sure way to reduce total ownership costs. However, these considerations must be made early in the acquisition cycle to be effective.

Design and acquisition management practices must recognize corrosion as a risk factor to be managed.

TYPES OF AIRCRAFT CORROSION

Aircraft corrosion occurs as it does on any other metal surface that is exposed to the oxygen and humidity present in the environment, as well as being exposed to foreign materials like dust and different types of pollutants. Of course, metal corrosion is accelerated by certain conditions such as harsh environments. For example, dealing with corrosion is commonplace in oil rigs because of the corrosive environment in the open sea.

Given the nature of aviation operations, aircraft corrosion is also common. In the end, aircraft are also exposed to harsh environments, both when flying and on the ground. Fortunately, there are ways to control how corrosion affects aircraft, starting by understanding how it happens and the different types of aircraft corrosion that can be found.

What is aircraft corrosion?

Generally speaking, aircraft corrosion is the rust that appears on the metal surfaces and components of an aircraft when the unprotected metal comes into contact with oxygen in the atmosphere.

However, aircraft surfaces and components are made of a variety of metals, and the rust may not appear in the typical reddish color as most people are used to identifying it.

For example, aluminum is one metal that corrodes differently. As described by the Aircraft Owners and Pilots Association (AOPA), **aluminum alloys "first shows as a whitish or gray "dulling" of the aluminum surface, then progresses to more and more severe pitting and eventual destruction of the metal."**

TYPES OF AIRCRAFT CORROSION

What causes aircraft corrosion?

In general, corrosion is associated with any metal surface being exposed to the oxygen and humidity of the environment. Also, many people understand that the closer to the sea, the worse the corrosion will be because of the effect of the minerals present in the seawater. However, there are more causes for corrosion to appear on airframe structures and other aircraft components.

One common factor that causes corrosion in aircraft is foreign material like dust and grease, acid batteries, or cleaning solutions. All of these elements can cause corrosion in the airframe if they remain in place for prolonged periods of time.

What are the effects of corrosion on aircraft?

The resulting corrosion damage causes crack propagation and stress accumulation and can lead to significantly decreased mechanical characteristics for an aircraft. As a result, the aircraft becomes unairworthy in a short period of time.

The good thing is that the effect of corrosion on aircraft happens progressively, so it can be treated to avoid major issues. However, sometimes corrosion can be hidden, and an untreated ongoing corrosion process can result in corrosive destruction, thus causing the aircraft system to fail.

In order to guarantee aircraft corrosion is treated in time, the types of aircraft corrosion must be known, so they can be identified during routine aircraft maintenance inspections.

DISSIMILAR METAL CORROSION

This is one of the types of corrosion where conductor is involved as described above. Therefore, this type of electrochemical corrosion can cause extensive pitting damage. **It is called dissimilar metal corrosion because it appears when different metal parts come into contact with each other in the presence of a conductor.**

Dissimilar metal corrosion often takes place out of sight, making it particularly dangerous since it can go a very long time before it is identified and treated. So, it is recommended to disassemble parts and components whenever this type of corrosion is suspected to make sure it can be identified.

Also, a precaution that aircraft mechanics can take to reduce the chances of this type of corrosion involves not using steel wire brushes or steel wool when cleaning the surface of the plane, because this can result in tiny pieces coming off and getting deep into the surface of the aircraft, which always increases the odds that dissimilar metal corrosion will occur.

Dissimilar Metal Corrosion
Image source: (CC) D3j4vu/Wikipedia

STRESS CORROSION

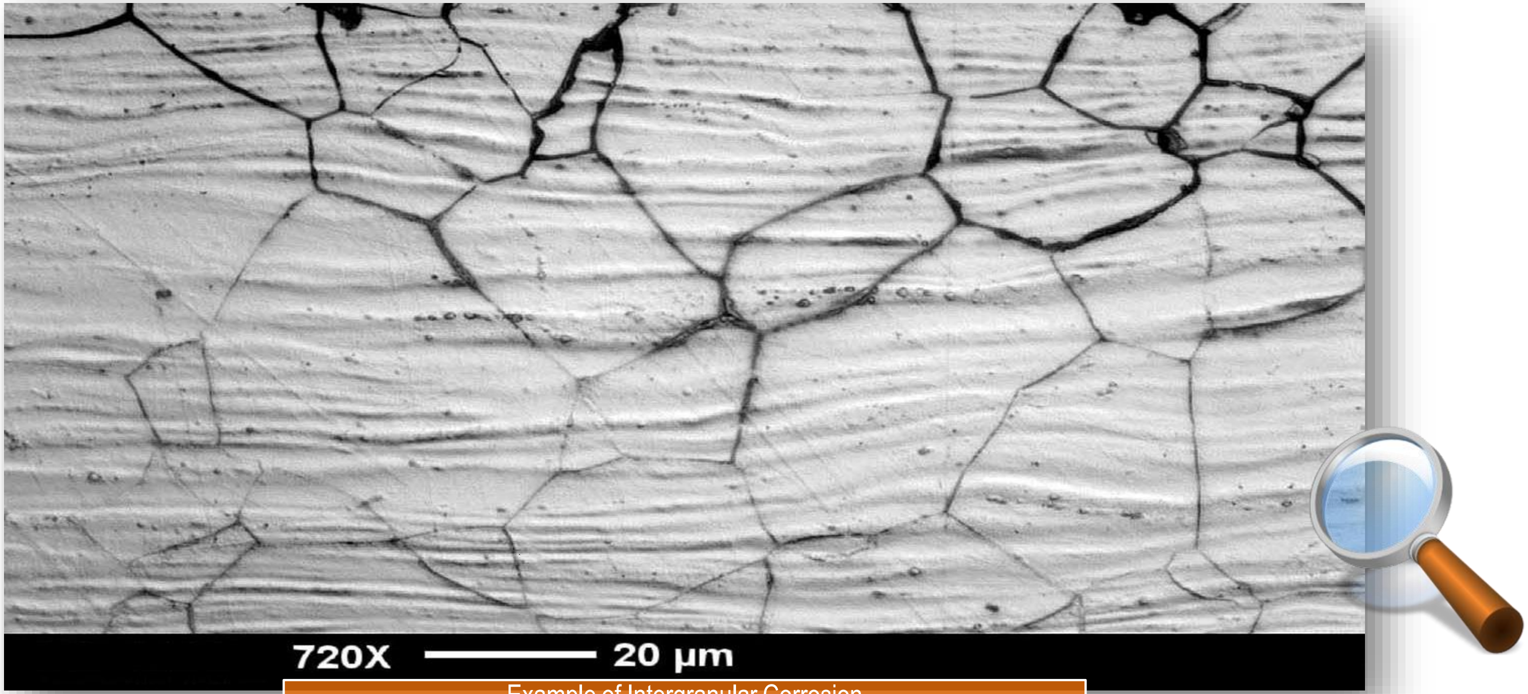
Stress corrosion occurs in parts that are exposed to high loads such as the engine crankshaft or the landing gear. **It is usually the result of superficial corrosion or scratches that are undetectable because finding out about the corrosion is often tricky. Typical causes for stress corrosion on airplanes include tapered bolts, press-fit bushings, external loads applied on the components, cyclic loads, or even the manufacturing procedure itself.**
During manufacturing processes, internal stress that may cause stress corrosion can be inadvertently induced. Many manufacturing companies carry out production using stress relief procedures. Nevertheless, there is still tension. Stress is externally introduced by riveting and welding on parts including bolts and rivets, clamping, or press fittings. **In the case that a small error is made or a fastened part becomes over-torqued, internal strain can arise, thus inducing loads that could result in stress corrosion.**

Stress Corrosion
Image source: © CEphoto, Uwe Aranas

INTERGRANULAR CORROSION

Intergranular corrosion is particularly tough because it affects the microstructure of an alloy, which is why it is often related to a lack of uniformity in the microstructure. Although intergranular corrosion often exists without surface evidence, it can lead to the lifting and flaking of surface metal over time. Extruded components may be particularly susceptible.

AOPA states that intergranular corrosion is "normally worst on 7000-series aluminum alloys (those with an appreciable amount of zinc, like wing spars, stringers, and other high-strength aircraft parts). **"However, they also highlight that "this is not frequently found but is a particularly nasty type of corrosion. It can be difficult to detect, and once you see it, it's too late: that piece of metal is toast."**

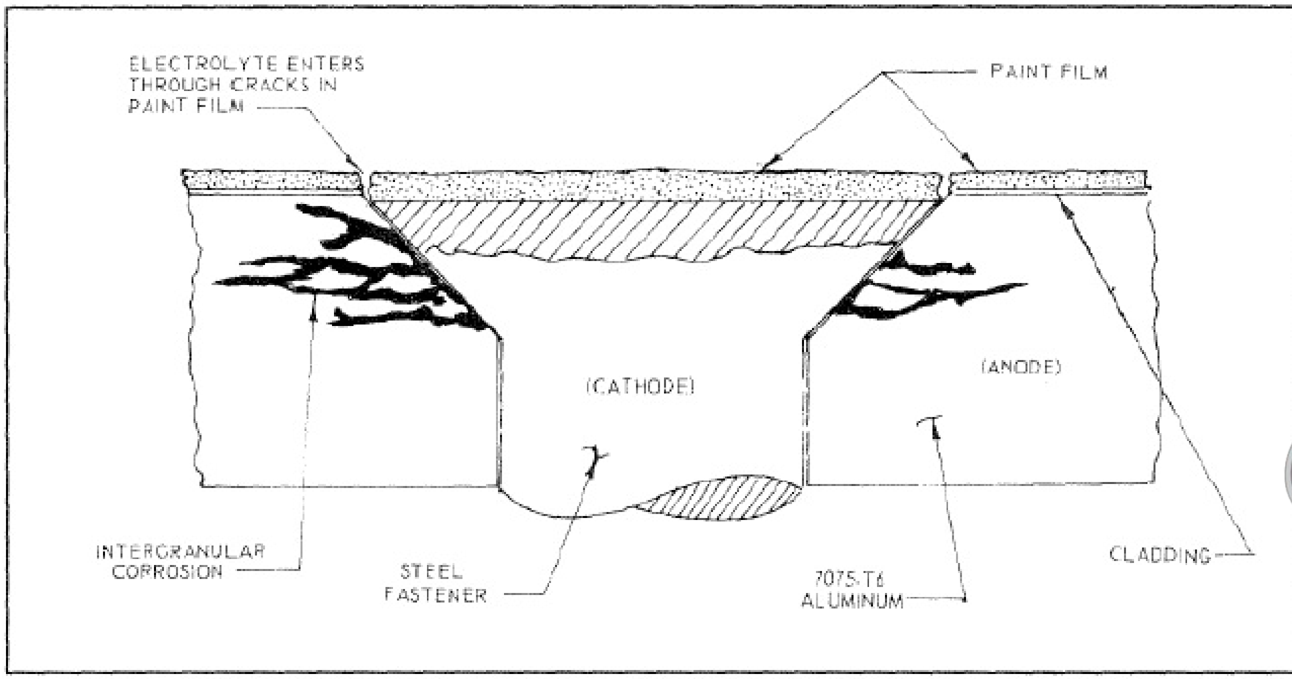


Example of Intergranular Corrosion
Image source: (CC) Antkyr/Wikipedia

INTERGRANULAR CORROSION

4.7.1 Steel, Titanium, Corrosion Resistant Steel (CRES), and Nickel Alloy Fasteners. Fasteners, and areas around these fasteners, are trouble areas. These areas are subject to high operational loads, moisture intrusion, and dissimilar metal skin corrosion. See Figure 4-4, Intergranular Corrosion of 7075-T6 Aluminum Adjacent to Steel Fastener.

Figure 4-4. Intergranular Corrosion of 7075-T6 Aluminum Adjacent to Steel Fastener



Example of Intergranular Corrosion
Source: FAA Advisory Circular 43-4B, Corrosion Control for Aircraft, 2018

SURFACE CORROSION

General **surface corrosion or uniform attack corrosion are the more common forms of corrosion in aviation.** Surface corrosion usually results from roughing, etching, or pitting a surface in metal often accompanied by a powdery deposit of corrosion product. Surface corrosion can occur either through direct chemical or electrical attacks. Sometimes corrosion spreads beneath surface coatings and is not detected by the rough surface or the powdered deposit.

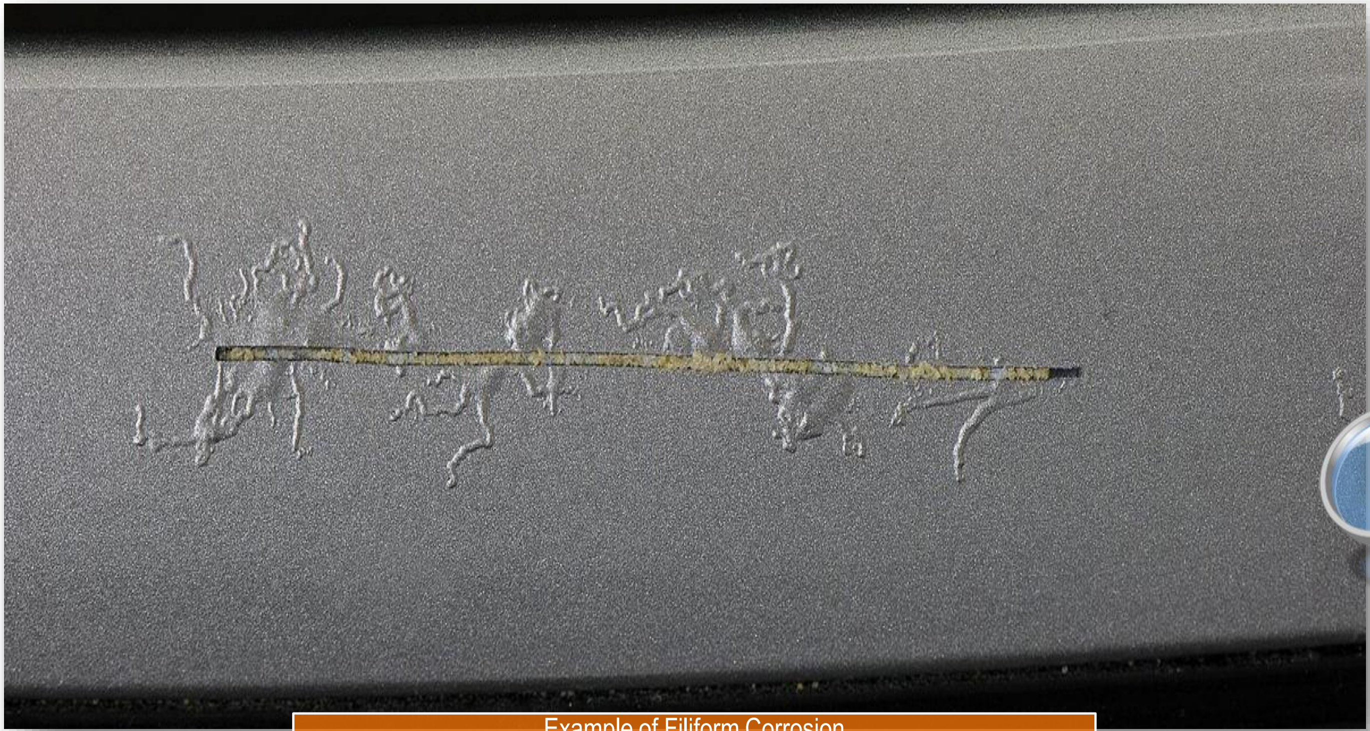
Surface attacks (or corrosion) are usually caused by exposing parts of the plane to oxygen for longer periods. **The most common causes include, but are not limited to:**

Bad paintwork, Inadequate preparation work by those making the paint job, Various contaminants and acids, Constant exposition to very high humidity conditions.

Example of Surface Corrosion on Aircraft Wing
Image source: Aeronautics Guide

FILIFORM CORROSION

Filiform corrosion is common in airplanes is because it mainly occurs on aluminum surfaces that have not been through the proper pre-painting process or covered with a corrosion-resistant alloy. In other words, the surface is not prepared for the polyurethane paint used on airplanes. **The moment it appears, it looks like "fine, worm-like lines of corrosion under the paint that will eventually lead to bubbling and flaking".** AOPA describes:
Consequently, filiform corrosion is easy to recognize and it is actually easier to prevent than it is to remedy, something that is not common with other types of corrosion.



Example of Filiform Corrosion
Image source: (CC) Matador/Wikipedia

RECOGNIZING CORROSION

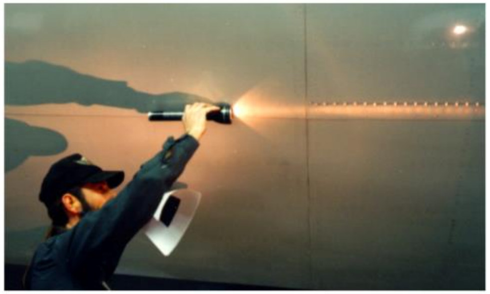
A very thorough visual inspection will reveal most corrosion, and Advisory Circular 43-4A describes corrosion inspections and control for aircraft in great detail.

Look for grayish-white powder on aluminum and reddish deposits on ferrous metals. Bumps or blisters in paint signify corrosion occurring under the surface, especially the filiform type common on aluminum that has been poorly prepared for painting. Filiform corrosion looks a little like cottage cheese under the paint.

Pay close attention to the trailing edges of control surfaces where the skins come together. Also, the inside of wheel wells on retractable models is a prime location for corrosion, not surprising considering its exposure to acids, salts, gravel, and other corrosion-producing substances. Use of a magnifying glass may reveal beginnings of corrosion not visible to the naked eye.

Checking for damage inside the aircraft is more difficult but necessary. Remove all inspection plates, and spend some time with a mechanic's mirror (a mirror mounted on a stick) and a good strong flashlight. You're looking for gray or whitish deposits on aluminum and the trademark rust on steel.

Areas of airplanes often damaged by corrosion include the propeller, cylinder fins, areas around fuel tanks or bladders, piano-type control hinges, and the battery box. Propeller corrosion occurs in two basic areas: on the surface of the blade, which is constantly abraded and exposed to the elements, and the hub of constant-speed propellers.



(a)

(b)

An example showing pillowing corrosion and surface micro deformations. (**a**) A specialist using a flashlight performs fuselage visual inspection; (**b**) the fuselage photo scanned showing surface micro perturbations caused by corrosion.

Aircraft Fuselage Corrosion Detection Using Artificial Intelligence Image source: MDPI

CORROSION CONTROL DURING THE DESIGN PHASE

Corrosion Control is the characteristics of a system design to preclude or reduce corrosion, materials selection, non-destructive inspections for corrosion detection, coatings, finishes, cleaning materials and washings, repairs, and other maintenance activities.

Corrosion prevention is an important step in the design of aerospace components. To ensure corrosion prevention is properly implemented, the following procedure should be followed: In order to prevent corrosion of aerospace components during design development, it is important to consider a number of factors. Firstly, the material of the components must be considered.

METALS SUSCEPTIBILITY: is a measure of how much a material will become corroded in an operating field. Metals that are more susceptible to corrosion, such as aluminum and magnesium, should be avoided or treated with protective coating. During the design of aerospace components, materials should be selected to resist corrosion. The use of corrosion-resistant materials should be selected to ensure the components remain structurally sound and corrosion-free. Examine the material chemical composition of the components to determine which corrosion protection methods are most suitable.

ENVIRONMENTAL CONDITIONS: Additionally, the environmental conditions that components will be exposed to should be considered. If the components will be exposed to saltwater or other corrosive substances, additional measures to protect the components should be taken. Evaluate the environment where the components will be used. This includes extreme conditions, salt fog, icing, climate, humidity, and temperature.

COATINGS: This may include the use of special coatings, or the use of special alloys that are more resistant to corrosion. Utilize protective coatings, lubricants, and/or protective sealants to reduce the risk of corrosion.

DESIGN OPTIMIZATION: Finally, the design of the components should be optimized for corrosion resistance, as certain designs may be more prone to corrosion. Design components to reduce the surface area exposed to potential corrosion. Ensure components are properly sealed and/or insulated to protect against moisture.

FINISH SELECTION: Corrosion prevention in this case involves cleaning the surfaces and providing a surface finish
through layers of coatings. For the surfaces of aluminum alloys, the coating of a corrosion inhibiting primer is the first coat. For the low-alloy steel components, the surface coating consists of a thin cadmium plating and a chemical corrosion inhibitor primer.
Stainless steel components are also cadmium-plated and primed as in the case of alloy steel components, as they may be connected to aluminum parts. A primer is used on titanium components too. Corrosion-inhibitor primers are required to be hydraulic fluid-resistant (Skydrol® for example) polyurethanes and epoxies.

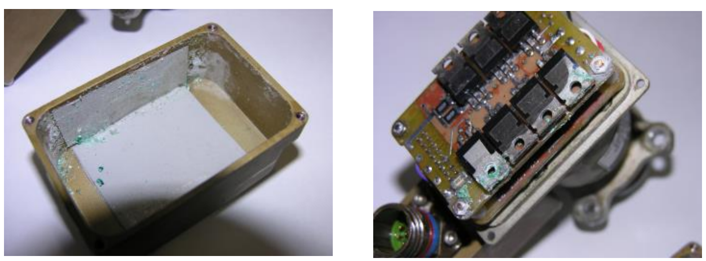
All above steps must be included in the Project Management Plan (MPP) in order to ensure verifications.

CORROSION CONTROL DURING THE DESIGN PHASE

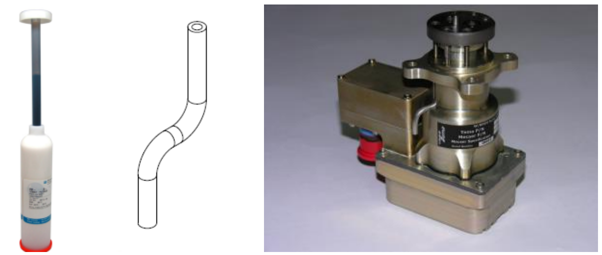
In order to prevent corrosion in aerospace components during design development, a corrosion prevention plan should be put in place. The plan should include the following (to be included in the MPP with a checklist):

- **MATERIAL SELECTION:** Proper use and selection of materials that are corrosion resistant. Once the materials are selected, the design should be evaluated for areas where corrosion could occur. This includes areas that may be exposed to the elements, areas that could be subject to vibration, and areas where two dissimilar metals come into contact. If any of these areas are present, the design should be revised to reduce the risk of corrosion. The selection of appropriate metal alloys is essential for ensuring long-term corrosion prevention and control. Aluminum is the automatic choice for most of the aircraft structures and components/parts. Along with aluminum alloys, steel and its alloys are also used in aircraft, both being highly prone to attacks of corrosion.

- **DESIGN TECHNIQUES:** Design and manufacturing techniques that will reduce the chance of corrosion.
    - **Moisture Drainage** - the moisture from a pressurized fuselage is required to be drained by **drain holes** with valves. Fluids are also required to flow in the direction of drain holes through a system of drain paths.
    - **Joint Sealants** - Crevice corrosion at joints is minimized by sealing the gaps on the joint surfaces with a polysulfide sealant. The sealant is used in skin-to-stringer as well as skin-to-shear types of joints in the fuselage, areas of skin doublers, chord-to-skin joints for the wing and wheel structure, etc. In cases of severe proneness to corrosion, such as electrical bonds and antenna peripheries, fillet seals are used.



Component Failure after Salt Fog Test - 2005



Component Re-Design with Drain Tube and ProSeal sealant

CORROSION CONTROL DURING THE DESIGN PHASE

STORAGE PRESCRIPTIONS: Proper storage and handling techniques that will limit contact with corrosive materials to be included in the design and into the CMM and SCS (separated parts not in contact and protection, sealed parts etc.).

CLEANING PRESCRIPTIONS: Regular cleaning and maintenance of components using specialized cleaners and lubricants.

PERIODIC INSPECTIONS: Regular inspections and tests to ensure that components are functioning properly and that corrosion is not present. (in the SCS and in the CMM).

DISPOSAL: Proper disposal of components that have become corroded or are no longer functional (no harmful products or compounds, ref. Rustguard).

All above prescriptions must be included in: Technical Documentation, Maintenance Documentation and Drawings.

CORROSION CONTROL DURING THE DESIGN PHASE

A corrosion prevention program is an essential part of design development for a new aerospace component. The plan must include the following steps:

1) **Identify the particular areas of the component that are at risk of corrosion.** Identify corrosion-prone areas in the design and develop strategies to reduce corrosion risks.

2) **Identify the possible sources of corrosion**, such as environmental conditions, chemicals, and other factors.

3) **Develop a plan for mitigating corrosion risks.** This can include materials selection, proper surface preparation, and protective finishes (ref. AS-COPRA First Issue - Corrosion Prevention Risk Assessment).

4) **Incorporate corrosion prevention techniques into the design process.** This includes methods such as galvanic corrosion prevention, cathodic protection, and corrosion monitoring (avoid dissimilar metals). Use corrosion inhibitors and other corrosion protection strategies.

5) **Test the design** for corrosion resistance before finalizing it (ref. paragraph 15).

6) **Monitor the effectiveness of the corrosion prevention plan.** Regular inspections and tests should be conducted to ensure that corrosion risks are being minimized (for example: include a verification point in the MPP after waterproofness, salt fog tests etc.).

7) **Make necessary changes** to the plan or the design if corrosion is still occurring.

CORROSION CONTROL DURING THE DESIGN PHASE

HOW TO CONTROL CORROSION BY IMPROVING DESIGN

The proper design to minimize corrosion is as important as the selection of materials. In many structures, a lack of design consideration the weakest link in corrosion control. Designers should have skills to determine the mechanical properties and strength required to ensure that a structure is resistant to corrosion. A background and solid understanding of the corrosion process is important as well. While selecting materials, the designer has to consider the particular environment, use and the corrosion control parameters.

DESIGN RULES

1) Designing structures and parts to prevent or control corrosion is more cost-effective than waiting for the equipment to fail in service.
2) Close communication between designers and corrosion engineers can be very beneficial and should be ensured in applications where corrosion is likely to be an issue.

(For more about the design process, read Corrosion Control Considerations in the Equipment Design Process).

CORROSION CONTROL DURING THE DESIGN PHASE

Here are a few key design rules that can be followed to help prevent corrosion.

DESIG RULES

Adjust Wall Thickness

Because corrosion involves the degradation of materials, the process continuously eats up the material and decreases its thickness. Therefore, part of corrosion-resistant design involves making allowances for this reduction (i.e., wall loss) in the thickness in pipes, storage tanks and other parts. A general method is to make the wall thickness twice of that which is required for the desired life of the structure. However, the wall thickness must meet mechanical requirements for stress, pressure and weight.
This general rule of using doubled wall thickness adds extra cost and weight. Therefore, detailed financial comparisons should be made to choose among these options. This rule does not need to be followed if there is reliable corrosion data and effective monitoring systems. For example, we might use different corrosion allowances for the upper and lower regions of a tall vertical vessel.

Ensure that there's Adequate Drainage

Tanks and other storage containers should be designed in such a way that they can be easily drained and cleaned. Therefore, all transitions should be smooth, and taps should be located so that the tank can be completely drained.

CORROSION CONTROL DURING THE DESIGN PHASE

DESIG RULES

Minimize Bi-Metallic Corrosion Cells

Avoid galvanic corrosion by using similar metal throughout the structure, if possible, or by avoiding electrical contact by insulating different materials. (For background information, see An Introduction to the Galvanic Series: Galvanic Compatibility and Corrosion.) Those components that are more prone to corrosion should be easily replaceable. Special parts (wasters) can also be used to attract the corrosion, thus protecting other parts. To avoid crevice corrosion, seals should be used and pressure should be adjusted on the gaskets to prevent liquid penetration inside the crevices. In this way, it is possible to avoid the presence of stagnant water in the crevices and narrow gaps.

Avoid Differential Aeration Cells

Differential aeration should be avoided. For the components immersed in water, sufficient aeration should be ensured to cause passivation, which slows the corrosion. Otherwise, aeration should be prevented as much as possible. Similarly, for the structures that are exposed to the atmosphere, easy drainage and an ample supply of air should be ensured, and vice versa for the porous surfaces or structure having cavities—they should be properly sealed.

Minimize Temperature Gradients

The equipment for heat transport should be designed so that surface temperature varies as little as possible. Cold and hot spots should be avoided. Superheated spots are prone to thermogalvanic corrosion and cold spots can enhance local condensation, which leads to corrosion. Therefore, the thermal gradient should be kept to a minimum.

CORROSION CONTROL DURING THE DESIGN PHASE

DESIG RULES

Minimize Stress Gradients

Stress concentrations in the components exposed to corrosive mediums should be avoided, especially when using materials susceptible to stress-corrosion cracking. Therefore, designers should aim for simple geometry, as abrupt changes in dimensions can provide sites for stress concentration.

Separate Environments

The surroundings should be considered to minimize the consequences of corrosion. This involves making sure that separate systems do not impair the environments of others. For example, if a copper alloy corrodes and the moisture containing copper ions come in contact with an aluminum component, it will result in galvanic corrosion. Polluting plants or the environment should be downwind to the structure to be protected if possible, so that air doesn't contain harmful impurities.

Minimize Turbulence in Pipe Systems

In piping systems, the designing should be such that the flow has minimum turbulence. Turbulent flow enhances corrosion, so the flow should be laminar and the thickness of the structure should be great enough that it can bear the effects. The number of bends should be as minimal as possible and it is essential to round the sharp bends. Sharp bends should be avoided in piping systems with high velocity fluids or solids in suspension to prevent erosion corrosion.

The Key: Avoid Heterogeneity

<u>The most general rule for proper design is to avoid heterogeneity.</u> Heterogeneity consists of different metals, uneven stress and temperature distribution. Sharp corners should be avoided because they are difficult to paint with uniform thickness. Complex geometries and narrow gaps impede surface treatments like painting, thermal spraying and blast cleaning; increase the cost; and make it difficult for cleaning and drying. All the relevant codes and standards should be met. Rules for minimum gaps between profiles are given in ISO 12944-3:2017.

CORROSION CONTROL DURING THE DESIGN PHASE

CORROSION CONTROL CONSIDERATIONS IN THE COMPONENTS DESIGN PROCESS

Corrosion is a global challenge that design engineers must address to reduce failures throughout the equipment life cycle. The electrochemical reaction that costs billions of dollars, both in direct and indirect costs, may lead to catastrophic incidents if not properly managed or prevented.

Direct expenses are incurred while repairing and replacing the corroded systems, while indirect expenses arise from physical and environmental impacts of the corrosion-related failures.

Effective corrosion control requires that designers integrate measures at an early stage in the design phase. By working with materials scientists, reliability and maintenance specialists, the designer should design reliable and cost-effective parts or equipment that provide the intended service throughout the service life.

An understanding of the causes and types of corrosion is important when deciding on suitable materials and finishes that match a specific environment.

CORROSION CONTROL DURING THE DESIGN PHASE

DESIGN DECISIONS IN CORROSION CONTROL

Corrosion is a complex problem that arises from multiple competing factors that vary with an application. The actual rates, location and extent of corrosion are dictated by the environment, equipment design, metallurgy and geometry.
A lack of accurate data and changing environmental factors make it difficult to get accurate corrosion rates, especially on new equipment and in new environments. **Laboratory tests are sometimes used to test and predict corrosion processes in a certain environment.** (To learn more about corrosion testing, read Corrosion Tests That Help Engineers Mitigate Corrosion – see paragraph 15).

The materials, corrosion protection methods and application methods are design elements that should be thoroughly evaluated, and applied effectively and economically. The expected life, risk of corrosion and whether to integrate control measures in the fabrication or to be carried out through preventive maintenance are things that must be balanced to ensure that the design is reliable and economical throughout the equipment service life.

The following factors must be considered for effective corrosion control:

- Causes of corrosion
- Environment
- Types of corrosion
- Materials used
- Design details
- Cost
- Disposal (no harmful products)

CORROSION CONTROL DURING THE DESIGN PHASE

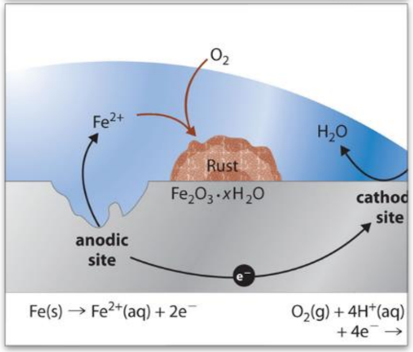
CAUSES OF CORROSION

Being an electrochemical reaction, corrosion will occur whenever there is the presence of:

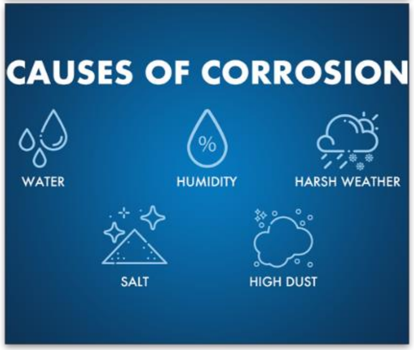
- **An anode and cathode**, such as with two dissimilar metals. This may also occur due to a potential difference created in the two concentration regions of a differential electrolyte.
- **A metallic conductor** between the two electrodes
- **An electrolyte** such as water

- ❑ Eliminating the causes may be restricted in practice, because of the function and feasibility.
- ❑ Avoiding dissimilar metal contact may be impossible because of cost, weight and functional issues.
- ❑ However, surface treatments, plating, coating, painting and sealing can minimize the corrosion potential.
- ❑ Water, on the other hand, cannot be avoided, but can be controlled using drain holes, sealants, drain paths and corrosion-inhibiting compounds.

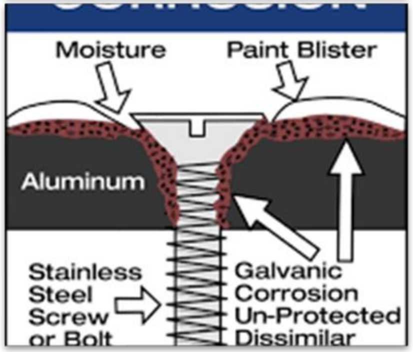
Iron Corrosion



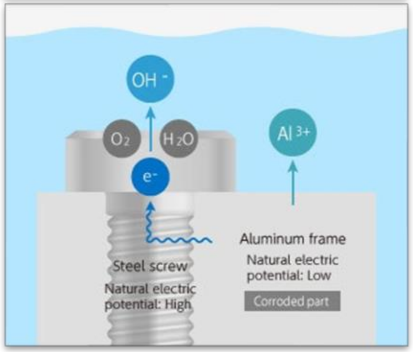
Environmental Causes



Galvanic Corrosion



Galvanic Corrosion



CORROSION CONTROL DURING THE DESIGN PHASE

ENVIRONMENT

The usage environment, presence of corrosion acceleration factors, and design-related corrosive micro-environments should **all be considered at an early stage.**

Common corrosive environments may contain one or a combination of the following:

- Water
- Oxygen
- Carbon dioxide
- Hydrogen sulfide
- Acids
- Bacteria

Factors that increase the rate of corrosion include:

- Temperature
- pH
- Humidity
- Chlorides such as saltwater
- Pressure
- Velocity
- Solids, dirt and debris
- Wear and abrasion

Severe environments require upfront attention and adequate steps taken to ensure the sustainability of the equipment in its service life. Design costs increase as the environment becomes more severe.

CORROSION CONTROL DURING THE DESIGN PHASE

CORROSION CONTROL

Corrosion control measures should be present at all stages, such as design, transportation, installation, handling and integration. Material surfaces should be protected and considerations made for joining, welding, gaps, adjacent materials, drainage and other contributing factors. **The designer should include provisions for in-service cleaning, inspections, coating and corrosion protection compounds reapplication.** Proper material selection, design and fabrication details, finishing, plating, drainage, sealing, galvanic coupling of materials, the use of corrosion-inhibiting compounds and suitable in-service corrosion control programs are all critical factors for corrosion control:

- **Material –** Passive metals should be used whenever possible, and added protection such as coatings applied when there is a risk of the metal becoming reactive.
- **Sealants –** When liquids cannot be avoided, they should be drained properly and sealants used to avoid liquid ingress.
- **Finishing –** A suitable surface finishing and coating is an effective means of controlling corrosion.
- **Drainage –** Prevent fluids from becoming trapped in crevices.

CORROSION CONTROL DURING THE DESIGN PHASE

DESIGN CORROSION PREVENTION AND RISK ASSESSMENT

Corrosion Prevention Risk Assessment (or Corrosion Risk Assessment Study CRAS) is one of a corrosion engineer's most important responsibilities. In fact, without corrosion assessment, mitigating or eliminating corrosion in any industry is almost impossible. The engineering shall use the Risk Assessment tool for each component (part number) that are already in production or for new products. For each component a Risk Analysis shall be made based on the following Risk Characteristics.

CP RISK IMPACT	CP RISK DESCRIPTION	RISK TREATMENT	ACTION
Full Rustproof	Very Low DRY - Corrosion rate failure very unlikely in-service life	No risk	
Rustproof	Low Normally DRY - Corrosion rate failure unlikely in-service life	Check Material Analysis	
Partially Rustproof	Moderate Normally WET -Corrosion rate failure possible in-service life	Check Material Analysis	
Corrosion Protected	Moderate Normally WET - Corrosion rate failure possible in-service life	Check Material Analysis	
Unprotected	High Normally WET - Corrosion rate failure likely in-service life	To Protect	Protect by Compound / Packaging
Oxidizable	Very High Normally WET - Corrosion rate failure very likely in-service life	To Protect / Redesign	Redesign / Change Material / Coating
Full Oxidizable	Very High WET - Corrosion rate failure very likely in-service life	To Protect / Redesign	Redesign / Change Material / Coating

Based on the results of the Risk Analysis the Enginenring Department shall define the Risk Treatment and the Actions needed.

For the above purpose the availabe tool is:
AS-COPRA Corrosion Prevention Risk Assessment

Corrosion Risk Assessment Study (CRAS) is carried out to identify the damage mechanisms, assessing the likelihood, consequence and overall risk. CRAS acts as a verification of material selection and proposed corrosion control measure.

CORROSION CONTROL DURING THE DESIGN PHASE

RESPONSIBILITY FOR CORROSION CONTROL

The Product Engineer is responsible for the application of the CPCP in all projects and to manage all detailed design controls (and all related technical documentation), also to use the **FF203 Engineering CPCP Control Checklist** for all projects (Components Part Numbers) in order to verify the compliance of the project to the CPCP requirements:
The Product Engineer is responsible to manage any reported failure by the **COFRES – Corrosion Failure Reporting System** (dealing with the PE, QAM and QCM).

AEROSYSTEMS	ENGINEERING CPCP CONTROL CHECKLIST	FF203 First Issue

Part Number	Description	MPP N°	Date

CPCP CHECKLIST		
CHECKLIST DATA TO BE REVIEWED	APPLICABILITY	COMPLIANCE METHOD / NOTES
Include discussion of CPCP requirements in design review Kick-Off meeting discussion	☒ YES ☐ NO ☐ N/A	
Include CPCP Control Actions into the MPP	☒ YES ☐ NO ☐ N/A	
Identify Quality Assurance (Customer/Government) CP requirements	☒ YES ☐ NO ☐ N/A	
Determine Environmental Severity Classification for the project location (Component Lifecycle Environment)	☒ YES ☐ NO ☐ N/A	
Assessment of high sustainable components requirements related to CPCP	☒ YES ☐ NO ☐ N/A	Ref. BOM
Select life-cycle-cost-effective material, coatings, active CPCP systems and design geometries consistent with the requirements and appropriate to the budget	☒ YES ☐ NO ☐ N/A	Ref. Material Analysis
Consider risk assessment/service life where appropriate	☒ YES ☐ NO ☐ N/A	
Develop CPCP preventive-maintenance strategy and program for the Maintenance Data to be provided	☒ YES ☐ NO ☐ N/A	Ref. CMM
Assess presence of hazardous materials	☒ YES ☐ NO ☐ N/A	Ref. Disposal
CPCP Test Requirements defined? Any other test required?	☒ YES ☐ NO ☐ N/A	
Needs of CPCP specific operator training?	☒ YES ☐ NO ☐ N/A	
Drawing Notes fot CPCP application are defined?	☒ YES ☐ NO ☐ N/A	
Other	YES ☐ NO ☐ N/A	
NOTES:		

Responsibilities	Name and Surname	Signature	Date
Product Engineering			
Project Manager			

COFRES
CORROSION FAILURE REPORTING SYSTEM

CORROSION CONTROL DURING THE DESIGN PHASE

- **Galvanic coupling of materials** – Designs should avoid coupling different materials unless required by weight, economic and functional considerations. When dissimilar metal coupling is necessary, appropriate finishing, sealing and other corrosion control methods should be applied.
- **Use of corrosion-inhibiting compounds** – In addition to finishes, sealants and drainage provisions, corrosion-inhibiting compounds offer added protection and should be reapplied periodically depending on the particular environment. (Inhibitors are discussed in How to Select the Best Volatile Corrosion Inhibitor (VCI) for Your Application.)
- **Eliminating other environmental contributing factors** – This is achieved by maintaining the pH, controlling gas leakages and breakout, removing oxygen, lowering chloride levels, and controlling bacteria and other contaminants. Care should be taken to maintain safe and uniformly distributed temperatures. Physical factors such as velocities and pressures should also be kept within acceptable levels without affecting the efficiency of the system.
- **Access for maintenance** – Easy access to all parts of the equipment or system should be provided for regular corrosion inspections and routine maintenance.
- **Effective corrosion control programs** – The designer should lay down an effective in-service maintenance procedure and inspection. A comprehensive control program maximizes corrosion protection and minimizes the downtime associated with corrosion-related maintenance and failures.
- **Environmental issues** – The design should ensure that materials used for the equipment, for corrosion protection and those from the processes, have minimal or zero toxic and hazardous emissions into the environment.

CONCLUSION

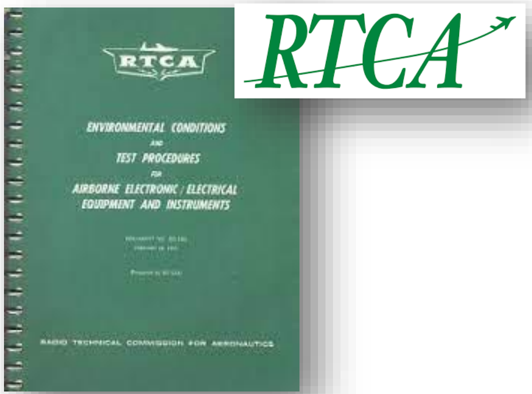
Understanding the factors contributing to the various types of corrosion in any specific environment is important in designing equipment with suitable corrosion protection that will last throughout its life cycle. **Material selection, the environment and control measures must be addressed early in the early design phase to establish an optimum and reliable solution.**

TYPES OF TESTS FOR CORROSION (IN AEROSPACE)

Corrosion testing is one of a corrosion engineer's most important responsibilities. In fact, without corrosion assessment, mitigating or eliminating corrosion in any industry is almost impossible.

There are several reasons for corrosion examination. Sometimes, in a materials selection process for an industrial application, an evaluation of different kinds of materials in a specific environment is required. The assessment of a new type of alloy in different types of environments to compare with conventional commercial alloys; an estimation of an inhibitors' efficiency in reducing the corrosion rate of metals; and understanding the mechanism of corrosion are the other reasons.

Corrosion tests are usually divided into two main categories: **laboratory tests and field tests**, each of which has its merits and demerits. For example, the environmental conditions present in real-world applications are different to those in laboratory situations. Therefore, it is difficult to extrapolate the results of laboratory tests to industry settings. On the other hand, in laboratory tests, it is possible to accelerate the corrosivity of the environment to obtain results more rapidly, something that is impossible in field testing.



Typical Aerospace Components Test Methods used for testing corrosion effects:

RTCA DO160G Environmental Conditions and Test Procedures for Airborne Equipment

- SALT FOG
- FUNGUS RESISTANCE
- SAND AND DUST
- HUMIDITY

MIL-STD-810H DOD Test Method Standard: Environmental Engineering Considerations and Laboratory Tests

- SALT FOG
- ACIDIC ATMOSPHERE
- HUMIDITY
- FUNGUS
- FLUID CONTAMINATION
- RAIN

TYPES OF TESTS FOR CORROSION – SALT FOG, SALT SPRAY

RTCA DO-160 – Section 14.0 – Salt Fog

This test determines the effects on the equipment of prolonged exposure to a salt atmosphere or to salt fog experienced in normal operations. The main adverse effects to be anticipated are:

- **Corrosion of metals.**
- Clogging or binding of moving parts as a result of salt deposits.
- Insulation fault.
- Damage to contacts and uncoated wiring.

Category S: When the equipment is installed in locations where it is subjected to a corrosive atmosphere in the course of normal aircraft operations, the equipment is identified as Category S and the salt fog test is applicable.

Category T: When the equipment is installed in locations where it is subjected to a severe salt atmosphere, such as equipment exposed directly to external unfiltered air on hovering aircraft that may operate or be parked near the sea, the equipment is identified as category T and the severe salt fog test is applicable…

RTCA/DO-160G

"Environmental Conditions and Test Procedures for Airborne Equipment"

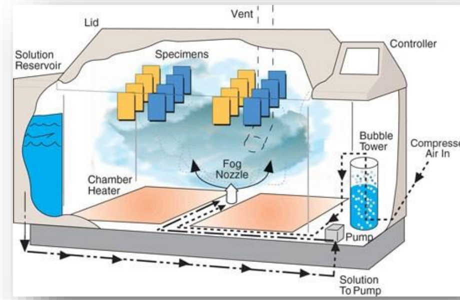
"Salt Fog" requirements for equipment qualification are often according to RTCA/DO-160:

- ***24 hours for "Category S Equipment"***

  When the equipment is installed in location where it is subjected to a corrosive atmosphere in the course of the normal aircraft operations, the equipment is identified as Category S and the salt fog test is applicable.

- ***48 hours for "Category T Equipment"***

  When the equipment is installed in location where it is subjected to a severe salt atmosphere, such as equipment exposed directly to external unfiltered air on hovering aircraft that may operate or be parked near the sea, the equipment is identified as Category T and the severe salt fog test is applicable.



TYPES OF TESTS FOR CORROSION – SAND AND DUST

RTCA DO-160 – Section 12.0 – Sand and Dust

This test determines the resistance of the equipment to the effects of blowing sand and dust where carried by air movement at moderate speeds. The main adverse effects to be anticipated are:

- Penetration into cracks, crevices, bearings and joints, causing fouling and/or clogging of moving parts, relays, filters, etc.
- Formation of electrically conductive bridges.
- Action as nucleus for the collection of water vapor, including secondary effects of **possible corrosion.**
- Pollution of fluids.

Category D: Equipment tested as recommended in the following paragraphs for Dust test is identified as Category D. Such equipment can be installed in locations where the equipment is subjected to blowing dust in the course of normal aircraft operations.

Category S: Equipment tested as recommended in the following paragraphs for both Dust test and Sand test is identified as Category S. Such equipment can be installed in locations where the equipment is subjected to blowing sand and dust in the course of normal aircraft operations. Such location includes cockpit or any other location not intentionally protected against sand and dust exposure.

TYPES OF TESTS FOR CORROSION – HUMIDITY

RTCA DO-160 – Section 6.0 – Humidity

This test determines the ability of the equipment to withstand either natural or induced humid atmospheres. The main adverse effects to be anticipated are:

- **Corrosion**
- Change of equipment characteristics resulting from the absorption of humidity.

For example: Mechanical (metals), Electrical (conductors and insulators), Chemical (hygroscopic elements), Thermal (insulators)

Equipment Categories:

Category A – Standard H. Environment

It ordinarily provides an adequate test environment for equipment intended for installation in civil aircraft, non-civil transport aircraft and other classes, within environmentally controlled compartments of aircraft in which the severe humidity environment is not normally encountered.

Category B – Severe H. Environment

Equipment installed in zones not environmentally controlled may be required to be operated under conditions such that it is subjected to a more severe atmospheric humidity environment for periods of time in excess of that specified for the standard humidity environment.

Category C – External H. Environment

Equipment may be required to be operated under conditions such that it is subjected to direct contact with outside air for periods of time in excess of that specified for the standard humidity environment.

TYPES OF TESTS FOR CORROSION – WATERPROOFNESS (AND RAIN TEST)

RTCA DO-160 – Section 10.0 – Waterproofness

These tests determine whether the equipment can withstand the effects of liquid water being sprayed or falling on the equipment or the effects of condensation. These tests are not intended to verify performance of hermetically sealed equipment. Therefore, hermetically sealed equipment may be considered to have met all waterproofness requirements without further testing. Equipment shall be considered hermetically sealed when the seal is permanent and airtight.

Category Y

Equipment that is installed in locations where it is subjected to condensing water in the course of normal aircraft operations is identified as Category Y. For equipment intended for installation in such locations, the condensing water proof test procedure applies and the equipment is identified as Category Y.

Category W

Equipment that is installed in locations where it is subjected to falling water (generally the result of condensation) in the course of normal aircraft operations is identified as Category W. For equipment intended for installation in such locations, the drip proof test procedure applies and the equipment is identified as Category W.

Category R

Equipment installed in locations where it may be subjected to a driving rain or where water may be sprayed on it from any angle is identified as Category R. For equipment intended for installation in such locations, the spray proof test procedure applies. Equipment that has passed the Category R requirements may be considered to meet the Category W requirement without further testing.

Category S

Equipment installed in locations where it may be subjected to the forces of a heavy stream of fluid such as would be encountered in aircraft de-icing, washing or cleaning operations is identified as Category S. For equipment intended for installation in such locations the continuous stream proof procedure applies. Water is used in this test to simulate the actual fluid forces. Equipment that has passed the Category S requirements may be considered to meet the Category W requirements without further testing.

CPCP DURING THE MANUFACTURING OF AEROSPACE COMPONENTS

In addition to the design, the manufacturing process should also be evaluated.

- Proper machining and welding techniques should be employed to ensure that no defects are present that could cause corrosion.
- All parts should be cleaned and treated prior to assembly, and appropriate sealants should be applied to areas where corrosion could occur.
- All metallic parts (no treated) should be protected (where applicable) by corrosion inhibitors during storage, before the assembly and before packaging.
- Finally, after the components are assembled, they should be tested and inspected to verify that they meet the design requirements and will not corrode. This testing can include accelerated corrosion testing and visual inspections (ATP and/or qualification tests).

The Corrosion Protection and Control Program during the manufacturing of aerospace components must be implemented in a manner that ensures that corrosion is prevented and controlled. This program shall include the following elements:

- **Detailed Visual Inspection** and testing of the aerospace components and all related materials to ensure corrosion prevention and control.
- **A system of corrective action** for any corrosion that is detected, including the replacement of any parts or materials that have been compromised.
- **Compliance with regulatory requirements** and standards related to corrosion prevention and control.
- **Training** and education of personnel to ensure that they are knowledgeable in the proper use and maintenance of the components and materials.
- **Documentation of all activities** related to the Corrosion Protection and Control Program to be included in the Traveller Cards (Cicli di Lavoro) as control steps (example CPCP Control). The Traveller Card must include the following: the selection of the appropriate coating material (oil, compound etc.), the application of the coating, and the inspection of the applied coating to ensure that it meets the required standards for corrosion protection (example: Alodine protection, Compounds, Sealings etc.).
- **An Audit System** to ensure that the program is functioning properly.

CPCP DURING THE MANUFACTURING OF AEROSPACE COMPONENTS

Corrosion Protection and Control Program to be included in the Traveller Cards (Cicli di Lavoro) as control steps (example CPCP Control).

CPCP Control

The Traveller Card must include the following: the selection of the appropriate coating material (oil, compound etc.), the application of the coating, and the inspection of the applied coating to ensure that it meets the required standards for corrosion protection (example: Alodine protection, Compounds, Sealings etc.).

Coating Protection

Ciclo di Lavoro

CPCP DURING THE MANUFACTURING OF AEROSPACE COMPONENTS

All metallic parts (no treated) should be protected (where applicable) by corrosion inhibitors during storage, before the assembly and before packaging.

Solvent-based high-flash corrosion inhibitor coating, eliminating oily surfaces that can attract dust and contaminants. This coatings protects for up to 6 months under shelter or can be used with VCI packaging for long-term protection.

Ideale per proteggere dall''umidità, come imballo per il trasporto via mare di componenti e pezzi meccanici, cuscinetti a sfera, lamiere, ecc.

Vantaggi: particolarmente resistente agli strappi, molto elastica, 100% idrorepellente; carta kraft con paraffina all''interno e all''esterno, senza acidi

Protection Storage

Protection Storage

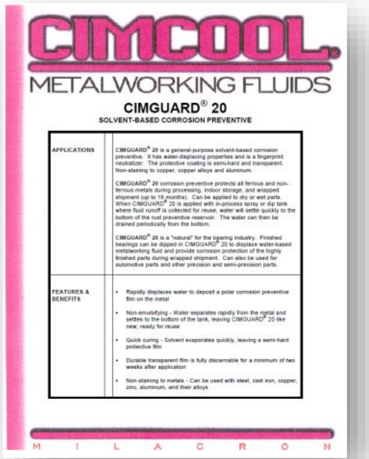
Carta Oleata

CPCP DURING THE MANUFACTURING OF AEROSPACE COMPONENTS

The **Corrosion Protection materials** provided by the company are:

- **Corrosion Inhibitors**
- **Rust Protection Oils**
- **Sealing compounds**
- **other**

For each of the above materials the company must provide all **TDS Technical Data Sheet and MSDS Material Safety Data Sheet.**


CIMCOOL
METALWORKING FLUIDS
CIMGUARD® 20
SOLVENT-BASED CORROSION PREVENTIVE
APPLICATIONS
FEATURES & BENEFITS
M I L A C R O N


CIMCOOL
Material Safety Data Sheet
CIMGUARD® SRP
CORROSION INHIBITOR CONCENTRATE
1 CHEMICAL PRODUCT AND COMPANY IDENTIFICATION
2 EMERGENCY INFORMATION
3 POTENTIAL HEALTH EFFECTS OF DIRECT EXPOSURE


SHEAT RB1
Rust Preventive Oil


ProSeal
PS890 Fuel Tank Sealant

Cimguard 20
Solvent based Corrosion Preventive

Ardrox AV40
Corrosion Inhibiting Compound

CPCP DURING THE MANUFACTURING OF AEROSPACE COMPONENTS

The **Corrosion Protection materials** provided by the company are SAFE for any application. **The use of PPE Personal Protective Equipment is highly recommended (DPI Dispositivi di Protezione Individuale).**

For each of the above materials the company must provide all TDS and MSDS.

JET LUBE
RUST GUARD

Replaced

ARDROX
AV40

CPCP DURING THE MAINTENANCE OF AEROSPACE COMPONENTS

During the maintenance process, it is important to inspect components for signs of corrosion. If corrosion is detected, the cause should be identified and the appropriate solution, such as replacement or repair, should be implemented.

Corrosion and environmental conditions are natural phenomena that adversely affect equipment in field service. Although never totally eliminated, the problems these factors cause can be minimized so that they are less severe and better controlled. This can be achieved by understanding equipment failure mechanisms and development/utilization of corrosion control technology.

As a general rule, maintenance personnel should assume corrosion is ongoing, regardless of visible physical evidence. The aim of corrosion prevention is to enable systems to perform satisfactorily for a specified time period. In other words, maintenance efforts should allow equipment to approach its maximum lifetime.

An effective CPCP shall include thorough cleaning, inspection, preservation, and lubrication, at specified intervals, to be included in the Maintenance Data (CMM) as detailed inspection steps.

- **Check for corrosion damage and integrity of protective finishes** during all scheduled and unscheduled maintenance (even if not stated in maintenance data or CMM). Early detection and repair of corrosion will limit further damage.
- When corrosion is discovered, **treat corrosion as prescribed in the CMM** as soon as possible and use only approved materials, equipment, and techniques.
- **Only affected areas shall be repaired.**
- All maintenance personnel shall **report corrosion promptly**, in accordance with directives established.

CPCP DURING THE MAINTENANCE OF AEROSPACE COMPONENTS

MAINTENANCE AND READINESS DATA COLLECTION

All activities using this instruction are required to use the current maintenance data collection system(s) of the company.
This will enable a **record of corrosion-related failures to be submitted to the Engineering Department for analysis.**
Reporting personnel shall identify/report corrosion discrepancies in accordance with this instruction and using the provided online system named **COFRES – Corrosion Failure Reporting System.**
The Maintenance Manager is responsible for the application of CPCP and all related Maintenance Documentation, also to identify and report any corrosion discrepancies in accordance with this instruction and using the provided online systems named COFRES – Corrosion Failure Reporting System.
The Maintenance Manager is responsible for the application of the **FF204 Maintenance CPCP Control Checklist** if no CP prescriptions are available or stated in the Maintenance Data or in the CMM.

AEROSYSTEMS	MAINTENANCE CPCP CONTROL CHECKLIST	FF204 First Issue

Part Number	Description	Serial Number (if applicable)	Date
CMM N°	CMM Title	Job Card N° (if applicable)	Any other Maintenance Data

CPCP CHECKLIST		
CHECKLIST DATA TO BE REVIEWED	APPLICABILITY	COMPLIANCE METHOD / NOTES
CPCP Inspection Procedure is available in the Maintenance Data (for the Component under maintenance)?	☒ YES ☐ NO ☐ N/A	
Visual Inspection Procedure is available in the Maintenance Data (for the Component under maintenance)?	☒ YES ☐ NO ☐ N/A	
The detailed Visual Inspection of the component to check Corrosion was performed?	☒ YES ☐ NO ☐ N/A	
Check for corrosion damage and integrity of protective finishes?	☒ YES ☐ NO ☐ N/A	
Corrosion on metal exposed parts?	☒ YES ☐ NO ☐ N/A	
Corrosion on connectors (body, seals, screws, pins)?	☒ YES ☐ NO ☐ N/A	
Corrosion on cabling?	☒ YES ☐ NO ☐ N/A	
Corrosion on coatings (as Anodized parts, Alodine parts, paint etc.)?	☒ YES ☐ NO ☐ N/A	
Corrosion Damages detected?	☒ YES ☐ NO ☐ N/A	
Cleaning of the component?	☒ YES ☐ NO ☐ N/A	
Lubrication or Protection of any part of the component?	☒ YES ☐ NO ☐ N/A	
Any other discrepancy?	☒ YES ☐ NO ☐ N/A	
If corrosion was discovered the discrepancy was reported with the online system: COFRES – Corrosion Failure Reporting System.	☒ YES ☐ NO ☐ N/A	
NOTES:		

Responsibilities	Name and Surname	Signature	Date
Maintenance Manager			

Aerosystems S.r.l. – Precision Aerospace Components
Via San Gottardo 4, 21021 Angera (VA) Italy

COFRES
CORROSION FAILURE REPORTING SYSTEM

CPCP DURING THE MAINTENANCE OF AEROSPACE COMPONENTS

CORROSION LEVELS

A CPCP requires a **method to notify** the Relevant Competent Authority (ENAC/EASA/FAA) as well as the aircraft's manufacturer (TCH) regarding findings as well as any data associated with such damage. The definitions for different corrosion levels have changed over time, causing issues for air carriers with mixed fleets so to check carefully the applicable documentation relevant to your aircraft type/component. Across Industry there are some differences in reporting requirements for the three corrosion levels.

Level 1
Corrosion is the damage occurring between successive inspections that is local and can be reworked/blended-out within allowable limits as defined by the manufacturer in a structural repair manual (SRM), service bulletin, etc.

Level 2
Corrosion is damage occurring between successive inspections that require rework or blend-out that then exceeds the manufacturer's allowable limits, requiring a repair or complete/partial replacement of a principal structural element.

Level 3
Corrosion is damage found during the first or subsequent inspection(s) which is determined by the operator to be a potential airworthiness concern requiring expeditious action.

COPRA –CORROSION PREVENTION RISK ASSESSMENT

Corrosion Prevention Risk Assessment is one of a corrosion engineer's most important responsibilities. In fact, without corrosion assessment, mitigating or eliminating corrosion in any industry is almost impossible. The engineering shall use the Risk Assessment tool for each component (part number) that are already in production or for new products. For each component a Risk Analysis shall be made based on the following Risk Characteristics. Based on the results of the Risk Analysis the Engineenring Department shall define the Risk Treatment and the Actions needed.

For the above purpose the available tool is: **AS-COPRA Corrosion Prevention Risk Assessment**

		Risk Treatment to be performed MANUAL (Decision)	This field detrmines the Impact	Impact Value calculated (0-1-2-3-4)	Red, Amber, Green indication of the status of the Action Plan (Closed, Running and Open)	
PRODUCT SUSCEPTIBILITY TO CORROSION	**CORROSION RISK IMPACT**	***RISK TREATMENT***	***IMPACT***	***IMPACT (VALUE)***	***RAG STATUS***	***RAG STATUS***
0 - FULL RUSTPROOF	0	No Risk	**No Actions**	**0**	Red	OPEN
1 - RUSTPROOF	1	Check Material Analysis	**To be analyzed**	**1**	Amber	RUNNING
2 - PARTIALLY RUSTPROOF	2	Check Material Analysis	**To be analyzed**	**1**	Green	CLOSED
3 - CORROSION PROTECTED	3	Check Material Analysis	**To be analyzed**	**1**		
4 - UNPROTECTED	4	To Protect	**Protect**	**2**		
5 - OXIDIZABLE	5	To Protect / Redesign	**Protect / Redesign**	**3**		
6 - FULL OXIDIZABLE	6	To Redesign / Evaluation	**Redesign / Evaluation**	**4**		

Subjective view of the probability of occurrence (1=low 4=high) Probability MANUAL

CORROSION RISK PROBABILITY	***VALUE***	
Very Low Exposition	1	This Probability Occurrence depends on Environment, Installation and Operation Lifecycle
Low Exposition	2	
Medium Exposition	3	
High Exposition	4	

COMPONENTS SUBJECTED TO CPCP

AS-COPRA Corrosion Prevention Risk Assessment

AS-COPRA First Issue January 18, 2023

Aerosystems - Product Portfolio General Obsolescence Management Plan

AEROSYSTEMS PART NUMBER	CUSTOMER PART NUMBER	DESCRIPTION	CUSTOMER NAME	MATERIAL ANALYSIS	TYPE	PRODUCT SUSCEPTIBILITY TO CORROSION	CORROSION RISK IMPACT	CORROSION RISK PROBABILITY	RISK CRITICALITY AND PRIORITY LEVEL (RISK RAG)	RISK TREATMENT	ACTION PLAN	PLANNED DUE DATE	IMPACT	IMPACT (VALUE)	LIKELIHOOD (1,2,3)	EXPOSURE	VERIFICATION PROGRESS OF THE ACTION PLAN (OR FURTHER ACTION)	STATUS RAG	LESSON LEARNED ALLISS (Reference)	ACTIONS PLANNED	CLOSURE DATE
2310000	AR516188	Commutator 14 Bars	Microtecnica	NONE	COTS	0 - FULL RUSTPROOF	0	1	0	No Risk	N/A	N/A	No Actions	0	1	0	No further actions	CLOSED	Not Applicable		21/02/2023
6011000	8G3040V00351	Wiper Blade	Leonardo Helicopters	PRESENT	VENDOR	1 - RUSTPROOF	1	4	4	No Risk	N/A	N/A	No Actions	0	3	0	All materials rustproof	CLOSED	Not Applicable		21/02/2023
6012000	8G3040V00151	LH Wiper Arm	Leonardo Helicopters	PRESENT	VENDOR	3 - CORROSION PROTECTED	3	4	12	No Risk	N/A	N/A	No Actions	0	1	0	Protected by Inhibitor	RUNNING	Not Applicable	ECO under proposal	
6012001	8G3040V00251	RH Wiper Arm	Leonardo Helicopters	PRESENT	VENDOR	3 - CORROSION PROTECTED	3	4	12	No Risk	N/A	N/A	No Actions	0	3	0	Protected by Inhibitor	RUNNING	Not Applicable	ECO under proposal	
6013000	8G3040V00451	Wiper Blade Spray Nozzle	Leonardo Helicopters	PRESENT	VENDOR	1 - RUSTPROOF	1	4	4	No Risk	N/A	N/A	No Actions	0	1	0	No further actions	CLOSED	Not Applicable		21/02/2023
7910000	N/A	Drain Valve	Mecaer Aviation Group	NONE	VENDOR	1 - RUSTPROOF	1	1	1	To Protect	N/A	N/A	Protect	2	1	2	To protect with Inhibitor	RUNNING	Not Applicable	Modify the Packaging Card with the application of the specified inhibitor and instructions	
7930000	N/A	Breather Cap with Filler	Mecaer Aviation Group	NONE	VENDOR	2 - PARTIALLY RUSTPROOF	2	1	2	To Protect	N/A	N/A	Protect	2	1	2	To protect with Inhibitor	RUNNING	Not Applicable	Modify the Packaging Card with the application of the specified inhibitor and instructions	
11-129 Rev. A	M039-01E002-045	V-BPEM Cabling	Mecaer Aviation Group	NONE	VENDOR	0 - FULL RUSTPROOF	0	2	0	To Protect	N/A	N/A	Protect	2	3	6	No further actions	CLOSED	Not Applicable		
16-209	6G6325L00151	Shroud, PRGB LH, UP	Leonardo Helicopters	NONE	VENDOR	0 - FULL RUSTPROOF	0	1	0	No Risk	N/A	N/A	No Actions	0	1	0	No further actions	CLOSED	Not Applicable		22/02/2023
16-219	6G6325L00251	Shroud, PRGB LH, DOWN	Leonardo Helicopters	NONE	VENDOR	0 - FULL RUSTPROOF	0	1	0	No Risk	N/A	N/A	No Actions	0	1	0	No further actions	CLOSED	Not Applicable		22/02/2023
16-229	6G6325L00351	Shroud, PRGB RH, UP	Leonardo Helicopters	NONE	VENDOR	0 - FULL RUSTPROOF	0	1	0	No Risk	N/A	N/A	No Actions	0	1	0	No further actions	CLOSED	Not Applicable		22/02/2023
16-239	6G6325L00451	Shroud, PRGB RH, DOWN	Leonardo Helicopters	NONE	VENDOR	0 - FULL RUSTPROOF	0	1	0	No Risk	N/A	N/A	No Actions	0	1	0	No further actions	CLOSED	Not Applicable		22/02/2023
16-609	6G6220L00251	Lightning Cable Assembly	Leonardo Helicopters	NONE	VENDOR	0 - FULL RUSTPROOF	0	1	0	No Risk	N/A	N/A	No Actions	0	1	0	No further actions	CLOSED	Not Applicable		22/02/2023
16-709	6G6220L00151	Lightning Cable Assembly	Leonardo Helicopters	NONE	VENDOR	0 - FULL RUSTPROOF	0	1	0	No Risk	N/A	N/A	No Actions	0	1	0	No further actions	CLOSED	Not Applicable		22/02/2023
19-109	109-0760L01-101	Filler Unit	Leonardo Helicopters	NONE	VENDOR	2 - PARTIALLY RUSTPROOF	2	2	4	To Redesign / Evaluation	N/A	N/A	Redesign / Evaluation	4	1	4	To protect with Inhibitor and Change Material	CLOSED	Not Applicable	Changed Material ECO-19-109-003 ECO Engineering Change Order	22/02/2023
31-249	80-11201-00	Solenoid Assembly	Fimac	NONE	VENDOR	0 - FULL RUSTPROOF	0	1	0	To Redesign / Evaluation	N/A	N/A	Redesign / Evaluation	4	1	4	No further actions	CLOSED	Not Applicable		
32-101 Rev. B	N/A	Brake Solenoid Assembly	Logic		COTS	0 - FULL RUSTPROOF	0	2	0	To Redesign / Evaluation	N/A	N/A	Redesign / Evaluation	4	1	4	No further actions	CLOSED	Not Applicable		
35-109 Rev. A	N/A	Parachute Electromagnet	Meteor		VENDOR	0 - FULL RUSTPROOF	0	2	0	To Redesign / Evaluation	N/A	N/A	Redesign / Evaluation	4	1	4	No further actions	CLOSED	Not Applicable		
40-129 Rev. B	623732	Assieme Motore AC 400V	Leonardo Airborne		VENDOR	0 - FULL RUSTPROOF	0	2	0	To Redesign / Evaluation	N/A	N/A	Redesign / Evaluation	4	1	4	No further actions	CLOSED	Not Applicable		
40-229 Rev. B	630226	Motore Martinetto	Leonardo Airborne		VENDOR	0 - FULL RUSTPROOF	0	2	0	To Redesign / Evaluation	N/A	N/A	Redesign / Evaluation	4	1	4	No further actions	CLOSED	Not Applicable		

AS-COPRA Corrosion Prevention Risk Assessment used to determine the Susceptibility to Corrosion, Risk Analysis, Risk Treatment and Mitigation Actions.

EWIS

Electrical Wiring Interconnection System (EWIS) means any wire, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy, including data and signals, between two or more intended termination points.

When selecting connectors take care on applicable SALT SPRAY Class, see Table Below (Connectors and Accessories with the same class).

3. SERVICE CLASS

Military	Finish	RoHS	Material	Material/ Description
C	Anodic Coating	■	Aluminum	200°C, 500 hour salt spray
F	Electroless Nickel	■	Aluminum	200°C, EMI shielding –65dB @ 10GHz, 48 hour salt spray
G	Electroless Nickel	■	Aluminum	200°C, Space grade, 48 hour salt spray
J	Olive Drab Cadmium		Composite	175°C, 2000 hours dynamic salt spray, EMI Shielding –50 dB@10 GHz specification min.
K	Passivated Stainless Steel	■	Stainless Steel	200°C, firewall capability, 500 hour salt spray resistance, EMI –45 dB @ 10 GHz specification min.
L	Stainless Steel w/ Nickel Plate	■	Stainless Steel	Corrosion resistant steel, 200°C, 500 hour salt spray, , non firewall, EMI shielding –65dB @ 10GHz specification min.
M	Electroless Nickel	■	Composite	200°C, EMI shielding –65dB @ 10GHz, 2000 hours dynamic salt spray
N	Stainless Steel w/ Nickel Plate	■	Stainless Steel	Hermetic connectors, corrosion resistant steel, 200°C
S	Stainless Steel w/ Nickel Plate	■	Stainless Steel	Non-hermetic connectors, corrosion resistant steel, 200°, firewall capability, 500 hour salt spray, EMI shielding –65dB @ 10GHz specification min.
T	Durmalon plated	■	Aluminum	Nickel-PTFE alternative to Cadmium, 175°C, 500 hour salt spray, EMI -50dB at 10GHz specification min.
W	Olive Drab Cadmium		Aluminum	175°C , 500 hour salt spray, EMI Shielding –50 dB@10 GHz specification min.
Y	Stainless Steel	■	Stainless Steel	Hermetic seal, 200°C passivated stainless steel
Z	Zinc-Nickel Plated	■	Aluminum	Zinc-Nickel Alternative to Cadmium, +175°C, 500 hour salt spray, EMI Shielding –50 dB @ 10 GHz specification min.

Reference: LHD - EWIS Corrosion Prevention campaign 139G2010X001

Reference: MIL-DTL-38999M, Detail Specification Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded or Breech Coupling), Environment Resistant with Crimp Removable Contacts or Hermetically Sealed with Fixed, Solderable Contacts, General Specification for

CORROSION INGRESS SEAL CONNECTORS - NEW


Mated with Plug using **CORROSION INGRESS SEAL**


Mated with Standard Plug

Amphenol Aerospace has developed a new **CORROSION INGRESS SEAL** for D38999 Series III-style plug connectors which will significantly increase mated pair protection against salt spray and corrosive atmospheres. The new, patent-pending “wiper design” seal fits in a D38999 Series III coupling nut while still allowing standard intermateability with the receptacle.
Early testing has indicated the new **CORROSION INGRESS SEAL** can have up to 10X the protection against D38999-specified salt spray -- from 48 hours to 480 -- while still maintaining shell-to-shell conductivity and EMI functionality. The new seal provides greater protection to the functional portion of the mating threads, allowing the mated connectors to perform longer in highly corrosive environments and areas with significant water ingress. Perfect for shipboard and other SWAMP (**S**evere **W**ater & **M**oisture **P**rone) environments.

Source: Amphenol Aerospace

EXAMPLE OF CORROSION DAMAGED CONNECTORS

Moisture Damage

Pin Oxidation

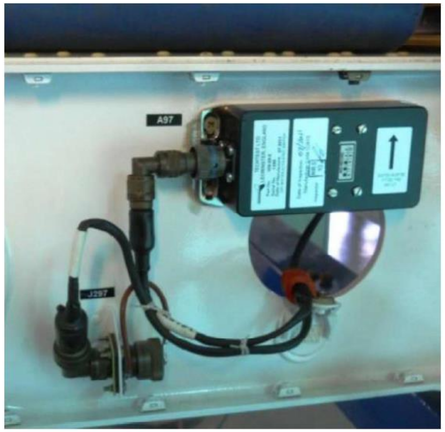
Galvanic Oxidation Component Connector

Galvanic corrosion in the F-16 main fuel shutoff valve connector.

Antenna Cable Plug

Antenna Cable Plug

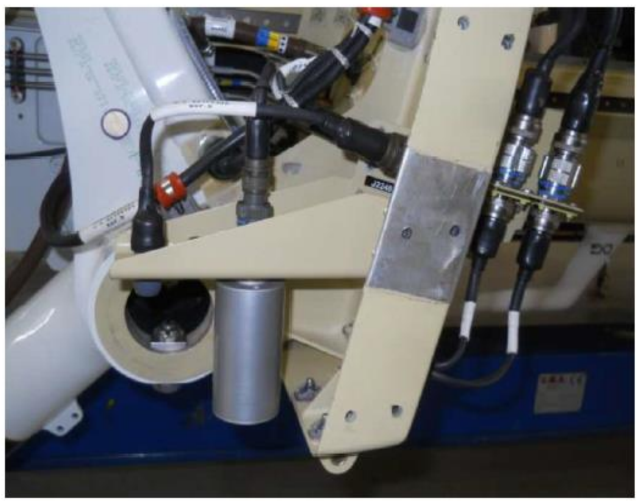
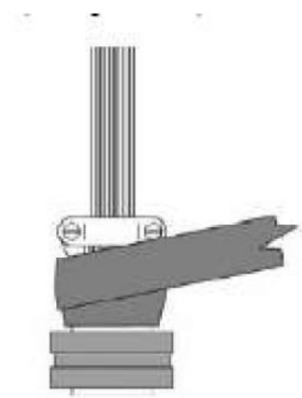
EXAMPLE OF CONNECTORS INSTALLATION – SOURCE “LEONARDO HELICOPTERS”

Correct	To be improved
	

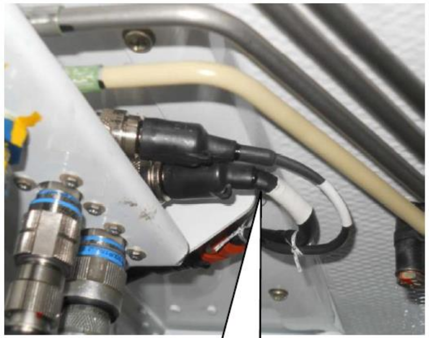
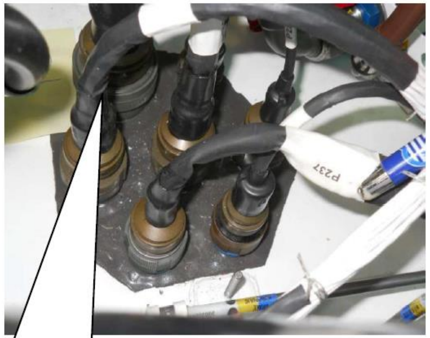
Additional protection maybe required	Additional protection maybe required
	

EXAMPLE OF CONNECTORS INSTALLATION – SOURCE “LEONARDO HELICOPTERS”

CPP n°	Corrosion Prevention Proposal (CPP)	CPP description
D5	Additional protection with tape	Design change for applying external taping for improving salt spray resistance (corrosion) on: • Connector - Connector adapter - Connector backshell Additional protection by taping shall be extremely minimized.

Additional protection required	Additional protection required
	

EXAMPLE OF CONNECTORS INSTALLATION – SOURCE "LEONARDO HELICOPTERS"

Correct	To be improved
	

Sealing assured

Sealing to be improved

Correct	To be improved
	

RESPONSIBILITY FOR CORROSION CONTROL

- **The Production Engineer** is responsible for the application of the CPCP in all projects and to manage all detailed design controls (and all related technical documentation), also to use the FF203 Engineering CPCP Control Checklist for all projects (Components Part Numbers) in order to verify the compliance of the project to the CPCP requirements. The Product Engineer is responsible to manage any reported failure by the COFRES – Corrosion Failure Reporting System (dealing with the PE, QAM and QCM).

- **The Quality Assurance Manager** is responsible for the application and update of the present Instruction and all related applicable documentation, also to manage any Non Conformity.

- **The Quality Control Manager** is responsible for the control of the application of the CPCP in all departments and to manage all detailed production controls (and all related production documentation), also to manage any Non Conformity dealing with the QAM; also to identify and report any corrosion discrepancies in accordance with this instruction and using the provided online systems named COFRES – Corrosion Failure Reporting System.

- **The Maintenance Manager** is responsible for the application of the present instruction and all related Maintenance Documentation, also to identify and report any corrosion discrepancies in accordance with this instruction and using the provided online systems named COFRES – Corrosion Failure Reporting System. The Maintenance Manager is responsible for the application of the FF204 Maintenance CPCP Control Checklist if no CP prescriptions are available or stated in the Maintenance Data or in the CMM.

- **The Production Manager** is responsible for the application of the CPCP in all production departments and to manage all detailed production documentation including CPCP controls (and all related production documentation); also to identify and report any corrosion discrepancies in accordance with this instruction and using the provided online systems named COFRES – Corrosion Failure Reporting System (dealing with the PE, QAM and QCM).

- **The Operators and Control Operators** are responsible for the application of the present instruction, to use all detailed production documentation including CPCP controls, to identify and report any corrosion discrepancies in accordance with this instruction and using the provided online systems named COFRES – Corrosion Failure Reporting System.

KNOWLEDGE OF CORROSION IDENTIFICATION TECHNIQUES

Common NDT methods used to detect corrosion include ultrasonic testing, radiographic testing, and magnetic flux leakage. Risk-based inspection and fitness-for-service assessments are additional methodologies and processes that can complement a monitoring program. Visual Inspection.

To conduct a **detailed visual inspection** of a component with the goal of monitoring corrosion, inspectors scan the unit, and all its parts with their eyes, trying to determine whether:

- **The existing corrosion** (i.e., the corrosion that is being monitored) has grown.
- **There are new areas with corrosion**, as indicated by a discontinuity in the surface.
- **Corrosion on metal exposed parts.**
- **Corrosion on connectors** (body, seals, screws, pins).
- **Corrosion on cabling**
- **Corrosion on coatings** (as Anodized parts, Alodine parts, paint etc.).
- **Corrosion on any fittings**

If the visual inspection indicates that corrosion is growing or that there is new corrosion present, inspectors may want to do a further review of the discontinuous areas with various kinds of non-destructive testing (NDT) tools to quantify the amount of corrosion that is present.

USE OF APPROPRIATE MATERIALS, EQUIPMENT, AND TECHNICAL PUBLICATIONS

The maintenance technical publications (Maintenance Data / CMM) of components of an aircraft are important engineering information for maintaining the continued airworthiness of aircraft, strictly guiding the maintenance of aircraft, and seriously affecting the efficiency of aircraft maintenance. All personnel must use the correct technical publications and the materials/equipment stated in the maintenance and manufacturing documentation.

The Corrosion Protection materials provided by the company are:

- ❑ **Corrosion Inhibitors**
- ❑ **Rust Protection Oils**
- ❑ **Sealing compounds**
- ❑ **other**

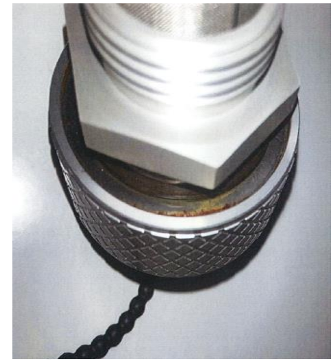
For each of the above materials the company must provide all TDS and MSDS.

DOCUMENTATION

- IO33 CPCP Corrosion Prevention and Control Program
- FF203 Engineering CPCP Control Checklist
- FF204 Maintenance CPCP Control Checklist
- AS-COPRA - Corrosion Prevention Risk Analysis
- AS-COFRES – Corrosion Failure Reporting System (online)
- ASC015 – Corrosion Prevention and Control Program Training Course

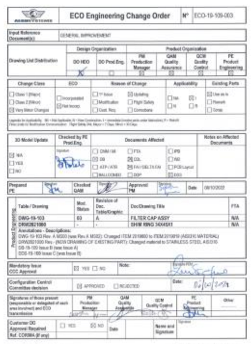
CASE STUDY – FILLER UNIT CORRODED - 2022

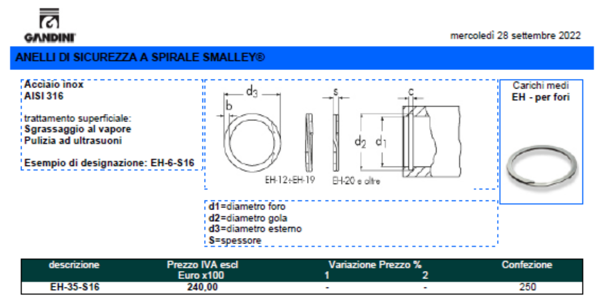
Notification of Corrosion found by the customer on the Filler Unit (Philadelphia) AW109
“the n°1 and n°2 Hydarulic Reservoir Filler Cap are corroded on the inside”



Received Unit and Investigation Report

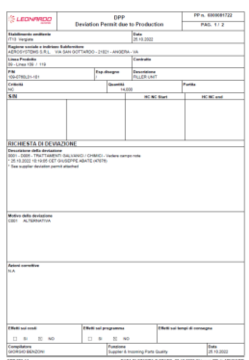
Change Solution ECO





Change of the affected parts with new stainless steel inox parts, change of DB, DDS and Drawings

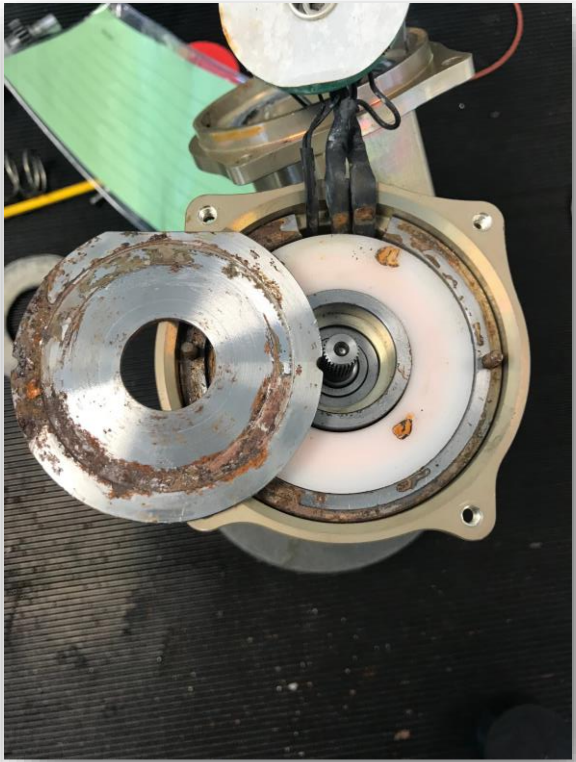
Extisting Units Solution Deviation Permit



Application of Inhibitor Compound on all repaired units

CASE STUDY – AC MOTOR CORRODED

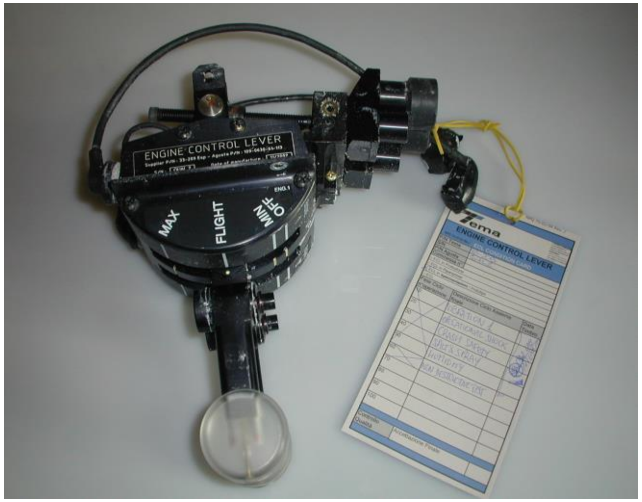
AC Motor damaged / burned as received shows internal corrosion

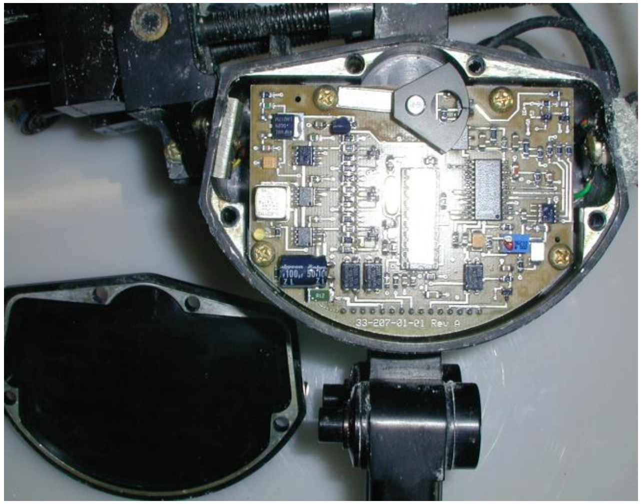


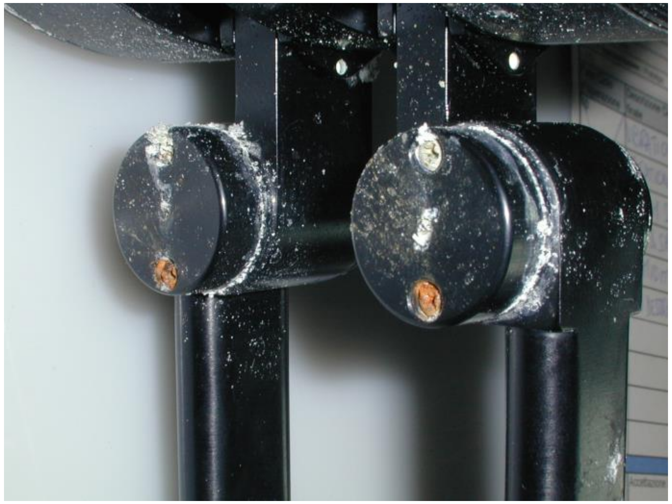
AC Motor damaged / burned as received shows internal corrosion of the brake disk

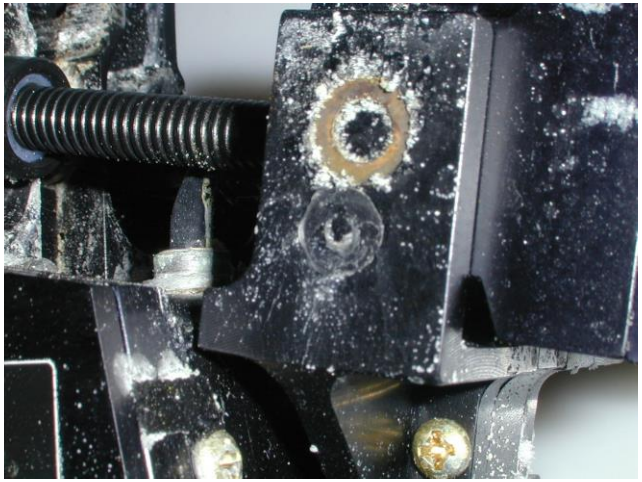
Corrosion found on the rotor

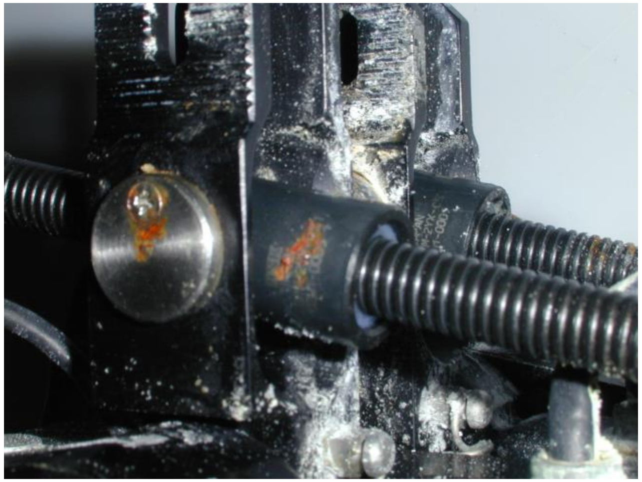
CASE STUDY – ENGINE CONTROL LEVER

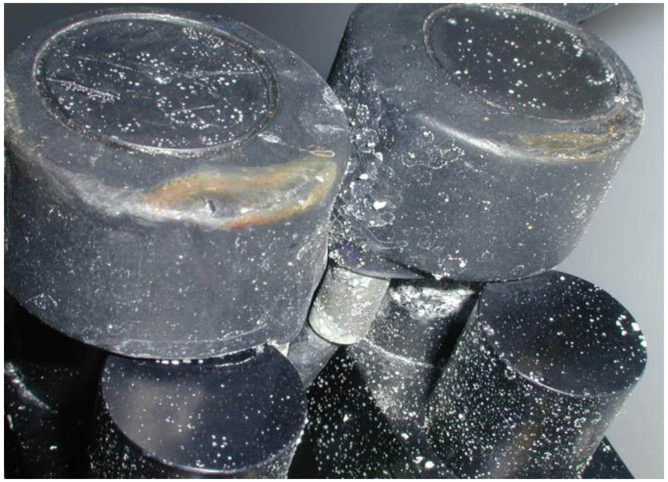












ECL Engine Control Lever after salt spray test show salt and corrosion on Screws and on metallic exposed parts not protected by inhibitors or similar product. The corrosion has not reached the internal circuit and the unit works normally.

ADDENDUM

Tasks to be included in the MPP: CPCP Control, to include CPCP in the KOM.
Tasks to be included in the CRW: CPCP Requirements and CPCP in the Risk Analysis

CIRCUITS

To include the CONFORMAL COATING in the BOM of each circuit assembly.

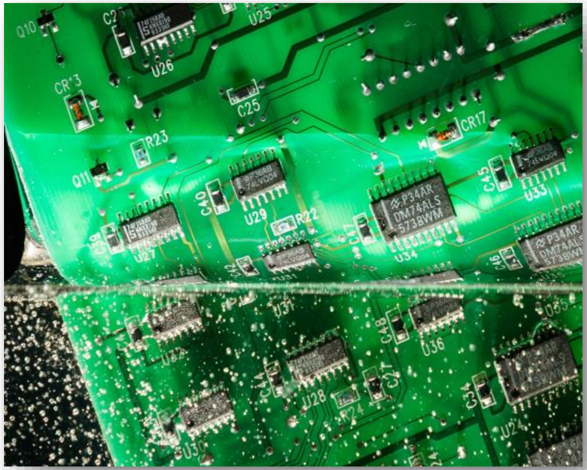
MIL-I-46058C, Insulating Compound (For Coating Printed Circuit Assemblies)

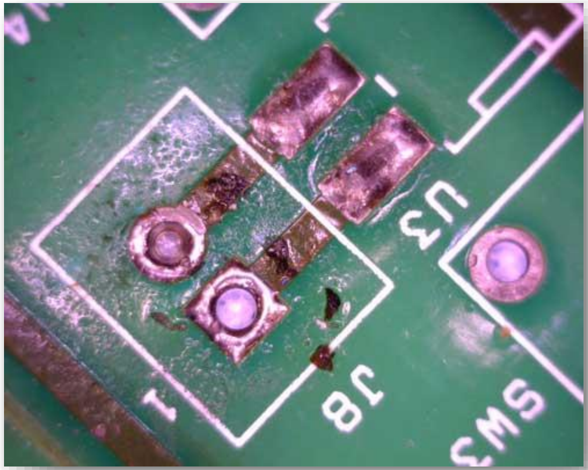
Conformal coating is a protective coating of thin polymeric film applied to printed circuit boards (PCB). The coating is named conformal since it conforms to the contours of the PCB.

Conformal coatings are essential for enhancing the reliability and long-term performance of electronic assemblies. They provide superior protection against: Dust, Dirt, Abrasion, Fungus, Moisture, Chemicals, Mechanical stress, Shock and vibration.

MIL-I-46058C was declared "inactive" in November 1998.

This deactivation meant the standard was "inactive for new designs, except for replacement purposes". This certainly does not mean however that MIL-I-46058C disappeared from the landscape. Today, the MIL-I-46058C standard persists for coating users and specifiers due to its requirement for independent third party certification and still being the only published conformal coating standard with an associated Qualified Product List.





QUESTIONS AND ANSWERS

ASC015 CPCP – Corrosion Prevention and Control Progam

By D. Zambra for Aerosystems

THIS TRAINING MUST BE PERFORMED EVERY 3 YEARS