



UNIVERSIDADE DA BEIRA INTERIOR  
Covilhã | Portugal

# 06-Manutenção

Fabricação e Manutenção de Aeronaves (10384)

2013

Daniel Gondar

Departamento de Ciências Aeroespaciais

# Objetivos

- Support the students with the knowlage of Aeronautic Maintenance in the following areas:
  - Corrosão;
  - Ensaaios não destrutivos;

# Acronyms and Abbreviations

- AD                      Airworthiness Directive
- AMO                   Aircraft Maintenance Organization
- AMP                   Aircraft Maintenance Programme
- AOC                   Air Operator Certificate
- ARC                   Airworthiness review certificate
- ARS                   Airworthiness review staff
- ATPL(A)              Airline Transport Pilot Licence (Aeroplane)
- AWC                   Aerial Work Certificate
- CAME                  Continuing Airworthiness Management Exposition
- CAMO                  Continuous Airworthiness Management Organization
- CDL                   Control Deviation List
- CPL(A)                Commercial Pilot Licence (Aeroplane)
- CTI                    Circular Técnica de Informação
- DDS                   Deferred Deffect Sheet (Section 4 of Tech Log)
- DOA                   Disign Organization Approval

# Acronyms and Abbreviations

- EPA European Parts Approval
- FTO Flyght Training Organization
- HIL Hold Item List
- MEL Minimum Equipment List
- NAA National Aviation Authority
- OC On Condition
- OH Overhaul
- PPL(A) Private Pilot Licence (Aeroplane)
- RET Removal
- SB Service Bulletin
- STC Supplement Type Certificate
- TBO Time Between Overhaul
- TCDS Type Certificate Data Sheet
- TLB Technical Log Book

# Corrosion

- Corrosion - due to a complex electrochemical action, is a damage area of any size and depth which results in a cross-sectional area change. Depth of such pitting damage must be determined by a cleanup operation. Damage of this type may occur on surfaces of structural elements.
- Classification of corrosion damage.
  - Corroded: mild to moderate - This corrosion can be cleaned up by chemical and/or mechanical methods not requiring structural repair.
  - Corroded: severe - This corrosion requires replacement of part or structural repair after cleanup of corrosion.

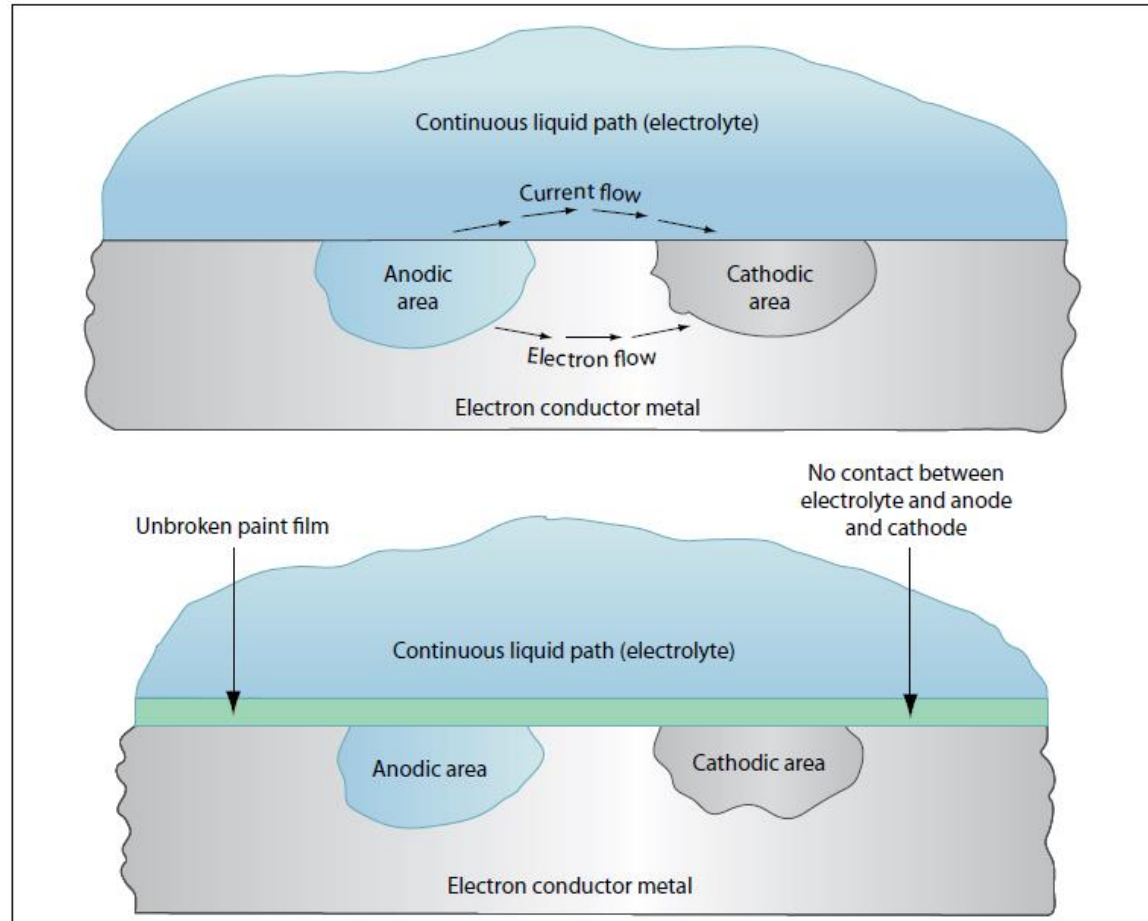
# Corrosion

- Determine the degree of corrosion damage as to classification described above. Use dial depth gage if damaged area is accessible. Before measurements are made, visually determine if corrosion is in an area which has previously been reworked.
- Types of Corrosion: There are two general classifications of corrosion that cover most of the specific forms:
  - direct chemical attack and
  - electrochemical attack.

# Corrosion

- In both types of corrosion, the metal is converted into a metallic compound such as an oxide, hydroxide, or sulfate. The corrosion process always involves two simultaneous changes:
  - The metal that is attacked or oxidized suffers what may be called anodic change, and
  - the corrosive agent is reduced and may be considered as undergoing cathodic change.

# Corrosion





# Corrosion

- Direct Chemical Attack, or pure chemical corrosion, is an attack resulting from a direct exposure of a bare surface to caustic liquid or gaseous agents. Unlike electrochemical attack where the anodic and cathodic changes may be taking place a measurable distance apart, the changes in direct chemical attack are occurring simultaneously at the same point. The most common agents causing direct chemical attack on aircraft are:
  - (1) spilled battery acid or fumes from batteries;
  - (2) residual flux deposits resulting from inadequately cleaned, welded, brazed, or soldered joints; and
  - (3) entrapped caustic cleaning solutions.
- Electrochemical Attack may be likened chemically to the electrolytic reaction that takes place in electroplating, anodizing, or in a dry cell battery. The reaction in this corrosive attack requires a medium, usually water, which is capable of conducting a tiny current of electricity. When a metal comes in contact with a corrosive agent and is also connected by a liquid or gaseous path through which electrons may flow, corrosion begins as the metal decays by oxidation.

# Corrosion



- **Forms of Corrosion:** There are many forms of corrosion. The form of corrosion depends on the metal involved, its size and shape, its specific function, atmospheric conditions, and the corrosion producing agents present. Those described in this section are the more common forms found on airframe structures
- **Surface Corrosion:** Surface corrosion appears as a general roughening, etching, or pitting of the surface of a metal, frequently accompanied by a powdery deposit of corrosion products. Surface corrosion may be caused by either direct chemical or electrochemical attack. Sometimes corrosion will spread under the surface coating and cannot be recognized by either the roughening of the surface or the powdery deposit. Instead, closer inspection will reveal the paint or plating is lifted off the surface in small blisters which result from the pressure of the underlying accumulation of corrosion products.

# Corrosion

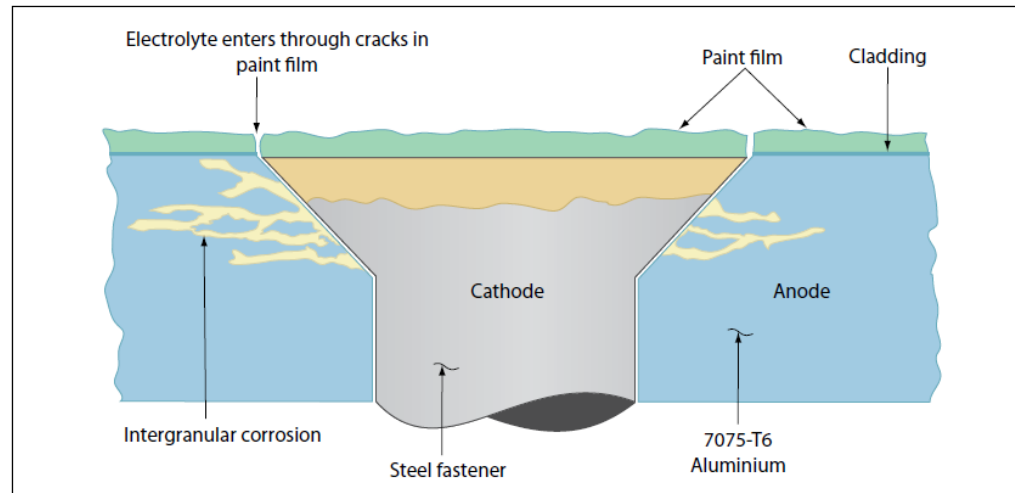


- **Surface Corrosion (cont.):**
- Filiform corrosion gives the appearance of a series of small worms under the paint surface. It is often seen on surfaces that have been improperly chemically treated prior to painting.
- **Dissimilar Metal Corrosion:** Extensive pitting damage may result from contact between dissimilar metal parts in the presence of a conductor. While surface corrosion may or may not be taking place, a galvanic action, not unlike electroplating, occurs at the points or areas of contact where the insulation between the surfaces has broken down or been omitted. This electrochemical attack can be very serious because in many instances the action is taking place out of sight, and the only way to detect it prior to structural failure is by disassembly and inspection.



# Corrosion

- **Intergranular Corrosion:** This type of corrosion is an attack along the grain boundaries of an alloy and commonly results from a lack of uniformity in the alloy structure. Aluminum alloys and some stainless steels are particularly susceptible to this form of electrochemical attack. [Figure 6-8] The lack of uniformity is caused by changes that occur in the alloy during heating and cooling during the material's manufacturing process. Intergranular corrosion may exist without visible surface evidence. Very severe intergranular corrosion may sometimes cause the surface of a metal to "exfoliate."



# Corrosion

- **Intergranular Corrosion (Cont.):** Very severe intergranular corrosion may sometimes cause the surface of a metal to “exfoliate.” [Figure 6-9]



- **Stress Corrosion:** occurs as the result of the combined effect of sustained tensile stresses and a corrosive environment. Stress corrosion cracking is found in most metal systems; however, it is particularly characteristic of aluminum, copper, certain stainless steels, and high strength alloy steels (over 240,000 psi).



# Corrosion

- **Fretting Corrosion:** is a particularly damaging form of corrosive attack that occurs when two mating surfaces, normally at rest with respect to one another, are subject to slight relative motion. It is characterized by pitting of the surfaces and the generation of considerable quantities of finely divided debris.



# Corrosion

- Factors Affecting Corrosion
- Climate: The environmental conditions under which an aircraft is maintained and operated greatly affect corrosion characteristics. In a predominately marine environment (with exposure to sea water and salt air), moisture-laden air is considerably more detrimental to an aircraft than it would be if all operations were conducted in a dry climate. Temperature considerations are important because the speed of electrochemical attack is increased in a hot, moist climate.
- Foreign Material: Among the controllable factors which affect the onset and spread of corrosive attack is foreign material that adheres to the metal surfaces. Such foreign material includes:
  - Soil and atmospheric dust.
  - Oil, grease, and engine exhaust residues.
  - Salt water and salt moisture condensation.
  - Spilled battery acids and caustic cleaning solutions.
  - Welding and brazing flux residues.

# Corrosion

- Cessna CPCP: <http://www.youtube.com/watch?v=GYo-rgfdsrE&feature=youtu.be>
- Corrosion Part 1: <http://www.youtube.com/watch?v=eKMPojS10DY>
- Corrosion Part 2: <http://www.youtube.com/watch?v=hlcMBENnt6Q>
- Corrosion Part 3: <http://www.youtube.com/watch?v=cHfRGQdnC04>



# Corrosion

- Corrosion Control for Aircraft Part 1:  
[http://www.youtube.com/watch?v=\\_SuszN7dHY8](http://www.youtube.com/watch?v=_SuszN7dHY8)
- Corrosion Control for Aircraft Part 2:  
<http://www.youtube.com/watch?v=SUQ0vH-r5yw>

# NDT

- NDT Inspection:

- Nondestructive testing (NDT) is the process of inspecting, testing, or evaluating materials, components or assemblies for discontinuities, or differences in characteristics without destroying the serviceability of the part or system. In other words, when the inspection or test is completed the part can still be used.
- Current NDT methods are:
  - Acoustic Emission Testing (AE) and Ultrasonic Testing (UT),
  - Electromagnetic Testing (ET),
  - Laser Testing Methods (LM),
  - Leak Testing (LT),
  - Magnetic Flux Leakage (MFL) and Magnetic Particle Testing (MT),
  - Liquid Penetrant Testing (PT),
  - Neutron Radiographic Testing (NR),
  - Radiographic Testing (RT),
  - Thermal/Infrared Testing (IR),
  - Vibration Analysis (VA),
  - Visual Testing (VT).

# NDT

- **Radiographic Testing (RT):** A radiographic inspection will show internal and external structural details. This inspection is applicable for all types of parts and materials. It is a type of nondestructive test that lets you to examine the parts of the airframe structure that you can not get access to or that you can not examine with other types of nondestructive tests.
- In a radiographic inspection test, an X-ray beam passes through a part or an assembly to expose a piece of radiographic film. Structural details of the part or assembly will show as differences in film density after the film is processed. An operator must interpret the radiograph to find defects or damage.

# NDT

- ULTRASONIC THICKNESS TESTING - METALS
- 1. Description
- A. Inspect metal structure to determine the remaining thickness after removal of corrosion or other blending procedures.

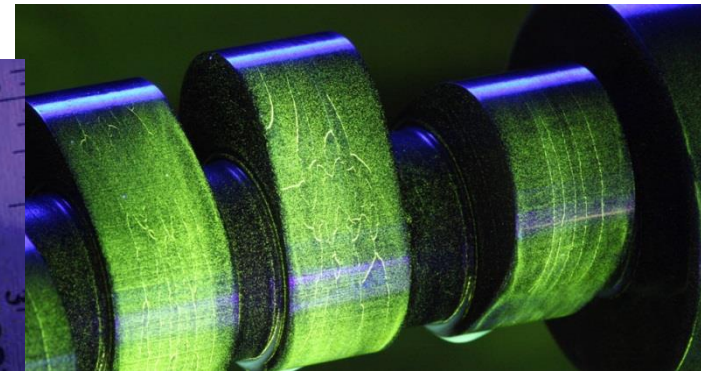
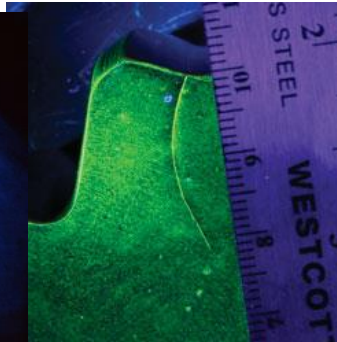
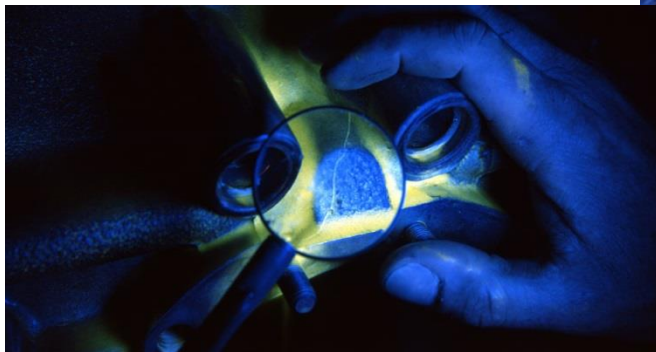


# NDT

- **EDDY CURRENT Inspection:** is effective for the detection of surface or near surface cracks in most metals. This method is accomplished by inducing eddy currents into the part and observing electrical variations of the induced field. The character of the observed field change is interpreted to determine the nature of the defect. Eddy current inspection can be applied to airframe parts or assemblies where the inspection area is accessible to contact by the eddy current probe. An important use of eddy current inspection is the detection of cracking caused by corrosion and stress around fastener holes with the fasteners installed.

# NDT

- **PENETRANT INSPECTION:** Visible dye penetrants (Type 2) shall not be used for inspections on this airplane or components thereof. The reason for this is visible dye penetrants will penetrate very fine cracks, but their sensitivity is so poor, they are easily missed and will not show an indication. The dye trapped in these tight defects cannot be cleaned well under even the best conditions. Removal under field conditions is impossible. Since in service inspections are normally reinspections of specific critical areas, the possibility of a dye buildup in defects preventing the entrance of subsequently applied penetrants cannot be tolerated.



# NDT

- **PENETRANT INSPECTION (Cont.):** Penetrant inspection is used to detect small cracks or discontinuities open to the surface that may not be evident by normal visual inspection. Penetrant inspection can be used on most airframe parts and assemblies accessible for its application. The inspection is performed by applying a liquid that penetrates into surface defects. Excessive penetrant liquid is removed and a suitable developer applied to draw the penetrant from the surface defects so that visual indications are obtained by color contrast and fluorescence of the penetrant under the display of a "black light." The penetrant method of inspection requires that the surface in the inspection area be thoroughly cleaned and free of paint.





# NDT

- **MAGNETIC PARTICLE INSPECTION:** is a nondestructive method for revealing surface and near subsurface discontinuities in parts made of magnetic materials. It consists of three basic operations.
  - Establishment of a suitable magnetic field.
  - Application of magnetic particles.
  - Examination and evaluation of the particle accumulations.





# NDT

- **MAGNETIC PARTICLE INSPECTION (Cont.):** Alloys which contain a high percentage of iron and can be magnetized, make up a class of metals called ferromagnetic. Magnetic particle inspection can detect discontinuities in parts made of ferromagnetic materials. If the part is made of material which is nonmagnetic, it cannot be inspected by this method. The magnetic particle inspection method will detect surface discontinuities including those that are too fine to be seen with the naked eye and those that lie slightly below the surface, and when special equipment is used, the more deeply seated discontinuities.

# NDT

- **OPTICAL INSPECTION** : Visual inspections with the aid of a borescope will show integral structural details of all types of parts and materials that are otherwise inaccessible to the eye. It is used as a means of inspection of airframe structure, engine components and other parts of the airplane that are not readily accessible and when it is determined that other types of nondestructive testing are not required.

# NDT

- NDT: <http://youtu.be/tlE3eK0g6vU>
- Ultrasonic testing: [http://www.youtube.com/watch?v=Qb-bY3\\_Wh14&feature=youtu.be](http://www.youtube.com/watch?v=Qb-bY3_Wh14&feature=youtu.be)