

CESSNA AIRCRAFT COMPANY
MODEL 172 SERIES (1977 - 1986)
SERVICE MANUAL

CORROSION

1. General

- A. This section describes corrosion to assist maintenance personnel in identification of various types of corrosion and application of preventative measures to minimize corrosion activity.
- B. Corrosion is the deterioration of a metal by reaction to its environment. Corrosion occurs because most metals have a tendency to return to their natural state.

2. Corrosion Characteristics

- A. Metals corrode by direct chemical or electrochemical (galvanic) reaction to their environment. The following describes electrochemical reaction:
 - (1) Electrochemical corrosion can best be compared to a battery cell. Three conditions must exist before electrochemical corrosion can occur:
 - (a) There must be a metal that corrodes and acts as the anode (+ positive).
 - (b) There must be a less corrodible metal that acts as the cathode (- negative).
 - (c) There must be a continuous liquid path between the two metals, which acts as the electrolyte. This liquid path may be condensation or, in some cases, only the humidity in the air.
 - (2) Elimination of any one of the three conditions will stop the corrosion reaction process.
 - (3) A simple method of minimizing corrosion is adding a layer of pure Aluminum to the surface. The pure Aluminum is less susceptible to corrosion and also has a very low electropotential voltage relative to the remainder of the alloyed sheet. This process is conducted at the fabricating mill and the product is called Alclad. Model 172 airplanes had sheet metal parts constructed of Alclad sheet.
 - (4) One of the best ways to eliminate one of the conditions is to apply an organic film (such as paint, grease or plastic) to the surface of the metal affected. This will prevent electrolyte from connecting the cathode to the anode so current cannot flow and therefore, prevent corrosive reaction and was not available for production Model 172 airplanes.
 - (5) Other means employed to prevent electrochemical corrosion include anodizing and electroplating. Anodizing and other passivating treatments produce a tightly adhering chemical film which is much less electrochemically reactive than the base metal. Because the electrolyte cannot reach the base metal, corrosion is prevented. Electroplating deposits a metal layer on the surface of the base material, which is either less electrochemically reactive (Example: chrome on steel) or is more compatible with the metal to which it is coupled (Example: cadmium plated steel fasteners used in aluminum).
 - (6) At normal atmospheric temperatures, metals do not corrode appreciably without moisture. However, the moisture in the air is usually enough to start corrosive action.
 - (7) The initial rate of corrosion is usually much greater than the rate after a short period of time. This slowing down occurs because of the oxide film that forms on the metal surfaces. This film tends to protect the metal underneath.
 - (8) When components and systems constructed of many different types of metals must perform under various climatic conditions, corrosion becomes a complex problem. The presence of salts on metal surfaces (sea or coastal operations) greatly increases the electrical conductivity of any moisture present and accelerates corrosion.
 - (9) Other environmental conditions that contribute to corrosion are:
 - (a) Moisture collecting on dirt particles.
 - (b) Moisture collecting in crevices between lap joints, around rivets, bolts and screws.

3. Types of Corrosion

- A. The common types of corrosion that are encountered in airplane maintenance are described in this section. In many instances more than one form of corrosion may exist at the same time. While this makes it difficult to determine the exact type of corrosion, it should still be possible to determine that a corrosive process is taking place. If it is impractical to replace an assembly or component, contact an authorized repair shop.

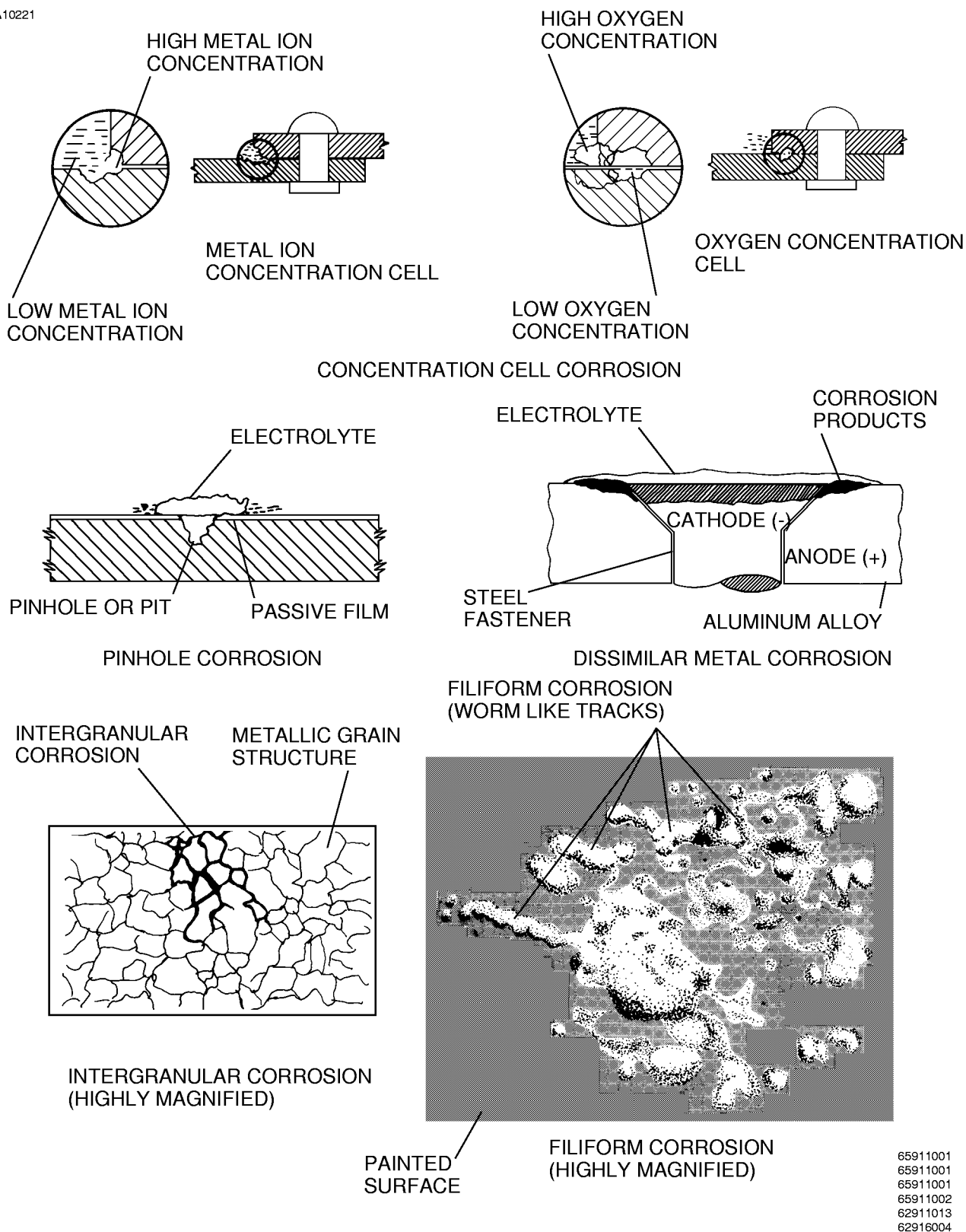
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MODEL 172 SERIES (1977 - 1986)
SERVICE MANUAL

- B. Direct Chemical Attack.
- (1) Direct chemical attack may take place when corrosive chemicals, such as battery electrolyte, caustic cleaning solutions or residual flux deposits are allowed to remain on the surface or become entrapped in cracks or joints. Welding or soldering flux residues are hygroscopic and will tend to cause severe pitting. Any potentially corrosive substance should be carefully and completely removed whenever such spillage occurs.
- C. Pitting Corrosion.
- (1) The most common effect of corrosion on polished aluminum parts is called pitting. It is first noticeable as a white or gray powdery deposit, similar to dust, which blotches the surface (Refer to Figure 1).
 - (2) When the deposit is cleaned away, tiny pits can be seen in the surface. Pitting may also occur in other types of metal alloys.
- D. Intergranular Corrosion.
- (1) Intergranular corrosion (Refer to Figure 1) takes place because of the nature of the structure of metal alloys. As metals cool from the molten state, a granular structure is formed. The size and composition of the grains and the material in the grain boundaries depend on several factors including the type of alloy and rate of cooling from the molten state or cooling after heat-treating. The grains differ chemically and may differ electrochemically from the boundary material. If an electrolyte comes in contact with this type of structure, the grains and boundary material will act as anode and cathode and undergo galvanic corrosion. The corrosion proceeds rapidly along the grain boundaries and destroys the solidity of the metal.
- E. Exfoliation gives the appearance of sheets of very thin metal separated by corrosion products. It is a form of intergranular corrosion. Since the corroded products are thicker than the uncorroded aluminum, exfoliation shows itself by "lifting up" the surface grains of a metal by the force of expanding corrosion. This type of corrosion is most often seen on extruded sections, where the grain thicknesses are usually less than in rolled alloy form.
- F. Dissimilar Metal Corrosion. (Refer to Figure 1)
- (1) Dissimilar metal corrosion occurs when dissimilar metals are in contact in the presence of an electrolyte. A common example of dissimilar metal contact involves the attachment of aluminum parts by steel fasteners.
- G. Concentration Cell Corrosion. (Refer to Figure 1)
- (1) Concentration cell corrosion occurs when two or more areas of the same metal surface are in contact with different concentrations of the same solution, such as moist air, water and chemicals.
 - (2) The general types of concentration cell corrosion are identified as metal ion cells and oxygen cells. Refer to Figure 1.
- H. Filiform Corrosion.
- (1) Filiform corrosion is a "concentration cell" corrosion process. When a break in the protective coating over aluminum occurs, the oxygen concentration at the back or bottom of the corrosion cell is lower than that at its open surface. The oxygen concentration gradient thus established, causes an electric current flow and corrosion results. Filiform corrosion results when this happens along the interface between the metal and the protective coating and appears as small worm-like tracks. Filiform corrosion generally starts around fasteners, holes and countersinks and at the edge of sheet metal on the outer surface of the airplane. Filiform corrosion is more prevalent in areas with a warm, damp and salty environment.
 - (2) To help prevent filiform corrosion development, the airplane should be:
 - (a) Spray washed at least every two to three weeks (especially in a warm, damp environment).
 - (b) Waxed with a good grade of water repellent wax to help keep water from accumulating in skin joints and around countersinks.

NOTE: Wax only clean surfaces. Wax applied over salt deposits will almost guarantee a trapped salt deposit, which is capable of accumulating moisture and developing into filiform corrosion.

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MODEL 172 SERIES (1977 - 1986)
 SERVICE MANUAL

A10221



Corrosion
 Figure 1 (Sheet 1)

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MODEL 172 SERIES (1977 - 1986)
SERVICE MANUAL

- (c) Keep the airplane hangared to protect it from the atmosphere.
 - (d) Fly the airplane to promote aeration of enclosed parts.
 - (e) Ensure all vent/drain holes are open to ventilate the interior of airplane.
- (3) To remove filiform corrosion once it has been discovered:
 - (a) Remove paint from corroded area.
 - (b) Remove corrosion by sanding area to metal surface, using either a ScotchBrite pad or 320 grit sandpaper (aluminum oxide or silicone carbide grit).
 - (c) Clean and refinish surface.
- I. Stress Corrosion Cracking.
 - (1) This corrosion is caused by the simultaneous effects of tensile stress and corrosion. The stress may be internal or applied. Internal stresses are produced by nonuniform shaping during cold working of the metal, press and shrink fitting general hardware and those induced when pieces, such as rivets and bolts, are formed. The amount of stress varies from point to point within the component. Stress corrosion is most likely to occur at points of highest stress, which are also subject to corrosion influence.
- J. Fatigue Corrosion.
 - (1) Fatigue corrosion is a special case of stress corrosion caused by the combined effects of cyclic stress and corrosion.

4. Typical Corrosion Areas

- A. Aluminum appears high in the electrochemical series of elements and its position indicates that it should corrode very easily. However, the formation of a tightly adhering oxide film offers increased resistance under mild corrosive conditions. Most metals in contact with aluminum form couples, which undergo galvanic corrosion attack. The alloys of aluminum are subject to pitting, intergranular corrosion and intergranular stress corrosion cracking.
- B. Battery Electrolyte.
 - (1) Battery electrolyte used in lead acid batteries is composed of 35% sulfuric acid and 65% water. When electrolyte is spilled, it should be cleaned up immediately. A weak boric acid solution may be applied to the spillage area followed by a thorough flushing with clean, cold running water. If boric acid is not available, flush the area with clean, cold water.
 - (2) If corrosion appears, use an approved repair method to repair the structure.
- C. Steel Control Cable.
 - (1) Checking for corrosion on a control cable is normally accomplished during the preventative maintenance check. During preventative maintenance, broken wire and wear of the control cable are also checked.
 - (2) If the surface of the cable is corroded, carefully force the cable open by reverse twisting and visually inspect the interior. Corrosion on the interior strands of the cable constitutes failure and the cable must be replaced. If no internal corrosion is detected, remove loose external rust and corrosion with a clean, dry, coarse weave rag or fiber brush.

CAUTION: Do not use metallic wools or solvents to clean installed cables. Metallic wools will embed dissimilar metal particles in the cables and create further corrosion. Solvents will remove internal cable lubricant, allowing cable strands to abrade and further corrode.

 - (3) After thorough cleaning of exterior cable surfaces, if the cable appears dry, the lubrication originally supplied on the cable has probably oxidized and needs to be replaced with a light oil (5w motor oil, "3 in 1" oil, LPS-2, WD-40 or Diesel Fuel). Apply the oil with a cloth and then rub the cable with the cloth to coat the cable with a thin layer of oil. Excessive oil will collect dust and be as damaging to the cable as no lubrication.
- D. Piano Type Hinges.
 - (1) The construction of piano type hinges forms moisture traps as well as the dissimilar metal couple between the steel hinge pin and the aluminum hinge. Solid film lubricants are often applied to reduce corrosion problems.

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MODEL 172 SERIES (1977 - 1986)
SERVICE MANUAL

- (2) Care and replacement of solid film lubricants require special techniques peculiar to the particular solid film being used. Good solid film lubricants are lubricants conforming to Specification MIL-PRF-81322.
 - (a) Solid film lubricants prevent galvanic coupling on close tolerance fittings and reduce fretting corrosion. Surface preparation is extremely important to the service or wear life of solid film lubricants.
 - (b) Solid film lubricants are usually applied over surfaces coated with other films, such as anodize and phosphate. They have been successfully applied over organic coatings such as epoxy primers.

CAUTION: Solid film lubricants containing graphite, either alone or in mixture with any other lubricants, should not be used since graphite is cathodic to most metals and will cause galvanic corrosion in the presence of electrolytes.

E. Requirements peculiar to faying surfaces of airframes, airframe parts and attaching surfaces of equipment, accessories and components.

- (1) When repairs are made on equipment or when accessories and components are installed, the attaching surfaces of these items should be protected. The following requirements are peculiar to faying surfaces on airframes, airframe parts and attaching surfaces of equipment, accessories and components:
- (2) Surfaces of similar or dissimilar metals.
 - (a) All faying surfaces, seams and lap joints protected by sealant must have the entire faying surface coated with sealant. Excess material squeezed out should be removed so that a fillet seal remains. Joint areas, which could hold water, should be filled or coated with sealant.
- (3) Attaching Parts.
 - (a) Attaching parts, such as nuts, bushings, spacers, washers, screws, self-tapping screws, self-locking nuts and clamps, do not need to be painted in detail except when dissimilar metals or wood contact are involved in the materials being joined. Such parts should receive a wet or dry coat of primer.

NOTE: Corrosion inhibiting solid film lubricants, Specification MIL-PRF-46010 and/or MIL-L-46147, may be used to protect attaching parts from corrosion.

- (b) All holes drilled or reworked in aluminum alloys to receive bolts, bushings, screws, rivets and studs should be treated before installation of fasteners or bushings.
 - (c) All rivets used to assemble dissimilar metals should be installed wet, with sealant, conforming to Specification MIL-PRF-81733 Corrosion inhibiting sealer (Type X).
 - (4) Close tolerance bolts passing through dissimilar metals should be coated before installation, with a corrosion inhibiting solid film lubricant conforming to Specification MIL-PRF-46010 and/or MIL-L-46147.
 - (5) Washers made of aluminum alloy of suitable design should be used under machine screws, countersunk fasteners, bolt heads and nuts.
 - (6) Adjustable parts threads such as tie rod ends, turnbuckles, etc., should be protected with solid film lubrication conforming to Specification MIL-PRF-46010 and/or MIL-L-46147.
 - (7) Slip fits should be assembled using wet primer conforming to Specification MIL-PRF-23377G or later, non-drying zinc chromate paste or solid film lubricant conforming to Specification MIL-PRF-46010 and/or MIL-L-46147.
 - (8) Press fits should be accomplished with oil containing material conforming to Specification MIL-C-11796, Class 3 and/or MIL-C-16173, Class 1 or with other suitable material that will not induce corrosion.

F. Electrical.

- (1) Bonding and ground connections should be as described by the installation procedure.
- (2) Potting compounds are used to safeguard against moisture. Corrosion in electrical systems and resultant failure can often be attributed to moisture and climatic condition.

CESSNA AIRCRAFT COMPANY
MODEL 172 SERIES (1977 - 1986)
SERVICE MANUAL

- (3) Corrosion of metal can be accelerated because of the moisture absorbed by fungi. Fungi can create serious problems since it can act as an electrolyte, destroying the resistance of electrical insulating surfaces. Specification ASTM D3955 or ASTM D295-58 outlines moisture and fungus resistant varnish to be used.

5. General Corrosion Repair

- A. This section provides general guidance on the repair of corroded area. The procedure presented is:
 - (1) Gain access to the entire corroded area.
 - (2) Mechanically remove the corrosion products
 - (3) Determine the extent of the corrosion damage
 - (4) Repair or replace the damaged components
 - (5) Finish the new or repaired parts.
 - (6) Replace removed components
- B. Gain access to the entire corroded area.
 - (1) Corrosion products typically retain moisture. If those products are not removed, corrosion will continue. Corrosion can take place within layered construction or under (behind) equipment fastened in place.
- C. Mechanically remove the corrosion.
 - (1) Chemicals will not remove corrosion. The best chemicals can do is interrupt the corrosion cell by either displacing water or shielding corrosion products from oxygen. In either case, the effect is temporary and will need to be renewed.
 - (2) Sand mild corrosion.
 - (3) Use rotary files or sanding disks for heavier corrosion. Finish up with fine sand paper.

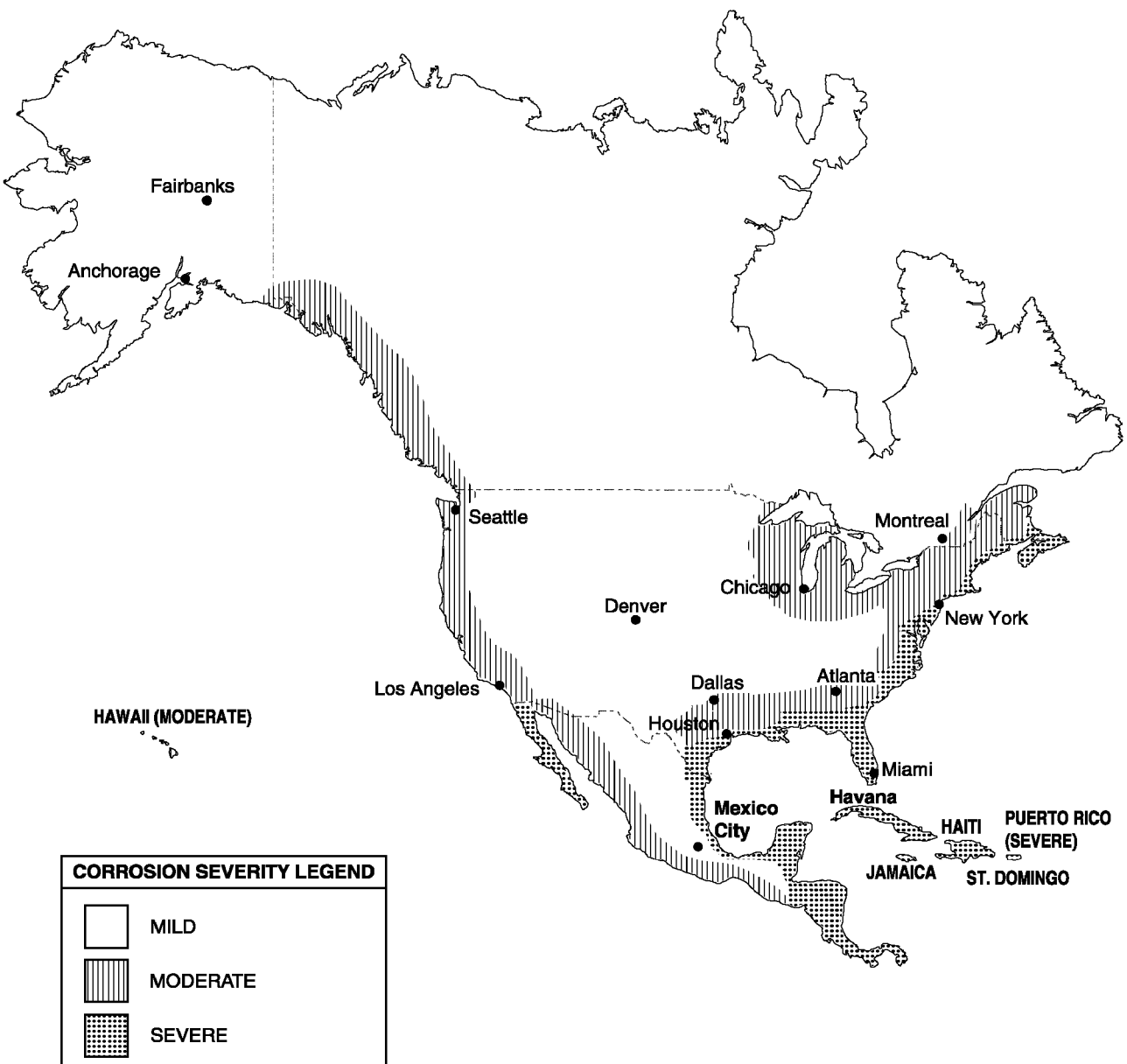
NOTE: Do not use metallic wool. Metal particles will be embedded in the surface, which will initiate additional corrosion.
- D. Determine the extent of corrosion damage.
 - (1) Direct measurement is simplest.
 - (2) Indirect measurement may be necessary
 - (a) Eddy Current or ultrasound tools can be used for thickness measurement away from part edges.
- E. Repair or replace corrosion damaged components
 - (1) Replace damaged or corroded steel or aluminum fasteners.
 - (2) If the material is sheet or plate, the thickness is allowed to be as little as 90% of the nominal thickness.
 - (3) This general allowance is not allowed if:
 - (a) The area of the part contains fasteners.
 - (b) The reduced thickness compromises the fit or function of a part.
- F. Finish the new or repaired parts
 - (1) Apply Alodine or similar anticorrosion compounds to new or repaired parts or
 - (2) Apply zinc chromate or
 - (3) Apply epoxy fuel tank primer.
 - (4) Paint the exterior or visible interior parts according to Section 19 of the applicable Model 172 Service Manual.
- G. Replace Removed Components.

6. General

- A. This section contains maps which define the severity of potential corrosion on airplane structure.
- B. Corrosion severity zones are affected by atmospheric and other climatic factors. The maps provided in this section are for guidance when determining types and frequency of required inspections and other maintenance. Refer to Figure 2, Figure 3, Figure 4, Figure 5, Figure 6 and Figure 7.

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MODEL 172 SERIES (1977 - 1986)
SERVICE MANUAL

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North America Corrosion Severity Map
Figure 2 (Sheet 1)

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SERVICE MANUAL

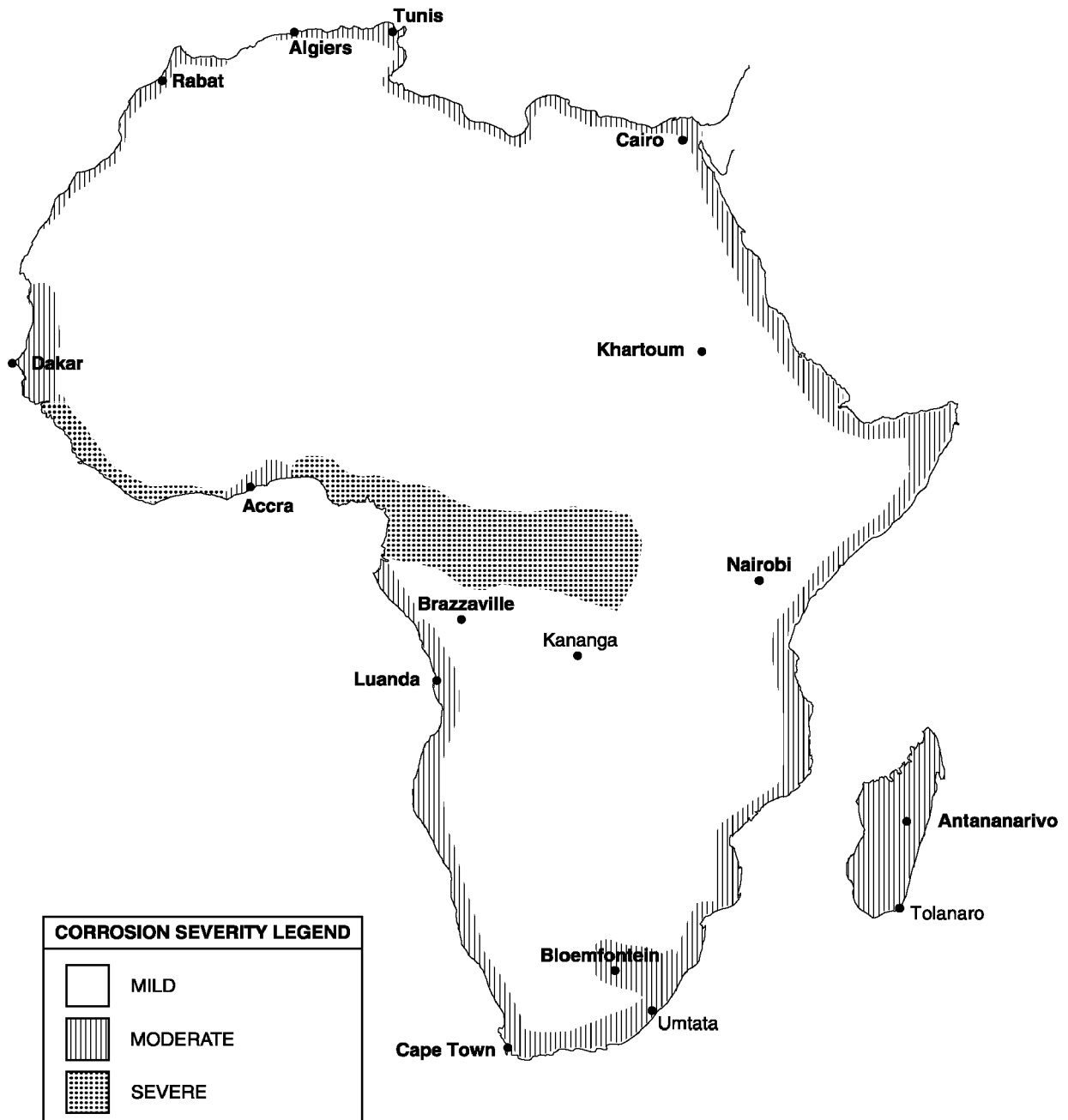
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South America Corrosion Severity Map
Figure 3 (Sheet 1)

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MODEL 172 SERIES (1977 - 1986)
SERVICE MANUAL

A27659



Africa Corrosion Severity Map
Figure 4 (Sheet 1)

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Asia Corrosion Severity Map
 Figure 5 (Sheet 1)

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MODEL 172 SERIES (1977 - 1986)
 SERVICE MANUAL

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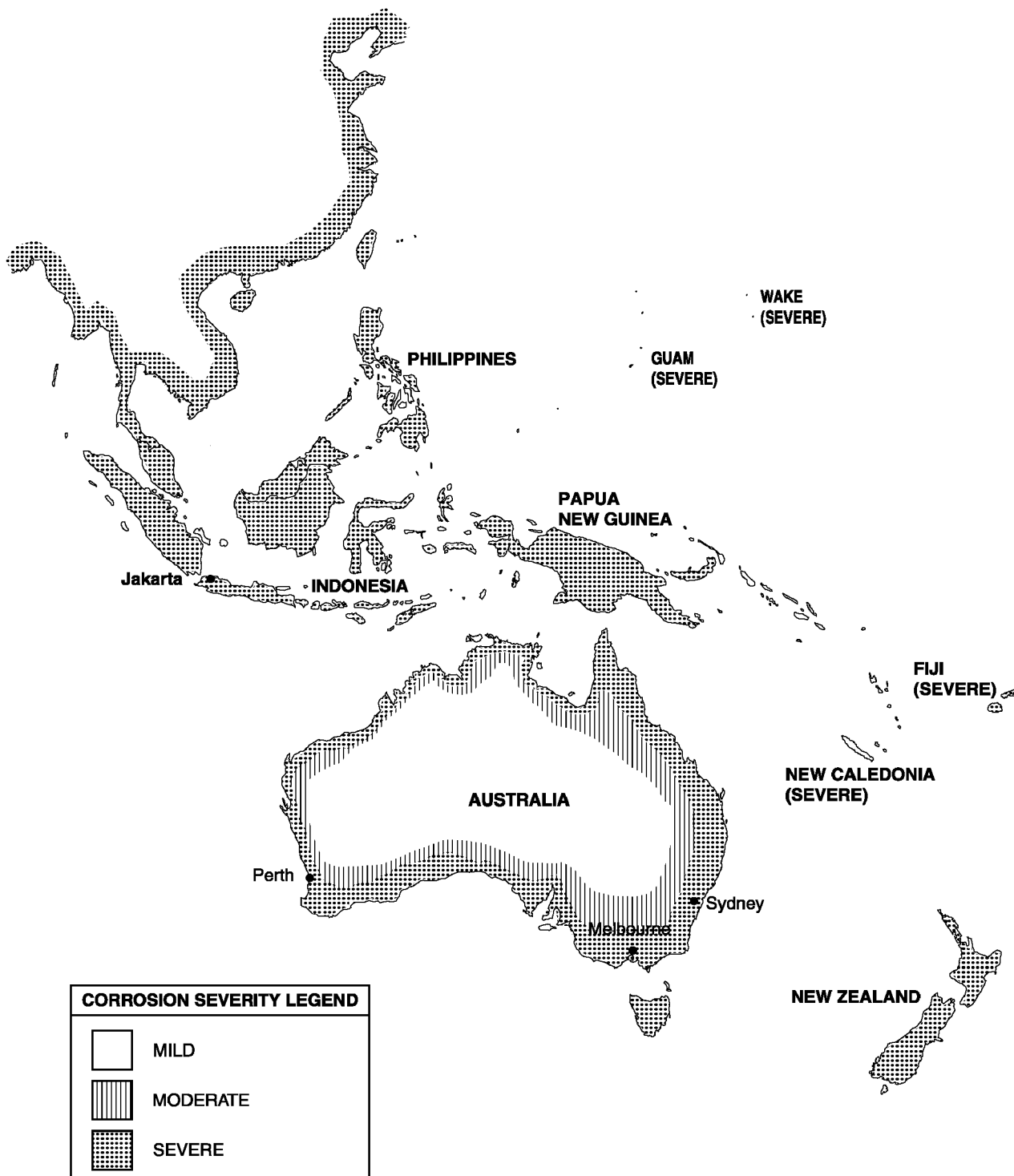


CORROSION SEVERITY LEGEND	
	MILD
	MODERATE
	SEVERE

Europe and Asia Minor Corrosion Severity Map
 Figure 6 (Sheet 1)

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MODEL 172 SERIES (1977 - 1986)
SERVICE MANUAL

A27660



South Pacific Corrosion Severity Map
Figure 7 (Sheet 1)