CHAPTER 6. CORROSION, INSPECTION & PROTECTION

SECTION 1. GENERAL

6-1. GENERAL. The purpose of this chapter is to provide information that will help maintenance personnel prevent, control, identify, and treat various types of corrosion. (Refer to AC 43-4A, Corrosion Control For Aircraft for a more in-depth study on the detection and treatment of corrosion.)

a. Corrosion is a natural occurrence that attacks metal by chemical or electrochemical action and converts it back to a metallic compound.

b. Four conditions must exist before electrochemical corrosion can occur. (See figure 6-1.) They are:

(1) A metal subject to corrosion (Anode);

(2) A dissimilar conductive material (Cathode), which has less tendency to corrode;

(3) Presence of a continuous, conductive liquid path (Electrolyte); and

(4) Electrical contact between the anode and the cathode (usually in the form of metal-to-metal contact such as rivets, bolts, and corrosion).

c. Elimination of any one of these conditions will stop electrochemical corrosion. (See figure 6-2.)

NOTE: Paint can mask the initial stages of corrosion. Since corrosion products occupy more volume than the original metal, painted surfaces should be inspected often for irregularities such as blisters, flakes, chips, and lumps.

6-2. FACTORS INFLUENCING CORROSION.

a. Some factors which influence metal corrosion and the rate of corrosion are:

(1) Type of metal;

(2) Heat treatment and grain direction;

(3) Presence of a dissimilar, less corrodible metal;

(4) Anodic and cathodic surface areas (in galvanic corrosion);

(5) Temperature;

(6) Presence of electrolytes (hard water, salt water, battery fluids, etc.);

(7) Availability of oxygen;

(8) Presence of biological organisms;

(9) Mechanical stress on the corroding metal; and,

(10) Time of exposure to a corrosive environment.

(11) Lead/graphite pencil marks on aircraft surface metals.

b. Most pure metals are not suitable for aircraft construction and are used only in combination with other metals to form alloys. Most alloys are made up entirely of small crystalline regions, called grains. Corrosion can occur on surfaces of those regions which are less resistant and also at boundaries between regions, resulting in the formation of pits and intergranular corrosion. Metals have a wide range of corrosion resistance. The most active metals, (those which lose electrons easily), such as magnesium and aluminum, corrode easily. The most noble metals (those which do not lose electrons easily), such as gold and silver, do not corrode easily.

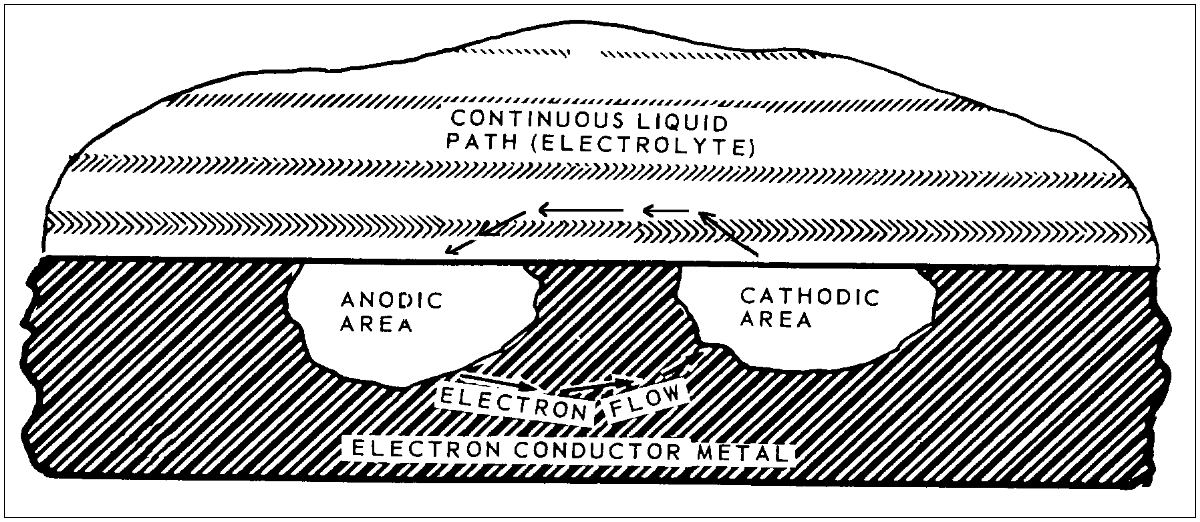

FIGURE 6-1. Simplified corrosion cell showing conditions which must exist for electrochemical corrosion.

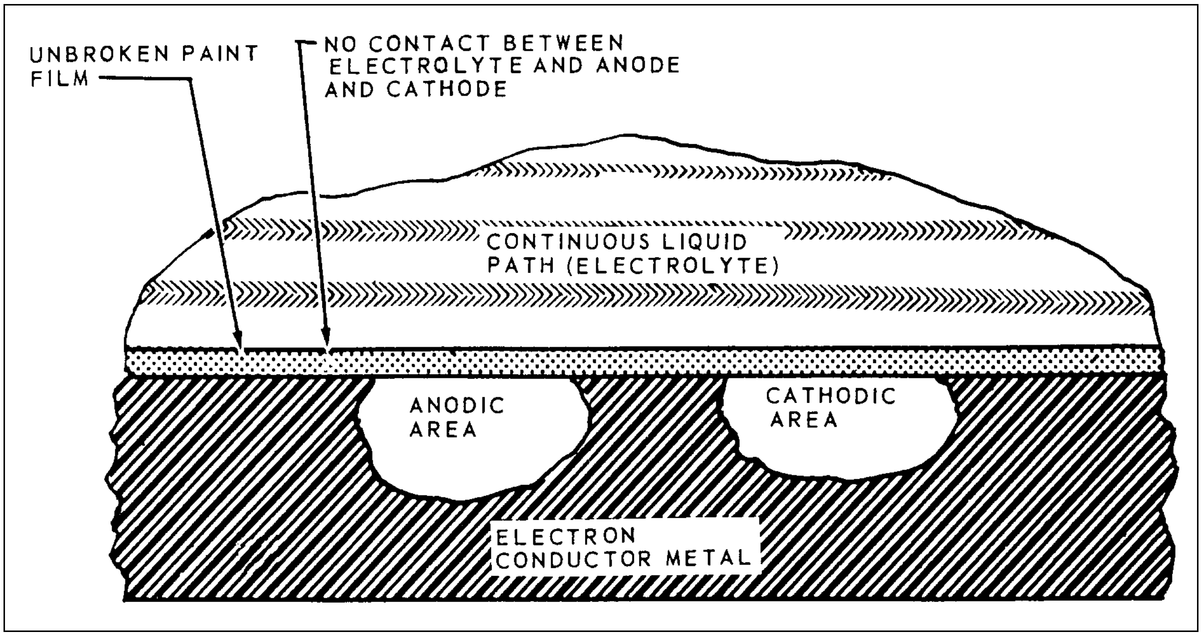

FIGURE 6-2. Elimination of corrosion by application of an organic film to metal surface.

c. Corrosion is quickened by high-temperature environments that accelerate chemical reactions and increase the concentration of water vapor in the air.

d. Electrolytes (electrically-conducting solutions) form on surfaces when condensation, salt spray, rain, or rinse water accumulate. Dirt, salt, acidic gases, and engine exhaust gases can dissolve on wet surfaces, increasing the electrical conductivity of the electrolyte, thereby increasing the rate of corrosion.

e. When some of the electrolyte on a metal surface is partially confined, (such as between faying surfaces or in a deep crevice) the metal around this area corrodes more rapidly. This type of corrosion is called an oxygen concentration cell. Corrosion occurs more rapidly because the reduced oxygen content of the confined electrolyte causes the adjacent metal to become anodic to other metal surfaces on the same part that are immersed in electrolyte or exposed to air.

f. Slime, molds, fungi, and other living organisms (some microscopic) can grow on damp surfaces. Once they are established, the area usually remains damp, increasing the possibility of corrosion.

g. Manufacturing processes such as machining, forming, welding, or heat treatment can leave residual stress in aircraft parts and can cause cracking in a corrosive environment.

6-3. COMMON CORROSIVE AGENTS. Substances that cause corrosion are called corrosive agents. The most common corrosive agents are acids, alkalies, and salts. The atmosphere and water, the two most common media for these agents, may also act as corrosive agents.

a. Any acid will severely corrode most of the alloys used in airframes. The most destructive are sulfuric acid (battery acid), halogen acids (hydrochloric, hydrofluoric, and hydrobromic), nitrous oxide compounds, and organic acids found in the wastes of humans and animals.

b. Alkalies, as a group, are not as corrosive as acids. Aluminum and magnesium alloys are exceedingly prone to corrosive attack by many alkaline solutions unless the solutions contain a corrosion inhibitor. Substances particularly corrosive to aluminum are washing soda, potash (wood ashes), and lime (cement dust).

c. The major atmospheric corrosive agents are oxygen and airborne moisture. Corrosion often results from the direct action of atmospheric oxygen and moisture on metal nd the presence of additional moisture often accelerates corrosive attack, particularly on ferrous alloys. The atmosphere may also contain other corrosive gases and contaminants, particularly industrial and marine salt spray.

d. The corrosiveness of water depends on the type and quantity of dissolved mineral and organic impurities and dissolved gasses (particularly oxygen) in the water. One characteristic of water that makes it corrosive is its conductivity. Physical factors, such as water temperature and velocity also have a direct bearing on its corrosiveness.

6-4. MICRO-ORGANISMS.

a. Bacteria may be either aerobic or anaerobic. Aerobic bacteria require oxygen to live. They accelerate corrosion by oxidizing sulfur to produce sulfuric acid. Bacteria living adjacent to metals may promote corrosion by depleting the oxygen supply or by releasing metabolic products. Anaerobic bacteria, on the other hand, can survive only when free oxygen is not present. The metabolism of these bacteria requires them to obtain part of their sustenance by oxidizing inorganic compounds, such as iron, sulfur, hydrogen, and carbon monoxide. The resultant chemical reactions cause corrosion.

b. Fungi are the growths of micro-organisms that feed on organic materials. While low humidity does not kill microbes, it slows their growth and may prevent corrosion damage. Ideal growth conditions for most micro-organisms are temperatures between 68 and 104 °F (20 and 40 °C) and relative humidity between 85 and 100 percent.

c. Damage resulting from microbial growth can occur when any of three basic mechanisms, or a combination of these, is brought into play. First, fungi have a tendency to hold moisture, which contributes to other forms of corrosion. Second, because fungi are living organisms, they need food to survive. This food is obtained from the material on which the fungi are growing. Third, these micro-organisms secrete corrosive fluids that attack many materials, including some that are not fungi nutrient.

d. Microbial growth must be removed completely to avoid corrosion. Microbial growth should be removed by hand with a firm non-metallic bristle brush and water. Removal of microbial growth is easier if the growth is kept wet with water. Microbial growth may also be removed with steam at 100 psi. Protective clothing must be used when using steam for removing microbial growth.

6-5.—6-10. [RESERVED.]

SECTION 2. TYPES OF CORROSION

6-11. GENERAL. All corrosive attacks begin on the surface of the metal making the classification of corrosion by physical appearance a convenient means of identification. (See figure 6-3.)

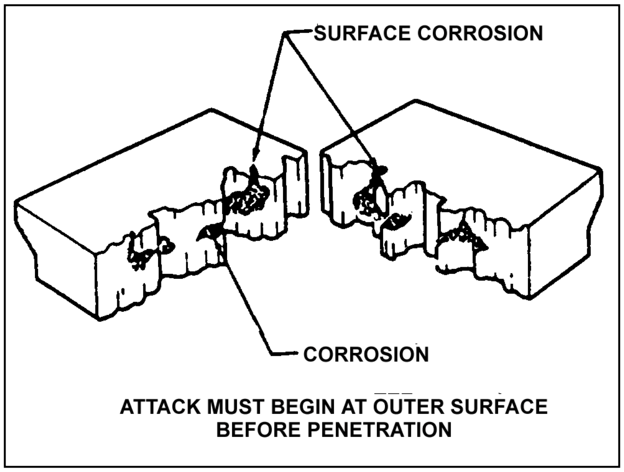

FIGURE 6-3. Corrosion attack.

6-12. GENERAL SURFACE CORROSION. General surface corrosion (also referred to as Uniform Etch or Uniform Attack Corrosion) is the most common form of corrosion and results from a direct chemical attack on a metal surface and involves only the metal surface. (See figure 6-4.) General surface corrosion usually occurs over a wide area and is more or less equal in dispersion. On a polished surface, this type of corrosion is first seen as a general dulling of the surface, and if allowed to continue, the surface becomes rough and possibly frosted in appearance. The discoloration or general dulling of metal created by exposure to elevated temperatures is not to be considered general surface corrosion.

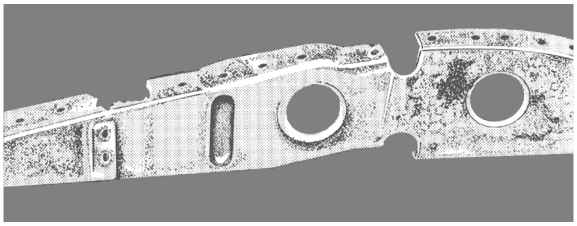

FIGURE 6-4. General surface corrosion.

6-13. PITTING CORROSION. Pitting corrosion is one of the most destructive and intense forms of corrosion. It can occur in any metal but is most common on metals that form protective oxide films, such as aluminum and magnesium alloys. It is first noticeable as a white or gray powdery deposit, similar to dust, which blotches the surface. When the deposit is cleaned away, tiny holes or pits can be seen in the surface. (See figures 6-5(a) and 6-5(b).) These small surface openings may penetrate deeply into structural members and cause damage completely out of proportion to its surface appearance.

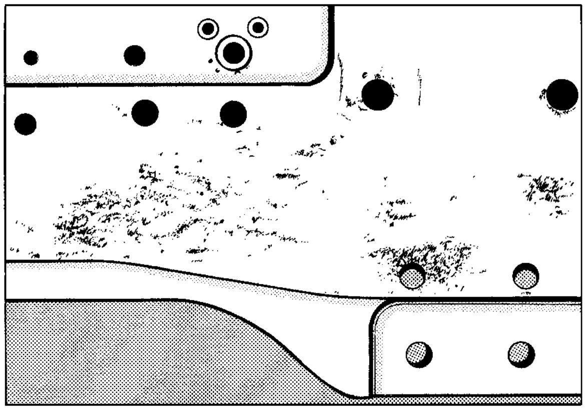

FIGURE 6-5(a). Pitting corrosion (external view).

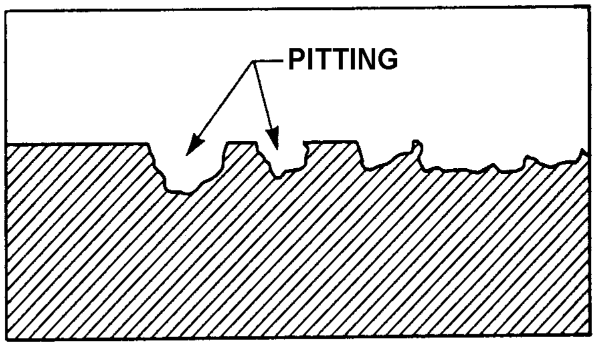

FIGURE 6-5(b). Pitting corrosion (magnified cross section).

6-14. CONCENTRATION CELL CORROSION. Concentration cell corrosion, (also known as Crevice Corrosion) is corrosion of metals in a metal-to-metal joint, corrosion at the edge of a joint even though the joined metals are identical, or corrosion of a spot on the metal surface covered by a foreign material. Metal ion concentration cells and oxygen concentration cells are the two general types of concentration cell corrosion. (See figure 6-6.)

a. Metal Ion Concentration Cells. The solution may consist of water and ions of the metal which is in contact with water. A high concentration of the metal ions will normally exist under faying surfaces where the solution is stagnant, and a low concentration of metal ions will exist adjacent to the crevice which is created by the faying surface. An electrical potential will exist between the two points; the area of the metal in contact with the low concentration of metal ions will be anodic and corrode, and the area in contact with the high metal ion concentration will be cathodic and not show signs of corrosion.

b. Oxygen Concentration Cells. The solution in contact with the metal surface will normally contain dissolved oxygen. An oxygen cell can develop at any point where the oxygen in the air is not allowed to diffuse into the solution, thereby creating a difference in oxygen concentration between two points. Typical locations of oxygen concentration cells are under gaskets, wood, rubber, and other materials in contact with the metal surface. Corrosion will occur at the area of low oxygen concentration (anode). Alloys such as stainless steel are particularly susceptible to this type of crevice corrosion.

6-15. ACTIVE-PASSIVE CELLS. Metals which depend on a tightly adhering passive film, usually an oxide, for corrosion protection are prone to rapid corrosive attack by active-passive cells. Active-passive cells are often referred to as a type of concentration cell corrosion. However, the active-passive cell is actually two forms of corrosion working in conjunction. The corrosive action usually starts as an oxygen concentration cell. As an example, salt deposits on the metal surface in the presence of water containing oxygen can create the oxygen cell. The passive film will be broken beneath the salt crystals. Once the passive film is broken, the active metal beneath the film will be exposed to corrosive attack. (See figure 6-7.) Rapid pitting of the active metal will result. This reaction can become locally intense due to several factors. First the reaction is augmented by the affected area, since the proportion of the exposed base metal is small compared to the surrounding nonreactive metal. This effectively concentrates the focal point of the reaction, often resulting in deep pits in a short time and a greater rate of corrosion.

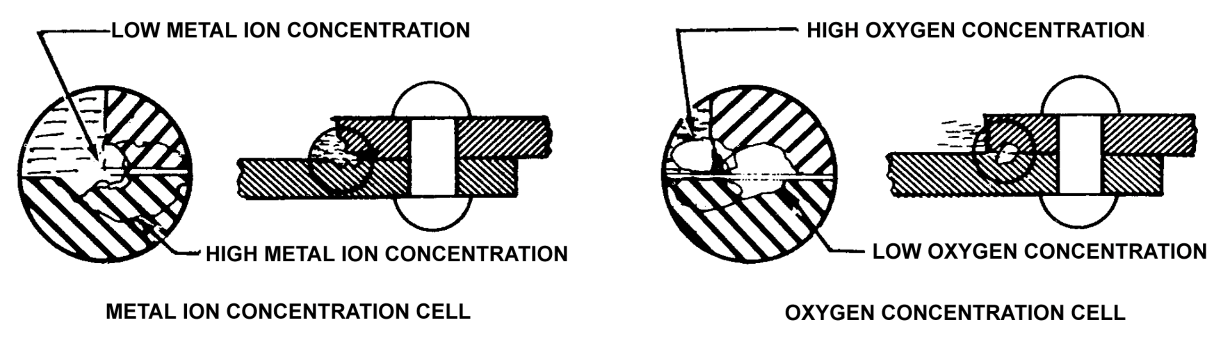

FIGURE 6-6. Concentration cell corrosion.

6-16. FILIFORM CORROSION. Filiform corrosion is a special form of oxygen concentration cell which occurs on metal surfaces having an organic coating system. It is recognized by its characteristic worm-like trace of corrosion products beneath the paint film. (See figure 6-8.) Polyurethane finishes are especially susceptible to filiform corrosion. Filiform occurs when the relative humidity of the air is between 78 and 90 percent and the surface is slightly acidic. This corrosion usually attacks steel and aluminum surfaces. The traces never cross on steel, but they will cross under one another on aluminum which makes the damage deeper and more severe for aluminum. If the corrosion is not removed, the area treated, and a protective finish applied, the corrosion can lead to inter-granular corrosion, especially around fasteners and at seams. Filiform corrosion can be removed using glass bead blasting material with portable abrasive blasting equipment or sanding. Filiform corrosion can be prevented by storing aircraft in an environment with a relative humidity below 70 percent, using coating systems having a low rate of diffusion for oxygen and water vapors, and by washing the aircraft to remove acidic contaminants from the surface.

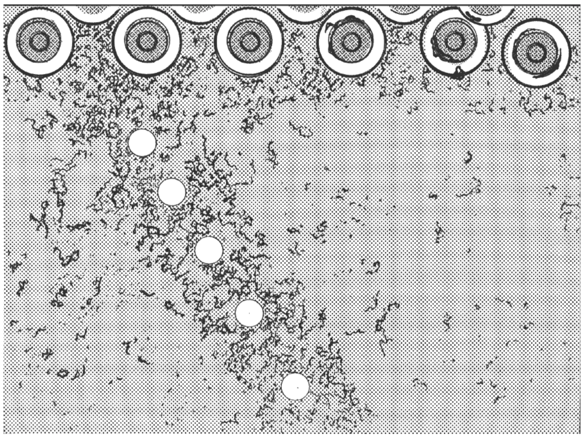

FIGURE 6-8. Filiform corrosion.

6-17. INTERGRANULAR CORROSION. Inter-granular corrosion is an attack on the grain boundaries of a metal. A highly magnified cross section of any commercial alloy shows the granular structure of the metal. It consists of quantities of individual grains, and each of these tiny grains has a clearly defined boundary which chemically differs from the metal within the grain. The grain boundary and the grain center can react with each other as anode and cathode when in contact with an electrolyte. (See figure 6-9.) Rapid selective corrosion of the grain boundaries can occur. High-strength aluminum alloys such as 2014 and 7075 are more susceptible to inter-granular corrosion if they have been improperly heat-treated and then exposed to a corrosive environment.

6-18. EXFOLIATION CORROSION. Exfoliation corrosion is an advanced form of inter-granular corrosion and shows itself by lifting up the surface grains of a metal by the force of expanding corrosion products occurring at the grain boundaries just below the surface. (See figure 6-10.) It is visible evidence of inter-granular corrosion and is most often seen on extruded sections where grain thickness are usually less than in rolled forms.

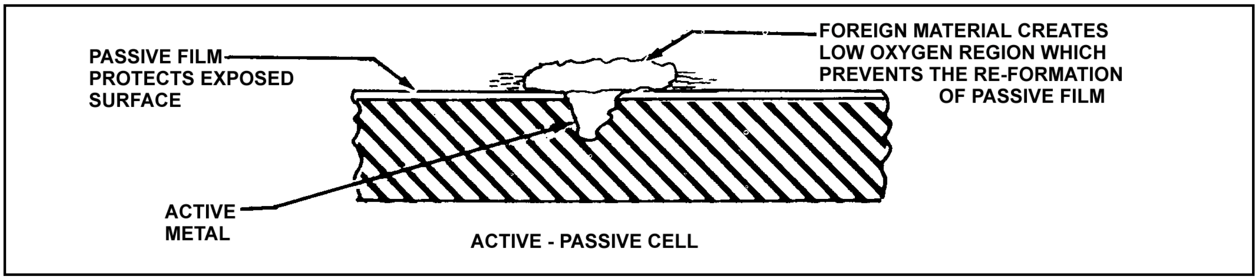

FIGURE 6-7. Active-passive cell.

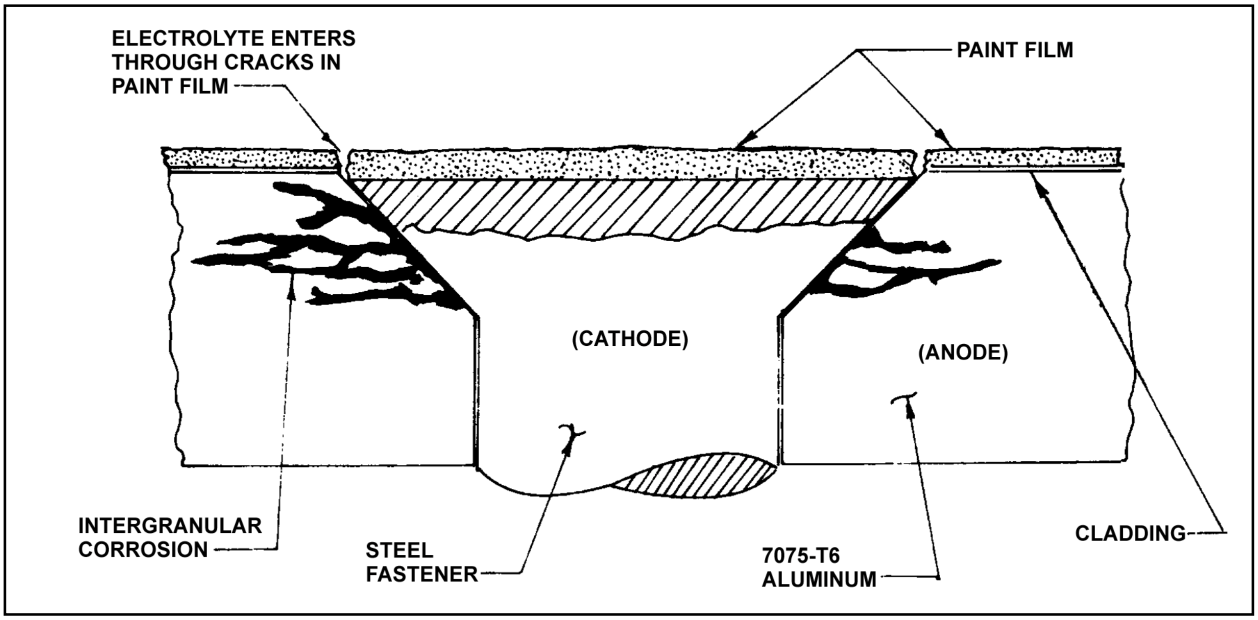

FIGURE 6-9. Inter-granular Corrosion of 7075-T6 aluminum adjacent to steel fastener.

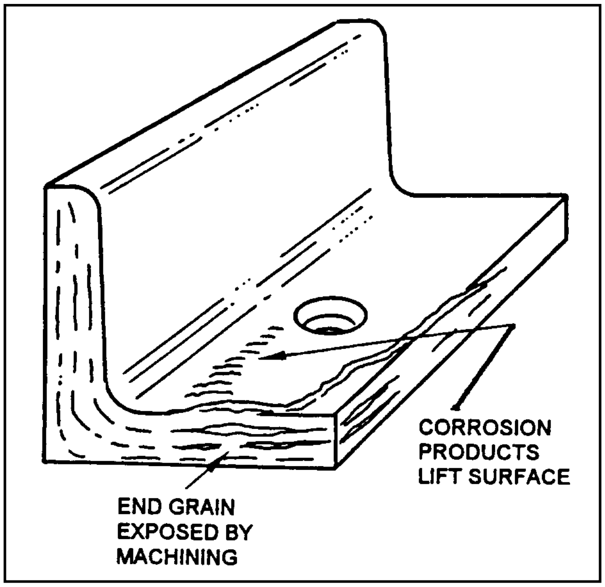

FIGURE 6-10. Exfoliation corrosion.

6-19. GALVANIC CORROSION. Galvanic corrosion occurs when two dissimilar metals make contact in the presence of an electrolyte. (See figure 6-11.) It is usually recognizable by the presence of a build-up of corrosion at the joint between the metals.

6-20. STRESS CORROSION CRACKING. This form of corrosion involves a constant or cyclic stress, acting in conjunction with a damaging chemical environment. The stress may be caused by internal or external loading.

a. Internal stress may be trapped in a part of structure during manufacturing processes such as cold working or by unequal cooling from high temperatures. Most manufacturers follow up these processes with a stress relief operation. Even so, sometimes stress remains trapped. The stress may be externally introduced in part structure by riveting, welding, bolting, clamping, press fit, etc. If a slight mismatch occurs, or a fastener is over-torque, internal stress will be present.

b. Internal stress is more important than design stress, because stress corrosion is difficult to recognize before it has overcome the design safety factor. The level of stress varies from point to point within the metal. Stresses near the yield strength are generally necessary to promote stress corrosion cracking. (See figure 6-12.) However, failures may occur at lower stresses. Specific environments have been identified which cause stress corrosion cracking of certain alloys.

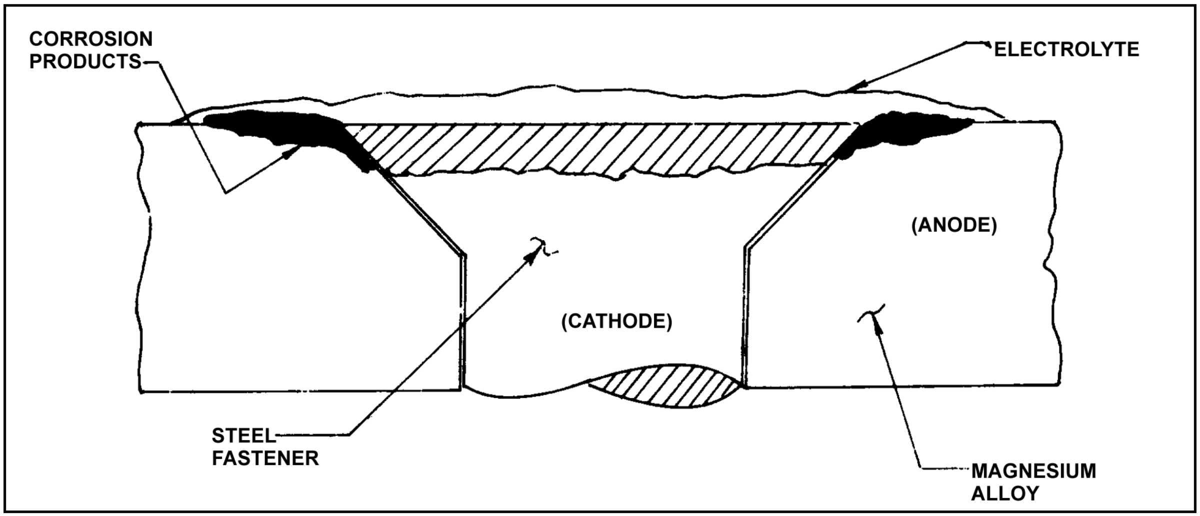

FIGURE 6-11. Galvanic corrosion of magnesium adjacent to steel fastener.

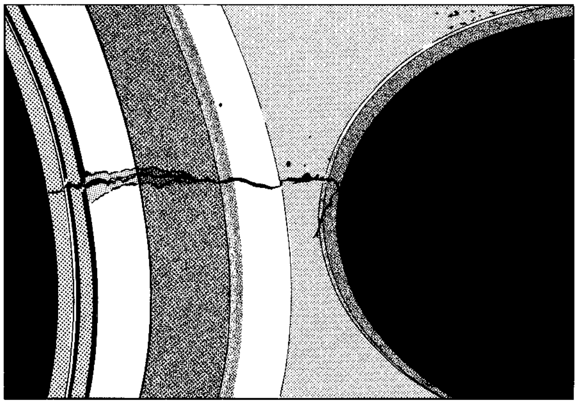

FIGURE 6-12. Stress corrosion cracking.

(1) Salt solutions and sea water cause stress corrosion cracking of high-strength, heat-treated steel and aluminum alloys.

(2) Methyl alcohol-hydrochloric acid solutions will cause stress corrosion cracking of some titanium alloys.

(3) Magnesium alloys may stress-corrode in moist air.

(4) Stress Corrosion may be reduced by

- applying protective coatings,
- stress relief heat treatments,
- using corrosion inhibitors, or
- controlling the environment.

6-21. FATIGUE CORROSION. Fatigue corrosion involves cyclic stress and a corrosive environment. Metals may withstand cyclic stress for an infinite number of cycles so long as the stress is below the endurance limit of the metal. Once the limit has been exceeded, the metal will eventually crack and fail from metal fatigue. However, when the part or structure undergoing cyclic stress is also exposed to a corrosive environment, the stress level for failure may be reduced many times. Thus, failure occurs at stress levels that can be dangerously low depending on the number of cycles assigned to the life-limited part.

a. Fatigue corrosion failure occurs in two stages. During the first stage the combined action of corrosion and cyclic stress damages the metal by pitting and crack formations to such a degree that fracture by cyclic stress will occur, even if the corrosive environment is completely removed.

b. The second stage is essentially a fatigue stage in which failure proceeds by propagation of the crack (often from a corrosion pit or pits). It is controlled primarily by stress concentration effects and the physical properties of the metal. Fracture of a metal part due to fatigue corrosion, generally occurs at a stress level far below the fatigue limit of an uncorroded part, even though the amount of corrosion is relatively small.

6-22. FRETTING CORROSION. Fretting corrosion,(also known as wear corrosion or friction oxidation) can occur at the interface of two highly-loaded surfaces which are not supposed to move against each other. However, vibration may cause the surfaces to rub together resulting in an abrasive wear known as fretting. (See figure 6-13.) The protective film on the metallic surfaces is removed by this rubbing action. With continued rubbing, metal particles sheared from the surface of the metal combine with oxygen to form metal oxide. As these oxides accumulate, they cause damage by abrasive action and increased local stress. The most common example of fretting corrosion is the *smoking rivet* found on engine cowling and wing skins. This is one corrosion reaction that is not driven by an electrolyte, and in fact, moisture may inhibit the reaction. Application of a lubricant or installation of a fretting-resistant material between the two surfaces can reduce fretting corrosion.

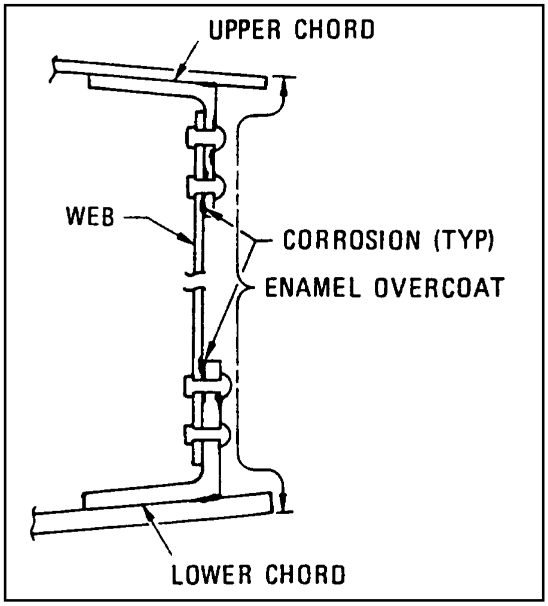

FIGURE 6-13. Fretting corrosion.

6-23.—6-28. [RESERVED.]

SECTION 3. CORROSION PROTECTION MEASURES FOR BASIC MATERIALS

6-29. GENERAL. In the repair of aircraft, apply corrosion proofing of the same type or equivalent to that originally applied unless the repair would result in increased susceptibility to corrosion, in which case use additional corrosion protection measures. The following is a list of the most commonly-used corrosion-proofing techniques.

6-30. ANODIZING AND RELATED PROCESSES. In anodizing, aluminum alloys are placed in an electrolytic bath causing a thin film of aluminum oxide to form on the surface of the aluminum. This is resistant to corrosion and affords a good paint base. However, other processes, which do not provide as good a corrosive protection as anodizing, are good paint bases. The processes are:

a. Alkaline cleaning followed by chromic acid dip;

b. Alcoholic phosphoric acid cleaner; and

c. Alkaline dichromate treatment.

6-31. PLATING. Steels are commonly plated with other metals to prevent corrosion. Plating is accomplished by placing the article in an electrolytic bath. Metals used in plating vary in the corrosion protection they afford steel. For instance, in platings that corrode before steel, such as zinc or cadmium, slight breaks or cracks throughout the plating will not result in rusting of the exposed steel. With the surface metal corroded, the steel is protected. However, when the steel corrodes faster than the plate metal, such as chromium, the amount of protection depends on the tightness of the plating. Post-plate bake treatment to relieve hydrogen embrittlement is a necessary part of replating procedures for high-strength steel parts. High-strength nuts and bolts are susceptible to failure from hydrogen embrittlement. Because of the potential failures of embrittled parts, careful control over the heat treatment, grinding, preplate cleaning, plating, and post-plate baking of high-strength parts is necessary.

6-32. PHOSPHATE RUST-PROOFING. This process is commercially known as Parkerizing, Bonderizing, Granodizing, etc. The coating placed on the part is used to protect steel parts after machining and before painting.

6-33. CHROME-PICKLE TREATMENT. Magnesium parts which have been immersed or brushed with a solution of nitric acid and sodium dichromate will be protected for temporary storage. The coating will also serve as a bond for subsequent organic finishes. Sealed chrome-pickle treatment is used on magnesium parts for long term protection. Diluted chromic acid is a touch-up treatment. It is less critical to apply and can be applied over previously-applied thin chromate films.

6-34. DICHROMATE TREATMENT. This treatment consists of boiling magnesium parts in a solution of sodium dichromate. It provides good paint base and protective qualities on all standard wrought magnesium alloys except the magnesium-thorium alloys. Acid pickling of the magnesium surface prior to application of the dichromate treatment is required if maximum corrosion resistance of the finish is expected.

6-35. STANNATE IMMERSION TREATMENT. Stannate immersion treatment deposits a layer of tin. It is a protective paint base for magnesium alloy parts which contain inserts and fasteners of a dissimilar metal such as brass, copper, or steel. This treatment cannot be used with parts containing aluminum inserts or fasteners because the high alkalinity of the bath attacks the aluminum.

6-36. GALVANIC ANODIZING TREATMENT. An electrolytic process that provides a paint base and corrosion-preventive film on magnesium alloys containing manganese.

6-37. CLADDING. Aluminum alloys which are susceptible to corrosion are frequently clad with pure aluminum. Slight pits, scratches, or other defects through the cladding material must be avoided, since the aluminum alloy core will corrode rapidly.

6-38. METAL SPRAYING. Metal is melted and sprayed on the surface to be protected. The surface must be properly prepared and thoroughly cleaned to prevent peeling of the sprayed coat.

6-39. SHOT-PEENING. Shot-peening and other treatments, by which the surface can be placed in compression, are effective in preventing stress corrosion.

6-40. ORGANIC COATINGS. Zinc chromate primer, enamels, chlorinated rubber compounds, etc., are organic coatings commonly used to protect metals.

6-41. DOPE PROOFING. When doped fabrics are applied over an organic finished metal structure, the dope will have a tendency to loosen the finish on the metal. For this reason, organic coatings on the metal are usually covered with a dope-proof paint, with metal foil, or with cellulose tape to prevent the dope from soaking through.

6-42. TUBE INTERIORS. Protect the interiors of structural steel and aluminum tubing against corrosion. A small amount of water entrapped in a tube can corrode entirely through the tube thickness in a short period. Coat the tube interior by flushing with hot linseed oil, paralketone, or other approved corrosion inhibitor. The flushing liquid is usually introduced through small holes drilled in the tubing. Allow the flushing liquid to drain and plug the holes with a screw or by other means to prevent entry of moisture. Air and watertight sealing of the tubing will also give adequate protection against corrosion if the tubing is internally dry before being sealed.

6-43.—6-49. [RESERVED.]

SECTION 4. CORROSION PREVENTIVE MAINTENANCE

6-50. GUIDELINES: ALL AIRCRAFT. Corrosion prevention depends on a comprehensive prevention and control plan, implemented from the start of operation of an aircraft, which includes:

a. Adequately-trained personnel in

(1) recognition of corrosion-inducing conditions;

(2) corrosion identification techniques;

(3) corrosion detection, cleaning, and treating; and

(4) lubrication and preservation of aircraft structure and components.

b. Inspection for corrosion on a scheduled basis.

c. Thorough cleaning, inspection, lubrication, and preservation at prescribed intervals.

d. Prompt corrosion treatment after detection.

e. Accurate record-keeping and reporting of material or design deficiencies to the manufacturer and the Federal Aviation Administration (FAA).

f. Use of appropriate materials, equipment, and technical publications.

g. Maintenance of the basic finish systems.

h. Keeping drain holes and passages open and functional. Sealants, leveling compounds, miscellaneous debris, or corrosion inhibitors should not block drain paths.

i. Replacing deteriorated or damaged gaskets and sealants (using non-corrosive type sealants) to avoid water intrusion and entrapment that leads to corrosion.

j. Minimizing the exposure of aircraft to adverse environments by keeping the aircraft in a hangar.

k. Periodic and frequent inspection of areas where there are foamed plastics or other absorbent material.

l. Daily draining of fuel cavities to remove accumulated water and other foreign matter.

m. Daily wipe-down of exposed critical surfaces of hydraulic cylinders.

6-51. GUIDELINES: AIRCRAFT OPERATING OVER SALT WATER. In addition to the inspection and treatment prescribed above, the following treatment shall be applied:

a. Remove all traces of salt water and salt water residue by thoroughly washing the aircraft with fresh water.

(1) After drying, coat the propeller, hubs, blades and other unpainted or unprotected parts of the engine and its installation parts by spraying or rubbing lightly with corrosion preventive compound, Specification MIL-C-16173, Grade 4.

(2) Apply this mixture on parts that move or require some lubrication and on all fittings subject to corrosion such as landing gear retracting plungers, control surface hinges, control cables, exposed rivets and bolts, and other similar parts not protected by paint. Apply with a cloth or a soft brush soaked in the mixture.

(3) Wipe off excess mixture. When applying the mixture take care that as little as possible is deposited on exhaust pipes or collector rings to avoid a fire hazard when the engine is started. Keep the ignition wires, propeller anti-icer feed hose, tires, and other rubber parts free of the mixture.

b. Where maximum corrosion protection is desired on stationary parts, use exterior surface corrosion preventive compound, Specification MIL-C-16173, grade I.

c. Wipe the exposed portion of the landing gear shock strut piston with a cloth soaked in the applicable hydraulic fluid.

d. Most parts of landing gear wheels are made from magnesium or aluminum alloys which corrode rapidly unless carefully protected. When the aircraft operates near salt water and off coral beaches, the corrosion can be very rapid. Inspect wheels to determine the paint condition.

e. Refinish portions of a wheel where paint has deteriorated, peeled, or chipped.

f. Except for friction and bearing surfaces, apply a protective coating to all parts of wheels and brake assemblies.

6-52.—6-62. [RESERVED.]

SECTION 5. VISUAL CORROSION INSPECTION GUIDE FOR AIRCRAFT

6-63. GENERAL. This guide provides a general inspection checklist for those parts or surfaces that can be visually inspected without disassembly of the aircraft. It is intended for use in establishing corrosion inspection areas for which the manufacturer has not provided a recommended corrosion inspection program. The manufacturer's recommended corrosion inspection program will take precedence over this guideline. These inspections should be accomplished in conjunction with other preventive maintenance.

6-64. EXHAUST TRAIL AREAS.

a. Visually inspect paint in areas of the exhaust trails for damage.

b. Visually inspect under fairings, around rivet heads, and in skin crevices, for corrosion in areas of engine exhaust trail.

6-65. BATTERY COMPARTMENTS AND BATTERY VENT OPENINGS.

a. Inspect battery compartment for electrolyte spillage, corrosion, and condition of protective paint.

b. Inspect area around battery vent for corrosion.

6-66. LAVATORIES AND GALLEYS. Inspection areas around lavatories, sinks, and ranges for spillage and corrosion. Pay particular attention to floor area and the area behind and under lavatories, sinks, and ranges.

6-67. BILGE AREAS.

a. Inspect bilge areas for waste hydraulic fluids, water, dirt, loose fasteners, drill chips, and other debris.

b. Remove any foreign material from bilge and inspect for corrosion.

6-68. WHEEL WELLS AND LANDING GEAR. Inspect wheel well area and landing gear components for damage to exterior finish coating and corrosion. Particular attention should be given to exposed surfaces of struts, oleos, arms, links, and attaching hardware; axle interiors, exposed position indicator switches and other electrical equipment; crevices between stiffeners, ribs, and lower skin surfaces; magnesium wheels, particularly around bolt heads, lugs, and wheel web areas; and exposed rigid tubing at "B" nuts and ferrules under clamps, and tubing identification tapes.

6-69. EXTERNAL SKIN AREAS.

a. Inspect external skin surfaces for damage to protective finishes and corrosion.

b. Inspect around fasteners for damage to protective finishes and corrosion.

c. Inspect lap joints for bulging of skin surface, which may indicate the presence of corrosion between the faying surfaces. Skin cracks and/or dished or missing fastener heads may also indicate severe corrosion in bonded joints.

d. Inspect area around spot welds for bulges, cracks, or corrosion.

e. Inspect piano type hinges for corrosion. When piano hinges are inspected they should be lubricated and actuated through several cycles to ensure complete penetration of the lubricant.

f. Inspect thick alloy skin surfaces for pitting, intergranular corrosion, and exfoliation of the metal. Look for white or gray deposits around countersunk fastener heads and raised areas or bumps under the paint film.

g. Inspect composite skins for corrosion of attachment fasteners.

6-70. WATER ENTRAPMENT AREAS. Inspect area around edge of drain holes for corrosion and ensure that drain holes are not blocked by debris.

6-71. ENGINE FRONTAL AREAS.

a. Inspect reciprocating engine cylinder fins, engine cases, and cooling air ducts for damage to exterior finish and corrosion.

b. Inspect radiator cooler cores for corrosion.

6-72. ELECTRONIC PACKAGE COMPARTMENTS.

a. Inspect circuit-breakers, contact points, and switches for evidence of moisture and corrosive attack.

b. Treatment of corrosion in electrical and electronic components should be done by or supervised by qualified personnel familiar with the function of the unit involved.

6-73. FLEXIBLE HOSE ASSEMBLIES.

a. Inspect hose assemblies for chafing, weather-checking, hardening, discoloration, evidence of fungus, torn weather protective coatings or sleeves, and corrosion of fittings.

b. Replace any defective, damaged, twisted, or bulging hoses.

6-74. SANDWICH PANELS. Inspect edges of sandwich panels for damage to the corrosion protection finish or sealant and for corrosion.

6-75. CONTROL CABLES.

a. Inspect control cables for bare spots in the preservative coating and corrosion.

b. If external corrosion is found, relieve tension on the cable and check internal strands for corrosion. Cables with corrosion on internal strands should be replaced. External corrosion should be removed by a clean, dry, coarse rag or fiber brush. A preservative should be applied after removal of external corrosion.

6-76. INTEGRAL FUEL CELLS.

a. Inspect top coat finish for breaks, peeling, lifting of surface, or other damage.

b. Inspect aircraft structure for top coat finish damage from pitting or intergranular corrosion.

6-77. ELECTRICAL CONNECTORS.

a. Inspect electrical connectors for breaks in potting compound and corrosion of pins and wires.

b. If the electrical connector is suspected of having moisture intrusion, disassemble the connector, clean the connector, and inspect it for corrosion.

6-78.—6-88. [RESERVED.]

SECTION 6. CORROSION REMOVAL PROCEDURES

6-89. GENERAL. General safety precautions for handling materials with hazardous physical properties are outlined in the following paragraphs. They also address emergency procedures for immediate treatment of personnel who have inadvertently come into contact with harmful materials. All personnel responsible for using or handling hazardous materials should be thoroughly familiar with the information in the following paragraphs.

6-90. SAFETY PRECAUTIONS.

a. Chemical. When required to use or handle solvents, special cleaners, paint strippers (strong alkalies and acids), etchants (corrosion removers containing acids), or surface activation material (Alodine 1200), observe the following safety precautions:

(1) Avoid prolonged breathing of solvent or acid vapors.

(2) Never add water to acid. Always add acid to water.

(3) Mix all chemicals per the manufacturer's instructions.

(4) Clean water for emergency use should be available in the immediate work area before starting work.

(5) Avoid prolonged or repeated contact with the skin of solvents, cleaners, etchants (acid), or conversion coating material (Alodine solution). Rubber or plastic gloves should be worn. Goggles or plastic face shields and suitable protective clothing should be worn when cleaning, stripping, etching, or conversion coating overhead surfaces.

(6) When mixing alkalies with water or other substance, use containers that are made to withstand heat generated by this process.

(7) Wash any paint stripper, etchant, or conversion coating material immediately from body, skin, or clothing.

(8) Materials splashed into the eyes should be promptly flushed out with water, and medical aid obtained immediately.

(9) Do not eat or keep food in areas where poisons may be absorbed. Always wash hands before eating or smoking.

(10) Verify that the area within 50 feet of any cleaning or treating operations where low flash point (140 °F or below) materials are being used, is clear and remains clear of all potential ignition sources.

(11) Suitable fire-extinguishing equipment should be available to the cleaning/treating area.

(12) Equipment should be effectively grounded where any flammable materials are being used.

(13) If materials (acid, alkali, paint remover, or conversion coatings) are spilled on equipment and/or tools, treat immediately by rinsing with clean water, if possible, and /or neutralizing acids with baking soda and alkalies with a weak (5 percent) solution of acetic acid in water.

(14) In confined location, do not use solvents with a low flash point, (below 100 °F) such as Methyl Ethyl Ketone (MEK) and acetone.

(15) All equipment should be cleaned after work has been completed.

(16) Check and follow all applicable restrictions and requirements on the use of solvents, primers, and top coats.

(17) Check and follow all applicable restrictions and requirements for use and disposal of waste material.

b. Blasting. The following precautions should be taken when using any type of blasting equipment:

(1) Operators should be adequately protected with complete face and head covering equipment, and provided with pure breathing air.

(2) Static-ground the dry abrasive blaster and the material to be blasted.

(3) Magnesium cuttings and small shavings can ignite easily and are an extreme hazard. Fires of this metal must be extinguished with absolutely dry talc, calcium carbonate, sand, or graphite by applying the powder to a depth of 1/2 inch over the metal.

(4) Titanium alloys and high-tensile-strength steel create sparks during dry abrasive blasting. Care should be taken to ensure that hazardous concentrations of flammable vapors do not exist.

6-91. CORROSION CONTROL WORK PROCEDURES. The effectiveness of corrosion control depends on how well basic work procedures are followed. The following common work practices are recommended:

a. If rework procedures or materials are unknown, contact the aircraft manufacturer or FAA authorized Designated Engineering Representative (DER) before proceeding.

b. The work areas, equipment, and components should be clean and free of chips, grit, dirt, and foreign materials.

c. Do not mark on any metal surface with a graphite pencil or any type of sharp, pointed instrument. Temporary markings (defined as markings soluble in water or methyl chloroform) should be used for metal layout work or marking on the aircraft to indicate corroded areas.

d. Graphite should not be used as a lubricant for any component. Graphite is cathodic to all structural metals and will generate galvanic corrosion in the presence of moisture, especially if the graphite is applied in dry form.

e. Footwear and clothing should be inspected for metal chips, slivers, rivet cuttings, dirt, sand, etc., and all such material removed before walking or working on metal surfaces such as wings, stabilizers, fuel tanks, etc.

f. Do not abrade or scratch any surface unless it is an authorized procedure. If surfaces are accidentally scratched, the damage should be assessed and action taken to remove the scratch and treat the area.

g. Coated metal surfaces should not be polished for aesthetic purposes. Buffing would remove the protective coating and a brightly polished surface is normally not as corrosion resistant as a non-polished surface unless it is protected by wax or paint.

h. Protect surrounding areas when welding, grinding, or drilling, to prevent contamination with residue from these operations. In those areas where protective covering cannot be used, remove the residue by cleaning.

i. Severely corroded screws, bolts, and washers should be replaced. When a protective coating, such as a cadmium plating on bolts, or screws, is damaged, immediately apply an appropriate protective finish to prevent additional corrosion damage.

6-92.—6-112. [RESERVED.]

SECTION 7. BASIC CORROSION REMOVAL TECHNIQUES

6-113. GENERAL. When active corrosion is found, a positive inspection and rework program is necessary to prevent any further deterioration. The following methods of assessing corrosion damage and procedures for rework of corroded areas could be used during cleanup programs. In general, any rework would involve the cleaning and stripping of all finish from the corroded area, removal of corrosion products, and restoration of surface protective film.

a. Repair of corrosion damage includes removal of all corrosion and corrosion products. When the corrosion damage is severe and exceeds the damage limits set by the aircraft or parts manufacturer, the part must be replaced.

b. If manufacturer information and limits are not available, then a DER must be consulted before the aircraft or part is returned to service.

6-114. PREPARATIONS FOR REWORK. All corrosion products should be removed completely when corroded structures are reworked. Before starting rework of corroded areas, carry out the following:

a. Document corrosion damage**.**

b. Position the aircraft in a wash rack or provide washing apparatus for rapid rinsing of all surfaces.

c. Connect a static ground line from the aircraft to a grounding point.

d. Prepare the aircraft for safe ground maintenance.

(1) Remove battery(s), liquid oxygen generator container (if installed), and external hydraulic and electric power.

(2) Install all applicable safety pins, flags, and jury struts.

e. Protect the pitot-static ports, louvers, airscoops, engine opening, wheels, tires, magnesium skin panels, and airplane interior from moisture and chemical brightening agents.

f. Protect the surfaces adjacent to rework areas from chemical paint strippers, corrosion removal agents, and surface treatment materials.

6-115. FAIRING OR BLENDING REWORKED AREAS. All depressions resulting from corrosion rework should be faired or blended with the surrounding surface. Fairing can be accomplished as follows:

a. Remove rough edges and all corrosion from the damaged area. All dish-outs should be elliptically shaped with the major axis running spanwise on wings and horizontal stabilizers, longitudinally on fuselages, and vertically on vertical stabilizers. (Select the proper abrasive for fairing operations from table 6-1.)

b. In critical and highly stressed areas, all pits remaining after the removal of corrosion products should be blended out to prevent stress risers that may cause stress corrosion cracking. (See figure 6-14.) On a non-critical structure, it is not necessary to blend out pits remaining after removal of corrosion products by abrasive blasting, since this results in unnecessary metal removal.

TABLE 6-1. Abrasives for corrosion removal.

METALS OR MATERIALS TO BE PROCESSED	RESTRICTIONS	OPERATION	ABRASIVE PAPER OR CLOTH			ABRASIVE FABRIC OR PAD	ALUMINUM	STAINLESS STEEL	PUMICE 350 MESH OR FINER	ABRASIVE WHEEL
			ALUMINUM OXIDE	SILICON CARBIDE	GARNET					
FERROUS ALLOYS		CORROSION REMOVAL OR FAIRING	150 GRIT OR FINER	180 GRIT OR FINER		FINE TO ULTRA FINE	X	X	X	X
		FINISHING	400				X	X	X	
ALUMINUM ALLOYS EXCEPT CLAD ALUMINUM	DO NOT USE SILICON CARBIDE ABRASIVE	CORROSION REMOVAL OR FAIRING	150 GRIT OR FINER		7/0 GRIT OR FINER	VERY FINE AND ULTRA FINE	X		X	X
		FINISHING	400				X		X	
CLAD ALUMINUM	SANDING LIMITED TO THE REMOVAL OF MINOR SCRATCHES	CORROSION REMOVAL OR FAIRING	240 GRIT OR FINER		7/0 GRIT OR FINER	VERY FINE AND ULTRA FINE			X	X
		FINISHING	400						X	
MAGNESIUM ALLOYS		CORROSION REMOVAL OR FAIRING	240 GRIT OR FINER			VERY FINE AND ULTRA FINE	X		X	X
		FINISHING	400				X		X	
TITANIUM		CLEANING AND FINISHING	150 GRIT OR FINER	180 GRIT OR FINER				X	X	X

c. Rework depressions by forming smoothly blended dish-outs, using a ratio of 20:1, length to depth. (See figure 6-15.) In areas having closely spaced multiple pits, intervening material should be removed to minimize surface irregularity or waviness. (See figure 6-16.) Steel nut-plates and steel fasteners should be removed before blending corrosion out of aluminum structure. Steel or copper particles embedded in aluminum can become a point of future corrosion. All corrosion products must be removed during blending to prevent reoccurrence of corrosion.

6-116. CORROSION REMOVAL BY BLASTING. Abrasive blasting is a process for cleaning or finishing ferrous metals by directing a stream of abrasive particles against the surface of the parts. Abrasive blasting is used for the removal of rust and corrosion and for cleaning prior to painting or plating. The following standard blast-cleaning practices should be adopted.

a. The part to be blast-cleaned should be removed from the aircraft, if possible. Otherwise, areas adjacent to the part should be masked or protected from abrasive impingement and system (hydraulic, oil, fuel, etc.) contamination.

b. Parts should be dry and clean of oil, grease, or dirt, prior to blast cleaning.

c. Close-tolerance surfaces, such as bushings and bearing shafts, should be masked.

d. Blast-clean only enough to remove corrosion coating. Proceed immediately with surface treatments as required.

6-117. CLEANERS, POLISHES, AND BRIGHTENERS. It is important that aircraft be kept thoroughly clean of contaminating deposits such as oil, grease, dirt, and other foreign materials.

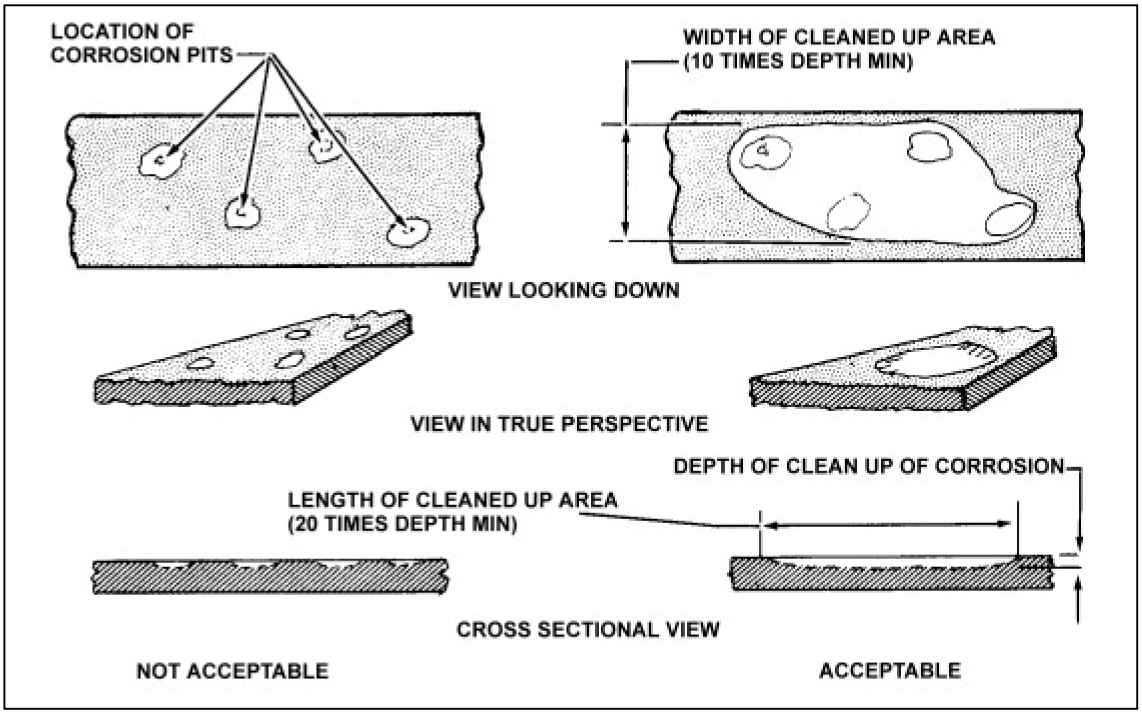

FIGURE 6-14. Typical example of acceptable cleanup of corrosion pits.

a. Materials. Do not use harmful cleaning, polishing, brightening, or paint-removing materials. Use only those compounds that conform to existing government or established industry specifications or that have been specifically recommended by the aircraft manufacturer. Observe the product manufacturer's recommendations concerning use.

b. Chemical Cleaners. Chemicals must be used with great care in cleaning assembled aircraft. The danger of entrapping corrosive materials in faying surfaces and crevices counteracts any advantages in their speed and effectiveness. Use materials that are relatively neutral and easy to remove.

c. Removal of spilled battery acid. The battery, battery cover, battery box and adjacent areas will be corroded if battery acid spills onto them. To clean spilled battery acid, brush off any salt residue and sponge the area with fresh water. For lead-acid batteries, sponge the area with a solution of 6 ounces of sodium bicarbonate (baking soda) per gallon of fresh water. Apply generously until bubbling stops and let solution stay on the area for 5 to 6 minutes, but do not allow it to dry. For nickel-cadmium batteries, sponge the area with a solution of 6 ounces of monobasic sodium phosphate per gallon of fresh water. Sponge area again with clean fresh water and dry surface with compressed air or clean wiping cloths.

6-118. STANDARD METHODS. Several standard mechanical and chemical methods are available for corrosion removal. Mechanical methods include hand sanding using abrasive mat, abrasive paper, or metal wool; and powered mechanical sanding, grinding, and buffing, using abrasive mat, grinding wheels, sanding discs, and abrasive rubber mats. The method used depends upon the metal and degree of corrosion. The removal method to use on each metal for each particular degree of corrosion is outlined in the following section.

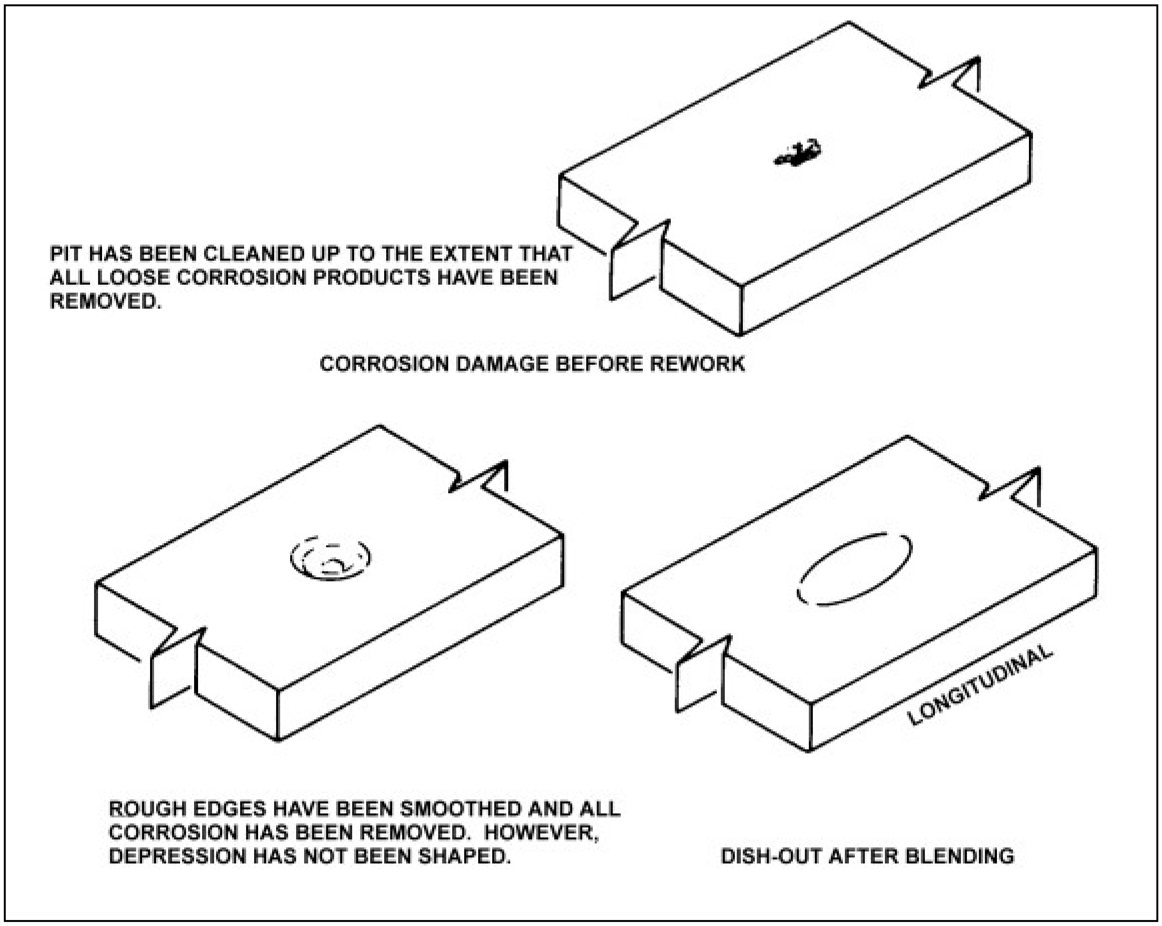

FIGURE 6-15. Blendout of corrosion as a single depression.

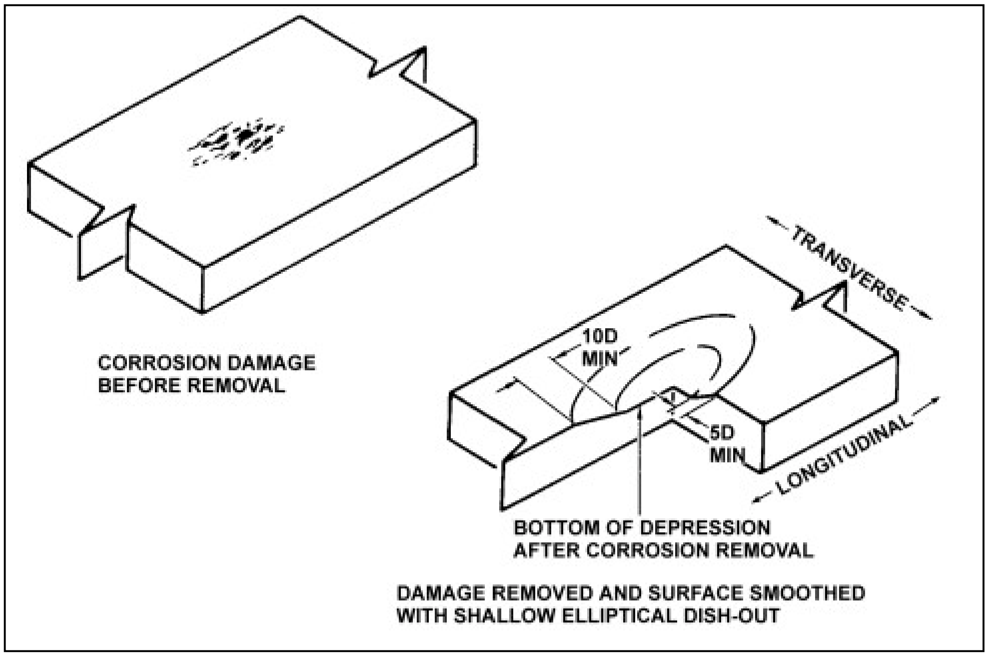

FIGURE 6-16. Blendout of multiple pits in a corroded area.

6-119.—6-131. [RESERVED.]

SECTION 8. ALUMINUM AND ALUMINUM ALLOYS

6-132. GENERAL. Aluminum and aluminum alloys are the most widely used material for aircraft construction. Aluminum appears high in the electro-chemical series of elements and corrodes very easily. However, the formation of a tightly-adhering oxide film offers increased resistance under most corrosive conditions. Most metals in contact with aluminum form couples that undergo galvanic corrosion attack. The alloys of aluminum are subject to pitting, intergranular corrosion and intergranular stress corrosion cracking. In some cases the corrosion products of metal in contact with aluminum are corrosive to aluminum. Therefore, aluminum and its alloys must be cleaned and protected.

6-133. SPECIAL TREATMENT OF ANODIZED SURFACES. Anodizing is the most common surface treatment of aluminum alloy surfaces. The aluminum sheet or casting is made the positive pole in an electrolyte bath in which chromic acid or other oxidizing agents produce a supplemental protective oxide film on the aluminum surface. The anodized surface coating offers the alloy a great deal of protection as long as it is not damaged. Once the film is damaged, it can only be partially restored by chemical surface treatment. Therefore exercise care to avoid breaking of the protective film, particularly at the edges of the sheet.

6-134. REPAIR OF ALUMINUM ALLOY SHEET METAL. After extensive corrosion removal the following procedures should be followed:

a. If water can be trapped in blended areas, chemical conversion coat in accordance with MIL-C-81706 and fill the blended area with structural adhesive or sealant to the same level and contour as the original skin. When areas are small enough that structural strength has not been significantly decreased, no other work is required prior to applying the protective finish.

b. When corrosion removal exceeds the limits of the structural repair manual, contact a DER or the aircraft manufacturer for repair instructions.

c. Where exterior doublers are installed, it is necessary to seal and insulate them adequately to prevent further corrosion.

d. Doublers should be made from alclad, when available, and the sheet should be anodized (preferred) or a chemical conversion coat applied after all cutting, drilling, and countersinking has been accomplished.

e. All rivet holes should be drilled, countersunk, surface treated, and primed prior to installation of the doubler.

f. Apply a suitable sealing compound in the area to be covered by the doubler. Apply sufficient thickness of sealing compound to fill all voids in the area being repaired.

g. Install rivets wet with sealant. Sufficient sealant should be squeezed out into holes so that all fasteners, as well as all edges of the repair plate, will be sealed against moisture.

h. Remove all excess sealant after fasteners are installed. Apply a fillet sealant bead around the edge of the repair. After the sealant has cured apply the protective paint finish to the reworked area.

6-135. CORROSION REMOVAL AROUND COUNTERSUNK FASTENERS IN ALUMINUM ALLOY. Intergranular corrosion in aluminum alloys often originates at countersunk areas where steel fasteners are used.

a. When corrosion is found around a fixed fastener head, the fastener must be removed to ensure corrosion removal. All corrosion must be removed to prevent further corrosion and loss of structural strength. To reduce the recurrence of corrosion, the panel should receive a chemical conversion coating, be primed, and have the fasteners installed wet with sealant.

b. Each time removable steel fasteners are removed from access panels, they should be inspected for condition of the plating. If mechanical or plating damage is evident, replace the fastener. One of the following fastener installation methods should be used:

(1) Brush a corrosion-preventive compound on the substructure around and in the fastener hole, start the fastener, apply a bead of sealant to the fastener countersink, set and torque the fastener within the working time of the sealant (this is the preferred method).

(2) Apply the corrosion preventive compound to the substructure and fastener, set and torque the fastener.

(3) Apply a coating of primer to the fastener, and while wet with primer, set and torque the fastener.

6-136. EXAMPLES OF REMOVING CORROSION FROM ALUMINUM AND ALUMINUM ALLOYS.

a. Positively identify the metal as aluminum.

b. Clean the area to be reworked. Strip paint if required.

c. Determine extent of corrosion damage.

d. Remove light to moderate corrosion with one of the following.

(1) Non-Powered Corrosion Removal.

(a) The removal of corrosion products by hand can be accomplished by use of aluminum grit and silicon carbide abrasive, such as non-woven, non-metallic, abrasive mat (Spec. MIL-A-9962), abrasive cloth, and paper. Aluminum wool, fiber bristle brushes, and pumice powder are also acceptable methods.

(b) Stainless steel brush (Spec. H-B-178, type III, class 2) may be used as long as the bristles do not exceed 0.010 inch in diameter. After use of this brush the surface should be polished with 60 grit aluminum oxide abrasive paper, then with 400 grit aluminum oxide paper. Care should be exercised in any cleaning process to avoid breaking the protective film.

(c) Steel wool, emery cloth, steel wire brushes (except stainless steel brush) copper alloy brushes, rotary wire brushes, or severe abrasive materials should not be used on any aluminum surface.

(2) Chemical Corrosion Removal.

(a) The corrosion removal compound aluminum pretreatment MIL-C-38334, an acid material, may be used to remove corrosion products from aluminum alloy materials or items (e.g., skins, stringer, ribs in wings, tubing, or ducts). MIL-C-38334 is available in two types:

1 Type I Liquid concentrate materials should be diluted in accordance with the manufacture's instructions before use. Type I has a 1 year shelf life; therefore it shall not be used after 1 year from the date of manufacture.

2 Type II Powdered concentrate materials should be dissolved in the volume of water specified on the kit. These materials have an indefinite shelf life in the dry state. Once mixed, they should be used within 90 days.

(b) Mix MIL-C-38334 in wood, plastic, or plastic-lined containers only. Wear acid-resistant gloves, protective mask and protective clothing when working with this acid compound. If acid contacts the skin or eyes, flush immediately with water.

(c) Apply MIL-C-38334 solution by flowing, mopping, sponging, brushing, or wiping. When applying the solution to large areas, begin the application at the lowest area and work upward, applying the solution with a circular motion to disturb the surface film and ensure proper coverage. If pumping is required, pumps, valves, and fittings should be manufactured from 18-8 stainless steel or plastic.

CAUTION: When working with MIL-C-38334, keep the solution away from magnesium surfaces. The solution must be confined to the area being treated. All parts and assemblies including cadmium-plated items and hinges susceptible to damage from acid should be masked and/or protected. Also mask all openings leading to the primary structure that could trap the solution and doors or other openings that would allow the solution (uncontrolled) to get into the aircraft or equipment interior. It is a good practice to keep a wet rag on hand at all times, for removal of spills or splashes.

(d) Allow the solution to remain on the surface for approximately 12 minutes and then rinse away with clean tap water. For pitted or heavily-corroded areas the compound will be more effective if applied warm (140 °F) followed by vigorous agitation with a non-metallic acid-resisting brush or aluminum oxide abrasive nylon mat. Allow sufficient dwell time, 12 to 15 minutes, before rinsing. After each application examine the pits and/or corroded area to determine if another application is required with a 4 to 10 power magnifying glass. (Select the power depending on the distance available to make the inspection.) Corrosion still on the area will appear as a powdery crust slightly different in color than the uncorroded base metal. Darkening of area due to shadows and reaction from the acid remover should not be considered.

(e) Once the corrosion has been removed and the area well-rinsed with clean water, a chromate conversion coating such as MIL-C-81706 or MIL-C-5541 alodine 1200, must be applied immediately thereafter.

e. Remove moderate to heavy corrosion with one of the following.

(1) Powered Corrosion Removal.

(a) Where the problem is severe enough to warrant the use of power tools, a pneumatic drill motor driving either an aluminum-oxide-impregnated nylon abrasive wheel, flap brush or rubber grinding wheel may be used with an abrasive value to approximately 120 grit, as needed. Corrosion-removal accessories, such as flap brushes or rotary files, should be used on one type of metal only. For example, a flap brush used to remove aluminum should not be used to remove magnesium, steel, etc. Pneumatic sanders may be used with disk and paper acceptable for use on aluminum.

(b) When mechanically removing corrosion from aluminum, especially aircraft skin thinner than 0.0625 inch, extreme care must be used. Vigorous, heavy, continuous abrasive grinding can generate enough heat to cause metallurgical change. If heat damage is suspected, hardness tests or conductivity tests must be accomplished to verify condition of the metal. The use of powered rotary files should be limited to heavy corrosion and should not be used on skin thinner than 0.0625 inch.

(2) Blasting.

(a) Abrasive blasting may be used on aluminum alloys using glass beads (Spec. MIL-G-9954) sizes 10 to 13, or grain abrasive (Spec. MIL-G-5634) types I and III may be used as an alternate method of removing corrosion from clad and non-clad aluminum alloys. Abrasive blasting should not be used to remove heavy corrosion products. Direct pressure machines should have the nozzle pressure set at 30 to 40 psi for clad aluminum alloys and 40 to 45 psi for non-clad aluminum alloys. Engineering approval should be obtained prior to abrasive blasting metal thinner than 0.0625 inch.

(b) When using abrasive blasting on aluminum alloys, do not allow the blast stream to dwell on the same spot longer than 15 seconds. Longer dwell times will cause excessive metal removal. Intergranular exfoliation corrosion is not to be removed by abrasive blasting; however, blasting may be used with powered corrosion removal to determine whether all exfoliation corrosion has been removed.

f. Inspect the area for remaining corrosion. Repeat procedure if any corrosion remains.

NOTE: If corrosion remains after the second attempt, use a stronger method, e.g., chemical to mechanical.

g. Using a blend ratio of 20:1 (length to depth) blend and finish the corrosion rework area with progressively finer abrasive paper until 400-grit paper is used.

h. Clean reworked area using dry cleaning solvent. Do not use kerosene or any other petroleum base fuel as a cleaning solvent.

i. Determine depth of faired depressions to ensure that rework limits have not been exceeded.

j. Apply chemical conversion coating, MIL-C-81706, immediately after reworking. If 48 hours or more have elapsed since the conversion coating was first applied and the primer or final paint system has not yet been applied, then reapply the conversion coating before continuing.

NOTE: These solutions should not be allowed to come in contact with magnesium or high-strength steels (180,000 psi). Do not permit solutions or materials to contact paint thinner, acetone or other combustible material: FIRE MAY RESULT.

k. Apply paint finish to area.

6-137.—6-147. [RESERVED.]

SECTION 9. MAGNESIUM AND MAGNESIUM ALLOYS

6-148. GENERAL. Magnesium and magnesium alloys are the most chemically active of the metals used in aircraft construction and are the most difficult to protect. However, corrosion on magnesium surfaces is probably the easiest to detect in its early stages. Since magnesium corrosion products occupy several times the volume of the original magnesium metal destroyed, initial signs show a lifting of the paint films and white spots on the magnesium surface. These rapidly develop into snow-like mounds or even white whiskers. The prompt and complete correction of the coating failure is imperative if serious structural damage is to be avoided.

6-149. TREATMENT OF WROUGHT MAGNESIUM SHEETS AND FORGINGS. Corrosive attack on magnesium skins will usually occur around the edges of skin panels, underneath hold-down washers, or in areas physically damaged by shearing, drilling, abrasion, or impact. Entrapment of moisture under and behind skin crevices is frequently a contributing factor. If the skin section can be easily removed, this should be accomplished to ensure complete inhibition and treatment.

a. Complete mechanical removal of corrosion products should be practiced when practical. Mechanical cleaning should normally be limited to the use of stiff bristle brushes and similar nonmetallic cleaning tools.

b. Any entrapment of steel particles from steel wire brushes, steel tools, or contamination of treated surfaces, or dirty abrasives, can cause more trouble than the initial corrosive attack. The following procedural summary is recommended for treatment of corroded magnesium areas when accomplished under most field conditions.

c. When aluminum insulating washers are used and they no longer fasten tightly to magnesium panels, corrosion is likely to occur under the washers if corrective measures are not taken.

(1) When machine screw fasteners are used, aluminum insulating washers must be removed from all locations to surface treat the magnesium panel.

(2) Where permanent fasteners other than machine screws are used, the insulating washer and fastener must be removed.

(3) When located so water can be trapped in the counter-bored area where the washer was located, use sealants to fill the counterbore. If necessary, fill several areas adjacent to each other. It may be advantageous to cover the entire row of fasteners with a strip of sealant.

6-150. REPAIR OF MAGNESIUM SHEET METAL AFTER EXTENSIVE CORROSION REMOVAL. The same general instructions apply when making repairs in magnesium as in aluminum alloy skin, except that two coats of epoxy primer may be required on both the doubler and skin being patched instead of one. Where it is difficult to form magnesium alloys in the contour, aluminum alloy may be utilized. When this is done, it is necessary to ensure effective dissimilar metal insulation. Vinyl tape will ensure positive separation of dissimilar metals, but edges will still have to be sealed to prevent entrance of moisture between mating surfaces at all points where repairs are made. It is recommended that only non-corrosive type sealant be used, since it serves a dual purpose of material separation and sealing.

6-151. IN-PLACE TREATMENT OF MAGNESIUM CASTINGS. Magnesium castings, in general, are more porous and more prone to penetrating attack than wrought magnesium skin. However, treatment in the field is, for all practical purposes, the same for all magnesium. Bellcranks, fittings, and numerous covers, plates, and handles may also be magnesium castings. When attack occurs on a casting, the earliest practical treatment is required to prevent dangerous corrosive penetration. Engine cases in salt water can develop moth holes and complete penetration overnight.

a. If at all practical, faying surfaces involved shall be separated to treat the existing attack effectively and prevent its further progress. The same general treatment sequence as detailed for magnesium skin should be followed. Where engine cases are concerned, baked enamel overcoats are usually involved rather than other top coat finishes. A good air drying enamel can be used to restore protection.

b. If extensive removal of corrosion products from a structural casting is involved, a decision from the aircraft manufacturer or a DER may be necessary to evaluate the adequacy of structural strength remaining. Refer to the aircraft manufacturer if any questions of safety are involved.

6-152. EXAMPLE OF REMOVING CORROSION FROM MAGNESIUM. If possible, corroded magnesium parts shall be removed from aircraft. When impossible to remove the part, the following procedure will be used.

a. Positively identify metal as magnesium.

b. Clean area to be reworked.

c. Strip paint if required.

d. Determine the extent of corrosion damage.

e. Remove light to moderate corrosion by one of the following means.

(1) Non-Powered Corrosion Removal.

(a) Non-powered removal can be accomplished using abrasive mats, cloth, and paper with aluminum oxide grit (do not use silicon carbide abrasive). Metallic wools and hand brushes compatible with magnesium such as stainless steel and aluminum, may be used.

(b) When a brush is used the bristles should not exceed 0.010 inch in diameter. After using a brush, the surface should be polished with 400 grit aluminum oxide abrasive paper, then with 600 grit aluminum oxide abrasive paper.

(c) Pumice powder may be used to remove stains or to remove corrosion on thin metal surfaces where minimum metal removal is allowed.

(2) Chemical Corrosion Removal.

(a) Chemical corrosion removal on magnesium alloys is usually done with a chromic acid pickle solution. Chemical corrosion removal methods are not considered adequate for areas that have:

1 Deep pitting,

2 Heavy corrosion and corrosion by products,

3 Previously had corrosion removed by mechanical means, or

4 Previously been sand blasted.

(b) Do not use this method for parts containing copper and steel-based inserts (unless the inserts are masked off) and where it might come into contact with adhesive bonded skins or parts.

(3) The following solution may be used to remove surface oxidation and light corrosion products from magnesium surfaces.

(a) Solution Composition and Operation:

1 Chromium Trioxide. 24 oz.

2 (O-C-303, Type II). Water to Make 1 gal. Reaction Time 1 to 15 min.

3 Operation Temperature. (Solution can be operated at room temperature for a longer reaction time if desired.) 190 to 202 °F.

4 Container Construction. Lead-lined steel, stainless steel, or 1100 aluminum.

(b) Mask off nearby operating mechanisms, cracks and plated steel to keep the solution from attacking them.

(c) Apply chromic acid solution carefully to the corroded area with an acid-resistant brush.

(d) Allow the solution to remain on the surface for approximately 15 minutes. Agitation may be required.

(e) Thoroughly rinse the solution from the surface with plenty of clean water.

(f) Repeat the preceding sequence as necessary until all corrosion products have been removed and the metal is a bright metallic color.

f. Remove moderate to heavy corrosion by one of the following means.

(1) Powered Corrosion Removal.

(a) Powered corrosion removal can be accomplished using pneumatic drill motor with either an aluminum-oxide-impregnated abrasive wheel, flap brush, or rubber grinding wheel with an abrasive value to approximately 120 grain size.

(b) Also a rotary file with fine flutes can be used for severe or heavy corrosion product buildup on metals thicker than 0.0625 inch. If a flap brush or rotary file is used, it should only be used on one type of metal. Do not use either a hand or rotary carbon steel brush on magnesium.

(c) Pneumatic sanders are acceptable if used with disk or paper of aluminum oxide. When using sanders, use extra care to avoid over heating aircraft skins thinner than 0.0625 inch.

(d) Do not use rotary wire brushes on magnesium.

WARNING: Cuttings and small shavings from magnesium can ignite easily and are an extreme fire hazard. Fires of this metal must be extinguished with absolutely dry talc, calcium carbonate, sand, or graphite by applying the powder to a depth of 1/2 inch over the metal.

(2) Blasting. Abrasive blasting is an approved method of corrosion removal on magnesium alloys of a thickness greater than 0.0625 inch. Remove heavy corrosion products by hand brushing with a stainless steel or fiber brush followed by vacuum abrasive blasting with glass beads, (Spec. MIL-G-9954) sizes 10-13; or grain abrasive (Spec. MIL-G-5634), types I or III at an air pressure of 10 to 35 psi (if suction equipment is used, use a 50 percent higher pressure). Upon completion of blasting, inspect for the presence of corrosion in the blast area. Give particular attention to areas where pitting has progressed into intergranular attack. This is necessary because abrasive blasting has a tendency to close up streaks of intergranular corrosion rather than remove them if the operator uses an improper impingement angle. If the corrosion has not been removed in a total blasting time of 60 seconds on any one specific area, other mechanical methods of removal should be utilized.

CAUTION: When blasting magnesium alloys, do not allow the blast stream to dwell on the same spot longer than 15 seconds. Longer dwell times will cause excessive metal removal.

g. Inspect the reworked area to ensure that no corrosion products remain. If corrosion products are found, repeat method used and re-inspect.

h. Fair depressions resulting from rework using a blend ratio of 20:1. Clean rework area using 240 grit abrasive paper. Smooth with 300 grit and finally polish with 400 grit abrasive paper.

i. Determine depth of faired depressions to ensure that rework limits have not been exceeded. Refer to the manufacture's specifications.

j. Clean reworked area using a solvent to provide a water-break-free surface. Do not use kerosene or another petroleum base fuel as a cleaning solvent.

k. Apply Chromic Acid Brush-on Pretreatment.

(1) Chemical pretreatment such as the following chromic acid solution (Conversion coat conforming to Spec. MIL-M-3171, type VI) provides a passive surface layer with an inhibitive characteristic that resists corrosive attack and also provides a bond for subsequent coatings. Properly-applied magnesium pretreatment tend to neutralize corrosion media in contact with the surface.

(2) The chromic acid brush-on pretreatment may be applied to all magnesium parts that require touch-up. This treatment is generally used in refinishing procedures or when parts and assemblies are too large to be immersed. This treatment is less critical to apply than the other brush-on treatments. It is relatively inexpensive and not as harmful when trapped in faying surfaces.

(a) Solution Composition and Operation:

1 Distilled Water 1 gal.

2 Chromic Acid (CrO_3) 1.3 oz.

3 (99.5 pure), Calcium Sulfate 1 oz. ($CaSo_4.2H_2O$)

4 Operating Temp. 70-90 °F.

5 Container: Stainless Steel, Aluminum, Vinyl, Polyethylene, or Rubber.

NOTE: Good application requires proper preparation of the chromic acid coating solution and cleaning of the surface where the solution will be applied. A water-break test is recommended if the cleanliness of the surface is in doubt.

(b) Add chemicals to water in the order shown.

(c) Stir vigorously for at least 15 minutes, either mechanically or by air agitation, to ensure that the solution is saturated with calcium sulfate. (Let solution stand for 15 minutes before decanting.)

(d) Prior to use, decant solution (avoid transfer of undissolved calcium sulfate) into suitable containers (polyethylene or glass).

(e) Apply solution by brush, swab, or flow on using low-pressure spray (non-atomizing) until the metal surface becomes a dull color (the color can vary from green-brown, brassy, yellow-brown to dark-brown). For good paint adhesion, a dark-brown color free of powder is considered best. The color may vary in using different vendors' materials.

NOTE: Too long an exposure to the brush-on solution produces coatings that will powder and impair adhesion of applied paint finish/films.

(f) Observe the coating closely during the treatment for color changes, rinsed with cold running water when the desired condition/color is reached and air dried. Preparation and use of test panels made of the same material and under the same conditions, before starting the actual treating operation may be used as to determine the application time required to produce the required coating. A good coating is uniform in color/density, adheres well and is free of loose powder.

l. Apply primer and top coat finish

m. Remove masking and protective coverings.

6-153.—6-163. [RESERVED.]

SECTION 10. FERROUS METALS

6-164. GENERAL. One of the most familiar kinds of corrosion is red iron rust. Red iron rust results from atmospheric oxidation of steel surfaces. Some metal oxides protect the underlying base metal, but red rust is not a protective coating. Its presence actually promotes additional attack by attracting moisture from the air and acts as a catalyst to promote additional corrosion.

a. Red rust first shows on bolt heads, hold down nuts, and other unprotected aircraft hardware. Red rust will often occur under nameplates that are secured to steel parts. Its presence in these areas is generally not dangerous. It has no immediate effect on the structural strength of any major components. However, it shows a general lack of maintenance and may indicate attack in more critical areas.

b. When paint failures occur or mechanical damage exposes highly-stressed steel surfaces to the atmosphere, even the smallest amount of rusting is potentially dangerous and should be removed immediately.

6-165. SPECIAL TREATMENT OF HIGH-STRENGTH STEEL. (High-strength steels heat treated above Rockwell C40, 180,000 psi tensile strength). Any corrosion on the surface of a highly-stressed steel part is potentially dangerous, and the careful removal of corrosion products is mandatory. Surface scratches or change in surface structure from overheating can cause sudden failure of these parts. The removal of corrosion products is required and will be performed carefully and completely.

a. Acceptable methods include careful use of mild abrasive mats, cloths, and papers, such as fine grit aluminum oxide, metallic wool, or fine buffing compounds.

b. Undesirable methods include the use of any power tool because the danger of local overheating and the formation of notches that could lead to failure. The use of chemical corrosion removers is prohibited, without engineering authorization, because high-strength steel parts are subject to hydrogen embrittlement.

6-166. SPECIAL TREATMENT OF STAINLESS STEEL. Stainless steels are of two general types: magnetic and nonmagnetic.

a. Magnetic steels are of the ferritic or martensitic types and are identified by numbers in the 400-series. Corrosion often occurs on 400-series stainless steels and treatment is the same as specified in high-strength steels. (See paragraph 6-165.)

b. Non-magnetic stainless steels are of the austenitic type and are identified by numbers in the 300-series. They are much more corrosion resistant than the 400-series steels, particularly in a marine environment.

(1) Austenitic steels develop corrosion resistance by an oxide film, which should not be removed even though the surface is discolored. The original oxide film is normally formed at time of fabrication by passivation. If this film is broken accidentally or by abrasion, it may not restore itself without repassivation.

(2) If any deterioration or corrosion does occur on austenitic steels, and the structural integrity or serviceability of the part is affected, it will be necessary to remove the part.

6-167. EXAMPLE OF REMOVING CORROSION FROM FERROUS METALS. If possible, corroded steel parts should be removed from the aircraft. When impractical to remove the part, follow the procedure below.

a. Prepare the area for rework.

b. Positively identify the metal as steel and establish its heat-treated value.

c. Clean the area and strip paint if required.

NOTE: Use of acid-based strippers, chemical removers, or chemical conversion coatings are not permitted on steel parts without engineering authorization.

d. Determine extent of corrosion damage.

e. Remove residual corrosion by hand sanding with mild abrasive mats, cloths, and papers, such as fine aluminum oxide grit.

f. Remove heavy deposits of corrosion products by approved mechanical methods for that particular form of steel and/or stainless steel.

g. Inspect the area for remaining corrosion. Repeat procedure if any corrosion remains and the structural integrity of the part is not in danger, and the part meets the rework limits established by the manufacturer or FAA authorized DER.

h. Fair depressions using a blend ratio of 20:1. Clean area using 240-grit paper. Smooth area with 300-grit paper and give final polish with 400-grit paper.

i. Determine depth of faired depression to ensure that rework limits have not been exceeded.

j. Clean reworked area with dry cleaning solvent. Do not use kerosene.

k. Apply protective finish or specific organic finish as required.

NOTE: Steel surfaces are highly-reactive immediately following corrosion removal; consequently, primer coats should be applied within 1 hour after sanding.

l. Remove masking and protective coverings.

6-168.—6-178. [RESERVED.]

SECTION 11. OTHER METALS AND ALLOYS

6-179. NOBLE METAL COATINGS - CLEANUP AND RESTORATION. Silver, platinum, and gold finishes are used in aircraft assemblies because of their resistance to ordinary surface attack and their improved electrical or heat conductivity. Silver-plated electrodes can be cleaned of brown or black sulfide tarnish, by placing them in contact with a piece of magnesium sheet stock while immersed in a warm water solution of common table salt mixed with baking soda or by using a fine grade abrasive mat or pencil eraser followed by solvent cleaning. If assemblies are involved, careful drying and complete displacement of water is necessary. In general, cleaning of gold or platinum coatings is not recommended in the field.

6-180. COPPER AND COPPER ALLOYS are relatively corrosion resistant, and attack on such components will usually be limited to staining and tarnish. Such change in surface condition is not dangerous and should ordinarily have no effect on the function of the part. However, if it is necessary to remove such staining, a chromic acid solution of 8 to 24 ounces per gallon of water containing a small amount of battery electrolyte (not to exceed 50 drops per gallon) is an effective brightening bath. Staining may also be removed using a fine grade abrasive mat or pencil eraser followed by solvent cleaning.

a. Immerse the stained part in the cold solution. Surfaces can also be treated in place by applying the solution to the stained surface with a small brush.

b. Avoid any entrapment of the solution after treatment. Clean the part thoroughly following treatment with all residual solution removed.

c. Serious copper corrosion is evident by the accumulation of green-to-blue copper salts on the corroded part. Remove these products mechanically using a stiff bristle brush, brass wire brush, 400-grit abrasive paper or bead blast with glass beads, (specification MIL-G-9954, size 13). Air pressure when blasting should be 20 to 30 psi for direct pressure machines. Do not bead blast braided copper flexible lines. Reapply a surface coating over the reworked area. Chromic acid treatment will tend to remove the residual corrosion products.

WARNING: Brushing, sanding, and abrasive blasting of copper and copper alloys can be dangerous due to the creation of toxic airborne particles. Take necessary precautions to ensure safety.

6-181. TITANIUM AND TITANIUM ALLOYS are highly corrosion resistant because an oxide film forms on their surfaces upon contact with air.

a. When titanium is heated, different oxides having different colors form on the surface. A blue oxide coating will form at 700 to 800 °F; a purple oxide at 800 to 950 °F; and a gray or black oxide at 1000 °F or higher. These coatings are protective discolorations and should not be removed.

b. Corrosive attack on titanium surfaces is difficult to detect. It may show deterioration from the presence of salt deposits and metal impurities at elevated temperatures so periodic removal of surface deposits is required. However, if corrosion develops on titanium, it usually occurs as pitting. Acceptable methods for corrosion removal are:

(1) Stainless steel wool or hand brush.

(2) Abrasive mats, cloths, and papers with either aluminum oxide or silicon carbide grit.

(3) Dry abrasive blasting using glass beads (spec. MIL-G-9954) sizes 10-13 or Aluminum oxide (spec. MIL-G-21380, type I, grades A or B) at a blast pressure of 40 to 50 psi (if using suction equipment use 50 percent higher pressure).

WARNING: Dry abrasive blasting of titanium alloys creates sparking. Ensure that hazardous concentrations of flammable vapors are not present.

(4) Hand polish with aluminum polish and soft cloth.

c. Titanium surfaces are susceptible to hydrogen embrittlement that can induce stress corrosion and associated pitting. Therefore, chemicals such as fire-resistant hydraulic fluids must be controlled. Chlorinated hydrocarbon solvents and chemical corrosion removers are prohibited from use on titanium and titanium alloys.

6-182.—6-192. [RESERVED.]

SECTION 12. PLATED PARTS

6-193. CHROMIUM AND NICKEL-PLATED PARTS. Nickel and chromium platings are used extensively as protective and wear-resistant coatings over high-strength steel parts (landing gear journals, shock strut pistons, etc.). Chromium and nickel plate provide protection by forming a somewhat impervious physical coat over the underlying base metal. When breaks occur in the surface, the protection is destroyed.

a. The amount of reworking that can be performed on chromium and nickel-plated components is limited.

b. The rework should consist of light buffing to remove corrosion products and produce the required smoothness. The buffing should not take the plating below the minimum allowable thickness.

c. Whenever a chromium or nickel-plated component requires buffing, coat the area with a corrosion-preventive compound, if possible.

d. When buffing exceeds the minimum thickness of the plating, or the base metal has sustained corrosive attack, the component should be removed and replaced.

e. The removed component can be restored to serviceable condition by having the old plating completely stripped and replated in accordance with acceptable methods and specifications.

6-194. CADMIUM AND ZINC-PLATED PARTS. Cadmium plating is used extensively in aircraft construction as a protective finish over both steel and copper alloys. Protection is provided by a sacrificial process in which the cadmium is attacked rather than the underlying base material. Properly functioning cadmium surface coatings may show mottling, ranging from white to brown to black spots on their surfaces. These show the sacrificial protection being offered by the cadmium coat, and under no condition should such spotting be removed merely for appearance sake. In fact, cadmium will continue to protect even when actual breaks in the coating develop and bare steel or exposed copper surfaces appear.

a. When the breakdown of the cadmium plating occurs and the initial appearance of corrosion products on the base metal develops, some mechanical cleaning of the area may be necessary but shall be limited to removal of the corrosion products from the underlying base material.

b. Under no condition should such a coating be cleaned with a wire brush. If protection is needed, a touch-up with primer or a temporary preservative coating should be applied. Restoration of the plate coating cannot be done in the field.

c. Zinc coatings offer protection in an identical manner to cadmium, and the corrective treatment for failure is generally the same as for cadmium-plated parts. However, the amount of zinc on aircraft structures is very limited and usually does not present a maintenance problem.

6-195.—6-205. [RESERVED.]

SECTION 13. CORROSION PROOFING OF LAND PLANES CONVERTED TO SEA PLANES

6-206. GENERAL. A special problem is encountered in the conversion of land planes to seaplanes. In general, land planes do not receive corrosion proofing to the same extent as do seaplanes. Corrosion-proofing standards for land planes converted to seaplanes are divided into two classes, necessary minimum precautions and recommended precautions. Regardless of such precautions, it is imperative that the exterior surfaces of seaplanes be washed with clear fresh water immediately following extended water operation, or at least once a day when operated in salty or brackish water. Wash interior surfaces of seaplanes exposed to spray, taking care to prevent damage to electrical circuits or other items subject to injury.

6-207. NECESSARY MINIMUM PRECAUTIONS. The following procedures are considered the minimum to safeguard the airworthiness of converted aircraft and are not in themselves intended to maintain airworthiness for an indefinite period.

a. Unless already protected, treat exposed fittings or fittings that can be reached through inspection openings with two coats of zinc chromate primer, paralketone, nonwater-soluble heavy grease, or comparable materials. This applies to items such as wing-root fittings, wing-strut fittings, control-surface hinges, horns, mating edges of fittings, and attached bolts.

b. Coat non-stainless control cables with grease or paralketone or other comparable protective coating, if not replaced with corrosion-resistant cables.

c. Inspect all accessible sections of aircraft structure. Clean structural parts showing corrosion and refinish if corrosion attack is superficial. If a part is severely corroded, replace with an adequately corrosion-proofed part.

6-208. RECOMMENDED PRECAUTIONS. Recommended precautions are those which are suggested as a means of maintaining such aircraft in condition for safe operation over extended periods.

a. Provide additional inspection openings to assist in detecting corrosion. Experience has shown openings to allow inspection of the lower and rearward portion of the fuselage to be particularly desirable.

b. Incorporate additional provisions for free drainage and ventilation of all interiors to prevent collection of moisture (scoop-type marine drain grommets).

c. Protect the interior of structural steel tubing. This may be done by air and watertight sealing or by flushing with hot linseed oil and plugging the openings. Inspect tubing for missing sealing screws, presence of entrapped water, local corrosion around sealing screws, welded clusters, and bolted fittings, which may be indicative of entrapped moisture.

d. Slit the fabric of fabric-covered aircraft longitudinally on the bottom of the fuselage and tail structure for access to these sections. Coat the lower structural members with zinc chromate primer (two coats); follow by a coat of dope-proof paint or wrap with cellophane tape and rejoin the fabric. This precaution is advisable within a few months after start of operation as a seaplane.

e. Spray the interior of metal-covered wings and fuselages with an adherent corrosion inhibitor.

f. Place bags of potassium or sodium dichromate in the bottom of floats and boat hulls to inhibit corrosion.

g. Prevent the entry of water by sealing, as completely as possible, all openings in wings, fuselage, control-surface members, openings for control cables, tail-wheel wells, etc.

6-209.—6-219. [RESERVED.]

SECTION 14. HANDLING AND CARE OF AIRCRAFT RECOVERED FROM WATER IMMERSION.

6-220. GENERAL. Aircraft recovered from partial or total immersion in standing water or flash floods require an in-depth inspection and cleaning of both the exterior and interior areas. Water-immersion increases the probability of corrosive attack, it removes lubricants, deteriorates aircraft materials, and destroys electrical and avionics components.

a. Sea water, because of salt content, is more corrosive than fresh water. However, fresh water may also contain varying amounts of salt and, as drying occurs, the salt concentration is increased and corrosive attack accelerated.

b. Prompt action is the most important factor following recovery of an aircraft from water-immersion. Components of the aircraft which have been immersed, such as the powerplant, accessories, airframe sections, actuating mechanisms, screws, bearings, working surfaces, fuel and oil systems, wiring, radios, and radar should be disassembled, as necessary, and the contaminants completely removed.

6-221. INITIAL FRESH WATER OR DETERGENT WASH. As soon as possible after the aircraft is recovered from water-immersion, thoroughly wash all internal and external areas of the aircraft using a water/detergent solution as follows:

a. Mix liquid detergent (MIL-D-16791, type I) and isopropyl alcohol (TT-I-735) in ratio of eight parts detergent, to 20 parts of alcohol. Add the detergent/alcohol mixture to 72 parts of tap water and mix thoroughly. For use, add one part of the preceding concentrate to nine parts of tap water (warm water if available) and mix thoroughly.

b. If the above specified detergent/alcohol materials are not available, use water-emulsion cleaning compound (MIL-C-43616). Add one part compound to nine parts water. If the MIL cleaning compound is not available, use any available mild household detergent solution with fresh tap water.

6-222. RECIPROCATING ENGINES AND PROPELLERS. Remove the propeller from the engine and the engine from the aircraft. The exterior of the engine and propeller should be washed with steam, or fresh water, preferably hot.

a. Major accessories, engine parts, etc., should be removed and all surfaces flushed with fresh water, preferably hot. If facilities are available, immerse the removed parts, time permitting, in hot water or hot oil, 180 °F, for a short time. Soft water is preferred. Change the water frequently. All parts must be completely dried by air blast or other means. If no heat-drying facility is available, wipe the cleaned parts with suitable drying cloths.

b. The constant-speed propeller mechanism should be disassembled, as required, to permit complete decontamination. Clean parts with steam or fresh water, preferably hot. Dry the cleaned parts in an oven, but if a heat-drying facility is not available, wipe the cleaned parts with suitable drying cloths.

6-223. AIRFRAME. The salvable components of the fuselage, wings, empennage, seaplane and amphibian hulls and floats, and movable surfaces should be processed as follows:

a. The fabric from fabric-covered surfaces should be removed and replaced.

b. Clean the aircraft interior and exterior using steam under pressure with steam cleaning compound. Direct the steam into all seams and crevices where corrosive water may have penetrated. Avoid steam cleaning electrical equipment, such as terminal boards and relays.

c. Areas that have been steam cleaned should be rinsed immediately with either hot or cold fresh water.

d. Touch up all scratches and scars on painted surfaces using zinc chromate primer or preservative.

e. Undrained hollow spaces or fluid entrapment areas should be provided temporary draining facilities by drilling out rivets at the lowest point. Install new rivets after drainage.

f. Remove and replace all leather, fabric upholstery, and insulation. Plastic or rubber foam that cannot be cleaned of all corrosive water must be replaced.

g. All drain plugs or drive screws in tubular structures should be removed and the structure blown out with compressed air. If water has reached the tubular interiors, carefully flush with hot fresh water and blow out water with compressed air. Roll the structure as necessary to remove water from pockets. Fill the tubes with hot linseed oil, approximately 180 °F, drain oil and replace drain plugs or drive screws.

h. Clean sealed wood, metallic, and other non-metallic areas, excluding acrylic plastics, with warm water. Replace wood, metalite, and other porous materials exposed to water-immersion unless surfaces are adequately sealed to prevent penetration by water. Virtually all solvents and phenolic type cleaning agents are detrimental to acrylics and will either soften the plastic or cause crazing.

i. Remove instruments and radios and applicable cables and plumbing, and repair and inspect as necessary.

6-224.—6-234. [RESERVED.]