

EO 05-1-2AH

ROYAL CANADIAN AIR FORCE



**CORROSION CONTROL
AIRCRAFT**

"REVISION"
NOTICE

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28 OCT 53

Revised 24 Nov 61

LIST OF RCAF REVISIONS

DATE	PAGE NO	DATE	PAGE NO
29 Oct 57	9		
9 Mar 60	ii		
9 Mar 60	7		
9 Mar 60	8		
9 Mar 60	9		
5 Sep 61	9		
24 Nov 61	ii		
24 Nov 61	7		
24 Nov 61	8		
24 Nov 61	9		

FOREWORD

Corrosion in its various forms is the result of poor housekeeping. It should be remembered that the best preventive maintenance scheme known is a high standard of cleanliness, combined with immediate action if corrosion is found.

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PART 1

FORMS OF CORROSION

GENERAL

1 There are four main forms in which corrosion will be encountered and it is the purpose of this Engineering Order to aid personnel in identification, to take the necessary action to remove the corrosion and to inhibit the surface to prevent further corrosion. Corrosion when encountered will be in one of the following forms:

- (a) Intragranular (Surface) Corrosion.
- (b) Intergranular (Intercrystalline) Corrosion.
- (c) Dissimilar Metal (Electrolytic) Corrosion.
- (d) Stress Corrosion.

INTRAGRANULAR (SURFACE) CORROSION

2 This is by far the most common form of corrosion which will be encountered in the RCAF, and early recognition of the symptoms is essential in combating this corrosion. Figure 1-1 shows a section of a panel which has been attacked by intragranular corrosion. The tell tale dirty white blotches which form on the skin are very evident in the picture, and indicate that preventive action should be instigated immediately.

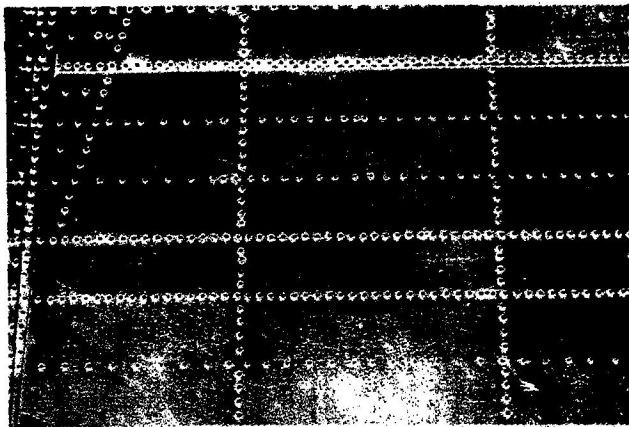


Figure 1-1 Surface Corrosion

3 Areas which are the most susceptible to this form of corrosion are the undersurfaces of wings and tailplanes, lower portions of air intakes, the areas around the battery compartment and areas subjected to relief tube spray, hot exhaust gases and the gases from gun fire. These areas should be inspected at regular intervals for any indication of corrosion.

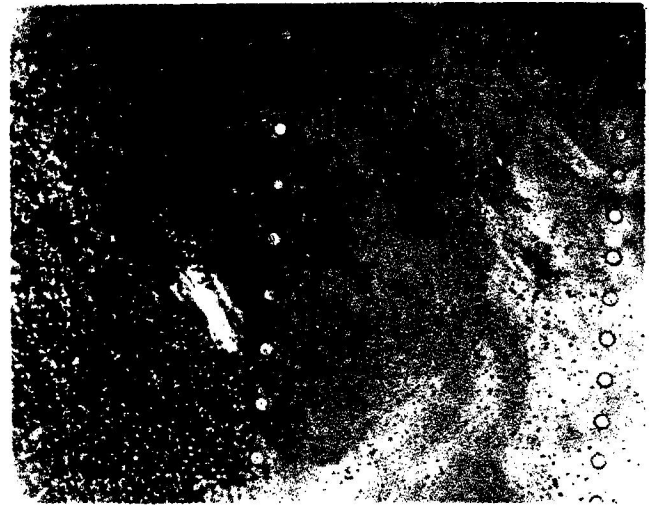


Figure 1-2 Severe Surface Corrosion

4 In Figure 1-2 we see a panel which has been allowed to proceed to a serious degree. The left hand side of the picture shows the surface appearance before the corrosion product has been removed, while the right hand portion of the panel has been cleaned and tested for penetration. The test for penetration is carried out using a 5 normal solution of sodium hydroxide, caustic soda, 1 part to 4 parts water by weight, which is applied to the surface and left for 2 minutes. Using a flashlight and a magnifying glass, 4 power or greater, inspect the base of the pits to see whether they have turned black. If the base of the pit is black, it indicates that the clad has been penetrated and that either the panel should be replaced or a form of surface treatment carried out. For recommended surface treatments, see Part 2. It will be left to the discretion of the Chief Technical Officer as to whether the panel will be replaced or surface treatment carried out.

5 In the case of extruded members or castings, the extent of corrosion allowed will depend upon the location and function of the member involved. In all cases the Chief Technical Officer will decide what program will be carried out. A suggested maximum reduction in cross sectional area due to the action of surface corrosion is 10%.

INTERGRANULAR (INTERCRYSTALLINE) CORROSION

6 A second and perhaps the most serious form of corrosion which will be encountered is intergranular or intercrystalline corrosion. The corrosion is more prevalent in the heat treatable aluminum alloys such as 17S, 24S, 57S, (52S Alcoa) and 75S, which have been subjected to improper heat treatment. In Figure 1-3 we have a photograph (x500) of a longitudinal section of a sample which has been improperly heat treated. In this photograph, it is possible to see the precipitation in the grain boundaries. It is this precipitation of alloying ingredients in the grain boundaries of the material which seriously decreases the materials' resistance to corrosion.

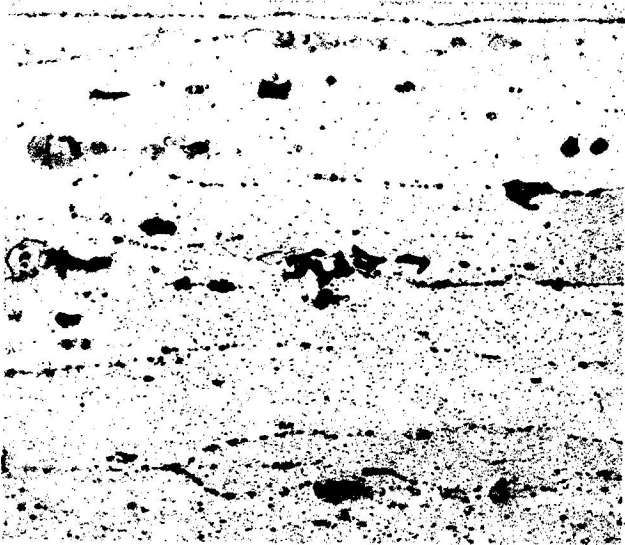


Figure 1-3 Grain Boundary Precipitation

7 The first indication that corrosion is beginning to attack a member will be the formation of slight blister-like raises on the surface of the metal. Upon probing with a sharp tool the metal will flake away much like rotten wood.



Figure 1-4 Intergranular Corrosion

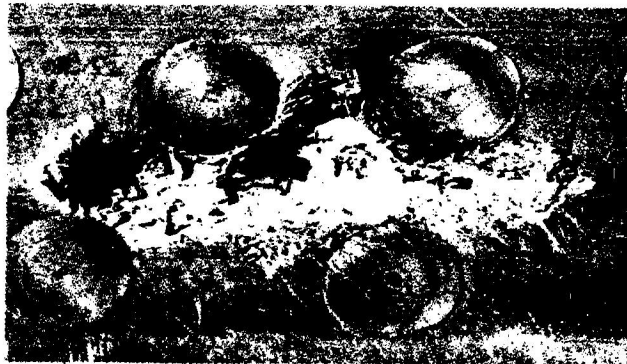


Figure 1-5 Intergranular Corrosion

Figures 1-4 and 1-5 show the appearance of a member after probing in which corrosion has reached an advanced stage. In Figure 1-6 we have a cross sectional view of a member which showed only a slight blister effect on the upper surface. The member when sectioned and subjected to microscopic examination showed the effects of severe intergranular corrosion. As shown, Figures 1-6 and 1-7, the effect of intergranular corrosion, dark lines, is to destroy the grain boundaries which in turn reduces the strength of the material. The fact that intergranular corrosion can reach a serious extent before being evident, makes it essential that when this form of corrosion is suspected, steps are taken to determine the extent of the damage. In Figure 1-8 we have a longitudinal cross section of a section of corroded metal showing the complete breakdown of grain structure which has occurred.



Figure 1-6 Micro Photograph - Destroyed Grain Boundaries

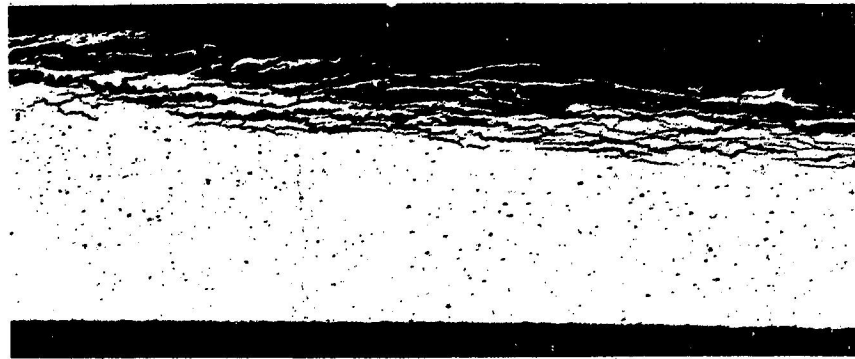


Figure 1-7 Micro Photograph of the Probed Area - Transverse

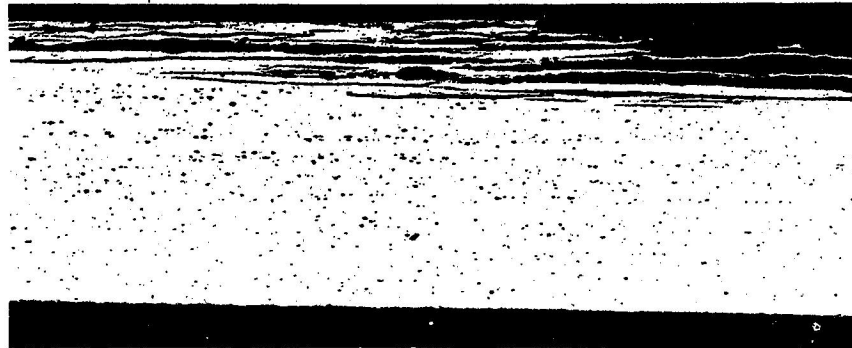


Figure 1-8 Micro Photograph of the Probed Area - Longitudinal

8 The use of clad sheet has, to some extent limited the danger due to improper heat treatment. However, if surface corrosion is allowed to penetrate the clad on a section which has been improperly heat treated, intergranular corrosion will attack the base metal. This action may be seen on Figure 1-9 where corrosion lines may be seen extending from the base of the pits. With clad material, corrosion may proceed until the only sound metal is the clad. In Figure 1-10

we have an example of this, but in this photograph the outer clad has been removed to show the extent of damage to the base metal.

NOTE

There is no known method of inactivating this form of corrosion. The only corrective action that may be taken is the replacement of the affected components.

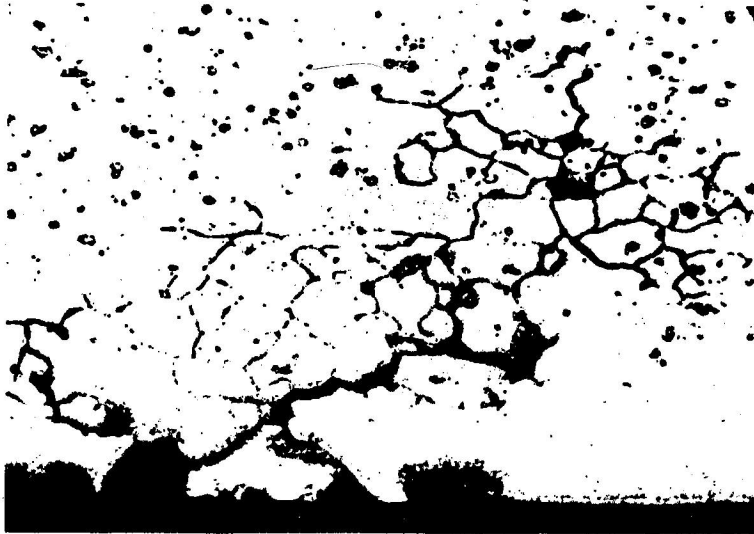


Figure 1-9 Intergranular Corrosion



Figure 1-10 Severe Corrosion of Core Material

DISSIMILAR METAL (ELECTROLITIC) CORROSION

9 A third form of corrosion encountered will be that caused by the contact of two dissimilar metals in the presence of an electrolyte, a solution capable of conducting an electric current. It has been established that every metal and alloy has an inherent electrical potential, and when one metal is in contact with a metal of different potential, in the presence of an electrolyte a galvanic cell is produced, and a current will flow from one metal to the other, resulting in the dissolution of one of the metals. The metal

from which the current flows is the anode and that to which the current flows is the cathode. The degree of corrosion may be estimated from the difference in potential between the two metals forming the cell with the anodic, negative, metal being corroded. Table 1 lists the galvanic series in sea water, but is not true in every respect since corrosion is proportional to the current flowing in the cell and this is influenced by cell resistance, ratio of contact areas, concentration, aeration, and type of corrosive medium.

TABLE 1.

GALVANIC SERIES IN SEA WATER	
1	Magnesium
2	Magnesium Alloys
3	Zinc
4	Aluminum (52SH, 61S, 3S, 2S, 53ST in this Order)
5	Clad 24ST and Clad 17ST
6	Cadmium
7	Aluminum (75ST, A17ST, 17ST, 24ST in this Order)
9	Mild Steel
10	13% Chromium Stainless Steel Type 410 (Active)
11	50-50 Lead-Tin Solder
12	18-8 Stainless Steel Type 304 (Active)
13	Lead
14	Tin
15	Manganese Bronze
16	Naval Brass
17	Nickel (Active)
18	Inconel (Active)
19	Admiralty Brass
20	Aluminum Bronze
21	Copper
22	70-30 Copper-Nickel
23	Nickel (Passive)
24	Inconel (Passive)
25	Monel

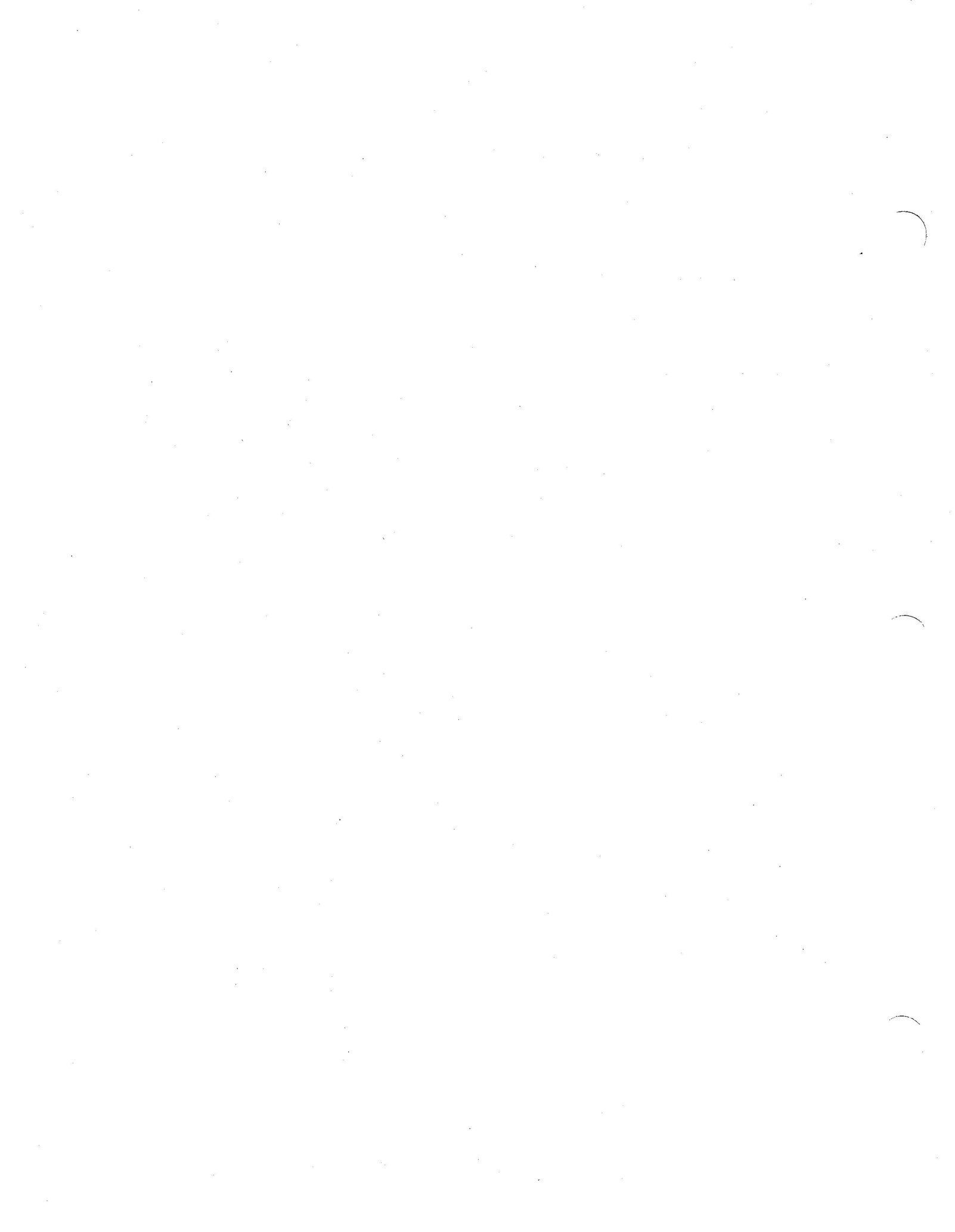
NOTE

A passive metal denotes a metal upon which a protective oxide film readily forms, that prevents further attack on the metal.

Table 1 is for information only. The positions of the metals in this Table does not enable the rate of corrosion to be determined.

STRESS CORROSION

10 This type of corrosion occurs when a particular member is subjected to both high stresses and corrosive conditions. This form of corrosion happens infrequently and is evident by the metal cracking in the areas of maximum stress. Aluminum, brass and magnesium alloys are particularly susceptible to this kind of failure. Stress corrosion will occur along lines of cold working if the metal has been stressed too highly and not properly relieved through heat treatment.



PART 2

CORROSION CONTROL

GENERAL

1 It is of the utmost importance that aircraft be kept thoroughly clean at all times. Whenever flying commitments permit a definite time should be set aside for cleaning aircraft. This cleaning of aircraft is considered essential in order to maintain airworthiness and to inhibit corrosion. In order to avoid damage to the aircraft through use of harmful materials, only those materials which have received AMCHQ approval are to be used. In washing aircraft and in paint removal from metal surfaces, care must be exercised to maintain the proper concentration of solution used, as a strong solution may be found to cause corrosion.

CLEANING

2 Instructions and approved methods for cleaning aircraft as detailed in EO 50-10A-2 Aircraft Cleaning External are to be followed.

SALT WATER OPERATIONS

3 Aircraft involved in operations from salt water shall be washed down with fresh water at the end of the days flying. Components not otherwise protected against corrosion shall be dried and either sprayed or wiped down with lubricating oil or hydraulic fluid depending on components being treated. Care shall be taken to ensure that as little fluid as possible is deposited on exhaust pipes or collector rings. The fluid will also be kept off all rubber components.

4 Magnesium or aluminum alloys are used in the landing gear wheels and unless protected, corrosion will set in rapidly. Inspection of the wheels should include a careful visual inspection of the paint surface. Portions of the wheel where the paint has deteriorated, peeled or chipped must be retouched with lacquer.

5 Hull and float interiors will be drained and flushed at regular intervals and in manner described in the applicable -2 Engineering Order.

METAL IN CONTACT

6 When fabricating metallic parts, care

must be exercised to prevent corrosion at the fraying surfaces. Similar metals present no difficulty and require only the use of zinc chromate primer before fabrication. The use of dissimilar metals present a much more difficult situation and precautions must be taken. In most instances the materials should be separated by an insulating material. Steel when in contact with aluminum should be cadmium plated or metalized with aluminum and then receive two coats of primer which must be dry before assembly. The installation of press fittings is accomplished using a heavy zinc chromate paste.

BATTERY ACID

7 To neutralize spilled battery acid, use sodium bicarbonate, baking soda, or sodium borate, borax, dissolved in water. The alkali salt must be completely removed after neutralization with copious quantities of water to prevent corrosion.

GUN BLAST PANELS

8 Gun blast panels and areas which the hot gases pass over shall be cleaned with an approved cleaner at the end of the days' flying, if the guns have been fired.

REMOVAL OF DRY CHEMICAL EXTINGUISHING AGENTS

9 When aircraft have been subjected to 21F/283 and 691 Dry Chemical extinguishing agents, the following preventative measures, if taken IMMEDIATELY will prevent corrosion:

- (a) Remove as much of the powder as possible by sweeping, brushing, vacuuming, or blowing with compressed air.
- (b) Wash affected parts thoroughly with soap and water.
- (c) Rinse thoroughly with clear water.

**CORROSIVE LIQUID CHEMICAL -
FIRE EXTINGUISHING AGENT**

10 Aircraft, engines, components and areas affected by discharge of Methyl Bromide (MB) Chlorobromomethane (CB) or Freon (CF₃BR) fire extinguishers are to be thoroughly sprayed with a suitable solvent and blown out with dry compressed air with special attention given to the valves and piping of the extinguishing system.

REMOVAL OF CORROSION PRODUCT

11 There are several means of removing the corrosion product, but care must be used to ensure that no further damage is done to the skin. Mechanical methods of removal may be one of the following; sandpaper, scrapers, wire brushing, aluminum wool.

NOTE

In no case shall steel wool be used in removing corrosion product from aluminum panels. The use of steel wool may cause electrolytic corrosion due to particles of steel wool embedding in the aluminum clad.

NOTE

Whenever possible chemical means of removing the corrosion products are preferred to mechanical means.

CORROSION REMOVAL - ALUMINUM

CHROMIC ACID WASH

12 A 10 percent solution shall be made by mixing 18.5 ounces, Avoirdupois, chromic acid Federal Spec. O-C-303 in 1 Imperial gallon of water. Stir the solution until the chromic acid is thoroughly mixed.

Procedure

13 The procedure for application of the corrosion inhibiting coat shall be as follows:-

- (a) Clean the affected areas thoroughly using an approved solvent.
- (b) Clean the corroded areas of corrosion product using the acid wash and a stiff fibre brush.

(c) Wash the area thoroughly with warm or cold water to remove all traces of corrosion.

(d) Coat area with the 10 percent solution of chromic acid applied uniformly with cloths, felt pads or brushes and allow to dry. This will act as an inhibitor.

(e) The chromic acid shall be thoroughly removed with a damp cloth and the metal dried. This is necessary to prevent staining of the finish.



The operator must wear protective clothing while carrying out this operation.

The chromic acid solution must be limited to a chromic acid content of between 9 and 11 percent. This corresponds to a hydrometer reading of 1.068 to 0.184.

Rags wetted with chromic acid solution shall be placed in a metal container to avoid the possibility of a fire caused by spontaneous combustion.

Acid solutions are to be contained in glass or earthenware containers.

Reference is to be made to EO 00-80-4/22 for further precautions when handling acid solutions.

PHOSPHORIC ACID TREATMENT

14 A 10 percent phosphoric acid alcohol solution shall be prepared by mixing the following:

- Isopropyl Alcohol 7 parts by volume 3-GP-525
- Phosphoric acid 85% . . . 1 part by volume Federal Spec. O-P-313
- Water 2 parts by volume

Procedure

15 The procedure for application of this corrosion, inhibiting coat shall be as follows:

- (a) Clean the affected area thoroughly using an approved solvent.
- (b) Apply the acid solution with a stiff fibre brush, scour to remove all traces of the cor-

rosion product. Allow the solution to remain for 2 or 3 minutes.

(c) Wash thoroughly with hot or cold water and dry.

WARNING

Phosphoric acid treatment in general has the same application as the chromic acid treatment but should not be used where it could become entrapped and remain in contact with the structure as it will cause severe corrosion.

Do not allow material to remain on the surface more than 3 minutes.

**CORROSION TREATMENT OF
MAGNESIUM ALLOY**

16 The treatment consists of a simple dip operation requiring one-half to two minutes, according to the freshness of the solution, in the following bath maintained at room temperature 21.1° to 32.2°C (70° to 90°F).

Sodium Dichromate	1.5 lbs.
Concentrated Nitric Acid	1.5 pints
Water	to make 1.0 gallon

Technical grades of these chemicals may be used. Pure aluminum, glass or ceramic tanks may be used for containing the solution. Welded pure aluminum tanks are most practical for large installations. After the dip the parts

should be held above the tank for approximately five seconds. This allows the adhering solution to drain off, and produces a better colored coating. The parts are then washed in cold running water followed by a dip in hot water to facilitate drying.

17 Magnesium die castings should be given a ten second dip in the chrome-pickle solution heated to 49°C (120°F). Longer time of treatment results in an excess of powdery deposit.

18 Articles too large to be immersed should be well brushed with a generous amount of fresh solution which is allowed to remain on the surface for about one-half minute and is then washed off. The coating thus formed is less uniform in color than that produced by the dip process but is equally good as a paint base.

NOTE

In treating riveted assemblies, care must be taken to avoid trapping solution in the joints.

When applying this chrome-pickle solution, precaution must be taken to ensure that this solution does not come in contact with areas where injurious effects may occur, such as plated surfaces, bearing surfaces, brass or copper.

SURFACE PROTECTION

19 Where additional surface protection is necessary zinc chromate primer Spec. MIL-P-6889A type 1 shall be used followed by a cellulose nitrate lacquer Spec. MIL-L-7178.

