

EO 05-1-3/23

# ROYAL CANADIAN AIR FORCE



## ANTI-CORROSION PRECAUTIONS

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## ANTI-CORROSION PRECAUTIONS

### ANTI-CORROSION PRECAUTIONS

#### General

1 The prevention of corrosion is of primary importance in aircraft maintenance. Corrosion is the oxidation or similar chemical change in the composition of a metal. Removal of dirt is a primary concern, since such accumulations in aircraft crevices absorb moisture which aids corrosion. Moisture-proof joints are important in corrosion control. For aircraft areas most susceptible to corrosion, see Figure 1.

#### Cleanliness

2 The best preventive maintenance is a high standard of cleanliness, combined with immediate action if corrosion is found. Instructions and approved methods for cleaning aircraft as detailed in EO 50-10A-2A are to be followed.

#### Factors Stimulating Corrosion

3 Atmospheric corrosion is stimulated by a damp atmosphere, since this maintains a film of water on the metal, an essential condition for corrosion. Other factors are oxygen (air) dissolved in this water film; acids or acid gases in the atmosphere, near the gun blast tubes, or batteries; salts that dissociate in water producing an acid reaction; contact of dissimilar metals (electrolytic corrosion); and the presence on the metal of a depolarizing surface, such as mill scale on iron.

#### Factors Inhibiting Corrosion

4 Factors inhibiting corrosion are the use of a self-sacrificing metal, such as zinc, to protect iron or steel; protective coating, such as aluminum on aluminum alloy; passivating of steels, or so treating them that they are

insoluble in acids and do not precipitate metals from solutions; or inducing formation of protective surface films (as of chromate).

#### Types of Corrosion

5 The four main types of corrosion are:

- (a) Intragranular (surface) corrosion.
- (b) Intergranular (intercrystalline) corrosion.
- (c) Dissimilar metal (electrolytic) corrosion.
- (d) Stress corrosion.

6 For complete information regarding methods of recognizing and combating these forms of corrosion, refer to EO 05-1-2AH.

#### Stress Corrosion

7 The effect of corrosion on a metal while it is under stress is often much more severe than under ordinary conditions. This is particularly true of metal members subjected simultaneously to fatigue stress and corrosion. Under such conditions, the number of stress applications required for failure of the metal is very much less than under non-corrosive conditions. A condition of internal stress may also serve to accentuate the destructive effect of what otherwise would be a mild corrosive attack. For example, hard-drawn brass tubing may crack under the action of relatively light surface corrosion, or the heads of rivets may snap off. Tightly drawn up bolts of non-ferrous metals may behave similarly.

## COATINGS

#### General

8 To prevent surface corrosion of all types of aircraft metals, various finishes are applied as protection. The kind of metal

**PASSENGER, CARGO, AND CREW DOORS**  
FLOORS AND STRUCTURE IN THESE AREAS SHOULD BE KEPT FREE OF RAIN WATER AND CONDENSATE AND THE FINISH MAINTAINED IN GOOD CONDITION.

**FLOOR SUPPORTS AND FLOORING**  
METAL FLOORS AND SUBSTRUCTURE WILL CORRODE IF CONTINUALLY IN CONTACT WITH MOISTURE OF ANY KIND. SPILLED FOOD AND LIQUIDS SHOULD BE WIPED UP AND THE AREA THOROUGHLY CLEANED AND TREATED AS SOON AS POSSIBLE.

**UNDER DE-ICER BOOTS**  
MOISTURE MAY BE ABSORBED BY THE PRIMER UNDER THE BOOTS AND RESULT IN CORROSION. INSPECT AND CORRECT AS REQUIRED.

**GALLEY AREAS**  
SPILLED FOOD, FRUIT JUICES, AND OTHER LIQUIDS IN PROLONGED CONTACT WITH METAL STRUCTURE WILL PROMOTE CORROSION. KEEP AREAS CLEAN AND DRY AND MAINTAIN THE ACID RESISTANT LACQUER IN GOOD CONDITION.

**INTEGRALLY STIFFENED PANELS**  
CORROSION MAY OCCUR AT LOW POINTS INSIDE THE INTEGRAL FUEL TANKS WHERE WATER CONDENSATE GATHERS. INTEGRALLY STIFFENED PANELS MAY NOT HAVE ALUMINUM CLADDING AND ARE MORE PRONE TO CORRODE. ENSURE THAT PROTECTIVE COATINGS ARE MAINTAINED IN GOOD REPAIR.

**AREAS IN PATH OF EXHAUST GASES**  
EXHAUST GASES ON THE NACELLE AND WING SKINS AND SEEPING INTO THE WING STRUCTURE MAY PERMEATE THE PROTECTIVE FINISH AND CAUSE CORROSION UNDERNEATH. CLEAN AFFECTED SURFACES THOROUGHLY AT EACH DAILY INSPECTION.

**BATTERY AREAS**  
SPILLED BATTERY ACID SHOULD BE CLEANED OFF THE STRUCTURE IMMEDIATELY. THE STRUCTURE IN THE BATTERY AREA AND THE EXTERIOR SKINS NEAR THE VENTS SHOULD BE INSPECTED AND WASHED PERIODICALLY AND THE ACID RESISTANT LACQUER MAINTAINED IN GOOD CONDITION.

**LAVATORY AREAS**  
SOAPY WATER OR OTHER FLUIDS IN THESE AREAS PROMOTE RAPID CORROSION AND DETERIORATION OF STRUCTURE. KEEP AREAS CLEAN AND DRY AND MAINTAIN THE ACID RESISTANT LACQUER IN GOOD CONDITION.

Figure 1 Areas most Susceptible to Corrosion

on which the finish is to be applied will determine the type of finish employed. On steel and its alloys several types of finishes are used. On magnesium only a few protective coatings may be applied.

9 The primary purpose of applying protective coatings is to stop corrosion in its first stage. All metal parts must be protected on both internal and external surfaces. Among the types of coating used to protect steel are peelable plastic films, waxes, metallic soaps, paints, lacquers, primers, petroleum-based compounds and metallic films.

#### Paints

10 Some paints protect the surface of metal by the formation of an impenetrable film, others exert a chemical protective action. Paints serve to protect the surface from dampness, sea water, oxidizing gases, smoke, etc. Periodic inspection of painted surfaces is necessary to check surface cracks, peeling or spalling, which leaves the surface vulnerable to corrosive action.

#### Metallic Films

11 Metallic coatings may be applied to ferrous metals by dipping parts to be protected into hot baths of the coating metal, by electro-plating from an appropriate solution, by metal spraying or by Sherardizing. The more common methods of hot dipping are galvanizing and tinning. Chromium, nickel, cadmium and copper plating are the more common methods of electroplating. The anodic oxidation process or anodizing is used exclusively for coating aluminum alloys.

#### Hard Drying Coatings

12 Hard drying coatings are usually employed for semi-permanent coverage of outside steel surfaces. Normally, such materials are either paints or non-oxidizing asphaltic materials. These contain thinners to facilitate application. Upon evaporation of the thinner, a hard, tough surface results which is reasonably resistant to wear and weather. The length of protection afforded by these materials varies widely according to their character and the kind of weather to which the protected surfaces are exposed.

## PETROLEUM-BASE PREVENTIVE MATERIALS

### General

13 Four types of petroleum-base rust preventive materials are used:

- (a) Lubricating oils and greases.
- (b) Specially prepared rustproofing oils.
- (c) Heavy non-drying compounds.
- (d) Hard-drying coatings.

### Greases and Oils

14 Lubricating greases and oils are temporary preventatives of corrosion on finished machine parts, tools, etc., while they are being shipped, stored, or otherwise not in service. They are suitable only when the steel is stored in a place where the conditions conducive to rusting are not severe and where the steel is protected against atmospheric condensation due to temperature changes. It is usually true that the heavier the oil, the better the protection, but no straight mineral oil or grease will give long-time rust prevention.

### Straight Petroleum Oils

15 These are well-refined lubricating oils containing no fatty oils or other added materials. Either a paraffin or naphthene-base oil can be used with good results. Light oils having a viscosity of from 85 to 250 seconds Saybolt universal at 100°F are used, chiefly for the temporary protection of sheet steel. They furnish good rust protection and lubrication between the sheets in a stack, although they do not give complete protection to the steel against rusting in the presence of moisture. Water will tend to penetrate a straight mineral oil film and cause rusting of the steel beneath, sometimes within a few hours.

### Special Rustproofing Oils

16 Many rustproofing oils are composed chiefly of petroleum lubricating oils with or without volatile thinners, to which have been added small amounts of other protective materials. The thinner acts as a solvent to reduce the viscosity and aid in uniformly spreading a thin layer of the rust preventing material.

They are particularly useful when storage conditions are such that steel surfaces are exposed to atmospheric changes but they are not intended for protection under outdoor atmospheric conditions, although the better grades will provide such protection to a limited extent. They will give a long-time protection to steel that is not exposed directly to the elements and they will give much better service in this respect than a straight mineral oil.

#### Heavy Non-drying Rustproof Compounds

17 These include petroleum compounds which are relatively viscous and non-hardening but which can be applied with a brush or heated for a dipping operation to produce a waterproof film. Some of these materials penetrate beneath existing rust and prevent further deterioration of the metal underneath. Most of them can be readily removed with a solvent, such as kerosene. They are especially suitable for the protection of steel surfaces during storage or shipment under unfavourable weather conditions.

18 Oils and greases may be applied by brushing, dipping, slushing or spraying. During wet-grinding operations, rust-preventative oils should be mixed with cutting fluids to reduce subsequent corrosion.

## REFINISHING CORRODED OR REWORKED METAL SURFACES

### General

19 Use the following instructions for the refinishing of corroded or reworked metal parts and assemblies. These treatments apply regardless of previous treatment of the part. The finishes specified are to be omitted from metal surfaces forming electrical bonds when such finishes prevent proper electrical bonding.

### Procedures for Aluminum

20 The following refinishing procedure applies to aluminum parts, assemblies, etc. which are not subsequently painted and from which the corrosion can be removed, leaving a surface which is practically free from pits or, in the case of clad aluminum materials, the corrosion can be removed leaving a surface in which the pits do not extend beyond the cladding. Refer to Paragraph 21, following.

21 On 2S, 3S, 52S, 61S and clad aluminum alloys, proceed as follows:

(a) Remove any primer or paint from corroded areas in accordance with EO 05-1-3/20.

(b) Remove any foreign matter (grease, oil, corrosion products, etc.) from the affected area by wiping with cleaner (Item 1), or water, depending upon the nature of the dirt. Remove corrosion products using cleaning compound (Item 2), Bon Ami (Item 3), fine abrasive paper (Item 4) or fine aluminum wool (Item 5).

(c) Brush on a 5% chromic acid solution using a stiff brush. Keep surface of part wet with the solution for two to three minutes.

(d) Rinse by wiping with a water-saturated cloth or by immersing in running water.

(e) Dry with a cloth or with an air blast.

(f) Apply finishes as follows:

(1) For surfaces forming part of the exterior of the aircraft which are not to be painted, no further finish is required.

(2) For surfaces on the interior of the aircraft, for surfaces not normally visible or for surfaces on the exterior of the aircraft which will be painted, coat with zinc chromate primer (Item 7), if not prohibited by the function of the part, and then coat with finish colour, if required.

22 For all other aluminum alloys proceed as follows:

(a) Clean as specified in Paragraph 21, preceding.

(b) If part is not yet assembled or if it can be removed, anodize. (Refer to Paragraphs 127 to 136 inclusive, following.) For parts which cannot be removed, refer to EO 05-1-3/21.

(c) Coat the entire part with zinc chromate primer (Item 7) except where priming would interfere with the functioning of the part.

### Procedure for Ferrous and Copper Alloys

23 For unplated alloys proceed as follows:

(a) Remove any paint in accordance with EO 05-1-3/20.

(b) Remove grease, oil, etc., in accordance with EO 05-1-3/20, or by wiping with cleaner (Item 1).

(c) Remove corrosion from parts corroded or reworked prior to assembly, as follows:

(1) Copper alloys: Pickle, (refer to EO 05-1-3/20).

(2) Ferrous alloys: Sandblast or pickle, (refer to EO 05-1-3/20).

(3) Heat resistant alloys: Pickle, (refer to EO 05-1-3/20).

(d) Parts found corroded during maintenance checks must be removed whenever possible, and treated as above for unassembled parts. Otherwise, use the following procedure:

(1) Remove primer or paint from affected areas in accordance with EO 05-1-3/20.

(2) Remove corrosion products using fine abrasive (Item 4), cleaning compound (Item 2) or Bon Ami (Item 3).

(3) No additional finish is required.

24 For cadmium plated alloys, strip parts showing any signs of corrosion and replate, whenever possible, (refer to Paragraphs 31 to 40 inclusive, following). This includes superficial corrosion of the plating as well as corrosion of the base material. Corrosion of the base material is evidenced by the discoloration of the plate (brown or red for steel, bluish-green for copper alloys). If part is superficially corroded (white corrosion products), and it is not desirable to remove or disassemble the part, wash off the affected area, remove corrosion by using fine abrasive, cleaning compound or Bon Ami, and treat with 5% chromic acid solution (Item 6) for two to three minutes. Wipe dry and coat with two coats of primer and two coats of lacquer (Item 8).

25 For chromium plated alloys from which the plating has been removed or which have corroded due to cracking, breaking or peeling of the chromium plating, strip and replate,

(refer to Paragraphs 41 to 52 inclusive, following). Nickel plated parts which have become corroded must be stripped and replated. Nickel plated parts which have become discoloured by heat (typical blue-grey to black colour) should not be considered as corroded and will not normally have to be refinished.

#### Procedure for Magnesium Alloys

26 For parts corroded or reworked prior to assembly, proceed as follows:

(a) Remove primer or paint, (refer to EO 05-1-3/20).

(b) Remove corrosion products and apply the proper chemical treatment in accordance with Paragraphs 141 to 146 inclusive, following.

(c) Finish as required by the applicable finish specification.

27 For parts corroded or reworked after assembly, whenever possible remove parts and treat as in Paragraph 26, preceding, for unassembled parts. Otherwise, proceed as follows:

(a) Remove primer or paint from affected areas, (refer to EO 05-1-3/20), and clean off other foreign matter by wiping with a cloth soaked with water or cleaner.

(b) Remove corrosion products using fine abrasive (Item 4), cleaning compound (Item 2) or Bon Ami (Item 3).

(c) Apply chrome-pickle solution, prepared as described in Paragraphs 147 and 148, following, with a small brush. Apply small amounts of fresh solution continuously until it has been on the surface for two minutes. Avoid an excess of the solution and do not allow it to come into contact with other metals.

(d) Wash surface thoroughly with cloth saturated with water. Do not rub. Make certain that all chrome-pickle solution is removed from cracks, recesses and faying surfaces. Finish reworked surfaces as specified in the applicable finish specification.



## PROTECTION OF STEEL TUBULAR MEMBERS AFTER WELDING

### General

28 Use the following procedure for the protective treatment of interior surfaces of sealed steel tubular members.

#### NOTE

This treatment must be performed after all welding is completed.

### Treatment

29 Treat sealed tubular members after welding, brazing or heat treatment is completed, as follows:

(a) Heat compound (Item 9), or linseed oil (Item 10), to 160° to 180° F and maintain the temperature.

(b) Apply heated protective material to the interior surfaces of the part by pressure through drilled holes in the member, or, in the case of small parts, by immersing in a bath of the material.

(c) Check the progress of the hot material by its radiation of heat through the exterior surface of the member.

(d) Rotate parts given the immersion treatment in the hot material so that each hole may at some time be uppermost and until bubbles have ceased to rise.

30 For aircraft exposed to sea atmosphere, proceed as follows:

(a) Apply cold corrosion-preventive compound (Item 11) to the interior surfaces of the part by pressure through drilled holes in the member, or, in the case of small parts, by immersing in a bath of the compound.

(b) Ensure that all interior surfaces of the member are thoroughly coated as follows:

(1) Apply the pressure-fed preventive to each drilled hole until the overflow is observed.

(2) Rotate immersed small parts in the preventive so that each hole may at one time be uppermost and until bubbles have ceased to rise.

(c) Seal the drain holes of the pressure-fed members by any convenient temporary method, such as tape or screws, and hold the material within the members for at least two minutes.

(d) Drain the treated parts thoroughly as follows:

(1) Drain large multi-section parts three to four hours with frequent change of position to ensure proper drainage of all low points and pockets.

(2) Small parts must be drained and rotated until all excess material has been removed.

(e) After parts have drained thoroughly, seal drilled holes by inserting a proper sized drive-screw which has been coated with unreduced zinc chromate primer (Item 7). If linseed oil is used as the protective material, use cotton wrapping cord (Item 12) about the drive-screw, in addition to the primer, to obtain a proper seal.

(f) Thoroughly clean the exterior of treated members with a clean cloth moistened with cleaner (Item 1).

(g) Dry surfaces with an air blast or soft cloth.

(h) Refinish as required.

## CADMIUM PLATING

### General

31 Cadmium plating is an electrical anti-corrosion process, using 6 to 12 volts d.c., by which cadmium is deposited directly on the surface of the material to be protected. Prior to plating, it is essential that the metal to be plated be properly cleaned. The following instructions are to be used as a guide by personnel engaged in cadmium plating.

### Plating Tanks and Equipment

32 Ensure the following equipment is available:

(a) Plating tanks made of steel or other authorized materials.

(b) Anodes of the ball or bar type, made of 99.9% (minimum) pure cadmium metal.



Allow approximately 2 pounds of anode per Imperial gallon of solution and locate in accordance with good plating practice.

(c) Rinse tanks, for hot water maintained at 180° to 212°F, and for cold water, of the recirculating type. Maintain a constant supply of clean water.

(d) A voltmeter and an ammeter in the electrical system.

(e) The plating solution at room temperature.

33 The initial make-up of the chromic acid solution is 5% by weight chromic acid (Item 6).

#### NOTE

When making solutions or adding chemicals to existing solutions, agitate the tank by compressed air until it is certain that the chemicals have been completely dissolved, or as in the case of calcium sulphate, the reaction is complete.

#### Cleaning of Parts

34 Clean parts prior to plating as follows:

(a) Clean by vapour degreasing, or with alkaline cleaner followed by rinsing in cold water, (refer to EO 05-1-3/20).

(b) Where parts are welded, scaled or corroded, follow with acid pickling and rinsing in cold water or sandblasting using a fine grit, (refer to EO 05-1-3/20).

(c) Remove any firmly adhering dirt by scrubbing with powder (Item 3) and rinsing in hot water.

(d) Before replating, reclean parts after stripping previous cadmium plate.

#### Masking

35 Mask parts to be selectively plated as follows:

(a) Clean in accordance with Paragraph 34, preceding, and coat areas of parts which are to remain unplated with stop-off lacquer (Item 14). Apply a sufficient number of coats of the lacquer to ensure adequate stop-off protection. Masking tape (Item 15) may be wrapped

around the area to be protected and the lacquer applied to cover the tape completely and overlap onto the part.

(b) Avoid all fingermarks and other contamination of the surface of the part when applying the lacquer.

(c) Allow the lacquer to dry, then reclean with alkaline cleaner, (refer to EO 05-1-3/20), and rinse in cold water. Do not use vapour degreasing on parts coated with the lacquer.

#### Thickness of Plating

36 The thickness of the cadmium deposit must not be less than .0003 inch nor more than .0010 inch, except as follows or where otherwise shown by drawing:

(a) The thickness of the cadmium deposit on externally threaded parts must not be less than .0002 inch, except where otherwise shown by drawing.

(b) Parts whose dimensional tolerances do not permit .0003 inch are to be given the maximum thickness of plating compatible with dimensional tolerances.

(c) Holes, recesses, internal threads and other areas where a controlled deposit cannot be normally obtained and which cannot be touched by a sphere 3/4 inch in diameter are not subject to a thickness requirement.

#### Plating

37 When plating, proceed as follows:

#### NOTE

Parts must be plated as soon as possible after completion of cleaning.

(a) Immerse the parts as cathodes in the plating tank and plate for a time and at a current density and voltage consistent with good plating practice.

(b) Rinse in cold water. Make sure that residue from the plating solution is thoroughly washed out of recesses and the inside of hollow parts.

- (c) Immerse all parts in the chromic acid solution (refer to Paragraph 33, preceding) at room temperature for 2 to 3 minutes.
- (d) Rinse in hot water.
- (e) Dry in air blast.
- (f) Remove the stop-off lacquer from masked parts by mechanical action or with thinner (Item 16).
- (g) Apply cadmium plating last to parts which are to be both chromium and cadmium plated.

#### Baking of Parts after Plating

38 For baking of parts after plating, refer to Paragraphs 63 to 68 inclusive, following.

#### Stripping of Cadmium Plate

39 When it is required to strip cadmium plate, immerse the parts in a solution of 1.2 pounds per Imperial gallon of ammonium nitrate (Item 17), until the cadmium is removed, then rinse in cold water.

#### Quality of Plating

40 Inspect plating as follows:

- (a) The surface of parts prior to plating must be reasonably smooth and free from irregularities.
- (b) After plating, the deposit of cadmium must be smooth, fine grained, adherent and free from blisters, pits, nodules, burning, discolouration and other defects.
- (c) Superficial staining resulting from rinsing and slight discolouration resulting from baking are not cause for rejection

## HARD CHROME PLATING

#### General

41 The following information and procedure is to be used for the hard chrome plating of steel and copper alloys.

#### Types of Plating

42 Chrome plating consists of two types; Type 1, used for decorative purposes only and commonly known as flash plating, and Type 2, classes A and B. Class A plating is performed on parts to the finish dimension, and requires no subsequent grinding operation. Class B plating is performed when it is intended to plate oversize and grind the part to the finish dimension after plating. Unless otherwise noted on the drawing, the minimum plating thickness after grinding must be 0.002 inches.

#### Plating Tanks and Equipment

43 Prior to plating ensure that the following equipment is available:

- (a) Rinse tanks constructed of mild steel, of the recirculating type, to maintain a constant supply of clean water.
- (b) Earthenware crocks to contain the bright dip and hydrochloric acid solutions.
- (c) Plating tanks made of steel or other approved materials.
- (d) Heating and cooling coils, anodes and linings of plating tanks made of lead containing 7% tin or of an approved synthetic organic material.
- (e) The number and location of anodes required in plating tanks consistent with good plating practice. Conforming anodes are required for plating parts on which significant surfaces would not otherwise receive an adequate and uniform deposit.
- (f) Facilities for agitation of the electrolyte by means of compressed air.
- (g) Connectors for suspending parts from bus bars, made of aluminum or copper, and of such a size that they do not overheat during plating.
- (h) A reversible electric circuit through the plating tank.
- (j) Control equipment consisting of a voltmeter, an ammeter and, for the heating and cooling system, an automatic means of controlling the temperature of the electrolyte within the specified limits.

### Preparation of Plating Solution

44 To prepare the plating solution, proceed as follows:

(a) Fill the clean tank to approximately two-thirds of its capacity with water and heat to about 125°F.

(b) Add, in small portions and with vigorous stirring, 2.7 pounds of compound (Item 18) for each Imperial gallon of final solution. Air agitation and/or paddles may be used for stirring while the solids are added but stirring must be continuous to prevent caking of the material on the bottom of the tank.

(c) While adding the compound, add the balance of the water needed to bring the solution to the working level and continue heating to maintain the solution temperature at 125°F.

(d) Stir the solution for a minimum of six hours to make sure that the compound is properly dissolved. Note that the compound does not dissolve completely. A small residue will remain undissolved and should be left in the tank.

(e) Near the end of the stirring period, raise the temperature of the solution to 150°F, while stirring is continued. After the temperature has reached 150°F, it should be reduced to the normal operating temperature, 125° (±5°)F.

### Bright Dip Solution

45 Make bright dip solution as follows:

Sulphuric acid (Item 19)	45.0% by volume
Nitric acid (Item 20)	7.0% by volume
Hydrochloric acid (Item 21)	0.5% by volume
Water	47.5% by volume

### Cleaning of Ferrous Alloy Parts Prior to Plating

46 To clean ferrous alloy parts prior to plating proceed as follows:

(a) Clean by vapour degreasing, or with alkaline cleaner followed by rinsing in cold water, in accordance with EO 05-1-3/20.

(b) Where parts are corroded or scaled, follow with acid pickling and rinse thoroughly in cold water in accordance with EO 05-1-3/20. If closely dimensioned areas are involved, treat such areas so that the dimensions are not appreciably affected.

(c) Remove adhering dirt by scrubbing with Bon Ami (Item 3). Corrosion and surface oxidation may be mechanically removed by buffing or by scrubbing. Following either of these operations, rinse the parts in hot water.

(d) Electroclean as instructed in EO 05-1-3/20, and rinse in hot water.

(e) When required, parts may be dipped for a maximum of 30 seconds in a 50% (by volume) solution of hydrochloric acid (Item 21) to remove any superficial oxidation. Parts must then be rinsed in cold water.

(f) Parts which are to be replated over an existing plating of chromium, or after stripping, must be subjected to the complete cleaning cycle before replating.

### Cleaning of Copper Alloy Parts

47 To clean copper alloy parts, proceed as follows:

(a) Clean by vapour degreasing. (Refer to EO 05-1-3/20).

(b) Remove surface oxidation and tarnish by buffing.

(c) Rinse in cold water.

(d) Immerse for not more than 30 seconds in bright dip solution (refer to Paragraph 45, preceding). The part must be uniformly bright on withdrawal from the bright dip solution.

(e) Rinse in cold water.

### Masking of Parts

48 To mask parts, proceed as follows:

(a) Clean parts as instructed in Paragraph 46, preceding, for ferrous alloy and Paragraph 47, preceding, for copper alloys.

(b) Apply sufficient coats of lacquer (Item 22) to ensure adequate stop-off protection.

Masking tape (Item 15) may be wrapped around the area to be masked before applying lacquer.

(c) Avoid contamination of the surface of the part to be plated when applying the lacquer.

(d) Allow the lacquer to dry and reclean as follows:

(1) Clean ferrous alloys with alkaline cleaner, rinse in cold water and follow with electrocleaning. (Refer to EO 05-1-3/20).

(2) Clean unmasked areas of copper alloys with a cloth dampened with thinners (Item 16) then immerse part in bright dip solution, (refer to Paragraph 45, preceding).

#### Plating Procedure

49 Immediately following cleaning and without drying, proceed as follows:

(a) Immerse parts in the plating tank and allow to reach bath temperature.

(b) Reverse etch ferrous alloy parts only by making parts anodes in the plating tank and applying a voltage of 4 to 6 volts for 1 minute at a current density of 3 amperes per square inch. Do not subject copper alloy parts to this reverse current treatment.

(c) With parts as cathodes, plate to the required thickness. Maintain the current density at 3 amperes per square inch. At 3 amperes per square inch, approximately 0.0020 inch of chromium plate should be deposited per hour.

(d) If ferrous alloy parts are removed from the plating tank after the start of the plating operation for thickness measurements or for any other reason, reverse the current for one minute when the parts are replaced in the plating solution before continuing the plating.

(e) Rinse parts in hot water, (180° to 212°F).

(f) Dry with an air blast.

#### NOTE

For parts which are to be both chromium and cadmium plated, apply the chromium plating first.

#### Treatment after Plating

50 To treat after plating, proceed as follows:

(a) Remove stop-off lacquer from selectively plated parts by mechanical action or by means of thinners if lacquer (Item 22) has been used.

(b) For parts requiring baking after chromium plating for the relief of hydrogen embrittlement, refer to Paragraph 64, following. Bake such parts as specified.

#### Stripping of Chromium Plate

51 When stripping of chromium plate is required, mask off unplated areas of selectively plated parts prior to immersion in the stripping solution and proceed as follows:

(a) Immerse the parts in a 20% (by volume) solution of hydrochloric acid (Item 21) until the chromium is removed. Rinse thoroughly in cold water. Do not leave parts in stripping solution longer than necessary to remove plate.

(b) Examine parts frequently during the stripping to ensure that they do not remain in the solution longer than the time required for complete stripping.

#### Quality of Plating

52 The surface finish of parts prior to plating must be reasonably smooth and free from irregularities detrimental to the final finish. After plating, all classes and types of chromium deposits must be smooth and free from frosty areas, indications of burning, pits and nodules. Type 1 deposits must be bright. When only a portion of a part is plated, the deposit must be so finished that the plated area blends smoothly with the adjacent unplated area. Where possible, check the thickness of chromium deposit on Type 2 plated parts by micrometer or other approved methods.

## ZINC PLATING

#### General

53 Though cadmium is definitely superior in some respects to zinc, tests have shown that zinc coatings are as good as cadmium coatings of equal thickness as a protection against exposure to weather in industrial, rural, suburban and sea coast atmospheres.

## Restrictions Governing the Use of Zinc Plating

54 Zinc plating may be substituted for cadmium plating with the following exceptions:

- (a) Since zinc is not as corrosion resistant as cadmium in the presence of salt water, all parts subject to salt spray or salt water must be cadmium plated.
- (b) When zinc is in contact with steel at high temperatures and subject to stress or vibration, the steel tends to crack. In the case of exhaust manifolds this is likely to cause failure of the part. All brackets, fittings and hardware in contact with exhaust manifolds or other parts subject to high temperature must be cadmium plated.
- (c) All nuts and bolts of corrodible steel must be cadmium plated.
- (d) Where electrical grounding is involved zinc may not make a satisfactory substitute for cadmium, since the electrical contact resistance of a zinc plated surface is higher than that of a cadmium plated surface. Lead plating is satisfactory in this respect, but lead should not be used in contact with aluminum, magnesium or zinc. Substitution of either lead or zinc for cadmium, in applications involving electrical grounding, must be approved by engineering authority.
- (e) Parts such as springs, lock washers etc., made of high or medium carbon steel and subject to appreciable alternating stress in service, must be cadmium plated. The zinc plating process often causes hydrogen embrittlement which results in breaking of the part under repeated stress.
- (f) Zinc plating is unsatisfactory in applications where the white corrosion products which may be formed from zinc coatings may interfere with the normal functioning of the part, or affect adjacent parts such as magneto and carburettor parts. Where such corrosion products might be a detriment to the normal operation of the part, zinc plating may only be used at the discretion of engineering authority.

55 Providing the restrictions in Paragraph 54, preceding, are adhered to, zinc plating may be substituted for cadmium plating without further engineering authority. It should be

noted, however, that the tolerance on zinc plating must conform to that specified for the original cadmium plating.

## Procedure

56 Parts are zinc plated by dipping them in molten zinc maintained at a temperature between 800° and 925°F.

## Other Coatings

57 The following anti-corrosion processes are included for information purposes and are not to be used except with engineering authority:

(a) Sherardizing: Parts are Sherardized by heating them in an atmosphere of zinc powder. The zinc combines with the surface of the metal part to increase its hardness, durability and corrosion resistance. The process is carried out by heating the parts in a closed, rotating chamber containing zinc powder at a temperature of about 700°F. Sherardizing is not considered to be as effective as zinc or cadmium plating.

(b) Parkerizing: Parkerizing consists of heating the parts to be treated in a bath of dilute iron phosphate. The bath is kept at about 190°F by means of steam coils. When the work is immersed, a rapid stream of bubbles passes off for a period of 30 to 45 minutes. When the bubbles stop, the coating process is complete. The coating left on the treated part is a basic ferrous-ferric phosphate. The surface is dull grey in colour and turns to a deep black after it is coated with paraffin oil. This process has the added advantage of coating the inside of tubular members which cannot be done by any electroplating process. This property is particularly important for seaplanes where moisture is frequently trapped in crevices or inside tubular members.

(c) Bonderizing: Bonderizing is the same as Parkerizing, except for the addition of reagents to the bath to speed up the reaction. The process is completed in from three to five minutes by this method. Bonderizing has the same characteristics as Parkerizing with reference to paint adherence and penetration in crevices. Neither of these coatings is very corrosion resistant in itself but either is quite satisfactory when painted. These and similar processes are frequently referred to as compound phosphate rust-proofing.

## PHOSPHATE TREATMENT

### General

58 The following procedure for phosphate treatment is to be used only where required by engineering drawings or modifications, finish specifications, and in the Electrofilm dry lubricant process. Parts fabricated from aluminum, magnesium and copper alloys and parts having soft soldered joints must not be phosphate treated.

### NOTE

On brazed assemblies, where only the brazed joint is of copper alloy, perform brazing and welding operations prior to phosphate treatment.

### Solutions Required

59 The following solutions are required for the phosphate treatment:

- (a) Mild alkaline cleaner, (refer to EO 05-1-3/20).
- (b) Vapour degreasing liquid, (refer to EO 05-1-3/20).
- (c) Phosphate treatment liquid, containing 3.5 Imperial gallons of compound (Item 23) to 100 Imperial gallons of water.
- (d) Chromic acid dip solution containing 0.100 to 0.125 ounces of chromic acid (Item 6) per gallon of solution.
- (e) Stripping solution consisting of 50% (by volume) hydrochloric acid (Item 21) and 50% water.

### Types of Phosphate Treatment

60 There are two types of phosphate treatment; one providing resistance to abrasion and the other protection against corrosion. For abrasion resistance type of protection, proceed as follows:

- (a) Clean the parts by either a mild alkaline immersion of 5 to 7 minutes at 180° to 212°F and rinse in cold water, or vapour degrease by an immersion of 2 to 5 minutes at 180° to 195°F.

(b) Immerse the parts in the phosphate treatment liquid for 10 minutes at 190° to 210°F.

(c) Rinse the parts in cold water for 2 minutes.

(d) Immerse the parts in chromic acid solution for 1 minute at 180°F.

(e) Rinse the parts in hot water (160°F minimum) until they come up to the temperature of the water.

(f) Bake those parts requiring hydrogen embrittlement relief, (refer to Paragraphs 63 to 68 inclusive, following). Parts requiring more than one plating operation, such as cadmium plating followed by phosphate treatment, are to be baked only after the final plating.

(g) Finish the parts by coating completely with oil (Item 57).

61 For corrosion protection, proceed as follows:

- (a) Clean the parts. (Refer to Paragraph 60 (a), preceding.)
- (b) Immerse the parts in the phosphate treatment liquid for 30 minutes minimum at 190° to 210°F.
- (c) Rinse the parts in cold water for 2 minutes.
- (d) Immerse the parts in chromic acid solution for 1 minute at 180°F.
- (e) Rinse the parts in hot water (160°F minimum) until they come up to the temperature of the water.

(f) Bake parts requiring hydrogen embrittlement relief, (refer to Paragraph 60 (f) preceding).

(g) Finish the parts with primer (Item 7) or coat with compound (Item 9) as required by the applicable finish specification.

### Stripping

62 When required, the phosphate coat may be stripped by immersion in the stripping solution (Item 21) at room temperature. The



parts are then rinsed in cold water. Parts must not be left in the stripping solution longer than necessary to remove the phosphate coating, since the solution will readily attack bare metal, as well as dissolving cadmium and zinc plating.

## BAKING OF STEEL FOR RELIEF OF HYDROGEN EMBRITTLEMENT

### General

63 Steels in the heat treated or cold worked condition are susceptible to embrittlement by hydrogen and resultant cracking, as a consequence of pickling, electrocleaning and electroplating. The following instructions cover the procedure to be used for the baking of carbon steels (e.g. SAE 1045, SAE 1060, SAE 1095, etc.), alloy steels (e.g. SAE 4130, SAE 4340, SAE 6150, NE 8630, NE 8740 etc.) and heat treatable corrosion resistant steels (e.g. AISI 410, AISI 416, AISI 420, AISI 501, etc.), but are not applicable to non-heat treatable corrosion resistant steels (e.g. AISI 302, AISI 321, AISI 347, AISI 405, AISI 430, etc.).

### Parts Requiring Baking

64 The following classes of low alloy and corrosion resistant steel parts must be baked for relief of hydrogen embrittlement:

- (a) All parts heat treated to 160,000 psi, (Rockwell C-36) and over.
- (b) All springs.
- (c) All parts which have been shot peened for increase of fatigue resistance.

### Processes after which Baking is Required

65 Baking for relief of hydrogen embrittlement is carried out on the classes of parts referred to in Paragraph 64 preceding, at the following times:

- (a) After cadmium plating.
- (b) After hard chromium plating.
- (c) After hard nickel plating.
- (d) After phosphate treating.

(e) After pickling (sulphuric and hydrochloric acid mixture for non-corrosion resistant steels, nitric and hydrofluoric acid mixture for corrosion resistant steels).

(f) After electrocleaning.

66 Parts, on which more than one of the above processes are required (e.g. pickling, followed by cadmium plating), are to be baked once only after the final operation.

### Procedure

67 Baking for relief of hydrogen embrittlement consists of heating the parts to the proper temperature and soaking for the following periods:

- (a) All except soft soldered parts: 3 hours minimum at 375° (±25°) F.
- (b) Soft soldered parts: 5 hours minimum at 325° (±25°) F.

68 Do not flex or otherwise stress parts, such as springs, between the commencement of the first operation which induces hydrogen embrittlement and the completion of the baking operation. Where the baking temperatures would influence the previous heat treatment of a part, (i.e., reduce its physical properties, such as in the case of carburized parts, where the baking temperature may be equal to or above the tempering temperature), refer to engineering authority for instructions.

## METAL SPRAYING

### General

69 The following instructions present general requirements for the apparatus, material and procedure to be used in metal spraying of aircraft parts for protection against corrosion and for building up worn metal surfaces. The information is applicable to metal spraying as performed with coating material in wire or powder form.

### Equipment

70 The apparatus consists of a metal spray gun, air cleaner and equipment for preparation of surfaces for metal spraying, as follows:

(a) The metal spray gun is provided with two-stage oxygen and acetylene regulators capable of maintaining uniform delivery pressures at any dial setting in the pressure range from 5 to 50 psi, and is equipped with accurate indicating pressure gauges.

(b) An oil and water extractor must be used in the air line to the metal spray gun in order to ensure clean, dry air.

(c) Suitable operations must be performed to ensure proper cleaning and surface preparation of the part to be sprayed.

#### Preparation of Parts

71 Perform all welding operations, if required, prior to metal spraying. Prepare surfaces to be sprayed with metal by removing all foreign material and corrosion products, then roughening by sand blasting, machine tool operation, electric bonding or combination of these methods.

72 Undercut by machining, if necessary, the worn surfaces of bearing journals to be repaired or build up by metal spraying to provide a thickness of deposited metal after finishing or fitting, not less than the minimum thickness shown in Figure 2. The undercut section should extend 1/4 inch or more beyond the bearing area whenever practicable, and the ends cut at acute angles so that the deposited coating will be dovetailed or keyed to the shaft or journal. The undercut section must be degreased prior to roughening.

73 If practicable, roughen worn journals and bearing surfaces by cutting spiral or annular grooves in the undercut section and spreading and roughening the ridges or lands thus produced with a rotary roughening tool.

#### Blasting

74 Roughen surfaces to be metal sprayed for corrosion prevention by suction or direct pressure blasting, using one of the abrasives listed in Paragraph 75, following. Hold the blast nozzle approximately eight inches from and perpendicular to the work being blasted.

#### Materials

75 The following materials are recommended:

(a) Sand (item 24), a hard silica type, jagged or angular, of approximately 40 mesh, for corrosion prevention coatings. The sand must be washed and dry, and is not to be re-used without screening to remove fine particles. Sand which has been used for blasting any other group of metals must not be re-used for blasting light alloys such as aluminum and magnesium, or corrosion resisting alloys such as stainless steel and inconel.

(b) Silicon carbide and aluminum oxide (Item 25) types of non-metallic abrasives with good cleavage fracture properties and of approximately 40 mesh for corrosion prevention applications can be used. The preceding re-use restrictions apply.

#### Scale Removal

76 Remove heavy scale from steel parts by directing the blast nozzle at an angle of about 40° to the work. After the scale has been removed, roughen the work by blasting with the nozzle perpendicular to the work surface.

#### Pressure and Time

77 The operating pressure and blasting time required for roughening vary with the type of equipment and abrasive used, the material being roughened and the degree of anchorage required. Exercise caution in selection of blasting pressure and time to prevent excessive

Diameter of Shaft	Minimum Thickness of Deposit Metal After Finishing		
	Reciprocating Rods and Light Duty Journals, etc.	Heavy Duty Journals Crankshaft, etc.	Press Fits
Less than 3	.030	.040	.020
3 to 6	.040	.050	.030
Over 6	.050	.060	.040

Figure 2 Minimum Thickness of Deposited Metal



dimensional loss and warping of the work, especially when structural parts, thin sections and soft materials are involved.

#### NOTE

Keep the surface absolutely clean. Handle only with gloved hands or by means of suitable holding devices. After a surface has been prepared, apply metal coat as soon as possible to avoid contamination.

#### Coating Metal Surfaces

78 In coating metal surfaces, proceed as follows:

- (a) Hold the spray gun 4 to 6 inches away from the surface and as nearly perpendicular to the surface as possible. The gun nozzle must not be held at an angle less than 45° to the surface as the fine particles will have a tendency to glide over rather than adhere to the surface.
- (b) As the gun is passed over a surface, a ribbon of metal is deposited which is heaviest at the centre and tapers off to nothing at the edge. In order to apply a coating which is sufficiently level, lap each ribbon over the adjacent ribbon by approximately one-third the ribbon width.
- (c) In applying several layers on sheet stock, deposit each successive coating at right angles to the preceding coating, thus forming a criss-cross coating.
- (d) The determination of the speed of moving the gun back and forth across the surface depends on the operator. Move the gun fast enough to ensure against depositing an excessively heavy coating but slow enough to permit covering the entire surface.
- (e) Worn spindles can best be built up by revolving in a lathe while spraying. Spray the ends of the undercut section first, with the gun nozzle held at approximately 45° to the work. Make sufficient passes in each direction to ensure thorough keying of the sprayed coating into the dovetail of each groove. Thereafter, mount the gun on the tool post perpendicular to the work and continue spraying. Speeds of approximately 50 surface feet per minute and feeds of about 1/16 inch per revolution are preferred.

#### Quality

79 The sprayed coating must be of fine texture and free of non-atomized particles of metal. Sprayed aluminum coatings of 0.002 to 0.004 inch thickness give satisfactory coverage and protection on aluminum alloy. Aluminum coatings thicker than 0.004 inch may flake when applied to aluminum alloy. Heavier coatings may be used on steel since better anchorage is obtained on steel than on aluminum alloy.

#### Treatment after Spraying

80 After metal spraying has been applied to a localized area, rub the surrounding edges lightly with a suitable abrasive to remove any metal spray adhering outside of the sandblasted area.

#### Potassium Dichromate Treatment

81 Whenever possible, steel structural parts which have been spray coated with aluminum alloy, and which are not to be primed, are to be boiled for 30 minutes in a 15% solution of potassium dichromate (Item 26), to increase the resistance to corrosion. After boiling, rinse all parts thoroughly in fresh water and dry. This treatment is not to be applied to sprayed engine cylinders.

#### Safety Precaution

82 Always wear a force-feed spray mask of an approved type when spraying zinc, cadmium, lead or when sandblasting. The toxic effect of zinc fumes is of a temporary nature but fumes of cadmium and lead are cumulative and are fully as dangerous as silica dust. The toxic effects of aluminum are considered to be negative, but all processing is to be done in a well-ventilated space and the breathing of any fumes in the concentrated form must be avoided.

#### Inspection

83 Make a visual examination of the processed surface for complete and uniform coverage. The coating must be free from defects such as cracks, porosity and lack of fusion. It must have the appearance of having a uniformly and finely divided grain structure with no evidence of non-atomized or unmelted particles.

84 The operating temperature of light metals is satisfactory if the operator can hold the back of his hand against the work for ten seconds. If he cannot, the work is overheated and should be allowed to cool before proceeding.

#### Coating Materials

85 Coating materials in the following forms are generally employed with the metal spray gun:

(a) Wire, of aluminum, babbitt, brass, bronze, cadmium, copper, low carbon, high carbon and corrosion resisting steel, lead, nickel, tin and zinc Specification AN-W-20. Both .125 inch and .091 inch diameter wires are standard. When ordering replacement wires for spraying, it is necessary to order the size specified for the particular type of gun, as maximum gun efficiency is obtainable only when the correct size wire is used.

(b) Metallic powders are also employed in the spray gun, as follows:

Metal	Nominal Mesh
Aluminum	300
Zinc	300
Brass	150
Copper	300
Bronze	300
Tin	150
Lead	200
Nickel	300

#### NOTE

To eliminate foreign matter or large particles, metallic powder must be sifted through an 80 mesh screen.

### USE OF METAL PUTTY

#### General

86 Metal putty may be used to restore damaged surfaces to their original aero-

dynamic smoothness and to reduce the probability of corrosion which may develop in the presence of surface dents and scratches.

#### Cleaning of Damaged Areas

87 Strip paint, if present, thoroughly with paint remover (Item 28). Clean all areas thoroughly by hand with mops, cloths and brushes in accordance with EO 50-10A-2A.

#### Repair of Damage

88 Remove ridges raised by scratches by wet or dry sanding with abrasive paper (Item 4). Clean and degrease scratches and dents with paint thinner (Item 28) before filling. The surfaces must be thoroughly dry before proceeding. Use metal putty (Item 27 or 29) to fill the scratches and dents found in the following surface areas:

(a) Leading edges and upper and lower surfaces of mainplanes, horizontal stabilizers and fins, back to a distance equal to one third of the chord.

(b) Ailerons, leading edges only.

(c) Any surface area for improved appearance.

#### Application

89 Apply the filler with a putty knife in thin coats (a minimum of four layers) to allow the solvent to evaporate. Allow three hours drying between coats. The fill, when complete and dry, should be slightly higher than the metal surface. Rub down and feather to the surface contour by wet sanding with abrasive paper, using plenty of water.

90 Refinish, if required, by etching, priming and lacquering.

#### NOTE

Because of a short shelf life of ninety days, metal putty (Item 27 or 29) is not stocked but must be purchased LPO by units as required.

## CORROSION OF ALUMINUM AND ITS ALLOYS

### General

91 Aluminum alloys have the advantage of superior resistance to corrosion. This is due to a thin protective film of aluminum oxide that is always present and which reforms rapidly if broken. There are a few media which have destructive action on this oxide film and against which protective measures must be taken. Processes have been developed for thickening this film artificially.

92 As a class, halides are more corrosive than nitrates or sulphates in contact with aluminum and its alloys. Heavy metals such as copper, lead, cobalt, nickel, etc., are usually deleterious to aluminum. As with other metals, an increase in temperature usually has the effect of reducing corrosion resistance. When aluminum alloy is coupled to a dissimilar metal of less positive potential such as copper, iron, nickel, lead, etc., (see Figure 3), there is a hazard of galvanic (electrolytic) corrosion accelerating the deterioration of the alloy depending on the environment. Very high purity aluminum (99.99% minimum aluminum) is extremely resistant to corrosion either by pitting or general surface attack, and is mainly used as a high purity cladding material.

### Evaluation of Corrosion

93 In evaluating corrosion, allowance must be made for the type of corrosion encountered. If corrosion is uniform, weight loss in a con-

venient measurement when translated into thickness loss. If pitting occurs, the depth of penetration should be determined. If intergranular corrosion develops, measure the tensile properties. If the equipment is subjected to stress and minimum mechanical properties are required, tensile losses should be used as a criterion of corrosion.

### Types of Corrosion

94 Types of corrosion are as follows:

(a) Uniform surface attack, which is a general deterioration of the whole surface. This occurs when the oxide film is dissolved and the metal exposed.

(b) Pitting, which is a more damaging form of corrosion is frequently associated with halogens and heavy metal salts. It can often be prevented by the use of inhibitors or cathodic protection.

(c) Galvanic corrosion, which will occur when aluminum is in electrical contact with a more noble dissimilar metal, (see Figure 3), This type of corrosion is eliminated by proper selection of metals placed in contact, by insulation, cathodic protection, and by control of the area exposed.

(d) Crevice corrosion is liable to occur in joint crevices between two pieces of one metal, and most likely between dissimilar metals. Crevices are to be avoided in original design.

Grouping of Metals			
I	II	III	IV
Magnesium alloys	Cadmium, Zinc, Aluminum and their alloys,	Iron, Lead and Tin and their alloys (except stainless steels)	Copper, Chromium Nickel, Silver, Gold, Platinum, Titanium, Cobalt, Rhodium and their alloys, Stainless Steels, and Graphite
<p><u>NOTE</u></p> <p>The metals shown are those on the surface of the part, e. g. zinc includes zinc casting, zinc coated, zinc hot dip or zinc metal sprayed parts.</p>			

Figure 3 Insulation of Dissimilar Metals

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>(1) Aluminum &amp; Alloys (2S, 3S, 4S, 51S, 53S, 61S Clad coated, sheet forms, and 43S cast form.)</li> <li>(2) Aluminum Alloys (Alloys of all forms other than specified above.) (The heat treated alloys.)</li> <li>(3) Magnesium Alloys.</li> <li>(4) Plated Steel, Copper &amp; Alloys (Brass, Bronze etc.)</li> <li>(5) Unplated Steel (Including the various blackening treatments such as parkerizing, bonderizing etc.)</li> </ul> | <ul style="list-style-type: none"> <li>(6) Unplated Copper &amp; Alloys (Brass, Bronze, etc.)</li> <li>(7) Corrosion-Resistant Metals (18-8, Monel, Inconel, etc.)</li> <li>(8) Lead</li> <li>(9) Wood</li> <li>(10) Plastics (Plexiglas, Tenite, Micarta, Bakelite, etc.)</li> <li>(11) Fabric</li> <li>(12) Rubber &amp; Synthetics Nycar Neoprene Thiokol.</li> </ul> |
|---|--|

Contact Surfaces	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Aluminum & Alloys	D											
Aluminum Alloys	D	D										
Magnesium Alloys	G	G	A									
Plated Steel, Copper & Alloys	C	C	G	A								
Unplated Steel	C	C	G	F	D							
Unplated Copper & Alloys	C	C	G	A	D	D						
Corrosion-Resistant Metals	C	C	G	A	F	F	A					
Lead	C	C	G	A	F	F	A	A				
Wood	E	E	G	A	E	E	A	A	A			
Plastics	E	E	A	A	E	E	A	A	A	A		
Fabric	B	B	A	A	E	E	A	A	A	A	A	
Rubber & Synthetics	E	E	A	A	E	E	A	A	A	A	A	A

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>(A) No additional protection, other than original finishes.</li> <li>(B) No additional protection, unless contacting surfaces are on exterior surfaces, when the metal surface receives two coats of primer, (Item 7) the fabric none.</li> <li>(C) Each surface to receive two coats of primer. If possible, apply primer (Item 7) before assembly, squeeze out and wipe away excess primer, leaving a fillet. Otherwise, apply a fillet all around the assembly.</li> <li>(D) Each surface should receive two coats of primer.</li> </ul> | <ul style="list-style-type: none"> <li>(E) The metallic surface should receive two coats of primer, the other surface none, except wood which should receive one coat of varnish (Item 30).</li> <li>(F) The unplated metallic surface should receive two coats, the other surface none.</li> <li>(G) The magnesium needs no additional protection. The other surface should receive two coats of primer, applied as in C, except in the case of wood, which should receive two coats of varnish (Item 30).</li> </ul> <p>Note:<br/>The term coat means one sprayed box coat, (a vertical and a horizontal pass with the spray gun). A brush application can build up sufficient film thickness to equal these two sprayed coats.</p> |
|--|---|

Figure 4 Recommended Protective Treatment for Material Combinations

(e) Intergranular corrosion is a type of corrosion which occurs only with heat treatable alloys and usually only when they have been incorrectly fabricated. (Refer to EO 05-1-2AH.)

#### Protection and Maintenance

95 Protection and maintenance begins with the design of the equipment but continual surveillance, cleanliness and the use of approved cleaning mixtures are necessary for trouble-free equipment.

#### Protective Coatings

96 Protective coatings for aluminum are:

- (a) Paints, lacquers and varnishes
- (b) Chemical
- (c) Electrochemical
- (d) Electroplated
- (e) Alcladding

## INSULATION OF DISSIMILAR METALS

#### Insulation of Magnesium Alloys

97 Contacts between magnesium alloys and other metals must be insulated by applying a total of two coats of zinc chromate primer (Item 7) to each surface. Where it is necessary to omit or remove paint coatings from magnesium alloy in contact with dissimilar metals for the purpose of electrical contact, separate the dissimilar metal contact by installing a shim of 2S, 52S or 53S aluminum alloy not greater than .016 inch thick.

#### Insulation of other Dissimilar Metals

98 To the faying or contacting surfaces of dissimilar metals in Groups II, III and IV, (see Figure 3), apply one additional coat of zinc chromate primer on each surface. It is emphasized that this requirement applies to metals in Group IV, including stainless steels. Special care must be taken to ensure that all cut edges, etc. are painted. Assemble all slip fits using wet zinc chromate primer (Item 7). Seal the edges of points of dissimilar metal contacts with zinc chromate primer after press fits are completed.

99 For additional protective treatment recommended for various material combinations, see Figure 4.

#### Cleaning

100 Periodic cleaning of aluminum equipment is the first step in maintenance. For removal of moist accumulations of dust and dirt, a mild soap and water solution is effective and may be the only cleaning necessary if carried out at regular intervals. Leave surfaces dry after cleaning. To remove grease and wax, use approved mixtures containing benzol, toluol, naphtha, kerosene, or trichloroethylene. For the cleaning of metals refer to EO 05-1-3/20.

#### Sea Water Neutralization

101 To neutralize the action of sea water, use potassium bichromate (Item 31) which inhibits corrosion of aluminum alloys in the presence of salt water. Place a linen or cotton bag, containing about two ounces of potassium bichromate crystals, at the lowest point of each watertight compartment of all aluminum alloy floats and hulls of aircraft operating on salt water. Replace these crystals when the water pumped from the compartments ceases to be coloured yellow.

#### Storage of Aluminum

102 Aluminum stores are to be kept dry, well ventilated and at reasonable uniform temperature. New equipment should be checked as received so that wet metal or parts may be separated and aired. Risk of contact with alkalis, nitrates, phosphates, acids and industrial fumes should be avoided.

## TREATMENT OF CORROSION

#### General

103 In most instances, any corrosion that is found will be surface corrosion, which is first noticed as a dirty white powder deposit, similar to dust, which blotches the surface. When the powder is cleaned off, the surface will either be clean or, if the corrosion is more advanced, small clean pits will be evident. This type of corrosion can be easily checked, but if it is allowed to continue uncurbed the blotching will spread over the



surface and corrosion will slowly enter the metal. There are several methods of removing and treating corrosion. The method chosen depends upon the severity of the corrosion.

#### Light Corrosion (No Pitting)

104 To remove light corrosion products, one of three methods can be used:

- (a) Cleaning (for very light corrosion only).
- (b) Hand polishing.
- (c) Chromic acid (Item 6) treatment.

#### Moderate Corrosion (Light Pitting)

105 This type of corrosion can be removed either by polishing followed by a chromic acid treatment, or by a chemical mixture of phosphoric acid (Item 22) and alcohol (Item 33) followed by a chromic acid treatment. If the phosphoric acid-alcohol mixture is used, mix in the following proportions and store in a glass or earthenware container:

Butyl alcohol (Item 33)	4 gallons
Water	2 gallons
Isopropyl alcohol (Item 34)	3 gallons
Phosphoric acid (Item 32)	1 gallon (14 pounds)
Nacconal NR (Item 36)	0.5 ounce

#### NOTE

If butyl alcohol (Item 33) is not available, isopropyl alcohol (Item 34) can be used for the entire alcohol content. If isopropyl alcohol is also not available, use denatured ethyl alcohol (Item 35).

106 Apply the cleaner to the surface with cloths or brushes. Do not allow the solution to enter seams or recesses. After two or three minutes, rub the surface lightly with a bristle brush. Thoroughly rinse with clear water. Dry at room temperature or with compressed air.

### WARNING

Exercise extreme care when handling the phosphoric acid-alcohol solution. Refer to EO 00-80-4/4 and EO 00-80-4/2.

#### Severe Corrosion (Deep Pitting)

107 Severe corrosion can be removed by one of three methods. Whichever method is used, a chromic acid treatment should follow:

- (a) Rub with sandpaper (Item 37) or with aluminum wool (Item 5) and kerosene (Item 38).
- (b) Use a buffing wheel and a rubbing compound.
- (c) Use a chemical mixture of phosphoric acid and alcohol.

#### Alclad Penetration Test

108 To determine if the Alclad has been penetrated by corrosion, by scratching or excessive buffing, apply the following test:

- (a) Apply one drop of sodium hydroxide solution (Item 39) (one part to four parts water by weight) to the cleaned surface. At the same time, apply one drop to a corrosion-free area.
- (b) After two minutes, remove the excess liquid from both areas by blotting with a cloth. Do not rub.
- (c) Examine the corroded area with a magnifying glass of not less than four power, and with the beam of a flashlight pointed into the penetrated area. The light is necessary to avoid shadows in recessed areas, which can lead to an incorrect conclusion in regard to the depth of penetration.
- (d) If the corroded area is black, corrosion has penetrated to the base metal. The non-corroded area to which the sodium hydroxide was added will provide a comparison, since the corroded area will be darker.
- (e) Immediately after inspection, treat the area with a 10% chromic acid solution, (refer to Paragraph 110, following).

109 If the Alclad surface has not been completely penetrated and if the surface is to be protected later by zinc chromate primer and the proper lacquers, use a 10% chromic acid solution to inhibit further corrosion. If the sheet is corroded excessively, replace it. It should be remembered that widely spaced corroded areas will not affect the strength of the metal any more than widely spaced pilot or tooling holes do, provided that the corrosive action has been stopped.

#### Chromic Acid Treatment (Chromodizing)

110 The chromic acid treatment should always be used in the case of pitting, since it is difficult to remove all corrosion products from the pits. Chromic acid serves as an effective inhibitor to additional corrosive action.

111 Make the chromic acid solution by dissolving 16 ounces of commercial flake chromic acid (Item 6) in one gallon of water. The addition of Nacconal NR (Item 36) will provide a wetting agent and assist in spreading the solution, which must be applied as follows:

- (a) Clean and thoroughly dry the surface to be treated.
- (b) Apply the solution with a clean cloth or brush.
- (c) After five minutes, remove the excess solution with a damp cloth. Since the solution will leave a yellow or brown stain, do not allow to dry on the surface unless the surface is to be coated or finished.

#### Chemical Removal of Aluminum Alloy Corrosion Products

112 Chromic acid etch may be used to remove corrosion products from all clad aluminum alloy material (clad skins, clad stringers, ribs in flap well, aluminum tubing, etc.). Do not scrape, sand, wire brush or otherwise abrade these clad surfaces, because the protective aluminum cladding adjacent to the corroded area will be removed, leaving a much larger unprotected area susceptible to further corrosion. Proceed as follows:

- (a) Mask off nearby non-clad aluminum, plated steel and magnesium as well as cracks and faying surfaces, to keep acid etchant from contacting these areas.

(b) Apply thickened acid etchant to the corroded area of clad aluminum alloy, using a brush or cloth.

(c) With a short, stiff, non-metallic brush, scrub the areas of deep pitting until all corrosion products are removed. Pay particular attention to areas around rivet heads and at butt joints of skins.

(d) Sponge off the acid etchant with a damp cloth that is frequently rinsed out in water. Do not leave etchant in contact with the surface for more than a short time (approximately 10 minutes).

(e) Repeat above steps as necessary, concentrating on the pitted areas, until all corrosion products are removed. The bottom of each pit should appear bright and the metal should be uniformly etched. Questionable areas should be examined with a magnifying glass.

(f) After all corrosion is removed, thoroughly rinse the treated area and dry with warm or compressed air.

(g) Apply the chemical surface treatment and final protective finish indicated for the area involved.

#### CAUTION

Personnel should wear rubber gloves and goggles while working with acid solutions. If the acid accidentally contacts the skin or eyes, wash it off immediately with large quantities of clear water. Consult the medical officer if the eyes are affected or if the skin is burned. Refer to EO 00-80-4/4.

#### Emulsion Cleaning to Remove Corrosive Contaminants

113 To remove corrosive contaminants by emulsion cleaning, proceed as follows:

- (a) Clean the affected areas with any approved emulsion cleaner or with cleaner (Item 1). Hand brushes with nylon (or other non-metallic) bristles should be used.

#### CAUTION

When working in the nose or main landing gear areas, cover tires to protect them from these solvents.

(b) Rub the surface briskly with a mop or cloth.

(c) After the small section has been gone over thoroughly and before it is allowed to dry, rinse with water.

(d) Either allow the surface to dry, or dry with clean cloths, or warm or compressed air

#### Removing Spilled Battery Acid

114 To remove spilled battery acid, proceed as follows:

(a) Rinse the affected areas with generous quantities of clear water to dilute and remove the acid, being careful not to spread acid into surrounding structure.

(b) After the acid is removed, treat the affected area with liberal quantities of 5% sodium bicarbonate solution (Item 13), applied with brush or cloth.

(c) Continue to add sodium bicarbonate solution until bubbles cease. Allow solution to remain on the surface for five minutes.

(d) Remove the sodium bicarbonate solution by rinsing with clear water, and wipe dry.

#### Final Protective Finish

115 The purpose of a chemical surface treatment is to inhibit further corrosion of the area and to provide a proper surface to receive a paint finish. The combination of chemical surface treatment and final paint finish constitutes the complete protective coating on the metal surface. The final protective paint finish is applied immediately after the chemical surface treatment. The surface to receive paint must be absolutely clean and dry and free from any contamination beyond the stained appearance due to the chemical surface treatment. Do not attempt to remove such stain or the benefits of the surface treatment will be lost.

#### Machine Polishing

116 To machine polish, proceed as follows:

(a) Apply a small amount of polishing compound, (such as Item 2) to the surface to be cleaned.

(b) Attach a lamb's wool buffer to the portable buffing machine.

(c) With the machine running, place the buffer on the skin surface. Be sure to keep the machine in motion at all times, otherwise the heat generated may cause the metal to can.

(d) If desired, the swirls and residue left around rivets and seams can be removed by hand polishing with the same compound that was used with the buffing machine.

#### Chromic Phosphoric Treatment

117 This treatment has two distinct applications, as follows:

(a) The prevention of corrosion on parts which are likely to be affected during normal service conditions.

(b) The inhibition of parts where corrosion has actually commenced due to contact with corrosive elements, such as immersion in sea water.

#### Preparation of Work

118 All machining, dressing or minor repairs must be completed on the surface to be protected, and the parts should be kerosene washed and degreased. It is imperative that the kerosene wash should remove all aluminum swarf from the parts, as the presence of finely divided aluminum causes rapid decomposition of the trichloroethylene (Item 40) used in degreasing, with consequent development of acidity.

119 Parts which contain steel studs or other steel fittings may be treated. The steel will be discoloured slightly after treatment, but this will not be detrimental. Copper or copper alloys should not be present when new parts are treated, but in certain instances, as in the case of engines undergoing repair where the removal of such inserts would necessitate extensive complementary rectification, the presence of copper alloy parts may be permitted. A careful examination of such fittings should be carried out after treatment to ensure that attack has not occurred to a dangerous extent.



**Application of Treatment**

120 The composition of the bath is as follows:

- (a) Chromic acid (Item 6) 0.75% by weight.
- (b) Phosphoric acid (Item 32) 0.50% by volume.
- (c) Make up to required volume with water.

121 Immerse parts to be treated in the boiling solution for 45 minutes. After being removed from the bath, wash the treated parts thoroughly in cold running water, then finally dip in clean boiling water and allow to dry.

**Safety Precautions**

122 Refer to EO 00-80-4/4 and EO 00-80-4/2 for precautions when handling chromic acid.

### **BRUSH ALODIZING OF ALUMINUM AND ALUMINUM ALLOYS**

**General**

123 The alodizing treatment is used on bare aluminum and its alloys to obtain the following results:

- (a) Good anti-corrosive qualities.
- (b) A good base for paint.

124 The alodizing treatment has poor wear qualities. The irriditing process is similar to the alodizing process but other materials are used. Use the brush Alodine solution for localized areas in repair and overhaul work and for refinishing aluminum alloys from which the original anodic coating has been removed or alclad aluminum alloys from which the cladding has been totally or partially removed in service.

**Preparation of Solution**

125 Slowly add to one (US) gallon of water 4 oz. of alodine 1200; Item 42. When completely dissolved add to this solution 1/2 fluid oz. of concentrated nitric acid; (Item 20). To accurately measure and weigh ingredients it is recommended that the facilities of the station hospital laboratory be used.

**Application**

126 To apply, proceed as follows:

- (a) Clean metal surfaces to be treated with Alodine, using cleaner (Item 1).
- (b) Etch the metal surface with etchant (Phosphoric acid treatment as outlined in EO 05-1-2AH), diluted three parts of water to one part of etchant.
- (c) Apply the etching solution with a swab or brush and allow it to remain on the surface for one to two minutes.
- (d) The etchant readily attacks magnesium and must not be allowed to contact any magnesium parts. Keep the etchant out of seams and faying surfaces.
- (e) Scrub the surfaces lightly and rinse thoroughly with water.
- (f) Apply the Alodine solution by brush to the surface to be protected, keeping the surface of the metal wet with the solution for a period of five minutes.
- (g) Apply the solution evenly. Do not smear.
- (h) Rinse thoroughly with cold water.
- (j) Dry with compressed air.

### **ANODIZING OF ALUMINUM AND ALUMINUM ALLOYS**

**General**

127 Anodizing is an anti-corrosive treatment with good wear qualities. It is usually used on bare aluminum alloys that are not to be painted or otherwise protected. The following procedure is to be followed in the anodizing of aluminum and aluminum alloys, using the chromic acid process. The procedure is limited to aluminum alloys containing not more than 5% copper.

**Equipment**

128 The equipment used is as follows:

- (a) The anodizing tank and the caustic soda tank are to be of mild steel. The anodizing

tank must have heating and cooling coils for maintaining the solution at the temperature specified, have facilities for agitating the solution by compressed air and be provided with cross-draft ventilation.

(b) The hydrofluoric acid tank, must be a lead-lined, mild steel tank.

(c) Heating coils are to be provided in the hot water rinse tank to maintain the water temperature at 180° to 212°F. Skimming troughs must be provided.

(d) The equipment is to include a motor-generator set of adequate output, a voltmeter and ammeter, preferably of the recording type, and an automatic temperature controller and recorder for the heating and cooling system.

(e) An automatic control unit for the voltage-time cycle and an automatic current cutout are to be used to avoid overloading the generator.

(f) Racks, clamps and wire used for connecting parts with bus-bars are to be made of aluminum alloy. Bus-bars are to be made of electrolytic copper.

#### Procedure for Anodizing

132 Immerse the clean parts in the anodizing bath, ensuring free circulation of the solution to all sections of the work. Avoid masking of parts by one another. Rack parts so that gas generated during the process can escape and no gas pockets can form.

133 After the bath has been loaded and the electrical contacts suitably made, apply a small voltage across the circuit. Increase voltage to 40 ( $\pm 1$ ) volts, by small increments, during the next 5 to 8 minutes. Do not overload the generator at any time during this period. Maintain the voltage at 40 ( $\pm 1$ ) volts for a minimum of 60 minutes.

#### Anodizing of Small Parts

134 Anodize rivets in perforated aluminum containers. When anodizing washers, ensure electrical contact and exposure of the total surface to the solution by mixing with rivets, or by stringing the parts on aluminum wire or rod.

#### Other Parts

135 Anodize other parts as follows:

(a) Anodize parts and assemblies too large for the bath by partial immersion. Ensure that there is an overlapping by the electrolyte.

(b) Rivetted and spot welded assemblies may be anodized provided they consist of aluminum or aluminum alloys only. Assemblies of this type are to be cleaned by vapour degreasing only.

(c) Selective anodizing must be done using lacquer (Item 22) and not by the stripping method.

(d) Treat forgings and castings to be anodized for the detection of cracks in accordance with these instructions except that the time at 40 volts must be 15 minutes.

(e) Process parts to be bonded separately from parts which are not metal bonded. Use similar anodizing procedure except that, after anodizing, the parts are rinsed in cold water, followed by a short dip (1/2 to 1 minute) in hot water. After anodizing, handle the parts with clean cotton gloves.

#### Preparation of Solution

129 Make the electrolyte solution of 5% (by weight) chromic acid (Item 6) in water. The chloride and sulphate content of the water must not exceed the equivalent of 0.02% of sodium chloride and 0.05% of sulphuric acid respectively.

#### Temperature of Solution

130 Maintain the temperature of the solution at 95° ( $\pm 5^\circ$ ), at all times. Do not use the anodic cycle to bring the temperature up to the required value.

#### Preparation of Parts

131 Clean all parts as specified in EO 05-1-3/20. When alkaline degreasing has been used, immerse the parts in the anodic tank while still wet from the rinsing operation. Clean immediately before the anodizing operation.

### Treatment after Anodizing

136 After the anodizing cycle has been completed, observe the following:

- (a) Drain and immerse the parts in clean water, at a minimum temperature of 180°F, for not less than 30 minutes, then drain and allow to dry. In the case of anodized fuel, engine oil and hydraulic oil tanks, dry by heating in an oven at 225° to 250°F, if available.
- (b) Keep the surface of the rinse bath clean by using a constant flow of water over the skimming trough.
- (c) Handle anodized parts carefully to prevent contamination with dirt and grease.
- (d) Paint parts, if required, as soon after anodizing as practicable.
- (e) If contamination of the anodized surfaces prior to painting has taken place, clean with cloths and thinners or by vapour degreasing.

### pH FACTOR

#### General

137 The concentration of hydrogen ions in a solution is indicated indirectly by a numerical scale called the pH scale. Neutral solutions have a pH of exactly 7. If the pH is a number less than 7 it indicates the presence of an acid. Similarly, a number greater than 7 indicates a basic solution.

#### Hydrion Paper

138 Special indicators, such as Hydrion paper (Item 44), show varying shades of colour which correspond to the whole range of pH values. To measure the acidity or alkalinity of a solution, place a drop of the solution on the paper.

#### Gramercy Universal Indicator

139 The Gramercy Universal Indicator (Item 45) is a mixture of solutions of dyes that can be used to measure the pH of a solution. To 10 cc of the solution, 1 cc of the indicator solution is added.

### Colour Charts

140 Colour charts for comparison are obtainable from the manufacturers of the testing reagents.

## CORROSION PROTECTION OF MAGNESIUM ALLOYS

### General

141 The following information is included for the guidance of personnel engaged in anti-corrosion protection of magnesium alloy components.

### Cleaning

142 For instructions regarding the cleaning of magnesium alloys, refer to EO 05-1-3/20.

### Types of Treatments

143 Magnesium corrosion preventive treatments are of the following types:

- (a) Type I Chrome-Pickle Treatment: For temporary storage and shipment, electrical bonding, touching up of previously treated work and brush application when permitted. Applicable to all alloys when close dimensional tolerances are not required.
- (b) Type II Sealed Chrome-Pickle Treatment: For general long time protection of all alloys when close dimensional tolerances are not required.
- (c) Type III Dichromate Treatment: For general long time protection of all alloys except those containing 1.5% or more of manganese, and including work for which close dimensional tolerances are required.
- (d) Type IV Galvanic Anodizing Treatment: For general long time protection of all alloys when close dimensional tolerances are required.

### NOTE

Parts processed by the above treatments are not to be subjected to temperatures above 500°F.

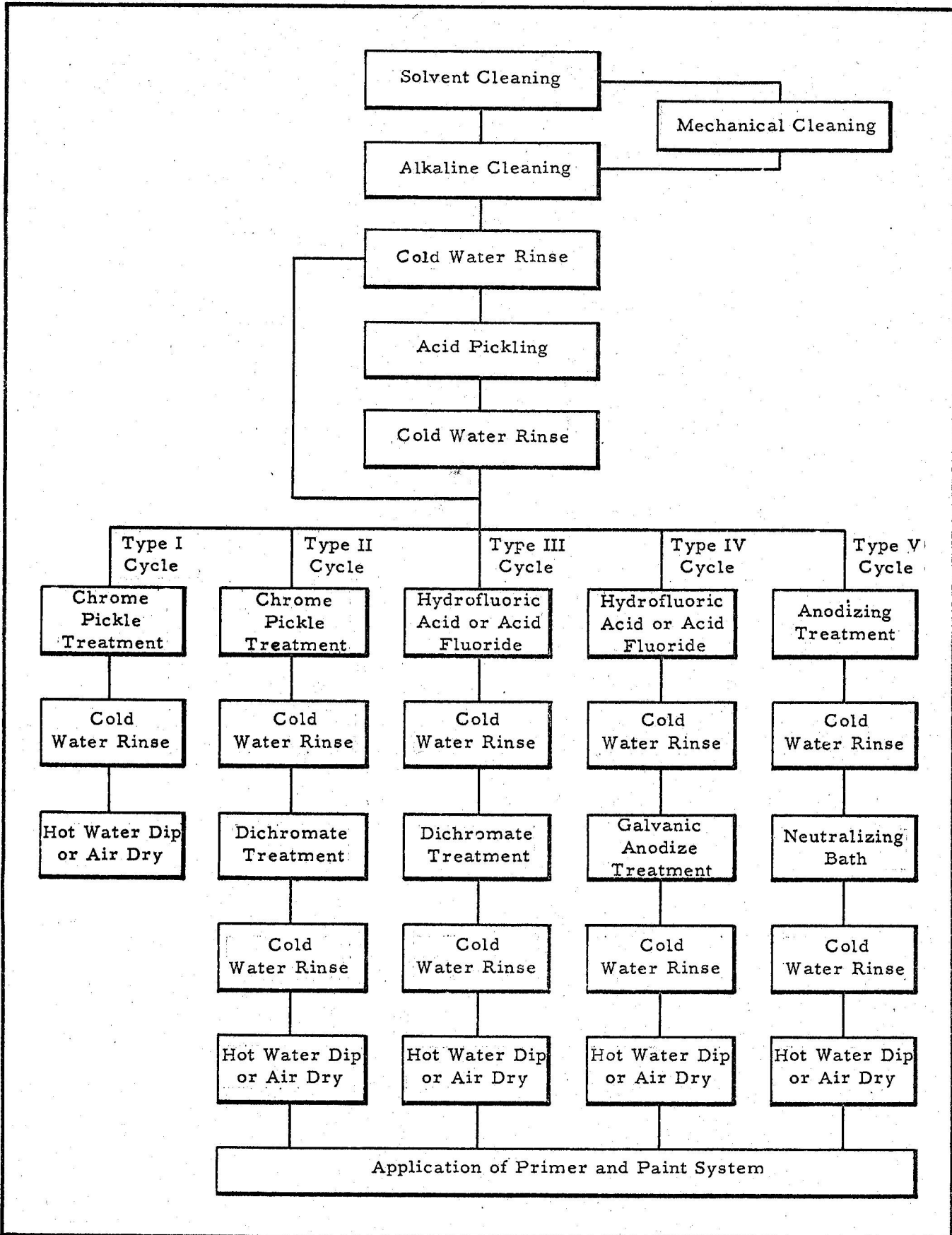


Figure 5 Cleaning and Treatment Cycles

(e) Type V Caustic Anodizing Treatment: For general long time protection of all alloys when close dimensional tolerances are not required. Parts processed by this treatment are not to be subjected to temperatures above 680°F.



Use protective clothing and equipment for protection of the eyes, protection from skin contact or inhalation of gases or compounds of nitric, sulphuric, phosphoric and other acids or bases. Refer to EO 00-80-4/4 and EO 00-80-4/2.

#### Applications of Treatments

144 Follow the sequence of the operations to be used for the application of treatments specified as detailed in Figure 5. Treated articles must be primed as soon as practical after thorough drying. Clean parts which are handled or processed after sealing or remain unprimed for extended periods prior to painting. Other methods of exposing the parts to the treatment solution than by immersion may be used.

#### NOTE

Types of tank construction other than those specified may be used provided they do not have an adverse effect on the solutions to be contained.

145 Magnesium base alloys are sometimes furnished with Type I treatment which provides protection during machining, shipment, and storage. The coating resulting from Type I treatment remaining on the unmachined area will impair the film produced by Type III and Type IV treatments and, consequently, must be removed. Type I treatment to which magnesium sulphate has been added, (refer to Paragraph 166, following), leaves a surface which is unfit for painting.

146 Castings containing bearings, studs, or non-magnesium inserts of any nature may sometimes require Types III and IV treatment, as in the case of refinishing work. Brass, bronze, cadmium and steel are unaffected by these treatments. Aluminum, however, is rapidly attacked during the hydrofluoric acid dip. The use of an acid fluoride bath instead of the hydrofluoric acid dip permits the treatment of parts containing aluminum inserts.

## PICKLING SOLUTIONS

### Chromic Acid Pickle

147 Use chromic acid pickling where parts with tolerance limits are to be finished, since this pickle causes no dimensional loss. It can be used to remove old chemical finishes by alternate immersion in an alkaline cleaner as specified in EO 05-1-3/20 and the chromic acid pickle. This pickle is satisfactory for removal of surface oxidation, corrosion products and for general cleaning of parts. It is not satisfactory for the removal of sand or the effects of blasting and must not be used for parts containing copper-base inserts unless masked off. Excessive amounts of chlorides or sulphates must not be allowed to build up in the solution, as these anions tend to form objectionable films on the metal. This latter condition may be recognized when the solution tends to coat rather than to clean the metal surface.

148 For the solution composition and operation, use a lead-lined steel, stainless steel, or 2S aluminum tank. Mix 24 ounces of chromic acid in enough water to make 1 gallon. With an operating temperature of 190° to 212°F, immerse from 1 to 15 minutes. Bath can be operated at room temperature for a longer time if desired.

### Chromic-nitrate Pickle

149 The chromic-nitrate pickle is generally used for removing burned-on graphite lubricants. It is not satisfactory for the removal of sand or the effects of blasting and must not be used for parts containing copper base inserts, unless masked off. Lack of chemical action and a pH of 1.7 or higher indicates depletion of the bath.

150 For the solution composition and operation, use a tank constructed of ceramic, stainless steel, lead-lined, or synthetic rubber-lined tanks or tanks lined with vinyl base materials. Mix 24 ounces of chromic acid (Item 6), 4 ounces sodium nitrate (Item 46) in enough water to make 1 gallon. With an operating temperature of 60° to 90° F and a pH value of 0.0-1.7, immerse from 2 to 20 minutes, as required.

### Sulphuric Acid Pickle

151 Sulphuric acid pickling is used on magnesium sand castings to remove the effects of blasting operations. The pickle should be applied before any machining operation, since the amount of metal removed is likely to exceed machining tolerances.

152 For the solution composition and operation, use ceramic, rubber-lined, lead, or other suitable tanks. Mix 3 to 7 fluid ounces of sulphuric acid (Item 19) in enough water to make 1 gallon. With an operating temperature of 70° to 90°F, immerse casting for sufficient time to remove the effects of blasting operations.

### Nitric-sulphuric Acid Pickle

153 As an alternate for the sulphuric acid pickle, (refer to Paragraph 151, preceding), a nitric-sulphuric acid pickle may be used. For solution composition and operation, use ceramic, rubber-lined or other suitable tanks. Mix 8 fluid ounces of nitric acid (Item 20), 2 fluid ounces of sulphuric acid (Item 19) and 90 fluid ounces of water. With an operating temperature of 70° to 90° F, immerse part for sufficient time to remove 0.002 inch of surface.

### Chromic-nitric-hydrofluoric Pickle

154 For pickling castings, particularly die castings, a chromic-nitric-hydrofluoric pickle may be used. For solution composition and operation, use a tank lined with synthetic rubber or vinyl base material. Mix 37-1/2 ounces chromic acid (Item 6), 3-1/4 fluid ounces nitric acid (Item 20), 1 fluid ounce hydrofluoric acid (Item 48) with enough water to make 1 gallon. With an operating temperature of 70° to 90°F, immerse part for 1/2 to 2 minutes.

### Phosphoric Acid Pickle

155 The phosphoric acid pickle may be used for pickling all types of die castings. For solution composition and operation, use a ceramic tank or a tank lined with lead, glass or rubber. Mix 0.9 gallons phosphoric acid (Item 32) with enough water to make 1 gallon. With an operating temperature of 70° to 80°F, immerse part for 1/2 to 1 minute.

### Acetic-nitrate Pickle

156 The acetic-nitrate pickle is suitable for removal of mill scale and other surface contamination from magnesium sheet to ensure maximum protective finishing. This pickle can be used on other wrought forms and on solution heat treated magnesium castings. For most effective results the pickle should be allowed to remove 0.0005 inch to 0.001 inch of metal per surface and therefore is not suitable for parts requiring closer tolerances. For solution composition and operation, use an aluminum, ceramic, or rubber lined tank. Mix 25-1/2 fluid ounces glacial acetic acid (Item 47), 6-2/3 ounces of sodium nitrate (Item 46) with enough water to make 1 gallon. With an operating temperature of 70° to 80°F, immerse part for sufficient time to remove 0.0005 to 0.001 inch of metal surface.

## TREATMENT PROCEDURE

### Type I Treatment

157 The Type I treatment is to be applied to cleaned magnesium parts. Wrought magnesium parts are to be treated in a chrome pickle bath conforming to Paragraph 162 following, and magnesium sand, permanent mould and die castings in a chrome pickle bath conforming to Paragraph 163 following. The parts are immersed and agitated in the proper bath for a period of time ranging from 1/2 minute in a solution containing the full quantity of nitric acid to 2 minutes in a solution in which the nitric acid is nearing depletion. Usually a one minute dip will be sufficient in a properly controlled bath. After the immersion period, the parts are to be held above the tank for 5 to 30 seconds. This allows the adhering solution to drain off and produce a better coloured coating. The parts must then be washed in cold running water followed by a dip in hot water to facilitate drying, or by exposure to heated air.

158 Magnesium die castings and aged sand castings are to be given a 15 to 30 second hot water dip followed immediately by a 10 second dip in the solution specified in Paragraphs 162 or 163, following, which is to be operated at 120° to 140°F. Excessive treatment time results in a powdery coating and failure to pre-heat the castings in hot water results in practically no coating in 10 seconds.



159 Sand castings in the solution heat-treated condition can be chrome-pickled with these solutions at room temperature. After dipping, parts are to be rinsed as described in Paragraph 157, preceding. Chrome-pickle solutions may remove as much as 0.0006 inch of metal per surface during treatment and, therefore, cannot be used on machined surfaces unless tolerances will permit or proper allowances have been made.

160 Magnesium parts containing steel or brass inserts can be given the Type I treatment.

161 The most desirable base for painting is a matt grey to yellow-red, iridescent coating, which exhibits a network of pebbled etch finish as viewed under magnification. Bright brassy coatings, which show a relatively smooth surface with only occasionally rounded pits when examined with magnification, are unsatisfactory where the treatment is used as a paint base, but are acceptable for protection during shipping and storage. This shade indicates an excess of nitric acid or nitrate salt build-up in the bath.

162 The chrome pickle bath for treating wrought magnesium is as follows:

(a) Use a tank constructed of stainless steel or one lined with glass, ceramics, synthetic rubber or vinyl base materials. Mix 1.5 pounds sodium dichromate (Item 49) and 1.5 pints nitric acid (Item 20) in enough water to make 1 gallon.

(b) Immerse part for 30 seconds to 2 minutes, with an operating temperature of 70° to 90°F, followed by 5 seconds draining.

163 The chrome-pickle bath for treating magnesium sand, permanent mould and die castings, is as follows:

(a) Use a tank constructed of 316 stainless steel (preferred) or a tank lined with synthetic rubber or vinyl base materials. Mix 1.5 pounds sodium dichromate (Item 49), 1.0 to 1.5 pints nitric acid (Item 20), and 2 ounces sodium acid fluoride (Item 50) with enough water to make 1 gallon.

(b) Immerse part for 1/2 to 2 minutes at an operating temperature of 70° to 140°F, followed by 5 seconds draining.

## Brush Application

164 Articles too large to be immersed must be carefully brushed with a generous amount of fresh solutions specified in Paragraphs 162 and 163, preceding. The solution is to be allowed to remain on the surface for at least 1 minute while brushing and then washed off immediately with plenty of cold running water. The coating thus formed is less uniform in colour than that produced by immersion but is equally good as a paint base. Powdery coatings are not satisfactory as paint bases and indicate poor rinsing or failure to keep the surface wet with solution during the 1 minute treatment time by continuous brushing over the same area. In treating rivetted assemblies, care must be taken to avoid entrapping solution in the joints. Brush application is suitable for touch-up of Type I, II, and III treatments which have been damaged by handling or removed by abrasion during paint stripping.

## Operational Difficulties

165 A brown, non-adherent, powdery coating may be encountered during chrome pickling. This may be caused by:

(a) The part being in the air too long before rinsing. The air interval must be as specified in Paragraph 157, preceding.

(b) The ratio of acid concentration to sodium dichromate content may have been too high.

(c) The solution may have been too hot.

(d) The metal was not properly degreased. Brown powder will occur at spots where oil exists.

166 To reduce intergranular corrosion of some alloys in the chrome pickle baths, magnesium sulphate (Item 51) may be added to the chrome pickle solution specified in Paragraphs 162 and 163 to the extent of 0.2 pound per gallon for use in Type I treatments for temporary storage and shipment where the coating will not be used as a base for painting. The addition of magnesium sulphate to chrome-pickle solutions used in the Type II treatment is not permitted.

### Type II Treatment

167 The Type II treatment is a combination of the chrome-pickle treatment and the dichromate treatment and is commonly known as the sealed chrome pickle. All the requirements for the chrome pickle treatment as specified in Paragraph 157, preceding, shall be effective for the Type II treatment, except that the parts do not need to be dried after rinsing. The dichromate treatment must not be applied to an old chrome pickle film. Old chrome pickle film is to be removed as specified in EO 05-1-3/20 and the part re-treated.

### Dichromate Treatment

168 For the dichromate treatment, proceed as follows:

(a) The freshly chrome-pickled parts must be immersed in the bath as follows:

(1) Using a steel tank, mix 1 to 1.5 pounds sodium dichromate (Item 49) and 1/3 ounce of magnesium fluoride (Item 52) with enough water to make 1 gallon. With temperature at boiling, immerse parts for 30 minutes.

(b) After the treatment, the parts are to be thoroughly rinsed in cold water followed by a dip in hot water to facilitate drying, or dried by exposure to heated air.

(c) The specified paint coating is to be applied as soon as practical after the treated parts are thoroughly dry.

### Type III Treatment

169 The Type III treatment or dichromate treatment provides satisfactory paint base and protective qualities on all standard alloys except those containing 1.5% or more manganese only and rare earth metal alloys similar to EK 30 and EK 31. The treatment effects no appreciable dimensional changes and normally is applied after machining. Castings and other parts containing bearings, studs and inserts of brass, bronze, cadmium plate and steel may be treated since these metals are not affected by the treatment. Aluminum, however, is rapidly attacked during the hydrofluoric acid dip which is an important step in this treatment. Where aluminum inserts are used or wrought parts are assembled with aluminum rivets, the acid fluoride dip must be used in place of the hydro-

fluoric acid dip. Close control of the Type III treatment is essential when applying this treatment to the alloy containing 3% aluminum and 1% zinc.

### Hydrofluoric Acid Solution

170 To make up hydrofluoric acid solution, use a lead, rubber, or synthetic rubber lined tank. Mix 24 fluid ounces of hydrofluoric acid (Item 48) with enough water to make 1 gallon. Maintain solution at 70° to 90° F.

171 After parts have been cleaned, they are to be pickled in the hydrofluoric acid solution. This operation both cleans and activates the magnesium surface. It is recommended that wrought alloy containing 3% aluminum and 1% zinc to be immersed for 30 seconds and that all other wrought alloys and castings be immersed for 5 minutes. After the immersion period, the parts must be thoroughly rinsed in cold running water. Thorough rinsing is important in order to minimize fluoride carry-over which will make the dichromate bath inoperative.

### Acid Fluoride Solution

172 To make up the acid fluoride solution, use a lead, rubber, or synthetic rubber lined tank. Mix 6-2/3 ounces of sodium acid fluoride (Item 50) with 1 gallon of water. This solution is to be used for all parts containing aluminum inserts, rivets, etc. and is used as an alternate treatment for Paragraph 170, preceding. Immerse parts in solution for 5 minutes minimum, with the operating temperature at 70° to 90° F. After immersion, the parts must be thoroughly rinsed in cold running water.

### Dichromate Treatment

173 After the parts have been given the fluoride treatment in the solution specified in either Paragraph 170 or 172, preceding, they must be boiled for 30 minutes in the solution specified in Paragraph 168, preceding. Properly applied coatings vary from light to dark brown, depending upon alloy. After the immersion period, the parts are to be rinsed in cold running water followed by a hot water dip to facilitate drying, or dried by exposure to heated air. The specified paint coating must be applied as soon as practical after the treated parts are thoroughly dry.



## Operational Difficulties

174 Abnormally heavy and loose, powdery coatings, failure to coat, or non-uniform coatings may be encountered during application of the Type III treatment. These faults may be caused as follows:

- (a) The hydrofluoric acid or acid fluoride bath is too dilute.
- (b) The pH of the dichromate bath is too low.
- (c) Treatment of oxidized, corroded or flux-contaminated parts result in grey to yellow coatings of a loose nature. Parts are to be cleaned as specified in EO 05-1-3/20.

175 Failure to coat or non-uniform coatings may be caused by:

- (a) The pH of the dichromate bath is too high.
- (b) The dichromate concentration is too low in the bath.
- (c) Oily matter has not been properly removed, resulting in a spotted coating where some areas are coated and others are not.
- (d) Previous chrome pickle coating was not completely removed. Use of either solution specified in Paragraphs 147 or 149, preceding, to supplement the alkaline cleaning may be required.
- (e) The part was not fluoride treated.
- (f) Alloy treated is one that contains 1.5% manganese only. The Type III treatment is not suitable for this alloy.
- (g) Too long a hydrofluoric acid dip with low aluminum-containing alloys produces a fluoride film that does not break down evenly in the normal time, producing a spotty coating. For these alloys, treatment time should be 1/2 to 1 minute.
- (h) The bath was not kept boiling during the treating period. This is particularly important when processing low aluminum-containing alloys. Minimum bath temperature is 200°F.

## Type IV Treatment

176 The Type IV treatment or galvanic anodizing treatment may be applied to all alloys. It causes no dimensional change and may be applied after machining operations. After parts have been cleaned, refer to EO 05-1-3/20, they are to be treated in hydrofluoric acid solution specified in Paragraph 170, preceding or in the acid fluoride solution specified in Paragraph 172, preceding.

## Galvanic Anodizing Solution

177 After the treatment in a fluoride solution, the work must be galvanically anodized for at least 10 minutes and for as long as 30 minutes in the galvanic anodizing solution. The steel tank is to be the cathode. If the tank is made of non-metallic material, steel cathode plates must be used. The magnesium parts must be electrically connected with the tank or the cathode plates, care being taken that the work does not make contact with the tank except by an external connection. An ammeter and rheostat should be in the electric circuit. The current density must not exceed 10 amperes per square foot of anode area at any time. A minimum of 70 ampere-minutes per square foot of anode must be maintained to secure a uniform coating. Ordinarily 70 to 150 ampere-minutes per square foot will be sufficient. After the immersion period, the parts are to be rinsed in cold running water, followed by a hot water dip to facilitate drying, or dried by exposure to heated air. The specified paint coating must be applied as soon as practical after the treated parts are thoroughly dry.

178 The solution composition and operation is as follows:

- (a) Using a steel tank, mix 4 ounces of ammonium sulphate (Item 53), 4 ounces sodium dichromate (Item 49), 1/3 fluid ounce ammonium hydroxide (Item 54) with enough water to make 1 gallon. Operating temperature is to be 120° to 140°F.

179 A properly applied Type IV treatment usually produces a coating that is uniformly black. Time of treatment, condition of bath and composition of the alloy influence the colour of the coating. Grey and non-uniform coatings indicate that articles were not properly cleaned before treatment or that the solution was depleted. An increase in time

required to secure a uniform coating also indicates a depletion of the solution.

#### Type V Treatment

180 The Type V treatment or caustic anodizing treatment is an anodic treatment employing an alkaline bath in which either direct or alternating low-voltage current produces a hard abrasion-resistant coating varying from light grey to light tan in colour, depending on the alloy and the type of current. The treatment can be applied to all alloys and forms. The coating produced can be painted after it is given a treatment in a neutralizing bath to counteract the effect of the free alkali remaining in the pores.

#### Anodic Treatment

181 Parts to be given the anodic treatment must be cleaned and suspended in the anodizing solution from 3 to 5 minutes before the current is applied. This further removes traces of foreign material from the surface and makes it more receptive to the anodic coating. If direct current is used, parts can be cathodically cleaned in the anodizing bath during this period by reversing the current, making the magnesium parts the cathode. The parts are to be made the anode and the current applied must be 10 to 20 amperes per square foot at 6 to 24 volts a. c. or 6 volts d. c. The anodizing time is to be 15 to 25 minutes. When maximum abrasion resistance and protection are required, the longer treating period is to be used. The lower current density is to be used when treating an alloy containing 1.5 percent manganese only. When the current is turned off after treating, the parts must be left in the bath at least 2 minutes to stabilize the coating. Parts are then removed and rinsed in cold running water for at least 5 minutes. The parts are then dipped in hot water to facilitate drying or exposed to heated air, unless the parts are to be painted, in which case the parts are to be immersed in a neutralizing bath for 5 minutes as specified in Paragraph 183, following. Dissimilar metals on any parts must be masked off before treatment. Vinyls are stable in this solution.

182 The solution composition is made up as follows:

(a) Using a steel or magnesium tank, mix 32 ounces sodium hydroxide (Item 39),

0.55 pint ethylene glycol (Item 55), and 1/3 ounce sodium oxalate (Item 56) with enough water to make 1 gallon. The operating temperature to be 165° to 175°F.

#### Neutralizing Bath

183 The Type V coating must not be painted immediately after treatment because of the free alkali that remains in the pores after rinsing. Since such free alkali interferes with paint adhesion, a neutralizing bath must be used to counteract such alkali. The treatment causes the coating to acquire a pale yellow colour due to chromate absorption. After treatment, the parts are to be thoroughly rinsed in cold running water followed by a hot water dip or exposure to heated air to facilitate drying. The specified paint coatings must be applied as soon as practical after the parts are thoroughly dry.

184 Solution composition is made by mixing 6-2/3 ounces sodium acid fluoride (Item 50) and 6-2/3 ounces sodium dichromate (Item 49) with enough water to make 1 gallon.

#### Racks for the Type V Treatment

185 Racks made of high aluminum content magnesium alloys such as one containing 9% aluminum, 2% zinc, and 0.15% manganese or aluminum alloys containing more than 8% magnesium should be used in applying the Type V treatment. Rubber or synthetic rubber covered steel racks may be used. Design of the rack must ensure very firm contacts at the bus-bar and to the part. The portion of the rack contacting the bus-bar is to be made of copper, bronze or brass which can be bolted to the lower part of the rack. The rack must make good contact with the magnesium parts. Steel racks may be exposed only at the point where contact is made to the parts. Since the oxide coating acts as an insulator, magnesium racks must be stripped of this oxide at the contact points by use of the chromic-nitrate pickle specified in Paragraphs 149 and 150, preceding, or by sanding prior to each use.

#### Material Specifications

186 For table showing item numbers, materials, specifications and manufacturers, see Figure 6.

Item No.	Material	RCAF Ref.	Specification	Manufacturer
1	Trichloroethylene	33C/163	MIL-T-7003	
2	Compound, Turco Red-X			B.W. Deane & Co. 3620 Namur, Montreal
3	Bon Ami	33C/666		Bon Ami Ltd Montreal
4	Paper, Abrasive	29/1869		
5	Wool, Aluminum	29/1162		
6	Acid, Chromic	33C/494	O-C-303	
7	Primer, Zinc Chromate	33A/462	MIL-P-6889	
8	Lacquer, Aluminized		MIL-L-7178	
9	Compound, Corrosion Preventive		AN-C-52, Type 1	
10	Oil, Linseed, Raw	33A/343	1-GP-1A	
11	Compound, Corrosion Preventive		AN-C-52 Type 2	
12	Cord, Cotton, Wrapping		MIL-C-2520	
13	Sodium Bicarbonate	33C/88		Technical Grade
14	Lacquer, Stop-off, Unichrome No. 324			Canadian Hanson and Van Winkle Co. 15 Murrow Ave. Toronto, Ont.
15	Tape, Masking	32B/96, 59, 60		Commercial Grade
16	Methyl Ethyl Ketone	33C/520	15-GP-52	
17	Ammonium Nitrate			Technical Grade
18	Compound, Unichrome CR-110 SRHS			Canadian Hanson and Van Winkle Co. 15 Murrow Ave. Toronto Ont.
19	Acid, Sulphuric Sp. Gr. 1.84	33C/4	15-GP-8a	
20	Acid, Nitric Sp. Gr. 1.42	33C/2	13-GP-34	

Figure 6 (Sheet 1 of 3) Table of Material Specifications

Item No.	Material	RCAF Ref.	Specification	Manufacturer
21	Acid, Hydrochloric	33C/1	15-GP-33	
22	Lacquer, Unichrome, Stop-off No. 323			Canadian Hanson and Van Winkle Co., 15 Murrow Ave., Toronto Ont.
23	Compound, Parco, (liquid)			Parker Rustproof Co., Detroit Mich.
24	Abrasive, Sand for sandblasting	29/2342		
25	Blastite, Aluminum oxide grit			Can. Carborundum Co., Niagara Falls Ont.
26	Potassium Dichromate	33C/308		Technical Grade
27	Putty, Metal, for patching			Minnesota Mining and Manufacturing Co., London Ont.
28	Remover, Paint	33A/456	1-GP-78	
29	Presstite 217.5			Minnesota Mining and Manufacturing Co., London Ont.
30	Varnish	33A/374	1-GP-20	
31	Potassium Bichromate			Technical Grade
32	Acid, Phosphoric	33C/3	O-P-313	
33	Alcohol, Butyl			Technical Grade
34	Alcohol, Isopropyl	34A/214	3-GP-525	
35	Alcohol, Denatured, Ethyl	34A/216	3-GP-530	
36	Detergent General Purpose	33CM/16	2-GP-103	
37	Paper, Abrasive, No. 400 grit	29/1867		
38	Kerosene	34A/217	3-GP-3	
39	Sodium Hydroxide	33C/672	15-GP-7	Technical Grade
40	Trichlorethylene	33C/163	MIL-T-7003	

Figure 6 (Sheet 2 of 3) Table of Material Specifications

Item No.	Material	RCAF Ref.	Specification	Manufacturer
41	DELETED			
42	Alodine 1200	33C/770		American Chemical Paint Co., Ambler, Penn.
43	DELETED			
44	Paper, Hydrion			Technical Grade
45	Indicator, Gramercy Universal			Technical Grade
46	Sodium Nitrate	33C/226		
47	Acid, Acetic, Glacial	14B/27		
48	Acid, Hydrofluoric			Technical Grade
49	Sodium Dichromate	33C/781	15-GP-35	Technical Grade
50	Sodium Acid Fluoride			Technical Grade
51	Magnesium Sulphate			Technical Grade
52	Magnesium Fluoride			Technical Grade
53	Ammonium Sulphate			Technical Grade
54	Ammonium Hydroxide	33C/726	O-A-451d	
55	Ethylene Glycol	34A/172	3-GP-850	
56	Sodium Oxalate			Technical Grade
57	Oil Low Temperature		3-GP-335A	

Figure 6 (Sheet 3 of 3) Table of Material Specifications

