Chapter 2-3

PREVENTION IN SERVICE

CONTENTS

Preventive principles

1 The first defence against corrosion is to keep the metal dry by preventing the ingress of water, or by draining and ventilating so that the surfaces dry out as quickly as possible. There is usually no corrosion where there is no water to serve as an electrolyte, and prevention is better than cure.

2 The second defence is to keep intact the protective treatment provided so that moisture is excluded from the metallic surface, so far as practicable, even if present on the outer coating. Protective treatment is applied during production as laid down in Def Stan 00-970 Chapter 801 (revised).

3 At bimetallic contacts it is particularly important to exclude moisture by maintaining dry conditions and keeping protective coatings intact.

Routine detection of corrosion

4 On parts of aircraft that are easily accessible and visible during normal servicing, corrosion should be detected in its early stages by constant surveillance and by periodic examination of particular parts as set down in servicing schedules.

5 All personnel, whether or not directly responsible for rectifying damage, must be on the alert to report corrosion or damaged protective finish, especially in positions inaccessible to frequent examination. Corrosion, like flight safety, is of concern at all times.

6 Periodic examination for corrosion is required particularly of bilge, wheel and rocket or gun blast areas, engine compartments, intake vents and plenum chambers, battery compartments, relief tube vents and fuel-cell chambers, seams and faying surfaces on the external skin. The protective coating of magnesium-alloy parts must be examined frequently. Further information appears in Chapter 1-3.

Detection in less accessible locations

7 Sound proofing material, usually glass wool, is fitted to some aircraft between the fuselage skin and a cover of leatherette or similar material. This sound proofing material must be kept dry by every possible means. If it does become damp, it must be dried out immediately, either by airing or by the use of drying and dehumidifying equipment. If it becomes a sodden mass, the adjacent fuselage structure will quickly corrode.

8 More extensive inspection and corrosion repairs should coincide with the removal of access panels and the dismantling of components for other purposes, or performed at preset intervals. Special procedures must be laid down for servicing in marine environments or aggressive climatic conditions.

9 Methods of examination, including visual inspection, with or without penetrants, magnetic particle, eddy current, radiographic and ultrasonic flaw detection are described in:

AP 119A-2000-1	NDT	General Information
AP 119A-2000-2	NDT	Safety Precautions
AP 119A-2000-3	NDT	Penetrant Flaw detection

Detection of corrosion by structural sampling

10 Many aircraft structural areas are inaccessible. Examination of these areas on a routine basis would result in excessive cost in terms of manpower and aircraft availability. To avoid this a policy of structural sampling may be used.

11 Structural sampling is a percentage examination of parts of the aircraft not adequately covered by routine servicing examinations. From the consolidated results of the examination of different areas on various aircraft, an assessment can be made of the condition of a fleet of similar aircraft, operating in similar conditions.

12 Aircraft are no longer returned automatically to manufacturers for refurbishing after a set number of years service. Many are retained in use after their intended life has expired. Many new types of aircraft in the

Services are designed for very long life therefore a policy of examination to detect corrosion in its early stages is becoming increasingly important. ▶ AP 100A-01, Leaflet 315, Structural Integrity of RAF Aircraft gives RAF policy on structural integrity from the design stage of an aircraft. AP 100A-01, Leaflet 316, Structural Integrity Examination of RAF Aircraft implements policy promulgated in Leaflet 315 considering the frequency of examination and the requirement for structural sampling. ◀

AIRCRAFT WASHING

General

13 The surfaces of all aircraft, painted or unpainted must be kept clean. The minimum frequency of complete aircraft washing is to be determined by the aircraft Engineering Authority and detailed in the aircraft Master Servicing List (MSL). Washing may be carried out more frequently if local conditions are adverse such as on board ship, at coastal airfields or when aircraft are engaged on maritime operations.

14 Partial washing or localised cleaning should be carried out as the condition of the aircraft demands. Such operations must be followed by the reapplication of corrosion preventive treatment and relubrication of bearings, in accordance with current aircraft publications.

15 During all cleaning processes, the mildest cleaning procedure that affords the desired results should be utilized. Fresh water suffices to remove salt deposits, compound cleaning aircraft surface (DTD 5507B) removes most contaminants, especially when used in conjunction with a hot wash machine. Heavy duty cleaning compound (DTD 5600) is also available. Removal of abrasive dust by dry rubbing is to be avoided at all times.

Precautions

16 The following precautions must be observed for all aircraft washing operations:

16.1 Protective clothing is to be worn, including rubber gloves, boots and apron, face and eye shields.

16.2 Do not allow any petroleum based cleaning material to contact oxygen equipment including gaseous liquid oxygen filling and venting points.

16.3 High pressure water jets from cleaning equipment may cause damage to thin section skin areas, electrical connections, loose paint and sealant. Ensure any damage is reported to the NCO IC Servicing.

16.4 Only authorised personnel may operate powered washing equipment.

Pre-wash precautions (RAF only)

17 The following pre-wash precautions must be observed for all RAF aircraft.

17.1 Position aircraft on the wash pan, nose into wind where possible.

17.2 Earth the aircraft, washing plant and all access staging.

17.3 Ensure all aircraft electrical power is switched off and external power is disconnected.

17.4 Chock mainwheels fore and aft and fit wheelcovers to all wheels. Do not allow tyres to stand in pools of cleaning material.

17.5 Close all doors, windows, hatches, canopies and openings to prevent water ingress.

17.6 Doors, hatches and canopies with pneumatic or pressure seals should be sealed with adhesive tape.

17.7 Flaps, spoilers, airbrakes, bomb and undercarriage doors should be positioned to allow maximum cleaning access to dirty areas.

17.8 Fit blanks, bungs or covers to all intakes, jet pipes, pitot headsand static vents.

17.9 Protect all exposed electrical connections including plyon bases.

17.10 Ensure fire extinguishers are positioned within 15 m (50 ft) of the aircraft.

Post wash checks

18 Carry out post wash checks as follows:

18.1 Ensure all drain holes are clear, exercise manually operated drains.

18.2 Operate control surfaces where possible to permit drainage of trapped water.

18.3 Remove temporary sealing tape.

18.4 Apply anti-corrosive treatment such as PX-24, if specified in aircraft servicing procedures.

18.5 Remove wheelcovers.

Note...

If wheelcovers were not fitted during washing, before returning the aircraft to service, the wheels must be removed, cleaned, wheel bearings relubricated and the wheels refitted.

18.6 Carry out post wash lubrication in accordance with aircraft servicing procedures (not normally carried out if the aircraft is proceeding to 2nd line servicing immediately).

Washing procedure

19 Aircraft should be washed in the following sequence with appropriate variations due to type:

CAUTION...

Cleaning solutions should not be permitted to dry on the surface since this may lead to staining.

19.1 Flush the aircraft surfaces with clean water to remove loose dirt. In hot weather, this action will also cool the metal thus preventing the rapid evaporation of cleaning solution.

19.2 Apply cleaning solution to undercarriage bays, exhaust tracks and heavily soiled areas such as urine tracks, allow to dwell for about 10 minutes and then apply more solution. Continue to apply cleaning solution as required to keep the area saturated.

19.3 Apply solution to the lower forward section of the fuselage and work upwards until the area forward of the mainplane is coated. Ensure that solution remains on the surface for 5 minutes, more being applied if needed. Agitate the solution with a soft bristled brush to break the bond between dirt and surface. Flush with clean water.

19.4 Wash the fuselage area between the leading and trailing edges of the mainplane as described in para 19.3.

19.5 Wash the remainder of the fuselage and the tail unit as described in para 19.3.

19.6 The mainplane should be washed in the following sequence: lower surface inboard to tip including flap, flap well and aileron; upper surface inboard to tip; thorough rinsing from upper to lower surfaces.

19.7 Complete the washing of undercarriage bays by the agitation of the solution with a soft bristled brush and the application of more cleaning solution as necessary. Rinse with clean water.

19.8 Flush the entire surface of the aircraft from upper to lower surfaces with copious quantities of clean water.

19.9 To prevent staining, any water remaining on surfaces should be removed where possible using squeegees, dry mops or cloths. Water used for rinsing should not be under high pressure, the object is to pass a large volume of water over the surface and float off the cleaning solution and contaminants.

Materials

20 Aircraft surface cleaning compound (DTD 5507B) is supplied in 25 litre containers. It is a clear yellow liquid, completely miscible with water, is non-flammable and non-toxic, and is intended to be used for the removal of oil, grease, dirt or other contaminants from aircraft skin surfaces. It can be applied to surfaces of fabric or metal, doped or painted, without attacking any of the materials of aircraft construction. It should be diluted in a ratio of 1 : 10 with water or to suit the state of contamination.

21 The compound may be used at full strength for manual application or diluted in a ratio of 1 : 9 for wash plant spray application. (This is normally carried out within the wash plant automatically). Spraying should take place as droplets rather than as an atomised spray, and at a line pressure of 3.45 to 4.83 bar (50 to 70 lbs/in^2).

22 Heavy duty cleaning compound (DTD 5600) is supplied in one gallon containers and has been introduced to remove heavy soiling which aircraft surface cleaning compound cannot remove. Application is to be by soft bristled brush, cloth or spray. The cleaner should be left for two to three minutes, to react chemically with the soiling and then thoroughly worked into the affected area using a cloth or soft bristled brush. Large quantities of water should be used to ensure thorough rinsing of the area.

23 It is stressed that heavy duty cleaning compound is to be used as sparingly as possible and only in cases where aircraft surface cleaning compound fails to remove soiling. It is to be used sparingly on acrylic paint finishes (DTD 5599A) and not on transparent plastics under any circumstances. The compound, if misused, may affect sewage treatment. For this reason its use is restricted as follows:

23.1 Before the cleaner is introduced on any RAF Station, the local PSA Superintendent is to be consulted to ensure that the effluent disposal facilities are situable.

23.2 The amount used at any station is not to exceed one gallon per day. This limit does not apply where special effluent collection tanks are provided.

24 If washing water containing the heavy duty cleaner is discharged into streams or rivers without treatment, it may cause serious pollution. Where

penstock valves are provided to divert surface water into storm drains during heavy rainfall, local orders are to be published to ensure that:

24.1 The penstock valves are in the correct position before washing starts

24.2 The penstock valves are moved only by PSA staff.

24.3 Notices are placed near the penstock valves to emphasise the need to ensure that the valves are in the correct position before washing begins.

Washing equipment

25 Cleaning compounds may be applied by a variety of means from hand application to hot washing processes. Mechanical washing equipment available includes:

25.1 Ardrox foam pressure pots types BCP51, BCP55 and aircraft washing foam dispenser small; compressed air powered with no rinsing facilities, designed for use on smaller aircraft and helicopters. See AFDSEC Scale 1212 and AP 119F-1903 series.

25.2 Electrical and internal combustion engine (ICE) driven washing plants. Mounted on 4-wheel chassis; powered rinse facility. AFDSEC Scale 1212 and AP 119F-1902 series.

25.3 Hot wash machines in the Warwick range, 11000, 12000, 13000 and 22000 series. Electrically powered with kerosene as the heating medium, these machines provide an excellent cleaning facility for all aircraft and will remove grease and contamination very effectively. Water ingress into aircraft electrical connections must be avoided by ensuring all connections are suitably waterproofed on assembly and by minimizing the amount of water sprayed onto connections. (AFDSEC Scale 1196 and AP 119F-1912 series.)

25.4 Machines in paras 25.2 and 25.3 automatically dispense cleaning compound in a 1 : 9 ratio. All the machines are compatible with DTD 5507B.

Notes...

(1) Ensure all electrical and ICE driven machines are sited well clear of aircraft, use extension hoses if necessary.

(2) Ensure that the exhaust from Warwick machines is not directed towards the aircraft. Site the machine downwind of the aircraft where possible.

Gun cleaning

26 Gun cleaning compound provides a simple and rapid soak method of removing carbon deposits and products of combustion which occur in gun mechanisms. It has a flash point of 46°C (115°F) and is available as a concentrate in 25 litre containers. In use, it leaves a thin film of oil on the cleaned surface to provide temporary protection against corrosion.

27 The compound is diluted with kerosene in the ratio one part compound to two parts kerosene. The procedure for the preparation of a tank of the solution is as follows:

27.1 Determine the volume of solution required, ensuring sufficient tank capacity remains for expansion on immersion of components.

27.2 Lightly agitate the concentrate, and pour one third of the determined volume into the tank.

27.3 Dilute the concentrate to the required volume using kerosene.

27.4 Thoroughly mix the solution.

27.5 Measure the specific gravity (sg) of the solution using a hydrometer (see para 32). At 17.5°C (63.5°F) this should be not less than 0.799 and not greater than 0.802. (To determine the correct sg at other temperatures refer to fig 1).

27.6 Measure the alkalinity (pH) value of the solution with indicator paper (para 34). This should not be less than 9.0 and not greater than 9.2.

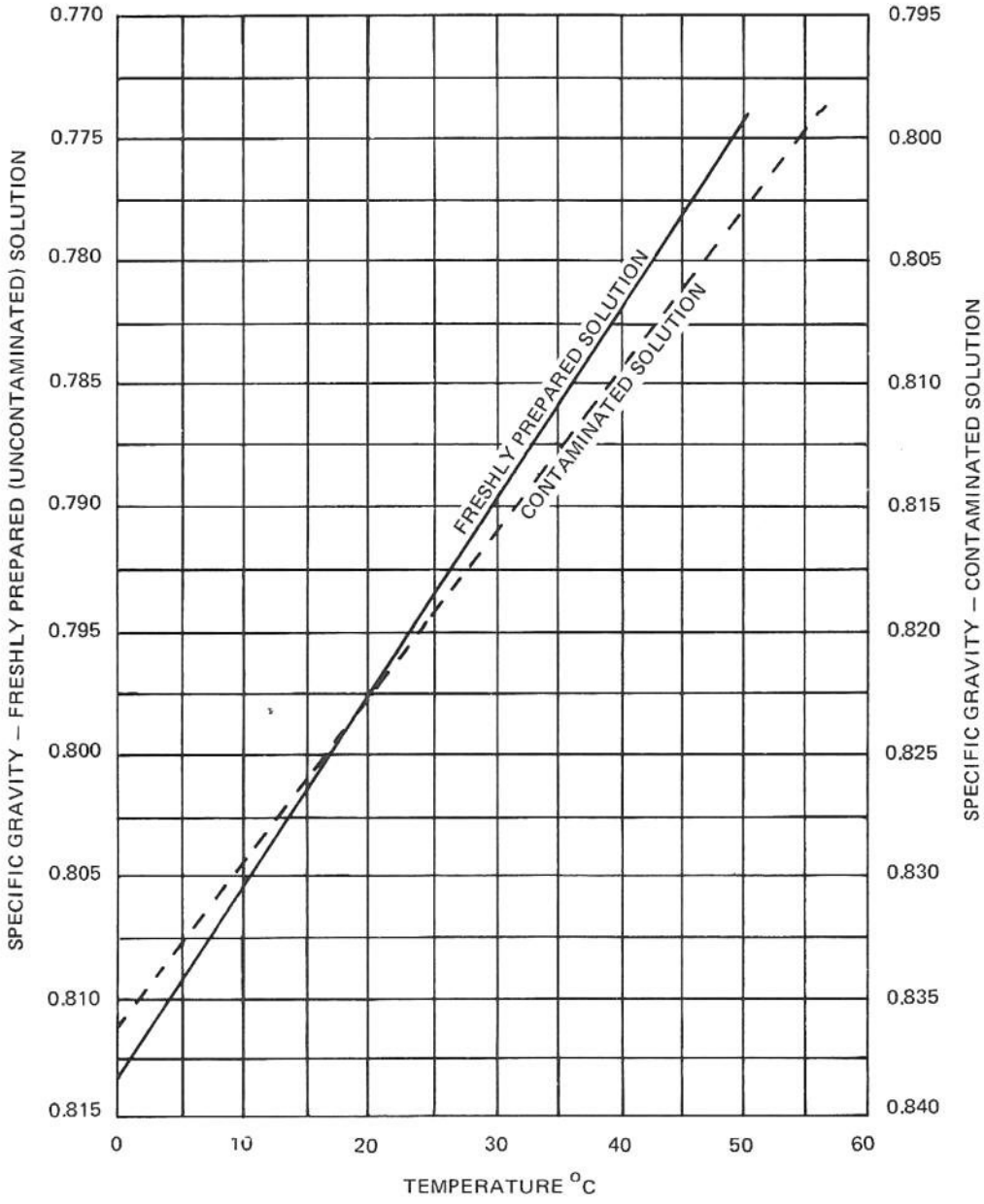

Fig 1 Specific gravity of gun cleaning solution at various temperatures

28 In use, the solution should be kept cool. Unnecessary exposure to sunlight is to be avoided. To prevent the loss of active solvents, containers are to be kept closed and cleaning tanks covered when not in use. Other cleaning agents must not be introduced into the solution.

29 The cleaning efficiency of the solution is governed by the degree of contamination. Contaminants may be soluble (oil, grease) or insoluble

(sludge), the former being the main cause of loss of efficiency. To reduce this, heavy coatings of preservatives and lubricants should be wiped from components prior to immersion. The sg and to a lesser extent the pH value of the solution provide a good indication of the degree of contamination. Insoluble contaminants consist largely of oxidised oil, carbon, iron or steel with traces of copper or copper alloy. These are present as a fine suspension or a black sediment at the bottom of the tank.

30 The method of use may be varied to suit specific conditions, but the principle of maintaining a copious supply of the solution in contact with the contaminated parts for not less than 10 minutes should be adopted. The degree of contamination will determine the soaking period which may be increased in the case of heavily fouled components. Components should be lifted from the tank, allowed to drain and then wiped with clean rag, or brushed to remove softened deposits.

31 To obtain maximum efficiency and economy in use, care should be taken to ensure maximum drainage from components, frequent removal of sludge and maintenance of the correct sg and pH values.

32 Testing for sg and pH requires the following equipment:

6C/5117 Hydrometer set sg 0.800 to 0.860
33C/2243416 Paper Indicator pH 6.5 to 10.0

Caution...

The hydrometer must not be allowed to contact the concentrated compound.

33 The sg of the solution must be checked monthly and whenever the efficiency of the solution is suspect. Allow the sludge to settle then take a sample of the solution and check it with the hydrometer. The sg should not exceed 0.825 at an ambient temperature of 17.5°C (63.5°F), or its equivalent derived from fig 1 for other temperatures.

34 The pH of the solution must be measured whenever the sg of the solution exceeds 0.825 at 17.5°C (63.5°F) (or the equivalent derived from fig 1 at other temperatures). The pH value is obtained by wetting an indicator paper with the solution and comparing the colour on the chart supplied. If the value obtained exceeds 9.5, the solution should be discarded as topping up with new solution will not materially improve its cleaning properties.

35 The solution is to be topped-up as necessary to account for losses incurred during component removal, evaporation and sludge removal. This is to be carried out by estimating the volume of solution required, adding one third of this volume as concentrate and two thirds as kerosene, directly to the tank. Mix the contents of the tank, allow sludge to settle and check the sg and pH values.

36 No special safety precautions are necessary beyond the normal requirements of barrier cream, rubber or plastic gloves and eye protection.

AIRCRAFT PROTECTION

Insulating materials

37 When insulating tape is used to prevent electrical contact between dissimilar metals, the tape must extend beyond the faces it separates to ensure that water or moisture collecting around the dissimilar metals will not bridge the tape.

38 Insulating washers, which reduce corrosion between steel screws and magnesium panels, should adhere to the magnesium so that moisture is excluded: this implies the use of adhesives. A sealant is better than a loose washer.

Avoiding damage to coatings

39 Since it is of prime importance to keep the external finish intact, every care must be taken to avoid damaging this protective barrier between the metal surface and the corrosive media. Suitable footwear must be worn, the soles free from embedded abrasives; mats should be used where they are available.

40 It is important to handle fuel hoses, tie down cables and other equipment with care, to avoid scratching the finish, and to place removed access panels and cowlings where they cannot be blown about or damaged. Paint films often suffer damage when tie-down cables are passed round supporting structures or through lightening holes. Use the tie-down points provided. Protect damaged finish with the minimum of delay, either by repair or by temporary reprotection.

First aid anti-corrosion kit

41 Portable anti-corrosion kits have been introduced to facilitate first-aid treatment of corrosion and damaged protective systems. These kits contain materials for surface treatment, jointing compounds, touch-up quantities of primers and finishes, and appropriate brushes and spray guns for the application of paints or temporary protectives, so that corrosion preventive maintenance can be carried out with minimum interruption to aircraft operations and other essential maintenance. Information on the kit and its use is given in Annex A to this Chapter and in AP 119A-0200-1E (2nd Edition).

Protecting dismantled aircraft

42 It is important to observe minimum protection requirements while critical surfaces and systems are exposed by partial dismantling. If skin panels or protective finishes have been stripped, keep aircraft under cover or wipe exposed areas with inhibitive fluid. Protect exposed bearings, electrical accessories and openings so that water does not enter during cleaning operations. Shroud or cover openings left by the removal of components. Coat exposed shafts and gears with soft preservatives or grease. Do not apply preservatives so thickly on cables that their movement through sheaves or bellcrank arms is impeded. Storage is discussed at greater length in Chapter 2-4.

43 When metal has corroded despite preventive measures, thoroughly remove the products of corrosion and apply new protective without delay.

Protecting complete aircraft

44 Aircraft parked in the open should be headed into the wind, and covers should be fitted. On fine days, proper ventilation is required and covers should be removed to allow damp materials to dry.

45 Covers protect vulnerable parts of aircraft against sand, dirt and adverse climatic conditions. Their use is particularly important overseas, where intense heat, cold or light, or sand storms or snow storms may be encountered. Covers are necessary when aircraft are parked at dispersal areas. The protection afforded by covers is one aspect of corrosion control although covers are not provided solely to prevent corrosion.

46 Unit standing orders or special instructions should regulate cover usage

in accordance with local climatic conditions, unless specific instructions are issued by higher authority.

47 AP 1086, Section 27D, lists the covers available for individual aircraft to protect aero engines, propellers, cockpits, observation panels, pressure heads, air intakes, sextant domes, undercarriages and other components.

48 Engine and jet pipe covers should be fitted (in addition to intake blanks) whenever adverse weather conditions are forecast or an extended non-flying period is envisaged. Openings are normally at the lowest point of covers, both to minimize water entry and to facilitate drainage. Care during fitment is vital to prevent damage to the aircraft surface finish by clips and buckles.

49 Propeller hubs and spinners are provided with covers to exclude water, dust and sand from variable pitch mechanisms and to protect the highly stressed spinners.

50 Air intakes and external apertures not protected by covers are to be sealed using bungs of a suitable shape.

Inhibitor cartridges

51 Def Stan 00-970, Chapter 801 (revised) specifies that in addition to the surface treatment for aluminium alloy integral tanks, an inhibitor cartridge or fine-mesh bag containing calcium chromate (to DTD 495) or strontium chromate shall be provided. The cartridge is installed where any free water present will contact it, dissolving the powder and forming a thin chromate film on the tank walls. Aircraft servicing schedules specify renewal intervals.

52 Chromate satchets, like that in fig 2, are sometimes used in very wet areas, such as the keels of pressurized aircraft. They are positioned suitably throughout the aircraft, with particular attention to the lowest point of the fuselage in the aircraft's standing attitude. The chromate dissolves away slowly; even inaccessible crevices are reached and protected. Cleanliness is the best protection, keels and bilges collect debris of many kinds. Chromate contaminated waste is to be disposed of in accordance with ▶ AP 100B-01 Order No. 1700. ◀

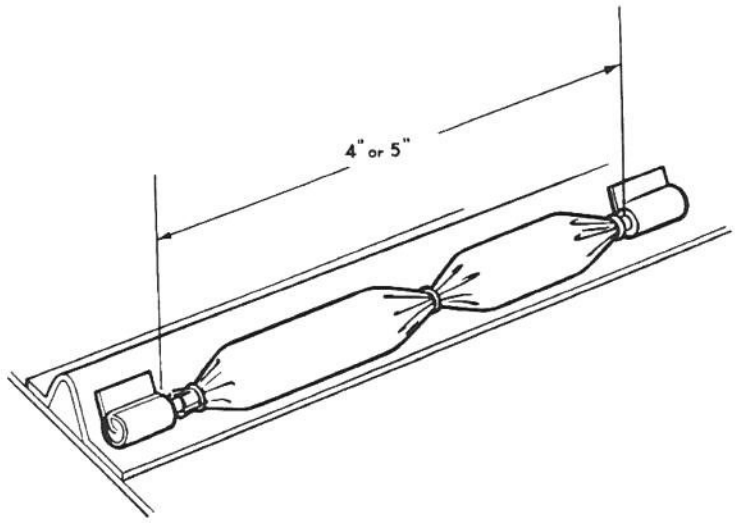

Fig 2 Typical chromate satchet

Microbiological attack on metal fuel tanks

53 Microbiological corrosion of metal fuel tanks by fungi, and by yeast and bacteria, is associated mainly with warmer climates (Florida, Australia and Central Africa in particular) and with the presence of water in aviation turbine fuels. It is not confined to aircraft operating exclusively overseas. Microbiological contamination is discussed in Chapter 1-1. Attack is controlled by reducing the water content of the fuel, adding icing inhibitor to the fuel, the use of protective coatings on metal fuel tanks, and removing contaminants and fungal deposits from the tanks.

Water in the fuel

54 The first defence against microbiological attack by fungi, yeast or bacteria is to eliminate water from the fuel supply and from aircraft fuel systems. Salt water is particularly detrimental, contributing directly to corrosion.

55 Fresh or sea water are employed deliberately to flush out fuel or act as ballast in tankers, and 'water bottoms' have been used to seal fuel storage tanks. Intentional water bottoms ceased to be used in British military avaiation fuel supply systems after adverse experience but the possibility remains that water may be introduced inadvertently. Some free water will gain admission to any vented fuel tank subject to variations of temperature due to condensation. Filters and filter separators cannot eliminate the presence of spores and drops of water.

56 Aircraft fuel systems need frequent and careful drainage; adequate drains must be provided but from no tank can water or fuel be drained completely. Drops of water are sufficient to start corrosion in the presence of micro-organisms.

Fuel additives

57 A fuel system icing inhibitor (FSII) assists in the prevention of fungal growth in aviation turbine fuels. It does not remove existing fungal deposits even when used in sufficient strength to kill the fungi, and it can be leached out of the fuel by the water content in an aircraft fuel tank. FSII is now required in all RAF turbine fuels, this fuel mixture is supplied from base-refuelling facilities ready mixed with additive, in a concentration of 0.10 to 0.15% by volume. Routine checks of the concentration are made by laboratory analysis of samples taken at intervals from airfield storage tanks.

Protective coatings

58 The problem of corrosion is particularly serious, though sporadic, in integral fuel tanks: wing tanks have been known to corrode through. Various coatings have been applied to the protection of metal fuel tanks. In the United Kingdom nitrile rubber (such as Buna-N) is used either alone on a pretreated surface or, on occasion, over an etch primer. Etch primers have been used alone. Sometimes polysulphides or fluorocarbon (Viton) provide protection, and chromate cartridges in conjunction with etch primers appear to be beneficial. Corrosion induced microbiologically has however been associated with Buna-N and with other coating materials.

Precautionary procedure when contamination occurs

59 Sea water inevitably contains micro-organisms resembling fungi or algae. If sea water gains admission in bulk to the fuel tanks of an aircraft the procedure is to drain the fuel system (by opening all tank, fuel-line and strainer drains) and to fill the system with fresh water containing 4 1/4 lb

(2.27 kg) potassium dichromate per 100 gallons (454.6 1) of water allowing this to stand for half an hour before draining again. The system is then filled with fuel and drained once more. Gauging probes, switches, pumps and valves are removed and sent for overhaul, examination and cleaning. Strainers are replaced or removed for examination, cleaning and flushing and then refitted. The metal surfaces and coatings of fuel cells are examined, corrosion removed and coatings and sealants repaired if they exhibit deterioration. Subsequently a close watch for slime in the strainers is to be maintained.

Inspection of fuel tanks

60 Clogging can occur particularly at filters and screens and across drain holes and small apertures. Fuel gauge elements are among the first items to be affected operationally and close examination of the fuel filter's contents may confirm that fungus is present and lead to further inspection of the tanks. Routine inspection of fuel tanks in aircraft and supply systems is needed since severe damage can be caused by microbiological corrosion before the filters provide warning that fungi are present.

61 Drain the fuel tanks for inspection but avoid contaminating the bulk fuel installation with infected fuel. Dry the tank by purging or airing until the fuel is evaporated and test the tank with an explosion meter appropriate to the fuel, before entering. If JP4 wide-cut gasoline fuel is present, exercise extreme caution. Look for green or brown slime or fungal deposits, visible while tanks are still wet, usually these are found low down in the tank. Remove the slime deposits with a bristle brush and a solution of one part by volume cleaning compound and five parts water at 50°C (122°F). Rinse with clean water in copious quantities. Closely inspect the bottom of the tank for breaks, pinholes and blisters in the coating, especially where slime, fungi or algae were deposited. High concentration of corrosive materials behind partial barriers of accumulated solids permit intensified local attack. Special attention should be paid to awkward corners where fuel can be trapped and remain for long periods.

62 Rectify the corrosion and coatings as necessary. See Chapter 3 and relevant aircraft manuals.