

Chapter 2-5THE EFFECT OF OPERATIONAL ENVIRONMENT

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INDUSTRIAL AND MARINE OPERATIONS

Environment

1 Chapter 1 of this manual discusses the corrosive effects of industrial atmospheres containing active chemical substances (sulphur dioxide etc) and of coastal and marine atmospheres containing salt. The rate of corrosion of an aircraft may be greatly accelerated unless appropriate preventive precautions are observed in aircraft design and in subsequent maintenance procedures.

2 Fig 1 and 2 show how spray can be generated by engine efflux or rotor downwash so that it covers a VSTOL aircraft or helicopter. Dinghy drills and sonar dunking operations expose aircraft to similar conditions. Conventional aircraft operating over the sea are equally vulnerable, and with low-level strike aircraft, there are additional problems of erosion of protective finish in high speed flight. Spray generated by the leading aircraft of a formation take off often envelops the remaining members during wet runway operations. Deposits resulting from this include grit, deicing residues, spilt fuel/oil and general runway dirt.

Control

Resistant materials

3 A solution to the problem of corrosion in hostile environments is to choose corrosion resistant alloys or protective coatings (Chapter 2-2). An alloy or coating adequately resistant to the contaminants in one environment may be inadequate in a different environment. As it is not always possible to predict where aircraft are to operate, the standard of protection should usually exceed the minimum satisfactory for one specific environment.

Reducing contamination

4 Corrosion in hostile environments can be diminished by reducing atmospheric pollution. Air conditioning, drying (by refrigeration for example) or just filtering will be beneficial inside buildings.

5 Aircraft must be washed (Chapter 2-3), to keep surfaces free from salt and other contaminants, as often as the situation allows or the availability of clean water permits. After aircraft wash, PX-24 or a similar dewatering agent should be applied to corrosion prone areas in accordance with aircraft servicing procedures to displace any residual water and to protect from any dissolved salts.

6 When sea spray comes into contact with unprotected metal there is urgent need to clean and dry the metal and reprotect it with the appropriate temporary or permanent protective (Chapter 2-3 and AP 119A-0202-1 'Corrosion in Naval Aircraft'). For ship-board aircraft, any period of low flying or foul weather should be followed if possible by a fresh-water rinse. Exposed pockets or cavities should be rinsed and dried out after general surface cleaning. In the absence of fresh water, a waterless cleaning agent must be employed for the removal of salt. If the surface is wet, it may be wiped down with PX-24 without water wash. Ardrex 607 may be used on dry surfaces (it is ineffective on wet surfaces). Gloves and eye shields should be used to protect the operator. Temporary protectives, if removed by washing, should be replaced. Trichloroethane is used to degrease and clean electrical equipment, instrument mechanisms and electronic components, including connections, switches, relays and ignition points, commutator or slip rings and brush assemblies.



Fig 1 Sea Harrier taxiing in wet conditions



Fig 2 Sea King on sonar dunking operations

DESERT OPERATIONSEnvironmentSun

7 In tropical and equatorial desert areas, summer temperatures regularly reach 50°C (122°F) in the shade and can exceed 80°C (176°F) inside fuselages. This heat accelerates corrosion, distorts skin surfaces and cracks protective finishes. Strong sunlight also produces ultraviolet degradation of protective finishes, reducing their resistance to corrosive attack. Fibre reinforced composite structural materials are also subject to ultraviolet degradation.

Sand

8 Windborne dust and sand containing up to 15% salt (NaCl) pose problems in desert operations. When driven by high winds the sand enters apertures, open panels and disconnected pipelines and connections. Even under normal conditions it settles and sticks to almost everything exposed. Fig 3 shows sand (seen as a pale grey discolouration) adhering to components in an undercarriage bay. The result is general degradation of protective finish, followed by corrosion. With oil or grease, sand forms abrasive compounds. Fig 4 shows sand mixed with a lubricant.

9 Sand erodes both the protective paint finish and the primary protective treatment of external magnesium and aluminium alloy components and skin surfaces. This is a severe problem in operations from temporary landing strips where the damage is increased by stones and rocks thrown up when the aircraft taxis or takes off. The areas of the aircraft most prone to damage in this way are the leading edges of wings and tailplane, the propeller leading edges (or helicopters rotors) and the undercarriage. (Fig 5).

Condensation

10 Although desert regions are often thought to be dry and waterless, the humidity can be as high as 95%. This causes condensation on aircraft when the temperature drops. Also in these high humidities, perspiration will not evaporate from the skin. Since perspiration contains many corrosive salts, care must be taken when handling unprotected components.

ControlReducing contamination

11 Whenever possible aircraft should be housed under cover in hangars and shelters mitigating the adverse effects of sun and sand. Covers supplied as part of aircraft equipment for cockpits, gunsights, propellers and other components must be fitted, apertures blocked and dismantled equipment shielded.

12 Engines should be started on firm ground wherever possible, so that loose material is not picked up by the slipstream, and well away from other aircraft.

13 Aircraft should be washed frequently, but there may be a shortage of fresh water. When the water used for washing has a high mineral content so that a film of salt remains on the skin of the aircraft, PX-24 must be applied to corrosion prone areas after washing. In the absence of water, waterless cleaning agents may have to be used, (see para 6) but care must be exercised to prevent damage to the surface by sand impregnated rags.



Fig 3 Sand adhering to undercarriage components

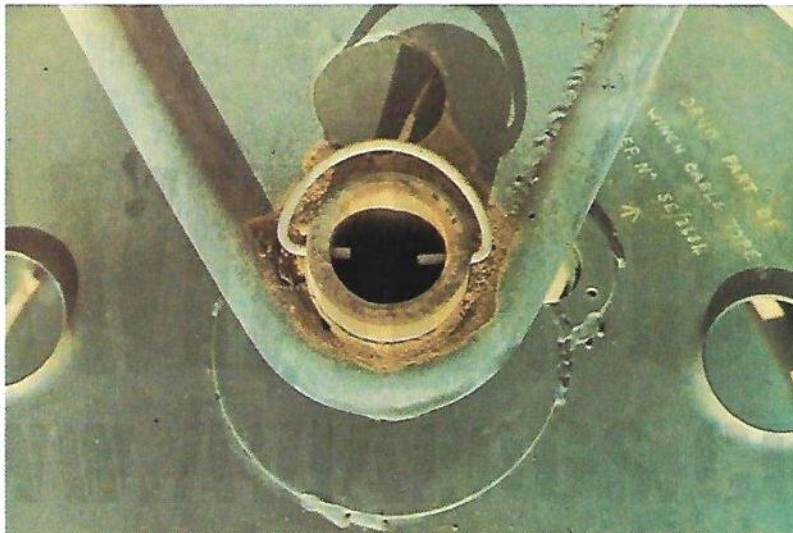


Fig 4 Sand in hoist-drum bearing



Fig 5 Hercules aircraft operating from a desert airstrip



Fig 6 Harrier operating on grass



Fig 7 Lynx helicopter weapon firing, illustrating exhaust deposition (Westland Helicopters)



Fig 8 Sea King helicopters operating in arctic conditions (Westland Helicopters)

14 Dust and sand should be removed by washing, or blowing with low-pressure air, not by dry rubbing. Cowlings and panels on removal must not be permitted to scratch protective coatings of components and must be supported clear of the ground and covered.

15 The outsides of pulleys and the insides of fairleads in contact with cables must be kept clean and dry in sandy locations. Moving parts requiring lubricant, should be cleaned and lubricated frequently (over lubrication could cause the formation of abrasive compounds) to replace loss by the thinning or evaporation of oil and the melting of grease. Care must be exercised to ensure lubricant does not contaminate other components due to melting or thinning.

Rectification

16 Anti-deterioration schedules, calling for extra inspection followed by the rectification of corrosion detected, must be followed whenever specified for particular aircraft in particular locations.

17 Difficulties may be encountered when paint schemes are rectified when the temperature and humidity are high. Wherever possible the rectification of paint schemes should be carried out under cover when humidity and temperature are reasonably low.

JUNGLE OPERATIONS

Environment

18 Operations in jungle environments still take place in Belize and may occur during detachments elsewhere. Summer shade temperatures reach 35°C (95°F) and relative humidity, up to 95%. High temperature and high humidity accelerate corrosion and equipment life is usually shorter than in temperate or hot, dry climates.

Condensation

19 Flying at high altitudes causes heavy condensation on inside surfaces, from air contained within an aircraft. Descending to warmer lower altitudes causes condensation on the chilled outside surfaces. Although condensation occurs at night or with changes of altitude in most climates, the effects are very much accentuated in tropical, humid environments.

20 Moisture may run down fuselage walls to form pools in the bottom of the aircraft. Inside main planes, tail planes and control surfaces, the condensation is heavier because the temperature change is usually greater. Moisture forms inside components and equipment.

21 Heavy condensation inside the conduits of mechanical remote controls is likely to cause corrosion of the cable, interior surface of the conduit and other internal metal components.

22 Change of pressure at different altitudes promotes the flow of air into, and out of, unsealed containers and sometimes into inaccessible places.

23 Instrument accuracy can be affected adversely by the slightest trace of corrosion. Photographic apparatus and materials are extremely sensitive to contaminants and corrosion which can cause seizure of camera control mechanisms.

24 Microbiological corrosion is more prevalent in hot, damp climates. The

organisms responsible breed quickly in temperatures around 30 to 35°C (86 to 95°F). The higher humidity results in greater quantities of condensed water in which they survive. (Refer to Chapter 2-3).

Control

Drying

25 Precautions must be taken to exclude rain from the aircraft internal structure, by using well fitted, well sealed access panels and inspection doors and by the use of covers, unless aircraft are under cover.

26 External engine surfaces should be protected against corrosion by placing aircraft in hangars, or by the use of covers, ventilating when conditions are suitable. Procedures for internal and external protection of aero-engines are given in AP 4471A, Vol. 1. Engines in storage, or in reserve aircraft, are liable to corrosion. Installed engines should be run periodically or inhibited if the engine cannot be run (AP 100E-20).

27 To reduce deterioration inside components, thoroughly air and dry them when conditions are suitable, by removing all inspection covers, detachable panels and cowlings and by opening cockpit hoods, cooling grills and cabin and other doors. Ventilation can be allowed during rain by leaving covers open at the bottom. Delicate instruments may have to be dried in hot boxes, manufactured locally. Water and oil traps need draining more frequently than in temperate climates.

28 Equipment should be stored in accordance with AP 830, Vol 2 (3rd Edition) Leaflet B1, with particular reference to Annex B.

Inspection

29 In humid climates careful examination of components enclosed by conduits is required. Prompt rectification of defects retards deterioration and reduces the chance of failure. Anti-deterioration schedules must be followed where specified.

30 Undercarriage shock-absorber struts should be examined frequently below the gaiter, for corrosion and deterioration. Aircraft wheel hubs are subject to corrosion particularly in salty conditions: the rim, hub and cooling fins require examination.

Lubrication

31 Normal lubrication applies in hot, damp locations unless special instructions are issued. More frequent lubrication and checks between lubricating periods are necessary when temperatures are high.

ARCTIC OPERATIONS

Environment

Condensation and freezing

32 Low temperatures do not directly accelerate metal corrosion, but Arctic or Antarctic climates are associated with adverse conditions. This is partly because servicing and repair work is more difficult in bulky clothing and thick gloves if performed in the open and partly because heated hangars, introduce the problem of heavy condensation.

33 When an aircraft is brought inside a hangar, condensate is deposited on the cold external skin and any ice is melted. When it is taken outside a

heated hangar, the severe fall in temperature tends to cause condensation inside the fuselage and wings. Observations on condensation in hot, damp climates are relevant to variations in temperature in cold environments and variations caused by changes of altitude.

34 Water is liable to enter openings where, particularly on freezing, it may interfere with component function: snow is very dangerous, particularly in the hinge areas of flying control surfaces and in undercarriage bays where it may hinder retracting gear.

Erosion and corrosion

35 The use of sand and salt on runways creates hazards of erosion and corrosion. Undercarriages and undersides of aircraft are particularly subject to this contamination. Aircraft must be washed in hangars when temperatures are below freezing point, it is difficult to keep aircraft both clean and dry in Arctic conditions.

36 When flying through rain, hail and snow storms, aircraft can suffer erosion along leading edges. This must be rectified at the earliest opportunity.

Control

Reducing contamination

37 Covers must be used on cockpits, wings, tailplanes, fins, undercarriage bays and engines when aircraft stand outside. Snow must be brushed off wheels to prevent it from entering brake mechanisms.

38 It is insufficient to break the ice in a blocked drainage hole: heat must be applied to remove all ice from the component and the hole, since water may have accumulated behind the blockage. For low temperature operation, extra drainage holes are sometimes provided and these must be serviced.

Lubricants

39 The oils and greases in Table 1 are suitable for use at temperatures at least as low as -40°C (-40°F). They are suitable for warmer climatic conditions, up to 120°C (248°F) or more in the case of greases. All contain additives and have corrosion-inhibiting properties. The Ministry of Defence 'Defence Guide DG-12' provides viscosity data and further information. Publications relating to specific items of equipment may prescribe other oils and greases for cold conditions.

40 Before operations at low temperature it may sometimes be necessary to remove lubricants not listed in Table 1, and to substitute lubricants having appropriate viscosities in low temperature conditions.

TABLE 1 LUBRICANTS SUITABLE FOR USE AT LOW TEMPERATURES

Lubricant	Applications
Mineral oils	
OM-12 (NATO O-142)	General purpose use in low temperatures
OM-150 (NATO O-140)	Flying controls, open bearings and hinges
Synthetic oils	
OX-14 (NATO O-147)	Aircraft instruments, electronic equipment, certain controls and circuit breakers
OX-27 (NATO O-156)	Certain aircraft turbine engines and auxiliary equipment (Synthetic oils are unsuitable for use with natural or neoprene rubbers and they also affect some paints and plastics)
Greases	
XG-271 (NATO G-382)	High speed ball and roller bearings, internal combustion engine accessories and certain fire control instruments (but not for helicopters)
XG-284 (NATO G-366)	Anti-fretting applications and helicopter general purposes
XG-287 (NATO G-354)	Aircraft general purposes in the temperature range -73°C (-99.4°F) to +121°C (250°F), instruments, gears actuators and mechanisms carrying high load (but unsuitable for use with natural or neoprene rubbers and affecting some plastics and paints)
XG-315 (NATO G-394) Silicone grease	Metal to rubber lubrication especially in aircraft pneumatic systems and guided weapons (but unsuitable for some plastics and synthetic rubbers)