

Chapter 1GENERAL CONSIDERATIONS

CONTENTS

Para			
1	Introduction		
6	Related publications		
7	Corrosion and aircraft life		
10	Environmental considerations		
15	Humidity		
17	Classification of atmospheres		
Table			Page
1	Yearly average relative humidity % variation with the hour		
		of the day	...
			4
2	Types of corroding atmosphere		4
3	Relative corrosivity of the atmosphere, at various sites, on		
		aircraft alloys	...
			4
Fig			Page
1	The effect of corrosion on the fatigue lives of long and		
		short term aircraft	...
			2
2	Yearly average relative humidity at 1300 hours G.M.T. at		
		ground level	...
			5/6

Introduction

1 In 1985, detected corrosion on Service aircraft resulted in the expenditure in the order of 80000 recorded manhours. To this must be added the cost of materials, replacement parts and restoration of surface finish.

2 Each branch of engineering faces its own corrosion problems and aircraft maintenance is no exception. Corrosion is one of the most persistent defects in Service aircraft and affects all types and makes despite the protection provided by manufacturers. High strength aluminium and magnesium alloys are readily attacked: high strength is often compromised against increased corrosion susceptibility.

3 This publication outlines (with special reference to aircraft) the nature of corrosion, the detection of corrosion, methods employed to control or prevent corrosion and general procedures for treating metals that have been exposed to corrosive environments.

4 The manual does not detail the routine procedures scheduled for particular designs of aircraft or their special features and it does not define safe limits beyond which replacement is needed rather than repair. Detailed information about corrosion treatment for specific aircraft will be found in their appropriate maintenance manuals.

5 To preserve intact an existing protective covering is usually very much simpler than later to rectify corrosion damage that has reached significant

proportions. The practice of "touching up" damaged protection schemes can help to safeguard against eventual severe corrosion damage that may seriously weaken critical parts of an aircraft structure and endanger the lives of its crew.

Related publications

6 In order to avoid repeating information contained in other manuals, cross reference has been made to those covering overlapping fields, such as AP 119A-0601 'Aircraft Painting' or AP 119A-20002-1 'Introduction to Non-Destructive Testing'. Some of the principal related APs which discuss the corrosion of aircraft are listed in the preliminary pages of this publication.

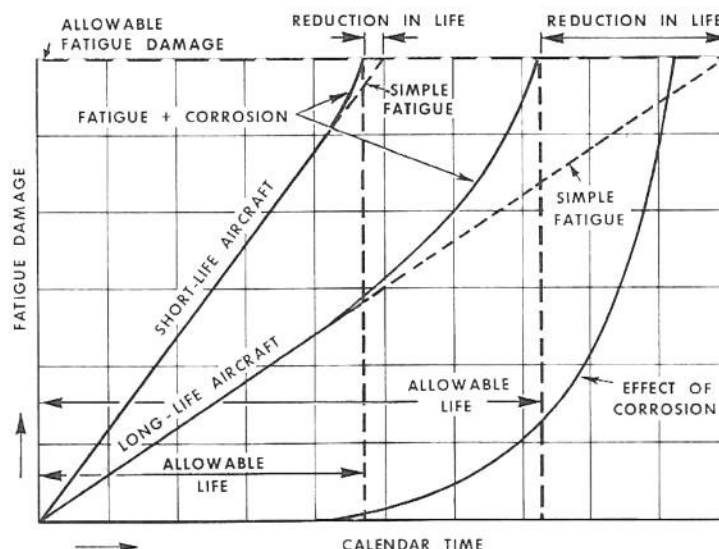


Fig 1 The effect of corrosion on the fatigue lives of long and short term aircraft

Corrosion and aircraft life

7 The corrosion of metals progresses with time and as an aircraft becomes older the effects of corrosion are cumulative. If the corrosion is not detected in its early stages, experience shows that the effects will become progressively more severe and will eventually become a serious hazard to the structural integrity of aircraft.

8 Largely because of increasing procurement costs, it has become almost routine to retain aircraft fleets in service longer than was originally planned. Thus corrosion may become at least as important as fatigue in the determination of the aircraft's life. This is illustrated in fig 1 which shows diagrammatically the effect of corrosion on the fatigue lives of long and short term aircraft. The short term aircraft may reach its allowable simple-fatigue life without being seriously affected by corrosion but the long term aircraft may have its simple fatigue life reduced because of this added effect.

9 It is obvious therefore that, if an aircraft is to remain operationally effective for the whole of its life, corrosion preventive measures must be of the highest possible standard at all times so that the designer's original fatigue and operational life predictions remain valid.

Environmental considerations

10 Most Servicemen are familiar with the wide variety of conditions under which Service aircraft have to operate and the corrosive effects of many

environments (refer to Chapter 2-4). They should also be aware of the corrosive agents present in industrial and marine atmospheres and how tropical environments and humid conditions contribute to the corrosion of aircraft materials.

11 The industrial atmosphere may contain dust particles which consist of (or contain) active chemical substances such as ammonium sulphate or sulphuric acid which cause or accelerate corrosive attacks on metal surfaces. Sulphur dioxide, a gas prevalent in industrial atmospheres, may often be the main cause of accelerated atmospheric corrosion of metals. Iron and zinc corrode much faster in an area like Sheffield than in rural districts.

12 The salt in marine atmospheres can greatly accelerate corrosion and has effects even some miles from the sea. The chloride ion in salt solutions initiates corrosion of aluminium alloys and stainless steels by causing breakdown of the protective passive oxide films. The presence of salt in the atmosphere also increases the electrical conductivity of moisture and favours the formation of local electrochemical corrosion cells on metal surfaces.

13 The higher temperatures encountered in tropical climates tend to accelerate the corrosion process and this coupled with high humidity, produces a very severe corrosion environment. The intensity of solar radiation is greater in tropical than in temperate zones and this produces a marked degradation of organic coatings.

14 In addition to the external environment the aircraft internal conditions also produce in some instances highly corrosive conditions. Aircraft operating fluids and gases, condensation, dirt, dust, runway foam and spray, all have corroding effects of greater or lesser degree. In particular, during the flight cycle, condensation, with its associated dissolved salts and gases, and spillage from services, (such as toilets and galleys) combine to create corrosive conditions.

Humidity

15 When the temperature of a metal is below the dewpoint, a thin layer (not always visible) of moisture forms and corrosion may occur where the protective oxide film is thin. In general each corrodible metal is liable to start corroding when the humidity exceeds a value that is critical for the particular metal and its environment. Iron carries an air-formed oxide film and does not rust until the relative humidity (r.h.) attains about 60% but rusting rapidly increases at about 80% r.h; probably, this second critical humidity is connected with a tendency of the corrosion product itself to hold or pick up moisture. Since the rate of corrosion depends on the nature of the corrosion product, it can be greatly influenced by atmospheric pollution.

16 Many parts of the United Kingdom, particularly near the coast, have relative humidities above 80% in the colder seasons. Fig 2 shows the average values of relative humidity in the months of February, May, August and November at 1300 hours G.M.T. The value of relative humidity during most of the twenty four hours is, however, higher than at 1300 hours G.M.T. as indicated by values for Kew and Glasgow in Table 1.

Classification of atmosphere

17 For corrosion purposes atmospheres are usually classified as rural, industrial, marine and marine-industrial, although it should be realized that there are wide variations of corrosivity within any one such atmosphere. Other types of atmosphere (but for which few corrosion data have been

recorded) are the arctic, tropical and tropical-marine environments. The various types of atmosphere and their corrosivity are crudely classified in Table 2.

TABLE 1 YEARLY AVERAGE RELATIVE HUMIDITY %:
VARIATION WITH THE HOUR OF THE DAY

Hours	0	3	6	9	Noon	15	18	21
Kew	85.9	87.6	87.4	79.6	70.7	67.9	73.4	81.4
Glasgow	85.9	86.8	86.8	81.7	75.3	74.4	77.1	83.1

TABLE 2 TYPES OF CORRODING ATMOSPHERE

Rate of corrosion	Type of atmosphere
Highly conducive to corrosion	Tropical, industrial, marine
Moderate corrosion	Temperate, suburban, marine
Moderate corrosion	Temperate, suburban, inland
Low rate of corrosion	Arctic, rural, inland

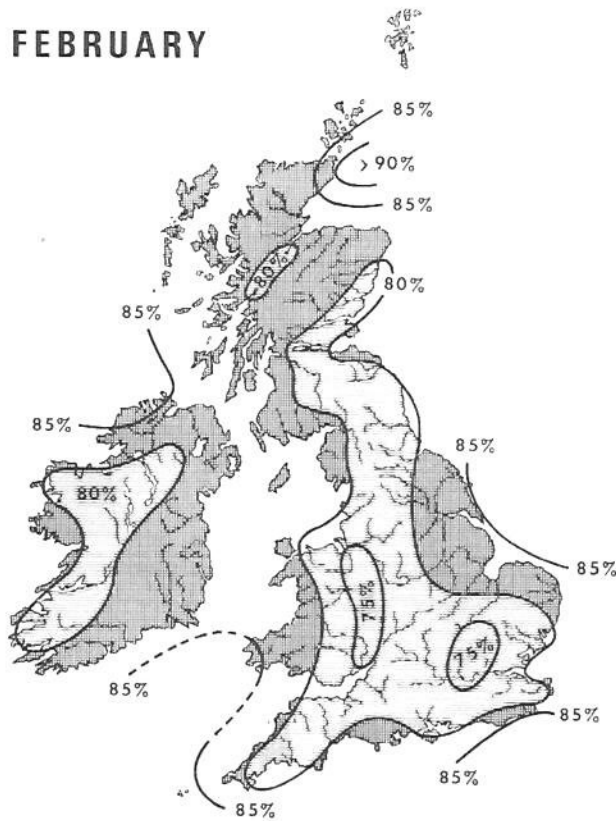
18 Table 2 shows that the atmosphere most conducive to corrosion is the tropical industrial marine atmosphere. This fortunately is fairly uncommon due to the lack of heavy industry in most tropical countries, but is likely to become an increasing problem as countries like Singapore become more industrialized. The tropical marine atmosphere is common and is found in such places as the Persian Gulf and Malasia.

19 Table 3 gives a rough guide to the relative corrosivity of various atmospheres throughout the world on the light alloys used in aircraft construction. Number 1 in the classification is the most corrosive atmosphere and number 6 is the least corrosive atmosphere of the locations shown. However, as stated in para 17, corrosivity may vary widely even in the same locations.

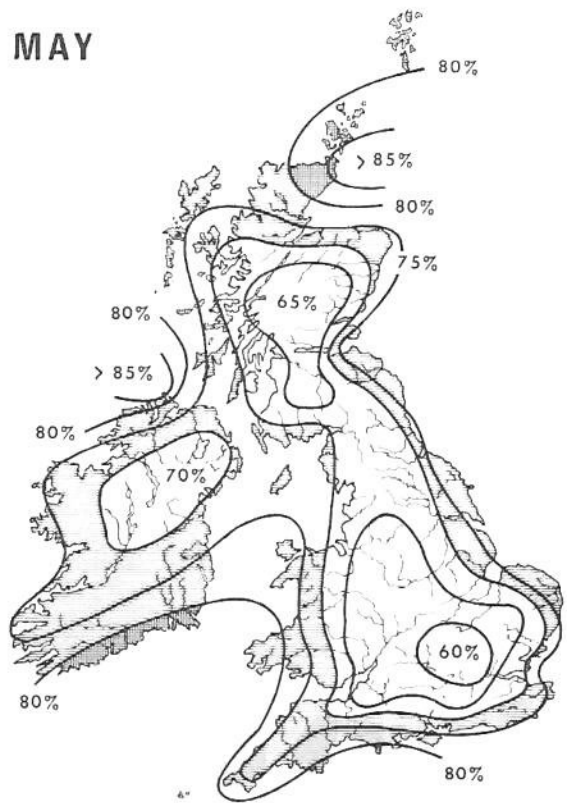
TABLE 3 RELATIVE CORROSIVITY OF THE ATMOSPHERE,
AT VARIOUS SITES, ON AIRCRAFT ALLOYS

Location	Atmosphere	Corrosivity
Persian Gulf	Tropical marine	1
Halifax (Canada)	Industrial marine	2
Brixham	Temperate marine	3
London	Temperate industrial	4
Banbury	Semi-rural temperate	5
Cold Lake (Canada)	Arctic marine	6

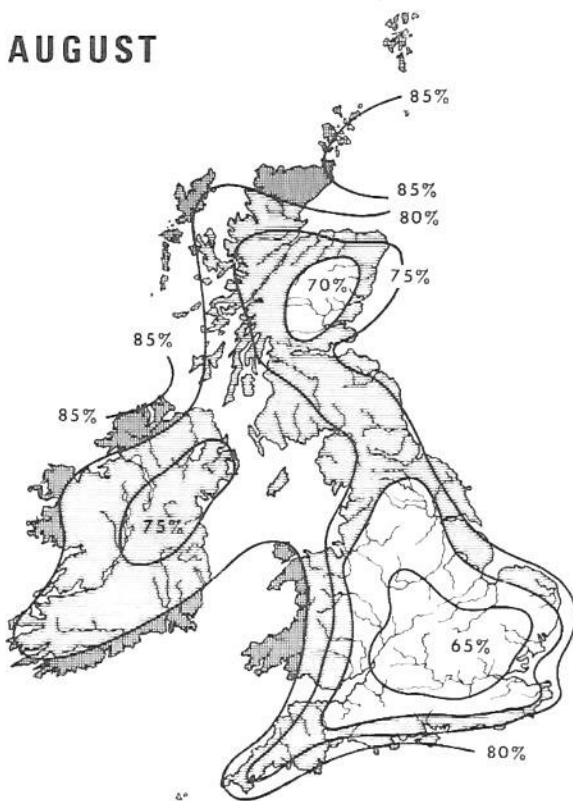
FEBRUARY



MAY



AUGUST



NOVEMBER

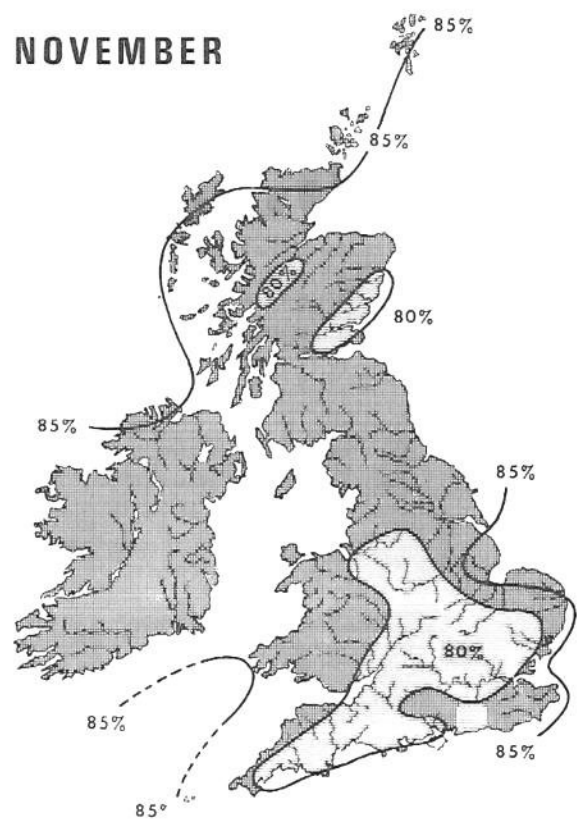


Fig 2 Yearly average relative humidity at 1300 hours G.M.T. at ground level