PART 2 : SECTION 4

CHAPTER 8

FLYING IN TROPICAL CONDITIONS

Introduction

1. The tropical regions of the world cannot be classified under any one set of characteristics. The barren mountains of Baluchistan bear little relation to the jungles of Malaya ; the monsoon rains of Northern Burma share no similarity with the endless sunshine of the Central Sahara. These regions, therefore, present to the pilot a widely different range of conditions, whose separate characteristics must be appreciated and understood to get the best performance from an aircraft.

2. The Royal Air Force has a wide experience of operating aircraft in all the tropical regions of the world. As a result, solutions have been found to most of the associated problems. Aircrew flying in a particular region for the first time are therefore advised to seek local knowledge whenever possible.

Difficulties Encountered in the Tropics

3. **General.** Heat, moisture, and dust are the three enemies to the efficient functioning of aircraft in tropical climates. It follows that aircraft should be exposed to their effects as little as possible, and for this reason should be kept under cover whenever feasible. Regardless of whether or not cover is available, however, the precautions outlined in paras. 4 to 11 should always be taken.

4. **Engines.** Engine covers, air intake and jet-pipe blanking plates, must always be fitted when the aircraft is on the ground. With piston-engined aircraft it is important that the exhaust ports should be covered as well as the air intakes, since dust can enter an engine through the exhaust manifold. Piston-engined aircraft operating in the tropics should be fitted with carburettor air intake filters, and these should always be in the FILTER position when such an aircraft is on the ground or flying at low altitudes.

5. Aircraft operating in tropical conditions have suitably modified cooling and lubrication systems; a high viscosity oil should be used.

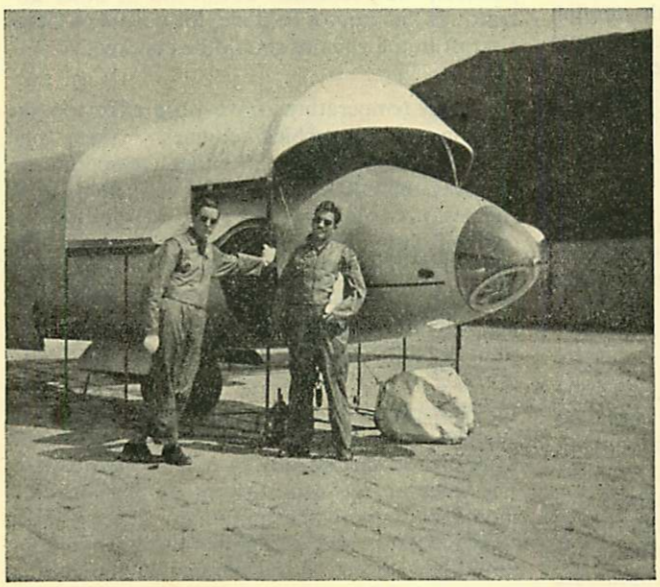

Fig. 1. Shading the Cockpit

A mobile canopy cover is shown, which is wheeled into position when the aircraft stands in the sun and is removed shortly before starting.

6. Ground running of all engines should be kept to a minimum. This is particularly important with piston engines, since the maximum permissible cylinder head, coolant, and/or oil temperatures can be quickly exceeded.

7. Heavy condensation may occur in fuel tanks. They should be kept full to reduce this likelihood and before each flight the fuel tank sumps must be drained of any condensation which may have occurred.

8. Heat causes the fuel in tanks to expand and vaporize, and with some gas-turbine fuels the more volatile elements may be driven off. Every effort should be made to keep the fuel tanks cool,

either by shading or by covering them with wet sheets or blankets. This is particularly important for jet aircraft which may be operating to the limit of their endurance. In the air, booster pumps and fuel pressurizing should be used to prevent vapour locks and to eliminate the possibility of fuel boiling during the climb.

9. **Airframes.** Extremes of temperature, heavy rain, dew, and dust combine to cause rapid deterioration of unprotected surfaces. In particular, some plastic materials soften when exposed to a hot sun. Wheel and cockpit covers, and, if available, mainplane covers should always be fitted whenever an aircraft is not in use; cockpits, when exposed to the direct sun, can become painfully hot. Covers should also be fitted over turrets and astrodomes. It is most important that covers are kept on static vents and pitot heads whilst an aircraft is on the ground to prevent blockage by water, dust, or insects.

10. Regular inspections of the airframe are even more essential than in temperate climates, since tropical conditions accelerate corrosion. The more inaccessible parts of the airframe should not be overlooked.

11. Flying control cables and rods may have a different coefficient of expansion to that of the main aircraft structure. They may therefore either tighten up or slacken off with varying temperature conditions, and suitable adjustments must be made. It is not normally desirable to adjust flying control operating linkages and tensions during the hottest times of day.

Aircraft and Engine Handling

12. Tropical conditions call for some modification or extension of the operating techniques normally used in temperate climates. These modifications are described in paras. 13 to 29.

13. **Pre-Flight Checks.** The full pre-flight check should be meticulously carried out. Special attention should be given to checks for corrosion and for deterioration of rubber components. Since electrical insulation may break down under conditions of high temperature or humidity, a functional check should be carried out on as many of the electrical circuits as possible while the aircraft is on the ground. Such checks are most necessary after flying from a hot, dry area into an area of high humidity.

14. On piston-engined aircraft, oil and coolant radiators must be carefully inspected for accumulated dust or mud which reduces their efficiency. Such accumulations must be washed off before flights. Air intakes on both piston and jet-engined aircraft should be inspected for accumulations of sand or dust, which must be removed before the engine is started.

15. **Survival Equipment.** A special check should be made of survival equipment, since the likelihood of a crew surviving a forced landing or ditching depends largely on the serviceability of the survival gear. All items should be checked for stowage, condition, and completeness. Re-fillable drinking water containers should be washed out and replenished at least once a day. Tinned water and foodstuffs should be checked to ensure that they have not exceeded their storage life, and should be replaced as required. The same check should be made on any pyrotechnics carried in the survival gear. Finally, it is a wise precaution to carry some water and food on one's person, in case the main survival equipment is lost after abandoning the aircraft.

16. **Starting Engines.** Before any attempt to start an engine, the wind direction and proximity of other aircraft should be assessed. If there is a possibility of dust or sand being blown over other aircraft, the aircraft to be started should, if at all possible, be positioned downwind of other aircraft. If this cannot be done, the covers on other aircraft in the vicinity should be checked.

17. High temperatures have little effect on the starting of gas-turbine engines. Since fuel atomizes very easily in high temperatures, however, there is a tendency to over-prime piston engines. An unsuccessful start on this type of engine is very often due to an over-rich mixture, and it is therefore preferable to under-prime rather than over-prime. The correct amount of priming for a particular type of engine under varying temperature conditions is soon learned.

18. **Warming-Up.** Piston engines warm up very quickly in hot climates, and running up should therefore be carried out as quickly as possible. The interval between starting up and take-off should be kept to the minimum. The cylinder head, coolant, and oil temperatures should be carefully watched. If the maximum temperatures are exceeded the engine should be stopped.

19. **Taxying.** Whenever possible, piston-engined aircraft should be moved about the airfield by

tractor. Failing this, taxying time should be kept to the minimum. Gas-turbine engined aircraft are not as sensitive to high temperatures, but nevertheless long periods of taxying should be avoided. Also, throttle movements should be slow and unhurried, as rapid throttle movements may cause the maximum j.p.t. to be exceeded more quickly than in cooler conditions.

20. When a number of aircraft are taxying out a suitable distance must be maintained between aircraft to eliminate the possibility of sand and dust thrown up by leading aircraft passing through the engines of the aircraft behind. This applies both to piston and gas-turbine engined aircraft, but more particularly to the latter type, especially when axial flow engines are used. It is often possible to plan the taxying paths of successive aircraft so that the wind blows the dust clear of the following aircraft. Full advantage should be taken of this whenever circumstances permit.

21. **Take-Off.** The take-off distance, more particularly for jet aircraft, may be considerably prolonged in high temperatures. This may be aggravated by the indifferent airfield surface and still further if the airfield is above sea level. The pilot should know the approximate take-off run required by his aircraft under all conditions of temperature, elevation, and aircraft loading. The effect of these conditions is greater for jet aircraft than for those with piston engines.

22. It may be necessary to limit the A.U.W. during the heat of the day. When, for reasons of range or endurance, this cannot be done, take-offs should be arranged for the coolest time of day. Airfield surfaces should be carefully checked. No hard and fast rules can be laid down as to how much soft sand, mud, etc., will lengthen the take-off run. The pilot must assess the effect of various conditions himself, and a preliminary taxy test over the runway to be used may be of considerable help in this respect.

23. Pilots of jet aircraft should find no difficulty in keeping the jet-pipe temperature within the specified limits during take-off, provided that harsh throttle movements are avoided and take-off power is used for no longer than necessary. Conditions for piston-engined aircraft may, however, be more critical, and both before and during take-off, the oil, cylinder head, and/or coolant temperatures must be watched to see that they do not exceed the maxima. As a general guide, it may be assumed that if temperatures are high at the start of a take-off :—

(*a*) The rise in coolant temperatures for a liquid-cooled engine is unlikely to exceed 15° to 20° C., and

(*b*) In air-cooled engines, the rise in cylinder head temperature may be as much as 60° to 80° C.

During a formation take-off from sandy or dusty airfields, the choice of take-off path should whenever possible be selected in relation to the wind direction. If the take-off can be made across wind, with the leader downwind and his formation in echelon on his upwind side, the dust thrown up by the leading aircraft will be blown clear of those which follow. Where such an arrangement is not possible, it may be necessary for sub-formations to wait for considerable periods to allow the dust thrown up by previous aircraft to subside.

24. **During Flight.** Engine-operating temperatures, both for piston and gas-turbine engines, may be expected to be somewhat higher under tropical than under temperate conditions. During the climb on piston-engined aircraft it may be necessary to climb at a higher speed than that recommended in Pilot's Notes to keep the engine temperatures within the limits. Whenever maximum range is required by a jet aircraft, it is important that the climb should be made as quickly as possible within the limitations imposed by engine temperatures. The increased time taken in the climb under conditions of high air temperature has important effects on the range of jet aircraft which must be fully appreciated by the pilot. The A.M.P.G. obtained from a given gas-turbine is also decreased owing to the lower efficiency of the engine in high air temperatures. This is discussed in Part 3, "Range and Endurance".

25. Considerable clear air turbulence may be caused by convection currents over land. In these conditions the speed and *g* loads should be kept at reasonable figures to avoid unintentional overstress. The effects of this type of turbulence may not be appreciated by the pilot when at high speed, owing to their transient nature, but the full extent of each transient "bump" is conveyed to the structure of the airframe. In order to avoid damage to the aircraft it is recommended that the speed should be reduced in turbulent conditions whenever operational considerations permit.

26. **Instrument Flying.** Aircraft flying in tropical regions may experience a wide variety of weather conditions. Large cumulonimbus cloud formations are common and can be very turbulent, especially in the regions affected by the inter-tropical front (I.T.F.) and the monsoons, whilst in other areas dust and sand-storms may be expected. It is therefore essential that a high standard of instrument flying is maintained. The problems of flying in thunderstorm conditions are fully discussed in Chapter 7 and should be carefully studied. Since thunderstorms are common occurrences in tropical climates, the possibility of having to penetrate is always present and the correct technique must be known.

27. **Landing.** It is generally advisable to make the final approach at a slightly higher speed than that used under temperate conditions. The reason for this is that the extra speed aids control of the aircraft in the turbulent conditions likely to be encountered near the ground in high temperatures. Approach speeds should not, however, be increased more than is absolutely necessary, since in high temperatures the I.A.S. remains the same whilst the T.A.S. is higher owing to the lower air density. This in itself increases the landing run.

28. Some difficulty may be experienced by pilots new to tropical areas in judging height during landings. This may be particularly noticeable when landing on featureless terrain, and when rising air currents cause refraction and upset perspective. In these circumstances some assistance is gained by using buildings, small bushes, clumps of grass, or other ground features to obtain an indication of the height of the aircraft during the round-out.

29. **After Landing.** Braking during the landing run should be done carefully to prevent the brakes overheating and fading. Unnecessary braking during taxying should be avoided, and the aircraft should be parked with the parking brake off and secured against movement by chocks in front and behind each wheel. If chocks are not available and the parking brake must be used, the brakes should be allowed to cool before being applied. Covers and blanking plates should be fitted and the aircraft put under cover when this is available. If an aircraft must be parked in the open, it should be turned into wind and carefully picketed down ; tropical storms may spring up at short notice, and are often very severe. There is often insufficient warning of such storms to allow for picketing aircraft when this has not already been done.

Navigation in Tropical Regions

30. Because of the vast areas of the tropical regions of the world, the relatively small number of airfields, the scarcity of navigational aids, and the difficult weather conditions which may be encountered, flight planning for cross-country flights in these regions should be very thorough. Routes should be planned so that full advantage may be taken of the available navigational aids and possible diversion airfields, especially for jet aircraft which may be operating past their point of no return.

Fig. 2. Take-Off from a Desert Airfield

The dust cloud thrown up can be such as to entail a lengthy interval before other aircraft could take off.

31. The weather at the destination airfield should be checked before take-off whenever possible. In areas where this information cannot be obtained, a report of the weather conditions should be obtained from the destination airfield as soon as possible after becoming airborne. Aircraft equipped with R/T only may be able to obtain this information from an intermediate station if direct communication is impossible.

32. Few airfields in the tropics are equipped with all-weather landing aids, and if the weather at the destination airfield is unacceptable the decision to divert or return to base must be made early.

33. With jet aircraft, the flight-planned fuel remaining at regular intervals along the route should be compared with the actual amount at these points. If an adverse comparison is obtained the decision to divert or return to base must be made before the point of no return is reached.

34. When flying over inhospitable territory, ground stations should be kept advised of the aircraft's position at frequent intervals. In the event of a forced landing, search operations are greatly facilitated if a recent position report is available.

35. The extensive cloud and thunderstorm development associated with the I.T.F. line squalls and the monsoons give rise to electrical disturbances which seriously affect the reception and accuracy of radio bearings, especially in the medium-frequency band. Sand-storms and heavy rain affect the efficiency of both Eureka and B.A.B.S. equipments. Thus it is advisable to make full use of D.R. and astro-navigational techniques to establish the track and position. Ground radio installations in the tropics may be few and far between, they may not be available when required, and their reliability, especially at maximum ranges, may be affected by weather conditions.

36. V.H.F./D.F. may also be affected by dust storms, electrical storms, and precipitation static, while temperature inversion coupled with multiple refraction may often produce freak results, especially at maximum ranges. Pilots of aircraft having only V.H.F./D.F. must therefore be especially careful in the compilation of flight plans, and be prepared to complete their flight on the flight plan if D.F. should prove unreliable. It is of paramount importance that pilots of such aircraft should take every opportunity of establishing their position by reference to ground features.

Radio under Tropical Conditions

37. Reference has already been made to the effect of heat and moisture on the electrical insulation and to the effect of tropical weather on the performance of V.H.F. and V.H.F./D.F. The importance of keeping radio equipment dry cannot be overstressed. The use of hygroscopic materials such as wood should be strictly avoided, and all components carrying high voltages should be hermetically sealed against moisture. As a further precaution against insulation leaks, a drying agent such as silica gel should be employed.

38. Tropical rains can completely blot out the propagation path and thus disrupt not only V.H.F./D.F. but also such systems as G.C.A. and B.A.B.S. The pilot using such systems should therefore be aware that such disruption can occur.

Care of Personnel

39. **On the Ground.** The newcomer to the tropics is exposed not only to the dangers of sunburn and heat stroke, but also to a variety of endemic diseases. The medical officer will advise on the precautions which should be taken to prevent casualties. These precautions may at times be inconvenient or distasteful, but as the alternative may be serious illness they should be strictly enforced and observed.

40. Sunburn may be avoided by the use of suitable clothing, and especially head-dress. Tinted glasses should also be worn to shield the eyes from the direct glare of the sun.

41. Many of the diseases common to tropical climates may be avoided by a high standard of personnel and unit hygiene. Others may be prevented by the use of prophylactic medicines. In either case, the instructions given by the medical officer should be meticulously observed, as failure to do so almost inevitably results in a high incidence of sickness, and in a disastrous drop in the operational efficiency of the unit concerned.

42. **In the Air.** Every effort should be made to counteract the tendency to chills caused by the rapid change of temperature between ground level and altitude. If possible, extra clothing should be donned in the aircraft, but if this is impractical the aircraft heating system should be turned on to prevent chilling. The time spent in the aircraft on the ground before take-off and after landing should be kept to the minimum to reduce the risk of excessive sweating, and if showers are available all aircrew should shower and rub themselves down after each flight.