PART 2 : SECTION 4

CHAPTER 6

LOW FLYING

Introduction

1. Low flying is defined as flying sufficiently close to the ground to give a true impression of speed, and for training purposes is considered to be below 400 feet above ground level. Low flying may be necessary at any time to meet operational requirements or because of bad weather ; the technique and problems involved should be known and practised to maintain a high standard.

2. Operational low flying involves fairly high speeds and the lowest altitudes, making use of ground contours as cover or to achieve surprise. Bad-weather low flying requires good control.

3. Low-flying exercises are designed to increase confidence near the ground, to teach low-level navigation, the estimation of distances, and to show the pilot his own and the aircraft's limitations under these conditions.

Regulations

4. Flying at less than 2,000 feet above ground or water level is prohibited, except when :—

(*a*) Taking off, preparing to land, landing, or making a forced landing.

(*b*) Necessitated by weather.

(*c*) Required in connection with exercises involving co-operation from the ground or water.

(*d*) Specially authorized.

(*e*) Authorized and carried out for training purposes in approved areas.

5. If forced by bad visibility and/or weather, or for any reason not stated above, to fly below 1,000 feet above ground or water, the occurrence is to be reported immediately after landing.

Flight Planning

6. Before low flying, the proposed area must be studied to become familiar with the positions of all landmarks, towns, prohibited areas, and possible hazards. The navigating technique at low level is fully explained in Chapter 14. It is sufficient to state here that a thorough study of the route or area is advisable before take-off, as this type of flying allows time for only brief reference to the map.

7. It is important that the salient features on the route should be memorized before take-off, especially those to be encountered just before the target, thus ensuring correct positioning at the last minute and achieving the maximum amount of surprise.

8. Good timing is important, and any alterations in speed must be made at an early stage of the flight if the target is to be reached at a pre-determined time.

9. During the pre-flight planning, the position of the sun relative to the aircraft during the flight should be studied. In hazy conditions the visibility up-sun is reduced and more attention should be given to memorizing landmarks on track and on the down-sun side of the track. When flying near towns interference from smoke drift should be anticipated.

10. If forced to deviate unexpectedly from the original flight plan by bad weather or for some other reason, more care must be taken owing to the possible presence of obstructions not considered in the briefing.

Speed

11. When flying low because of bad weather, the selected speed depends on the prevailing weather. If the cloud is low but the visibility good, fly at or near the range speed. In bad visibility reduce to the minimum safe cruising speed so as to have more time to avoid unexpected obstructions and to navigate accurately.

12. With turbo-jet aircraft it may be necessary to fly at a speed greater than minimum safe cruising so that the power is high enough to ensure a ready response to the throttle. In piston-engined aircraft it is also advisable to have extra power readily available by selecting a higher r.p.m. than that normally used at minimum safe cruising speed.

Height

13. When flying under low cloud, the aircraft should if possible be kept well clear of the cloud base to ensure maximum visibility and to reduce the risk of collision with obstructions or other aircraft. To facilitate map reading the altitude should be as high as possible consistent with the exercise. The height used depends on the nature of the terrain, the cloud base, and the visibility ; operationally, however, the lower limit is set by the skill and ability of the pilot.

14. If flying up the slope of a hill in a low-powered aircraft, the climb should be started early in case the best angle of climb is less than the gradient of the hill.

15. When low flying, the altimeter cannot always be relied upon as, like the A.S.I., it is subject to pressure errors. The altimeter over-reads when the A.S.I. over-reads, and vice versa, the amount of error varying with speed. At sea level the relationship between the required correction to the altimeter (in feet) and the A.S.I. pressure error correction (P.E.C.) is approximately :—

I.A.S. (knots)	Alt. Corr. in Feet
200	A.S.I. P.E.C. in knots × 18
300	,, ,, ,, ,, × 30
400	,, ,, ,, ,, × 48

For some time after levelling out near the ground following a rapid descent from altitude the altimeter may *over-read* by as much as 200 ft.

Effect of Wind

16. Movement over the ground, including drift, is more apparent when low-flying than when flying at normal altitudes. When flying upwind or downwind the decrease and increase in ground speed may be noticeable at low I.A.S. and there may be a tendency to increase or reduce the power accordingly. The latter could be dangerous because, if taken to the extreme, the aircraft would eventually stall.

17. Turns made near the ground can be deceptive because of drift. When turning downwind there is an illusion of slipping inwards during the turn, and when turning into the wind of skidding outwards. Therefore before correcting apparent turning inaccuracies the instruments should be checked to determine quickly whether the apparent faults are real or illusory. However, the drift which causes these optical illusions is very real, and plenty of room must therefore be allowed for the turn. The stronger the wind the greater the allowance required.

Turning Radius

18. The effect of what may be termed "directional inertia" is not very apparent at normal heights but it becomes an important factor when low-flying. Turns must be entered in ample time to be completed within the available space. Similarly, during recovery from a dive, the pull-out must be started early enough to allow for the aircraft continuing for a short while along its descent path. In a Rate 1 turn, the diameter of the turning circle in miles is roughly equal to two-thirds of the speed in miles per minute. For example, at 360 knots, or six miles per minute, the diameter is four miles ; at 420 knots, or seven miles per minute, the diameter is four and two-thirds miles. This relationship is useful when map reading in poor visibility at low altitude.

19. Turning near the ground necessitates the utmost vigilance. In bad visibility the ability to turn tightly is desirable as it helps to avoid sudden obstructions and/or to keep a landmark in view. As small-radius turns require a large angle of bank, the turn must be accurate, a slipping turn particularly being potentially dangerous. During the turn the power should be increased to keep the airspeed constant.

Turbulence

20. Turbulence, sometimes severe, can be encountered when flying within a few hundred feet of the ground. It can be caused by a gusty wind, by the passage of air over undulating ground, and by irregular heating of the earth's surface. In turbulent conditions an adequate safety margin must be allowed when flying low. In its movement over obstacles such as hills, the air near the ground becomes turbulent, and on the leeward side of the obstacles the wind may change speed considerably. Strong down draughts may be experienced on the leeward side of large hills and mountains. A safe height and margin of speed above the stalling speed must be maintained under such conditions.

Use of Flaps

21. At low speeds it may be expedient to use partial flap to increase the margin of speed above the stall. Flap also causes more drag, necessitating more power, and with a propeller-driven

aircraft causing a stronger slipstream and so giving improved control. With a jet-engined aircraft the use of flap requires a higher power setting which, as already stated, is an advantage from the point of view of rapid engine acceleration. The use of flap gives a better forward view on many aircraft because of the more nose-down attitude at a given I.A.S. Although flaps give these advantages it must be remembered that their use also reduces the range, and, on a multi-engined aircraft, they may affect the handling qualities when on asymmetric power. Care must be taken when selecting flap, up or down, to allow for any trim changes that may occur.

22. Use of partial flap gives a greater margin of safety in a tight turn. In high-performance aircraft it should be remembered that, although the conditions are otherwise favourable for a very tight turn at the speed in use, the effects of *g* coupled with the possibility of turbulence may constitute a hazard. It might, therefore, be better to use partial flap to achieve the same radius of turn at a slower speed.

Flying Over the Sea

23. There are no special problems in flying low over water. If the sea is rough, heights can be judged with fair accuracy, but when flying over a calm, glassy sea, particularly in hazy conditions, the judgment of height can be very difficult and there may be little or no visual difference between 5 ft. and 50 ft. Salt spray on the windscreen can reduce visibility considerably and it may be helpful to use the windscreen de-icer. As stated in para. 15, the aneroid altimeter may be unreliable at low level, especially at high speed, and therefore extra caution is required. Greater dependence can be placed on the radar altimeter when flying over a calm sea. When flying over a glassy sea, or large stretches of sand, drift is difficult to estimate and there may be no definite horizon ; ample margin of height must be allowed, especially when turning—quick references being made to the instruments.

Flying Over Snow

24. Flying over snow is similar in many ways to flying over the sea. Lack of relief, and a changed terrain caused by fresh snow must be allowed for. Drift estimation is difficult and the horizon may be poorly defined. It must be remembered that many of the landmarks normally expected may be obliterated or appear very different when the ground is snow-covered. In certain conditions the snow-covered ground and the sky merge into a single white surface, *i.e.* there is no visual horizon. Known as a "white-out", this is dangerous at low levels, and if in doubt as to the exact whereabouts of the ground the aircraft must be climbed away on instruments.

Radio Aids

25. Radio reception is adversely affected by low altitude. This should be borne in mind when flying low in bad visibility and relying on radio aids. The higher the frequency of the radio aid the more will it be affected by a decrease in altitude. Radio aids may also be unreliable owing to the reflection of signals by high ground or obstructions. Trailing aerials must be wound in.

High-Speed Low Flying

26. The problems associated with high-speed low flying and normal bad-weather low flying are basically the same. Visibility must be reasonably good, but to balance this the navigation problem becomes more difficult because of increased speed. Fuel consumption in a turbo-jet aircraft may be quadrupled at low altitude, and the range is proportionately reduced. The ability to fly and navigate accurately at low level is therefore all the more important.

27. Obstacles are approached at a much higher closing speed, and avoiding action must be taken earlier. To obtain a reasonably small turning radius all turns have to be done at large angles of bank.

28. There are certain other problems common only to high-performance aircraft, namely :—

(*a*) Altimeter errors become extremely important at high speed. When descending from altitude for high-speed low flying, sufficient height must be allowed for the pull-out, bearing in mind altimeter error, altimeter lag, and the inertia of the aircraft. There is also a danger of the canopy misting over heavily and suddenly after a rapid descent from altitude ; to prevent this all available heating should be directed onto the cockpit transparencies as soon as the descent is started, in spite of temporary discomfort.

(*b*) If airbrakes are used in the descent it is important to wait until the aircraft is flying level before the airbrakes are closed, otherwise the resulting acceleration may cause more height to be lost than was intended.

(*c*) When flying at high speed in turbulence the loading caused by sudden manœuvres, such as pulling up sharply to avoid an obstacle, coupled with the loading imposed by turbulence, may cause overstress and even structural failure. It is quite possible, with many high-performance aircraft, to exceed the structural limitations of the aircraft momentarily without the pilot sensing any great loading himself; however, the full impact and consequences of these stresses is always felt by the airframe, irrespective of the duration.

(*d*) On some aircraft, trim changes incurred by the selection of airbrakes or flaps, or by the dropping of external stores, are quite marked. Allowance must be made for these effects.

(*e*) Turbulence while flying low at a speed approaching the compressibility mach number may suddenly increase the T.A.S. to the extent that the compressibility mach number is exceeded. Since turbulence momentarily affects the angle of attack of the wings, if an aircraft is flying close to its compressibility mach number a sudden increase of angle of attack may induce the onset of compressibility at a lower mach number. It is therefore imperative that the aircraft should be flown at a speed sufficiently below the compressibility mach number for manœuvres to be carried out safely.

Lookout

29. A sharp lookout must always be maintained when flying low. Areas set aside for low-flying practice are likely to be used by a number of aircraft at the same time. The pilot can only afford to look inside the cockpit very occasionally and he must therefore check the cockpit before low flying, paying special attention to the fuel state, stowage of loose articles, and ensuring that the harness is tight and locked. The utmost vigilance must be observed. If an emergency occurs, there will be less time to take remedial action than when flying at normal altitudes.