PART 3

HANDLING

LIST OF CHAPTERS

PART 3

Chapter 1 — STARTING, TAXYING AND TAKE-OFF

Contents

1 Preparation for flight

Carry out the External, Cockpit and pre-starting checks.

2 Starting the engine

(*a*) Press and release the starter button.

(*b*) When the starter fires, the engine speed should build up rapidly to 1,500 RPM. As the engine lights up, the RPM increase to idling 3,000 ± 200. The sequence should take about 30 seconds. The JPT may momentarily exceed the idling limit. During the start, check that the fire warning light remains out.

(*c*) When RPM have stabilised, check that the JPT has returned to normal and the oil pressure is not less than 10 PSI at 3,500 RPM.

(*d*) *Failure to start*

(i) If the cartridge does not fire, close the HP cock immediately. It must not be assumed that the breech is empty and the time switch should be allowed to run out (30 seconds) before attempting a further start. If the second and third cartridges fail to fire, have the defect investigated.

(ii) If the cartridge fires, but the engine fails to light up, close the HP cock without delay. If it is suspected that an excess of fuel has collected in the engine a second cartridge should be fired with the ignition switch and the HP cock off. This procedure entails a 30-second delay whilst the time switch runs out. A third attempt may be made after an interval of at least 30 seconds as controlled by the time switch, provided the engine has stopped.

(iii) If, due to a circuit fault, the starter button does not hold in, irrespective of whether a cartridge is fired or not, a period of at least 30 seconds must elapse before the button is again pressed.

(iv) If the pressure relief valve sticks open as indicated by intermittent clouds of black or yellow smoke from the starter exhaust without RPM indication, wait at least until the time switch runs out (30 seconds) and then fire a second cartridge.

(v) The run of the time switch must not be shortened by use of the engine master switch, otherwise over-speeding of the starter may occur.

(*e*) Carry out the After Start checks.

3 Taxying

(*a*) Taxying is normal for a nosewheel type aircraft. Fuel consumption at idling RPM is about 15 lb. per minute.

(*b*) The aircraft should not be taxied at a speed which requires excessive use of the brakes as this causes over-heating of the tyres and reduces their life. When full drop tanks are carried, special care should be taken to avoid overstressing the landing gear.

(*c*) To avoid discharging the batteries engine RPM are to be kept above 3,700 during waiting periods before take-off and after landing.

(*d*) Carry out the Before Take-off checks.

4 Take-off

(*a*) A check that the power control indicators are black must always be made immediately before take-off at not less than 4,500 RPM.

(*b*) Align the aircraft and roll forward a few yards to straighten the nosewheel. Apply the brakes with the rudder bar central and open the throttle smoothly. If the brakes do not hold at 7,200 RPM they should be considered unserviceable and the aircraft should not be flown. Check oil pressure at 7,200 RPM is at least 14 PSI. Release the brakes and open the throttle fully, checking the engine operation (see para. 5).

(*c*) In crosswind conditions, gentle braking is necessary to keep straight until the rudder becomes effective at 90 knots.

(*d*) Ideally, the nosewheel should be eased off the ground between 115 and 135 knots depending on configuration. However, on some aircraft, when carrying 4 × 100 gallon drop tanks, it may prove impossible to lift the nosewheel within this speed band. Under the worst conditions of CG and rigging tolerances it may be necessary to attain 150 knots before the nosewheel can be lifted.

(*e*) Coarse rearward stick movement may result in the tail cone touching the runway when the nosewheel is raised; the follow-up tailplane increases this possibility and must not be used for take-off. Depending upon weight and attitude, the aircraft unsticks between 130 knots (clean) and about 155 knots (4 × 100 gallon drop tanks).

(*f*) When comfortably airborne apply the brakes fully and raise the landing gear. Carry out the After Take-off checks. There is no noticeable change of trim as the landing gear retracts. Retraction takes 6-8 seconds and must be complete before 250 knots is reached.

(*g*) Until experience is gained the lightness of the flying controls may lead to over-controlling in both pitch and roll.

(*h*) *When carrying drop tanks*

Use 38° flap. When safely airborne raise the landing gear and then the flaps, trimming nose-down as the flaps come up; delay in raising the flaps results in a marked nose-up change of trim when they are raised.

(*j*) *Manual reversion*

(i) Should manual reversion occur on take-off it is safe to continue the take-off. Using the recommended trim setting, a strong pull force is required to raise the nose-wheel but the aircraft will be in trim at 160 knots.

(ii) In case hydraulic failure has occurred, it is recommended that the landing gear and flaps (if the latter have been used for take-off) are left down, care being taken not to exceed the maximum permissible speed.

5 Engine handling at take-off

(*a*) The RPM are governed at 8,100 at which maximum thrust is obtained, but at full throttle this figure varies with OAT whilst still maintaining maximum thrust. Below are the relevant figures:

+15°C	8,100 RPM
0°C	8,085 RPM
−10°C	8,075 RPM
−20°C	8,045 RPM

RPM at take-off should not be lower than the above figures allowing a tolerance of 50 RPM

(*b*) Malfunctioning of the swirl vane system will allow the engine to reach maximum RPM without producing maximum thrust and the aircraft will only accelerate very slowly. Therefore to verify that maximum thrust is being obtained the following checks should be carried out:

(i) Maximum RPM are not obtained except at full throttle.

(ii) The rate of acceleration is normal when the brakes are released.

(iii) The JPT is more than 580°C.

6 Abandoning take-off

If, at 21,000 lb., the take-off is abandoned at a speed of 100 knots the aircraft should take the following distances to stop, depending on whether the brake parachute is used and the state of the runway; in all cases it is assumed that the brakes are applied fully within 3 seconds of abandoning take-off and that the HP cock is closed. Full flap should be lowered as soon as possible; the drop tanks may be jettisoned to reduce stopping distance but it should be done before streaming the brake parachute. (See Part 4, Chapter 3, para. 7, for engagement of runway safety barrier).

Brake parachute	*Wet runway*	*Dry runway*
Not used	1000 yds.	800 yds.
Used	900 yds.	720 yds.

PART 3

Chapter 2 — HANDLING IN FLIGHT

Contents

1 Climbing

(*a*) *Best rate of climb*

(i) Climb at full throttle, within the limitations, at the speed appropriate to the configuration, maintaining this speed until the recommended mach number is reached.

(ii) The recommended climbing speeds are:

Clean or with 2 × 100 gall. tanks	430 kts/0·85M
With 4 × 100 gall. tanks or 2 × 100 gall. tanks and RP rails ...	370 kts/0·82M

(iii) Above 20,000 feet it is important to hold the recommended speed to avoid a considerable reduction in the rate of climb.

(*b*) *Normal climb*

If maximum rate of climb is not essential set 7,950 RPM using the same speeds as above.

2 Engine handling

(a) On the climb

(i) High speeds at low altitudes may reduce maximum RPM by as much as 100. This coupled with the effect at Chap. 1, para. 5 (*a*) may cause the RPM at the start of the climb to read as much as 150 less than the static ground figure. This condition disappears as the climb progresses.

(ii) Maximum RPM may also be reduced if the top temperature controller comes into operation. On some engines the temperature controller reaches the limit of its control at altitudes above 40,000 feet when climbing at full throttle. It therefore becomes necessary to close the throttle slightly to maintain JPT below 690°C.

(iii) During a climb at full throttle RPM increases gradually but must not be allowed to exceed 8,150 RPM. When climbing at intermediate power it is necessary to close the throttle gradually as altitude is gained to maintain 7,950 RPM.

(b) In flight

(i) At intermediate throttle settings differing combinations of airspeed and ambient air temperature may cause the selected RPM to vary. It is then necessary to adjust the throttle if constant RPM are required.

(ii) The idling RPM increases with altitude and with increasing airspeed.

(iii) Negative G must not be applied for more than 10 seconds.

(iv) It is recommended that movement of the throttle should be smooth and progressive. Rapid throttle opening should be avoided at speed below 200 knots above 30,000 feet otherwise surging may occur. If surging occurs, throttle back and increase IAS.

(v) At low altitudes maximum power can be obtained within 5 seconds if RPM are above a minimum of 4,500 and at high altitudes within about 10 seconds from idling.

(vi) Closing the throttle rapidly at high indicated airspeed may cause damage to the engine, and should be avoided.

3 Flying controls

(*a*) *Ailerons* (*in Power*)

The ailerons are light throughout the speed and mach number range giving a high rate of roll, but see para. 12.

(*b*) *Elevator* (*in Power*)

(i) The force required for any manoeuvre depends on the distance the control column is displaced from the 'zero load' position and is completely independent of airspeed. It follows, therefore, that when large elevator deflections are required, e.g. at low airspeeds and very high mach numbers, the stick forces are relatively heavy: at high airspeeds however, since only small deflections are usually required, the stick forces are light. The control is light, effective and should be used cautiously until its characteristics are known and its effectiveness appreciated. However, elevator effectiveness is somewhat limited by jack stalling, which occurs when the air load on the elevator equals the jack output force and restricts movement of the control column rearwards. For this reason the aircraft is limited in the ground attack role to 0·88M below 10,000 feet. Depending on the tailplane angle and CG position jack stalling may occur when manoeuvring above this speed and for this reason particular care should be taken when flying in the ground attack role at high IMN; if it occurs the tailplane trim must be used as a means of control and speed should be reduced.

(ii) Longitudinal control is sensitive at aft CG, i.e. at high and low fuel states and particularly when outboard stores are carried. Use of the tailplane interconnection aggravates the sensitivity and for this reason the interconnection should be OFF for take-off and landing and at high speed/low level.

(*c*) *Rudder*

The rudder is light at low airspeeds and becomes progressively heavier as speed increases. The application of rudder produces a strong rolling tendency.

(*d*) *Trimmers and tailplane*

NOTE: Care must be taken not to operate the tailplane trim switch inadvertently during manoeuvres as this may result in excessive G being applied.

(i) The aileron tab trimmer must not be used whilst the controls are in Power, and it should be locked in the neutral position. The aileron spring feel trim should normally be used to counteract any out-of-trim forces which may occur in Power. It must not be used when flying in Manual.

(ii) The tailplane trimmer should be used in the normal manner. When manoeuvring, the stick forces are light and little use of the trimmer is required. The full-power elevator tends to mask any out-of-trim forces which may be present. Always trim out the stick force when practicable (but see para. 10 WARNING); if this is not done and inadvertent Manual reversion occurs the stick force may be too heavy for the pilot to hold. If the normal tailplane trimmer fails, use the standby control; this operates at about one-third the speed of the normal control. If both trimmers fail, the aircraft can be flown throughout its speed range with the trim at full nose-down, but at full nose-up the elevator is not sufficiently powerful to stop the nose rising at speeds in excess of approximately 420 knots.

(iii) *Follow-up tailplane*

The tailplane gives an improvement in manoeuvring capabilities above 0·9M. Handling characteristics are otherwise normal, but it should be noted that the tailplane remains fully operative with the elevator in Manual. It is not, however, of much assistance, since stick movements in Manual are usually small and within the neutral dead movement of the follow-up mechanism. The tailplane interconnection can be selected ON at any speed provided the aircraft is trimmed for hands-off flight before the selection is made. If the control column is held away from the trimmed position at the moment the interconnection is switched ON, the tailplane immediately moves from its trimmed position to align itself with the position of the elevator. When flying with the interconnection ON, if the control column is moved away from the trimmed position the tailplane automatically follows-up; when the control column force is released, the tailplane reverts automatically to the trimmed position. These tailplane movements are shown on the trim indicator. The interconnection must be OFF for all ground attack manoeuvres.

(*e*) *Airbrake*

(i) The airbrake may be used throughout the speed range. Its use may cause the hydraulic warning light and audio warning to come on momentarily.

(ii) Selection of airbrake causes moderate buffeting and a momentary nose-down change of trim which reverts to a moderate nose-up trim change when the airbrake is fully extended. Correcting the out-of-trim forces at high airspeed may lead to over-controlling.

(*f*) *Flaps*

(i) *At high mach number*

Lowering flap produces a nose-down change of trim, the intensity of which increases with the amount of flap extended and with speed. If the mach limitation for the use of flap is inadvertently exceeded, the nose-down change of trim, combined with the normal nose-down trim change experienced at 0·90M onwards may result in longitudinal control being completely lost, due to elevator jack stalling.

(ii) *At high airspeed*

If the IAS limitations for the use of flap are inadvertently exceeded, the flap angle is limited according to the air load to prevent damage, but sufficient flap will be extended to create a strong nose-down change of trim. This can result in elevator jack stalling and tailplane actuator clutch slip. In this event not only is longitudinal control lost but the aircraft cannot be trimmed nose-up by either the main or the standby systems. In extreme cases, the air loads may then force the tailplane to move in opposition to the actuator thereby causing an additional nose-down change of trim.

WARNING: If longitudinal control is lost as indicated in (i) and (ii) above, the flaps must be raised and speed reduced. When the flaps are raised the nose-up trim change is very strong.

(iii) *At low airspeed*

With full flap, below 250 knots, lateral rocking may occur but is easily controllable: raising the flaps to 60° reduces this tendency.

(*g*) *Changes of trim*

Increase and decrease power	Nil.
Landing gear down ...	Transient nose-up — slight nose-down when locked down.
Landing gear up ...	Slight nose-up (see Part 3, Chap. 4, para. 2 (*c*)).
Flap up	Initially negligible but becoming strong nose-up from 38° upwards.
Flap down	Initially strong nose-down during first 38° (particularly above 200 knots) becoming negligible.
Airbrake OUT	Low speed — negligible. High speed — transient nose-down, nose-up when extended.
Airbrake IN	Low speed negligible. High speed — initially sharp nose-down, reverting to negligible when retracted.

4 Flying with external stores

(*a*) *With drop tanks on inboard and outboard pylons*

The handling characteristics with inboard drop tanks are similar to those of the clean aircraft. With four full tanks, longitudinal control is sensitive particularly on take-off, on the climb and at high altitude. Due to the light stick forces care must be taken not to over-control. At high airspeeds, only very light stick forces are required to exceed the maximum permitted G. With fuel in the outboard tanks manoeuvres in the rolling plane must not exceed 360° to avoid the build-up of excessive rates of roll. When outboard drop tanks are carried, buffet may commence at approximately 0·84M at sea-level. With increasing altitude the onset of buffet may be delayed to 0·88M and the intensity decreases. Buffet may be accompanied by mild lateral rocking. This buffet will damage the ailerons and should be avoided.

(*b*) *Pressure errors*

The presence of a drop tank on the port outboard pylon has a material effect on the pressure error resulting in under-reading of the pressure instruments; for example the altimeter under-reads by about 1,000 ft. when flying at about 540 knots at low level. (See Part 5, Chap. 2, para. 1).

5 Flying for endurance

The recommended speed band is 220-250 knots depending on the configuration (see Recovery Data tables on Flight Reference Cards).

6 Flying at reduced speed

Fly at 170-200 knots using 23° (2 notches) flap. RPM is 6,600-6,700 approx. and full power can be achieved within 2 seconds.

7 Flying in turbulent conditions

The recommended speed for flight in turbulent conditions is 300 knots/0·8M.

8 Stalling

NOTE: Because the rate of descent is very high and because it is possible to induce an inadvertent spin when the aircraft is fully stalled, stalling practice is not to be continued beyond the buffet stage nor below 25,000 ft.

(*a*) (i) Pre-stall buffet speeds, in knots, throttle fully closed, are:

At 18,500 *lb.*	
Landing gear and flap up	140 knots
Landing gear down and flap up ...	140 knots
Landing gear down and full flap ...	130 knots

NOTE: The above speeds decrease by approximately 5 knots per 1,000 lb. reduction in weight.

(ii) The pre-stall buffet speeds increase slightly with increasing altitude up to 30,000 feet but by about 10 knots between 30,000 feet and 40,000 feet.

(*b*) Use of the airbrake increases the buffet but does not affect the stalling speeds or other characteristics.

(*c*) Under typical approach conditions, the buffet speeds quoted above are not appreciably affected, but the height lost during recovery is reduced.

(*d*) (i) Although the aircraft must not be deliberately fully stalled in flight, the characteristics are described here to assist pilots who inadvertently enter the fully stalled condition.

(ii) If the control column is held back, after the buffet stage is reached, a nose-up change of trim occurs, and though it varies in degree from aircraft to aircraft, counteraction may require full forward stick movement. There is little tendency for a wing to drop. Relaxation of the forward pressure on the control column at this point leads to a further reduction in forward speed accompanied by a very high rate of descent. In this condition the elevator is relatively ineffective and response is slow. A spin or spiral may develop and in any case, considerable height will be lost. The ailerons are effective near the stall but large deflections cause the aircraft to yaw in the direction of the downgoing wing and increase the possibility of a spin or spiral developing.

◀(*e*) Outboard stores seriously affect the stall characteristics, particularly the time taken for recovery after initiating recovery action. This feature is aggravated if inboard stores are also carried. ▶

9 Low speed flying

Low speed flying is permitted under the following conditions, with no underwing stores or with two empty drop tanks on the inboard pylons:

(*a*) With flaps and landing gear retracted, the aircraft may be decelerated at constant altitude at a minimum altitude of 10,000 feet to the initial onset of buffet or to a minimum speed of 140 knots whichever occurs earlier.

(*b*) With flaps and landing gear extended the aircraft may be decelerated at constant altitude using 6,900 RPM at a minimum altitude of 10,000 feet to the initial onset of buffet or to a minimum speed of 130 knots whichever occurs earlier.

10 G-stalling

WARNING: Care must be taken to ensure that the stick force is never completely trimmed out when G is being applied at high mach numbers because, as speed falls through 0·91M when the trim changes to nose-up and the elevator and tailplane becomes more effective, a sudden increase in G may result. This is particularly important below 10,000 feet when manoeuvring near limiting G and/or black-out threshold.

(*a*) G-stalling is subject to the over-riding restriction of +7G.

(*b*) During turns and pullouts, adequate stall warning is given by buffeting at all heights. If the backward pressure on the stick is continued inadvertently after the stall warning, a momentary pitch-up and a sudden increase in G may result. It may occur when G is applied at speeds above 0·9M in the height band 25,000 to 30,000 feet. However, if pitch-up occurs it is possible to maintain some degree of longitudinal control. Buffeting is considerable and wing dropping may occur.

(*c*) Little effort is needed to produce buffet or to reach limiting G.

11 Spinning

(*a*) Intentional spinning is prohibited. The following information is provided to acquaint pilots with the spin characteristics and recovery actions in case the aircraft is spun inadvertently. Generally, the aircraft is most reluctant to enter a spin accidentally unless coarse use is made of the ailerons during manoeuvres within the buffet. Under these conditions an erect spin is more likely to occur than an inverted spin but the latter may result from a poorly executed loop, a stall turn type of manoeuvre, or when full aileron rolling manoeuvres are performed and the stick is moved appreciably back. It is therefore recommended that these spin-prone conditions be avoided.

(*b*) *The erect spin*

The attitude is oscillatory during the first 3 to 4 turns but thereafter should settle down with the nose some 50° below the horizon and each turn taking about 3 seconds. The stabilised rate of descent is 20,000-25,000 feet per minute when the flight path approaches the vertical and the height loss per turn may vary from 1,000-1,500 feet.

(*c*) *Erect spin recovery*

(i) The aircraft recovers readily within 1-2 turns when the consolidated recovery action is taken, i.e. full rudder to oppose the yaw and the stick held fully forward, aimed at the white datum, thus ensuring the ailerons are neutral.

(ii) The standard recovery is relatively insensitive to elevator position or tailplane setting. However, the elevator position does affect the steepness and rate of rotation of the spin, both increasing with forward movement of the stick. The main reason for holding the stick forward is to remove any chance of the spin restarting in the opposite direction.

(iii) The effect of ailerons is critical and if any significant aileron is applied to oppose the roll, the aircraft may not recover until the ailerons are centralised. If the aircraft appears reluctant to recover from the spin full aileron should be applied in the direction of the roll, i.e. away from the foot applying the rudder. The ailerons are the most effective control in the spin and can overcome the rudder under any condition.

(iv) As a last resort the aircraft will usually recover if the controls are abandoned. The effect of altitude is not marked but recovery appears to improve with decreasing altitude. The height required to regain level flight from the time auto-rotation ceases may be in the order of 6,000 to 10,000 feet.

(*d*) *The inverted spin*

(i) As in the erect spin the attitude initially is very oscillatory and the nose pitches above the horizon several times before the spin stabilises. This occurs after 3-4 turns with the nose some 45° below the horizon and each turn taking about 3 seconds. The height lost per turn is about 1,500 feet.

(ii) Due to the marked upside-down sensation there is no difficulty in recognising that the spin is inverted; the direction of yaw is clearly discernible. It is emphasised that in the inverted spin the indications of yaw and roll are in opposite directions whereas in the erect spin they are in the same direction. The acceleration should average -1 to -2G.

(*e*) *Inverted spin recovery*

(i) The spin should stop within 1-2 turns when the rudder is fully applied to oppose the yaw and the stick moved fully forward, aimed at the white datum, i.e. ailerons neutral. The rudder, which is the most powerful control in the inverted spin, must be applied and maintained in a determined manner as the footloads are moderately high and this recovery requires full rudder deflection. The seat harness and rudder pedals should always be suitably adjusted to enable full rudder to be applied.

(ii) As in the erect spin the use of ailerons in the direction of roll is favourable to recovery and if the spin shows no signs of stopping, the stick should be fully moved laterally in the direction of the roll, i.e. towards the foot which is applying the rudder. When aileron is used to assist recovery the spin develops into a rolling motion with a rapidly increasing airspeed. At this stage the aileron should be centralised since if the deflection is applied for too long the aircraft may be driven back into an inverted spin and a severe flicking motion may result. It is important to aim at a clean recovery in the first instance as abortive recoveries may lead to the aircraft spinning more determinedly in a steeper attitude and at a higher IAS. Abandoning the controls will not lead to recovery as the rudder tends to be blown in a pro-spin direction.

(iii) Tailplane trim position does not have any marked effect on the spin or the recovery. However, the recovery is improved by having the stick fully forward to reduce the rate of rotation. Holding the stick fully forward also has the additional advantage of making it easier to apply full aileron, and reducing the possibility of the aircraft entering an erect spin after recovery.

(f) Consolidated spin recovery action

The following recovery action, which covers both the erect and the inverted spin, should be taken when any unusual manoeuvre occurs:

(i) Centralise the controls and take no further action until a recognisable spin develops.

(ii) Apply full rudder to oppose the direction of yaw as observed visually or indicated by the turn indicator.

(iii) Hold the stick fully forward against the white datum on the instrument panel.

(iv) Centralise all controls immediately autorotation ceases.

(v) If the aircraft does not recover apply full aileron in the direction of roll and jettison wing stores.

NOTE 1: It cannot be over-emphasised that there is only one optimum recovery action; if the aircraft does not recover, recheck actions.

NOTE 2: Be ready to centralise the ailerons when and if the spin reverts to a downward roll, the latter being associated with a rapidly increasing airspeed.

NOTE 3: It is important to resist the instinctive tendency to move the stick away from the direction of the roll. When drop tanks are fitted, aileron position is particularly critical during recovery.

NOTE 4: Landing gear and flaps should be raised if down and engine power reduced to idling although it is not considered that these factors will appreciably affect the recovery.

NOTE 5: If recovery has not been achieved by 10,000 feet the aircraft should be abandoned.

12 Inertia cross-coupling

(*a*) Experience has shown that the aircraft is not generally prone to any significant inertia cross-coupling effects. The following information is provided to give the conditions under which it may be possible for inertia cross-coupling to occur, its effects and the action to be taken in this event.

(*b*) Inertia cross-coupling may be induced by continuous full aileron rolls at high altitude, particularly if the control column is moved fore and aft from the trimmed position.

(*c*) The effects of inertia cross-coupling are likely to be violent gyrations in roll, pitch and yaw which can lead to loss of control and possibly severe structural damage. These effects may occur without warning or may be preceded by buffet, sideslip and G variations.

(*d*) If inertia cross-coupling is experienced, the controls should be centralised smoothly. This can best be done by releasing any applied pressure and allowing the controls to centralise. If then the rate of roll does not appear to be decreasing, it is probable that the aircraft is entering a spin which may be inverted or erect. If this occurs, and is confirmed by instrument indication, the appropriate spin recovery action should be taken.

13 Flying at high airspeed

(*a*) When flying at high airspeed all control movements must be smooth and progressive to avoid over-controlling, particularly when flying at aft CG and/or in turbulent air. Use the tailplane trimmer carefully. Take care not to exceed the G limitations in harsh manoeuvres.

(*b*) The maximum rate of roll increases with airspeed up to 420 knots; at higher speeds, however, the rate of roll progressively decreases due to jack stalling. Normally maximum rate of roll is not required.

14 Flying at high mach number

(*a*) *General*

The maximum speed obtainable in level flight at full throttle is 0·94M. The aircraft will reach sonic speed in a 30° to 40° dive at full throttle, but see (*e*) (ii) below. When outboard tanks are carried speed is limited to 0·88M or the onset of buffet.

(*b*) *Trim changes*

(i) As speed increases to about 0·90M there is a progressive nose-up change of trim. Between 0·90M and 0·94M a nose-down trim change followed by a nose-up trim change occurs, the aircraft being almost back in trim again by 0·96M. At higher speeds as the aircraft becomes supersonic the trim changes to slight nose-down.

(ii) When outboard drop tanks are carried, a mild nose-down trim change occurs between 0·87M and 0·88M. This is accompanied by buffet and possibly gentle lateral rocking.

(*c*) *Changes in stick force, and tailplane and elevator effectiveness*

(i) As the mach number is increased beyond 0·92 the elevator becomes less effective. This is particularly evident at transonic speeds when even large elevator deflections have a delayed and reduced response. The tailplane may be used to assist in manoeuvring although its effectiveness is somewhat reduced.

(ii) Since the effectiveness of the elevator decreases as mach number increases, greater deflections are required to manoeuvre. Consequently, the stick forces increase.

(*d*) *Transonic flight*

Practice transonic flights should be made by putting the aircraft into a 30° to 40° dive with the tailplane interconnection ON. Set the trim at zero otherwise the full range of tailplane movement is not available for recovery without using the trim switch. At 0·97M very slight wing drop may occur which can easily be counteracted with aileron; if the dive angle is too shallow the aircraft reaches a maximum speed of 0·97M, at which speed the elevator is not effective enough to increase the angle of dive.

(*e*) *Recovery from transonic dives*

(i) During recovery the throttle should be closed. The airbrake may be used; its extension causes moderate buffeting and nose-up change of trim. It is not very effective in reducing speed. Recovery can be made without using the tailplane trim but jackstalling may occur. Normally the tailplane should not be trimmed more nose-up than 0°, as a nose-up trim change occurs as speed falls through 0·91M due to increasing effectiveness of the tailplane and elevator.

(ii) Recovery from supersonic dives at low altitudes, using maximum obtainable elevator angle, may lead to minor damage of the elevator skin. To avoid risk of structural damage, therefore, the recovery from supersonic dives should be completed by 20,000 feet.

15 Aerobatics

(*a*) Until experience is gained, the following speeds in knots, are recommended:

Roll	350
Loop	425
Roll off the top	450
Vertical roll	500

(*b*) It is recommended that until experience is gained loops are started between 10,000 and 15,000 feet.

16 Descent

The two recommended forms of descent are as follows:

(*a*) *Range/rapid descent*

Set 6,500 RPM and, with the airbrake OUT and the flaps UP, descend at *0·9M/400 knots.

(*b*) *Instrument descent*

Set 6,900 RPM and, with the airbrake OUT and the flaps at 23° descend at *0·9M/300 knots.

* But see mach limitations when carrying outboard drop tanks.

PART 3

Chapter 3 — CIRCUIT PROCEDURE AND LANDING

Contents

1 Circuit procedure

(*a*) 620 lb. of fuel should be allowed for a circuit, landing and possible overshoot. With the landing gear lowered fully, 6,900 RPM and 23° flap give a comfortable speed of about 200 knots. To reduce speed for joining the circuit flap can be used within the limitations to augment the airbrake. Do not select more than one hydraulic service at a time and allow the cycle of each hydraulic operation to be completed before the next service is operated.

(*b*) Carry out the Pre-Landing checks.

(*c*) *Final approach*

(i) Turn across wind at 160 knots, aiming to lower full flap on the final stages. Steep approaches are not recommended.

(ii) To ensure rapid engine response maintain at least 4,500 RPM until finally committed to a landing. Under conditions of high wind or gustiness it is more comfortable if the speeds below are increased by 5 knots.

(iii) The recommended speeds, in knots, at the runway threshold are:

At 18,500 lb.	145
At 17,000 lb.	140
At 16,000 lb.	135
At 15,000 lb.	130

(iv) It is recommended that the brake parachute is streamed when landing at AUW above 17,000 lb.

2 Landing

As the touch-down point is approached, check the rate of descent and fly the aircraft gently on to the ground at about 5-10 knots less than the runway threshold speeds. Holding off may result in an excessive nose-up attitude (particularly in the case of a flapless landing or when carrying stores on the outboard pylons) with the likelihood of scraping the tail cone and/or dropping a wing: if the latter occurs, corrective aileron may be effective in raising the wing, but it is recommended that the rudder is used as the primary lateral control during the touch-down phase. Lower the nosewheel on to the runway immediately after touch-down and apply gentle braking.

3 Braking

NOTE: The shortest landing run is achieved by putting the nosewheel firmly on to the runway immediately after touch down, streaming the brake parachute, applying maximum wheel braking and simultaneously pulling the control column fully back and trimming nose-up.

(*a*) *General*

The maxaret units do not operate until the wheels are turning, therefore, if the aircraft is allowed to touch down with brakes on, the wheels will lock and the tyres may burst. The aircraft must be firmly on the runway before the brakes are applied.

(*b*) *Dry surface*

The maxaret units normally prevent wheels locking when excessive brake pressure is applied. The landing run can be considerably reduced by applying full brake pressure continuously but, since this causes rapid tyre wear, gentler use of the brakes is recommended. If skidding or wheel slipping is felt, or if difficulty in keeping straight is encountered, release the brakes momentarily. After a landing which has involved heavy braking, ten minutes should elapse before the next landing; in addition, if the intervening period of taxying has involved prolonged use of the brakes, twenty minutes should elapse before the next landing. The same precautions should be observed for brake tests.

(*c*) *Wet surface*

The retardation may be considerably reduced, depending on the degree of wetness of the runway surface. On a wet surface, it is recommended that light braking application should be commenced as soon as the aircraft is firmly on the ground and the wheels turning. The brake application may be increased progressively as the speed is reduced. If skidding or wheel-slipping is felt, the pressure should be momentarily released and gradually re-applied.

(*d*) *Flooded or icy surfaces*

Due to the drastic reduction in braking effectiveness, these surfaces should be avoided when possible. When landing, an accurate touch-down at the correct speed is essential and the brakes should be applied carefully. If the wheels lock, the brakes should be released and time allowed for the wheels to rotate before re-applying the brakes.

(*e*) *Use of the braking parachute*

The braking parachute may be used for full stop landings to assist deceleration. Once the aircraft is firmly on the ground, stream the parachute and apply the wheelbrakes. Correct streaming is indicated by a marked increase in deceleration and the red warning light coming on. After clearing the runway and before jettisoning the parachute, set the engine at 4,000 RPM. At this RPM full voltage from the generators to the release is assured and a pull force is applied to the parachute. When the parachute is jettisoned, or if it fails to jettison, return the control switch to STREAM immediately.

4 Overshooting

(*a*) Open the throttle smoothly to the power required, raise the landing gear and at a safe height raise the flaps and retrim as necessary. If it is necessary to over-shoot from the runway after the braking parachute has been streamed, open the throttle fully and select JETTISON-OFF. If the parachute fails to jettison, try the instructor's control. If the parachute still fails to jettison increasing speed to 155 knots should ensure separation.

(*b*) Provided that a minimum fuel state of 200 lb. per side is indicated, a further circuit may safely be attempted.

Below this fuel state care must be taken to avoid excessive attitude or acceleration on overshoot, which may cause fuel in the tanks to move away from the booster-pumps resulting in possible fuel starvation.

5 Instrument approach

The following are the recommended airspeed and flap settings for an instrument approach with the landing gear lowered. The power setting is approximate and may require adjustment to meet configuration and wind variations:

	RPM	*Flaps*	*Airspeed knots*
Downwind	6,900	23°	180
Base leg	6,900	23°	180
Glide path	6,900	Full	150/160

When practising GCA's with a high fuel state or carrying out a GCA prior to landing overweight, maintain the higher recommended airspeed on the glidepath.

6 Flapless landing

The circuit should be adjusted to give a long shallow approach and the threshold crossed at the same speed as for landing with flaps. With a clean aircraft speed decreases very slowly when the throttle is closed. When drop tanks and/or rocket rails are fitted, speed decreases more quickly and the threshold speed should be increased by 5 knots. Take care to avoid an excessive nose-up attitude, especially when outboard stores are carried and with low fuel states. Place the aircraft firmly on the runway as soon as possible, lower the nosewheel to the ground, stream the brake parachute, apply the brakes and, if necessary, close the HP cock. The landing run is very much increased.

7 Crosswind landing

The "crab" technique is recommended when landing crosswind. In light crosswinds no difficulty should be encountered but in strong crosswinds full rudder may be necessary to yaw the nose into line with the runway before touchdown. At low speeds the effect of rudder is delayed and this must be anticipated; the use of full rudder will produce a marked roll which must be countered by judicious use of aileron. When drift has been checked, fly the aircraft on to the ground and place the nosewheel on the runway without delay. If the crosswind is strong or gusting, increase the approach and threshold speeds by 5 knots.

Part 3

Chapter 4 — FLYING IN MANUAL

Contents

1 Selecting Manual

◀(*a*) It is structurally safe to fly in Manual within the speed limitations and, in emergency, Manual could be selected at any altitude and airspeed. However, until experience is gained, it is recommended that selection of Manual and subsequent practice flying in Manual should be carried out above 10,000 feet. This is because of the out-of-trim forces which may be present when Manual is selected, the heaviness of the controls and the reduction of manoeuvrability when in Manual. When flying in Manual control at speeds above 250 knots, a two-handed pull will be required to counteract the nose-down trim change if flap is lowered without simultaneously trimming nose-up on the main or standby trimmer. ▶

(*b*) Provided that the aircraft is in trim in Power control, the trim changes on selection to Manual are normally slight. If the tailplane and elevator are incorrectly rigged, however, these changes may be large. Because of this possibility, when practice flying in Manual is to be carried out after adjustment or replacement of flying control surfaces, the first selection should be made above 10,000 feet and at a low airspeed.

(*c*) Before selecting Manual, ensure:

Airspeed ... ... Within limitations for Manual flying.

Trim:

- Tailplane ... ... In trim.
- Aileron and rudder trim indicators ... Neutral.
- Aileron trim lock ... Disengaged.

Fuel ... ... Correctly balanced.

2 Flying in Manual

(*a*) The elevator forces are high but tolerable and no difficulty should be experienced with longitudinal control. The ailerons are heavy and require considerable effort to produce only small deflections. Reaction of the aircraft to aileron deflection is slow and delayed; therefore, all necessary aileron movements must be anticipated. The rudder, the further effect of which is marked, can be used to assist control in the rolling plane but should be used with care at low airspeeds.

(*b*) *When carrying stores*

Because of the increased inertia, lateral control is less effective; this is particularly noticeable on the approach when lateral rocking, due to either turbulence or over-controlling, is difficult to damp out. In gusty or severe crosswind conditions consideration should be given to jettisoning the stores before attempting to land. Should the rocking be marked, aileron buffet is slightly reduced and better control is achieved by selecting 60° flap, instead of 80°, on the final approach. The remaining flap may be lowered after touch-down to provide maximum drag on the landing run.

(*c*) *Trim changes*

Trim changes in manual are similar to those in power (see Part 3, Chapter 2, para. 3 (*g*)), but are more noticeable due to the greater stick forces involved. When the landing gear is lowered, the aircraft may roll one way or the other depending upon which leg lowers first.

3 Landing in Manual

(*a*) Until pilots have considerable experience of flying in Manual control, practice landings should be made only in ideal conditions, i.e. a steady wind down the runway. Because any asymmetric lowering of the landing gear is liable to cause lateral control difficulty, the landing gear should be lowered at a safe height. A wider than normal circuit should be made, followed by a long straight powered approach. Lateral rocking may be encountered in which case 60° instead of full flap is recommended. It must be remembered, however, that following hydraulic failure, use of the emergency lowering system will give full flap only.

(*b*) When the airspeed is below 170 knots with landing gear and full flap down, aileron buffet can be felt on the control column. The stick force required to flare the aircraft varies considerably and in cases of forward CG may be high. If an overshoot has to be made, the landing gear should not be raised until a safe height is reached, because of control difficulties near the ground. Re-trim the aircraft during flap retraction to counter the nose-up change of trim; the trim change is most marked during the final stages of retraction. If remaining in the circuit, two notches of flap may be left down.

◀(*c*) *With drop tanks*/SNEB MATRA *launchers*

Manual landings should not be attempted with either fuel in the drop tanks or with SNEB MATRA launchers, when flying in turbulent conditions and when a crosswind will be encountered. ▶

(*d*) *With asymmetric loads*

Before attempting a Manual landing with any asymmetric load other than an empty inboard drop tank, a low speed handling check must be made at a safe height to determine that lateral control is adequate at a threshold speed that will ensure a safe landing. If this check is not satisfactory and the asymmetric store cannot be jettisoned, the aircraft should be abandoned. Trials have shown that with a nominal 1,000 lb. weight on an inboard pylon, the wings cannot be held laterally level below 180 knots.

▶◀

(*e*) *With asymmetric drag* (e.g. one landing gear leg locked up)

(i) There are three dangers which must be avoided:

1. High airspeeds and resultant high control forces.

2. Improper trimming.

3. Attempting to control the aircraft laterally with ailerons only — unbalanced flight.

(ii) Alone or in combination these dangers could result in disastrous loss of control, but approaches can be flown safely in this emergency condition using the following technique:

1. Counteract the yaw (as observed on the slip indicator) with rudder.

2. When in balanced flight (ball central) maintain wings level with ailerons.

3. Trim out any resulting loads. The rudder forces can be trimmed out down to 150 knots.

4. Manoeuvres should be gentle and all turns should be accomplished with co-ordinated aileron and rudder, with the emphasis on rudder.

5. If possible carry out a slow speed handling check and in order to keep control forces to a minimum avoid speeds above 170 knots.

6. On the approach flap may be used and subject to a satisfactory slow speed handling check an approach speed of 160 knots and a threshold speed of 150 knots may be used.

4 Reselecting Power

After reselection, check that the appropriate magnetic indicators are black and the aileron trim locking guard is engaged.


R-Type mask
used on Dominie
by RAF until 2011