PART III

HANDLING

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PART III

Chapter 1. PREPARATION FOR FLIGHT

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1. External checks

Check the outside of the aircraft systematically for signs of damage and for security of panels, filler caps, doors and the like. The engine intakes and boundary layer ducts must be free from obstruction and the jet pipe free from distortion. Check the main and nosewheel oleos for extension, the tyres for cuts and creep, and the brake leads for security and leaks. The elevator accumulator gauge in the port side of the fin should read 1,575 lb./sq. in. and the aileron accumulators gauge in the starboard wheel bay should read 900 lb./sq. in. Remove the pressure head cover. Check that the armament safety plug has been correctly connected.

2. Cockpit and pre-start checks

(*a*) On entering the cockpit and before strapping in, check that the ejection gun sear and emergency oxygen bottle pins are removed, that the flight instruments supply circuit breakers are closed. Check that the hood rail locking indicators have their pointers in line with the centres of the pins.

(*b*) Strap in, adjust the rudder pedals to ensure full rudder deflection is available and connect radio, oygen and anti-G suit ; have both the seat safety pins removed and stowed. Then check :

Item	*Check*
Undercarriage selector	Down button fully in
Battery master switch	ON.
All air inlets	As required
Hood rails indicators	Locked.
Brake parachute switch	JETTISON—OFF Warning light out.
Clear aircraft switch bar	Up.
Undercarriage emergency air pressure	2,000 lb./sq. in. (min.)
Flaps emergency air pressure	2,000 lb./sq. in. (min.).

Item	*Check*
Wheel brakes accumulator air pressure	750 lb./sq. in. (min.).
Tailplane main (pre mod. 907) and hood motors circuit breakers	Closed.
Inverter select switch	NORMAL. Magnetic indicator white.
Cockpit pressure warning test switch	Operate and check warning.
Cockpit temperature selector .	As required.
Cockpit temperature control .	AUTO.
Cockpit pressure master switch	ON.
Flood flow control switch . .	AUTO.
L.P. cock	ON.
V.H.F.	Channel selectors OFF.
V.H.F. set selector	As required.
G.G.S. selector dimmer . . .	As required.
Relight switch	Test. If serviceable an irregular clicking sound is heard.
Throttle damper	Adjust as required.
H.P. cock/throttle	Full and free movement Set 1 inch open.
Aileron and rudder trim indicators	Neutral.
Top temperature control switch	ON.
Tailplane interconnection switch	OFF.
Hood control switch and clutch selector	Clutch FREE, manual operation of hood. Clutch LOCKED. Switch as required.
Tailplane standby motor switch	Function. Cover fully lowered.
Undercarriage emergency control	Ensure control not pulled out.
Triple pressure gauge	Reading.
Hydraulic pressure warning light	Out.
Undercarriage position indicator and selector buttons	Three green lights. Day/night switch. Bulb changeover. Warning light out. Down button fully in. Up button not twisted to emergency.

Flaps emergency control .	Ensure control not pulled out.
Flaps selector lever	Up.
Power control switches . . .	Both OFF. Magnetic indicators white.
Flight and engine instruments .	Condition. Turn and slip supply NORMAL.
Ignition switch	ON (normally locked ON).
Generator failure warning lights	On.
Camera, pressure head heater and starter master switches . .	OFF.
G.G.S. circuit breaker . . .	Closed.
Fire warning light	Out.
Accelerometer	Reset.
Autostabiliser switch	Wired OFF (inoperative).
G.G.S. switch	OFF.
E2B compass	Serviceability.
Fuel level warning lights . .	Out.
Bomb/R.P. switch	Gated OFF.
Bomb fusing switch	OFF.
Cockpit altimeter	Condition.
Fuel low pressure warning . .	On (out if pressure in system).
Audio warning switch . . .	On (spring-loaded in on position).
Oxygen	Main and emergency supplies connected. Emergency bottle control in. ON/OFF valve wired ON. NORMAL (Mk. 17E) or 100% (Mk. 17D) selected. Check for mask leaks by pressing in emergency switch in central position. Return switch central. Indicators operation
Explosion protection light . .	Out. If on, operate reset switch.

Emergency and compass lamp switches	As required.
Engine anti-icing switch	SHUT.
Cockpit lighting switches	As required.
Fuel gauges	Contents. (If transfer indicators are cross-line a full indication will not be given).
Outboard drop tank indicators	Black if fuel in tanks, otherwise white.
Booster pump switches	OFF.
Booster pump warning lights	On (Out if pressure in system).
Transfer indicators	Cross-line (if pressure in system, in-line, and contents gauges read full).
Tank selector switches	AUTO (normally locked in AUTO).
Tank selector indicators	REAR.
Emergency oxygen bottle selector	Down.
Rebecca	Off.
Anti-G control	ON. Pressure 1,800-2,000 lb./sq. in. Depress button gently to test.
I.F.F. switches and control panels	As required.
Navigation lights	As required.
Butt test switch	Gated.
Fire warning test switch	Operate to test circuit.
Booster pump test switch	Off.
Booster pump and starter circuit breakers	Closed.
Flying controls	Full and correct movement. Rotate spring feel trim fully in both directions. Check stick moves laterally in same sense. Return to neutral.
Parking brake	On. Pressure at each wheel. (If accumulator pressure is between 750 and 1,500 lb./sq. in. each brake needle should read accordingly).

PART III

Chapter 2. STARTING, TAXYING AND TAKE-OFF

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1. Starting the engine

(*a*) Starter master bar . . . Up. Check aurally that No. 2 inverter starts up. Magnetic indicator white. Artificial horizon flag—black.

Booster pumps . . . . ON. Warning lights out.

Without delay press and release the starter button.

(*b*) When the starter fires, the engine RPM should build up rapidly to 1,600. As the engine lights up, the RPM increase to idling ($2{,}500 \pm^{200}_{0}$) and the throttle should be closed. The JPT may momentarily exceed the idling limit.

(*c*) *Failure to start*

(i) If the starter fails to fire, check the position of the switches and press the starter button again. A third attempt must not be made until a check confirms that the drainhole is clear.

(ii) If the starter fires and the engine rotates but fails to light up, set the throttle to the H.P. cock OFF position. If the aircraft batteries are not fully charged an external electrical supply should be used. The starter may only be fired again when the engine has stopped rotating and at least one minute must elapse before a second attempt is made. If it is suspected that an excessive amount of fuel has collected in the engine the starter should be fired with the ignition switch off and the throttle set at the H.P. cock OFF position, but in this case forty-five minutes must elapse before a further attempt to start is made.

(iii) Provided that the engine lights up each time, the starter can be fired three times at a minimum of one minute intervals but should be limited to three per forty-five minutes.

2. **Checks after starting**

Item	*Check*
Fire warning light	Out.
RPM	$2{,}500 \pm {}^{200}_{0}$.
JPT	Maximum 525°C.
Oil pressure	10 lb./sq. in. (minimum).
Generator warning lights	Out. Main inverter running. Magnetic indicator black.
Airbrake	Operation with test switch Magnetic indicator should go white, then black.
V.H.F.	Frequency selected.
Rudder and aileron trimmers	Operation. Set neutral. Lock on.
Tailplane inter-connection	Test, (See Part I, Chap. 5, para. 12(*c*). Leave OFF.
Hydraulic pressure	$2{,}850 \pm {}^{150}_{50}$ lb./sq. in. on both centre needle of triple pressure gauge and brake accumulator gauge. Pressure at each wheel 1,500 lb./sq. in. Warning light out.
Elevator and aileron power controls	Engage. Magnetic indicators black.
Flaps	Operation.
Instruments	Correct functioning Erect artificial horizon if necessary. Set Mk. 4F compass and compare with E.2.B. Set altimeter.
Fuel	Contents full. Check both the booster-pump switches ON, check that each failure warning light is out. Transfer indicators—" in-line ". Tank indicators—REAR. L.P. warning light out.
DME	Set to SB.

NOTE : If a check on low-geared Manual aileron is required apply full lateral stick deflection and switch to Manual, observing a decrease in aileron angle. Re-switch to Power and check aileron reverts to its original position.

3. Taxying

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

(*b*) The aircraft should not be taxied at a speed which requires excessive use of the brakes as this causes overheating of the tyres and reduces their life.

4. Checks before take-off

Item	*Check*
Trim	Tailplane. Clean a/c—Neutral. With 38° flap and/or inboard stores—1° Nose-up. With 38° flap and outboard stores—½° Nose-up. Spring feel trim-Neutral. Rudder and aileron trim—Neutral, lock on. Tailplane interconnection OFF.
Fuel	Contents. Booster pumps switches ON. Warning lights out. Transfer indicators in-line. Tank selector switches AUTO. Indicators at REAR. L.P. warning light out. Drop tank indicators black (if fuel in outboard tanks).
Flap	Up (38° with drop tanks).
Instruments	Check and set. Pressure head heater ON.
Engine anti-icing	As required.
Oxygen	100% (Mk. 17D) or NORMAL (Mk. 17E). Reaching mask Indicators annunciating. Emergency switch central.

Hood	SHUT (not OFF). Clutch LOCKED, Seal inflated. Pressurisation ON.
Harness	Tight and locked.
Hydraulics	Pressure 2,850 $\pm \frac{150}{50}$ lb./sq. in. Flying controls in Power. At 4,500 RPM apply full aileron and elevator and ensure that the magnetic indicators remain black. Warning lights out.
Brake parachute (Post mod. 785)	JETTISON—OFF. Warning light out.

5. **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 6,800 RPM they should be considered unserviceable and the aircraft should not be flown. Release the brakes and open the throttle fully, checking the engine operation (see para. 6).

(*c*) In cross-wind conditions, gentle braking is necessary to keep straight until the rudder becomes effective.

(*d*) Ease the nosewheel off at about 125 knots and hold it just off the runway, taking care not to achieve an excessive nose-up attitude. The follow-up tailplane increases the possibility of touching the tail cone on the ground. At normal loads the aircraft will unstick at 150 knots.

(*e*) When comfortably airborne apply the brakes and raise the undercarriage, holding the brakes on until the undercarriage is locked up. There is no noticeable change of trim as the undercarriage retracts but the nosewheel locks up with a distinct thud. It may be necessary to climb quite steeply initially as retraction must be completed before 250 knots is reached.

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

(*g*) *When carrying external stores*
Using 38° flap the nosewheel can be eased off at 125 knots and the aircraft flown off at 145-150 knots. When safety airborne immediately raise the undercarriage and then the flaps ; delay in raising the flaps will result in an increasing nose-down change of trim as speed increases.

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

(ii) It is recommended that, because of there being a possible hydraulic failure, undercarriage and flaps (if the latter have been used for take-off) are left down, care being taken not to exceed the maximum permissible speed.

6. **Engine handling at take-off**
(*a*) The RPM are governed at 8,000 at which maximum thrust is obtained, but at full throttle this figure will vary with O.A.T. whilst still maintaining maximum thrust. Below are the revant figures :

+30°C.	—	8,025 RPM
+15°C.	—	8,000 RPM
+10°C.	—	7,985 RPM
0°C.	—	7,955 RPM
—10°C.	—	7,925 RPM

At full power check that the oil pressure is 25 lb./sq. in. minimum.

(*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 :

1. Maximum RPM are not obtained at part throttle.
2. The JPT is more than 560°C.
3. The aircraft begins to creep forward against the brakes at 7,000 to 7,200 RPM.
4. The rate of acceleration is normal when the brakes are released.

7. **Abandoning take-off**
If, at 24,000 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 throttle is closed to the HP cock shut position.

Brake parachute	Wet runway	Dry runway
Not used	1040 yds.	830 yds.
Used	920 yds.	750 yds.

PART III

Chapter 3. HANDLING IN FLIGHT

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1. Climbing

NOTE : If cockpit pressure has been set OFF for take-off, set it ON at 5,000 feet.

(*a*) *Best rate of climb*

(i) Climb at full throttle at the speed appropriate to the configuration (see (iii). Allow the speed to increase to the recommended figure during the initial climb to 5,000 ft.

(ii) Below 20,000 feet the rate of climb is not greatly affected by variation in speed. Above 20,000 feet it is important to keep the recommended speed.

(iii) Recommended climbing speeds are :

		Initial Climb IAS
Clean	0·85M	450
2×100 gall. tanks	0·85M	450
2×230 gall. tanks	0·85M	450
4×100 gall. tanks	0·82M	350
2×100 gall. tanks & 24RP	0·82M	320
2×230 gall. tanks / 2×100	0·80M	320

(*b*) *Normal climb*

If maximum rate of climb is not essential set 7,800 RPM using the same speeds as above.

2. **Engine handling**

(*a*) *On the climb*

(i) High forward speeds at low altitudes may reduce maximum RPM by as much as 100. This coupled with the effect at Chap. 2, para. 6(*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 will disapear 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 685°C.

(iii) During a climb at full throttle RPM will increase gradually but must not be allowed to exceed 8,100 RPM. When climbing at intermediate power it is necessary to close the throttle gradually as altitude is gained to maintain 7,800 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 will then be necessary to adjust the throttle to maintain a constant figure.

(ii) With the throttle fully closed, the idling RPM increase with altitude and with increasing airspeed.

(iii) Negative G must not be applied for more than 15 seconds.

(iv) It is recommended that movement of the throttle should be smooth and progressive. However, rapid throttle movement can be made at any altitude if necessary, but the ACU will automatically control the rate of RPM acceleration.

(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 10 seconds from idling.

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. Depending on the tailplane angle and C.G. position, jack stalling may occur when manoeuvring above 0·93M ; if it occurs the tailplane trim switch must be used as a means of control.

(ii) Longitudinal control is light and sensitive particularly at high and low fuel states. This control condition depends upon CG position, the CG being furthest aft at take-off and the condition is particularly aggravated when stores are carried on outboard pylons. 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; the angle is usually between $\frac{1}{2}°$ and $1\frac{1}{2}°$ nose-down

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. During sustained flying always trim out the stick forces (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 will not however be of much assistance, since stick movements in Manual are small and within the neutral dead movement of the follow-up mechanism. The tailplane interconnection can be selected ON or OFF at any speed provided that the aircraft is trimmed for hands-off flight whenever either selection is made. Always fly the aircraft in the trimmed condition whenever possible.

(*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*

As speed is increased from 0·9M to 0·94M a marked nose-down trim change occurs ; lowering flap (see Part II, Chap. 2, para. 1(*c*)) also produces a marked nose-down change of trim, the degree of out-of-trim increasing with the amount of flap selected and with speed. As mach number is increased beyond 0·92 elevator and tailplane effectiveness decreases. If 0·9M is exceeded

inadvertently with flaps lowered, or if flap is lowered inadvertently at speeds in excess of 0·9M longitudinal control will be very substantially reduced and in the worst condition may be lost completely. If control is lost with any degree of flap lowered, raise the flap immediately.

(ii) *At high airspeed*
If speed is increased inadvertently beyond 350 knots (See Part II, Chap. 2, para. 1 (*c*)) with flap extended, the increasing air loads decrease the flap angle which results in a nose-up change of trim.

(*g*) *Changes of trim*

Increase and decrease power	Nil.
Operation of undercarriage .	Negligible except when ailerons are in Manual (See Part III, Chap. 5, para. 3).
Flap down	Strong nose-down above 200 knots.
Airbrake	Low airspeed–negligible High airspeed and high mach number–slight transient nose-down, moderate nose-up when extended.

4. **Flying with external stores**

(*a*) *With drop tanks*
The handling characteristics with inboard drop tanks are similar to those of the clean aircraft. With four drop tanks, longitudinal control on the climb is sensitive and 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, not more than half control column travel is to be used during manoeuvres in the rolling plane. Buffet from the outboard tanks may commence at approximately 0·86M at sea level to 0·88M at high altitude, and decreases in intensisty as height is increased. This buffet will damage the ailerons and should be avoided.

(*b*) *Flying with RP.s*
Aileron movement becomes restricted at 0·97M when carrying RP.s. When drop tanks are carried on the inboard pylons as well it is difficult to exceed 0·98M.
(*c*) *Flying with bombs*
The aircraft should not be committed to dives which will result in exceeding 0·90M with insufficient height for pull-out, in view of the deterioration in longitudinal control above this speed.
(*d*) *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 airspeed indicator and mach meter as compared with clean aircraft.

5. **Flying for endurance**
The recommended speed band is 220-250 knots depending on the configuration (See Recovery Data tables on the Flight Reference Cards).

6. **Flying at reduced speed**
(*a*) Fly at 170-200 knots using 23° (2 notches) flap.
(*b*) If the flaps are fully down, lateral rocking may occur between 200 and 250 knots. If the rocking becomes excessive, raise the flaps. Any lateral rocking which occurs below 200 knots is easily controlled with the ailerons.

7. **Flying with the hood open**
The hood may be opened fully below 200 knots, but at about 150 knots excessive vibration sets in. This vibration is reduced if the hood is closed to the halfway position, i.e. about level with the pilot's shoulders. In this position the noise level is high and rather distracting but landings can be made without undue inconvenience.

8. **Flying in turbulent conditions**
The recommended speeds for flight in turbulent conditions are as follows :

Climbing or level flight	Above 25,000 ft. Below 25,000 ft.	0.83M 350 knots
Descending (airbrakes out, flap 23°)	Above 35,000 ft. Below 35,000 ft.	0.83M 280 knots

9. 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*) Pre-stall buffet speeds, in knots, throttle fully closed are : *At max. landing weight*—17,000 *lb.* (*See Part* V, *Chap.* 1, *para.* 3(*b*))

Undercarriage and flap up	135
Undercarriage down and flap up	135
Undercarriage down and full flap	125

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

(*b*) Above 30,000 feet buffet occurs at approximately 135-140 knots with the throttle fully closed, undercarriage and flap up.

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

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

(*e*) (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 will occur, and though it will vary in degree from aircraft to aircraft counteraction may require full forward stick movement. There is little tendency for a wing to drop, but should it occur it can easily be controlled by the ailerons. Relaxation of the forward pressure on the control column at this point will lead 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.

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

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 blackout threshold and especially in flight with an aft C.G. condition.

(*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 feet 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.

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 20-25,000 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 the 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. The ailerons are the most effective control in the spin and can overcome the rudder under any conditions.

(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 autorotation ceases may be in the order of 6,000 to 10,000 feet.

(*d*) *The inverted spin*

NOTE: This information is based on spinning trials of the Mk. 7.

(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 ft.

(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 as perceived by the pilot 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 aileron 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 I.A.S. Abandoning the controls will not lead to a 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 additonal 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 :

1. Centralise the controls and take no further action until a recognisable spin develops.
2. Apply full rudder to oppose the direction of yaw as observed visually or indicated by the turn indicator.
3. Hold the stick fully forward against the white datum on the instrument panel.
4. Centralise all controls immediately autorotation ceases.

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

NOTE :

1. It cannot be overemphasised that there is only one optimum recovery action ; if the aircraft does not recover—recheck actions.
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.
3. It is important to resist the instinctive tendency to move the stick away from the direction of the roll.
4. Undercarriage and flaps should be raised if down and engine power reduced to idling although it it is not considered that these factors will appreciably affect the recovery.
5. If recovery has not been achieved by 10,000 feet the aircraft should be abandoned.

12 **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 C.G. 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.

13. **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.

(*b*) *Trim changes*

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.

(*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 the tailplane movement will not be avilable 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 will reach 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 the 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. Normally the tailplane should not be trimmed more nose-up than 0°, as a nose-up trim change occurs as speed falls through 0·95M due to the 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. Additionally a transient rudder buzz may be experienced over the speed range 0·97–0·98M. To avoid risk of structural damage, therefore, the recovery from supersonic dives must be completed by 20,000 feet.

14. **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 in the height band 10,000 feet to 15,000 feet.

15. Descent

The two recommended forms of descent are as follows :

(*a*) *Range descent*
Close the throttle and descend at 0·80M or 400 knots, if below 17,000 feet, with the airbrake in and the flaps up.

(*b*) *Rapid descent*
Reduce RPM to 6,500, extend the airbrake, lower the flaps to 23° (2 notches) and descend at 300 knots.

PART III

Chapter 4. CIRCUIT PROCEDURE AND LANDING

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1. Circuit procedure

(*a*) 620 lb. of fuel should be allowed for a circuit, landing and possible overshoot. With the undercarriage lowered fully,6,500 RPM and 38° flap (four notches) give a comfortable speed of about 180 knots. To reduce speed for joining the circuit, flap, within the limitations, can be used successfully 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. The undercarriage should only be selected down with the wings laterally level, unless mods. 686 and 687 are incorporated.

(*b*) *Checks before landing*

Item	*Check*
Airbrake	In, indicator black.
Tailplane interconnection	OFF.
Undercarriage	DOWN below 250 knots. Three green lights.
Flaps	As required. Fully down on finals.
Fuel	Contents. Booster pumps ON.
Harness	Tight and locked.
Brakes	Pressure, operation, off Main supply $2{,}850 \pm \frac{150}{50}$/ lb./sq. in.
Radar ranging	OFF.

NOTE : The brake lever should be held on for 2-3 seconds. If the system is serviceable both brake needles will remain at maximum pressure. If a hydraulic pipe is fractured, a lower than normal pressure will be indicated initially and this will decrease at a rate depending on the size of the fracture. The check should not be repeated because at each operation hydraulic fluid will be lost.

(*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 most 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 maximum landing weight (17,000 lb.) (See Part V, Chap. 1, para. 3(*b*))	140
At 16,000 lb.	135
At 15,000 lb.	130

2. **Landing**

(*a*) 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 with the likelihood of scraping the tail cone and the subsequent danger of dropping a wing ; if the latter occurs, corrective aileron may be effective in raising the wing, but will cause the aircraft to yaw markedly in the direction of the down-going wing. The nosewheel can be held off at speeds down to about 70 knots, but the shortest run is achieved by putting the nosewheel firmly on to the runway and applying the brakes.

(*b*) *When carrying drop tanks*

Cross the threshold at 140 knots and fly the aircraft on to the ground at 135 knots.

(*c*) *Braking*

NOTE : The landing run may be reduced by lowering the nose-wheel on to the runway, applying the brakes and simultaneously pulling the control column fully back and trimming nose up.

(i) *Dry surfaces.* When the nose-wheel has been lowered on to the runway, the brakes can be used continuously and the maxaret units will normally prevent wheel locking when excessive brake pressure is applied. The landing run can be considerably reduced by using continuous full brake once the aircraft is firmly on the ground ; this action causes rapid brake and tyre wear and unless the shortest possible run is required, more gentle use of the

brakes is recommended. If the aircraft is allowed to touch down with the brakes on, the wheels will lock, The aircraft must be firmly on the ground before the brakes are applied, as the maxaret units do not operate until the wheels are revolving. If slip or skid is felt or if difficulty is experienced in keeping straight, the brakes should be released momentarily. After a landing involving heavy braking ten minutes should elapse before the next landing ; in addition, if the intervening period of taxying has required prolonged use of the brakes twenty minutes should elapse before the next landing. The same precautions should be observed for brake tests.

(ii) *Wet surfaces.* Depending upon the degree of wetness of the runway surface the retardation may be drastically reduced. Under wet conditions it is recommended that light intermittent braking action should be commenced as soon as the aircraft is firmly on the ground and the wheels have had time to revolve normally. The brake pressure may then be progressively increased and can be held continuously as the speed falls off. If a slip or skid is suspected the pressure should be released momentarily and re-applied gradually.

(iii) *Flooded or icy runways.* Whenever possible these conditions should be avoided due to the drastic reduction in braking effectiveness on flooded or icy surfaces. However, if a landing has to be made, extreme caution is required and an accurate touchdown at the recommended threshold speed is essential. The brakes must be used very carefully, an excessive application of continuous pressure can lead to wheel locking and subsequent tyre damage. If the wheels lock and the brakes are momentarily released by the pilot, time must be allowed to enable the wheels to commence revolving and to reach normal R.P.M. before the maxaret units will become effective.

(*d*) *Use of the braking parachute* (*Mod.* 785)

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 wheel-brakes. Correct streaming will be indicated by a marked increase in deceleration and the amber warning light coming on.

After clearing the runway and before jettisoning the parachute, set the engine to 4,000 R.P.M. At this R.P.M. full voltage from the generators to the release is assured and a pull force is applied to the parachute by jet efflux. Clean separation of the parachute will follow when the switch is set to JETTISON-OFF. Prolonged taxying with a streamed parachute is not recommended.

(*e*) *Going round again*

Open the throttle smoothly to the power required, raise the undercarriage and at a safe height raise the flaps and retrim as necessary. If it is necessary to overshoot from the runway after the braking parachute has been streamed, select JETTISON-OFF before opening the throttle. If the parachute fails to jettison, increasing speed to above 155 knots should ensure separation.

3. **Instrument approach**

The following are the recommended airspeed, power and flap settings for an instrument approach with the undercarriage lowered :

	RPM (Clean a/c)	Flaps	Airspeed knots
Downwind	6,500	23°	170/180
Base leg	6,500	23°	170/180
Glide path	6,500	Full	150/160

4. **Flapless landing**

A very long shallow powered approach should be made and the threshold crossed at the normal speed. Even when the throttle is closed, speed decreases very slowly. The aircraft should therefore be placed firmly on to the runway as soon as possible, the nosewheel lowered on, the brakes applied, and, if necessary, the H.P. cock set off. The landing run is very much increased.

5. **Cross-wind landing**

For cross-wind landings use the " crab " technique. In light winds no difficulty should be experienced in touching down, but in strong cross-winds full rudder may be required to correct crabbing. The rudder has a delayed reaction

which will require anticipation. The effect of full rudder is to produce a marked roll which must be counteracted with aileron. When the crabbing has been corrected fly the aircraft gently on to the ground and lower the nose-wheel on immediately to decrease the angle of attack of the wings and thus reduce the tendency for the cross-wind to lift the into-wind wing. Take care to centralise the rudder before applying the brake. If the cross-wind is gusting strongly increase the approach speed by 5 knots.

6. Checks after landing

Item	*Check*
Brake pressure	Sufficient.
Flaps	Up.
Cockpit pressure	Off.
Camera master switch	Off.
Pressure head heater	Off.
Tailplane	Set to neutral. Tailplane switch OFF.
D.M.E.	OFF.
V.H.F.	One set OFF.

7. Stopping the engine

Release the brakes as soon as the chocks are in position *and set the flying controls switches off*. (See Part I, Chap. 5, para. 13). When the RPM have stabilised at 2,500 (minimum) lift the over-ride catch and set the throttle to the H.P. cock OFF position. Then check :

Both booster-pumps	OFF.
All electrics	Off.
Battery master switch	Off.
Hood clutch selector	FREE.
L.P. cock	OFF when engine stops rotating.
Ejection seat	Replace both safety pins before leaving the cockpit.
Armament safety plug	Disconnected.

PART III

Chapter 5. FLYING IN MANUAL

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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 and the extreme heaviness of the controls and lack of manoeuvrability when in Manual. The out-of-trim forces are usually slight provided that the aircraft was in trim in Power, but if the tailplane and elevator are incorrectly rigged these forces may be large. Because of this possibility, when practice flying in Manual is to be carried out, the first selection to Manual should be made above 10,000 feet and at a low airspeed.

(*b*) *Before selecting Manual, ensure* :

Airspeed	250 knots or 0·80M if above 40,000 ft. (Mods. 686 and 687 not embodied). Within limitations (Mods 686 and 687 embodied).
Tailplane	In trim.
Aileron and rudder trim indicators	Neutral.
Aileron trim lock	Disengaged.

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 some effort, but full stick deflections can be obtained with a single-handed force up to 220 knots. 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 must be used with care at low airspeeds.

(*b*) *When carrying external stores*

(i) 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.

(ii) Pre-mods. 686, 687 due to the increased turbulence below the wing and the tendency of the ailerons to up-float, the likelihood of obtaining a false anchorage when re-engaging Power is increased.

(*c*) *Trim changes*

Increase and decrease of power	Nil.
Operation of undercarriage .	Roll in either direction (depending on which main leg lowers first). See para. 3.
Flaps down	Strong nose-down especially above 200 knots.
Flaps up	Strong nose-up, especially above 200 knots.

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 undercarriage is liable to cause lateral control difficulties, the undercarriage must be lowered at a safe height. A wider than normal circuit should be made, followed by a long straight powered approach.

(*b*) When the airspeed is below 150 knots with undercarriage and full flap down, appreciable aileron buffet can be felt on the control column. Use the same speeds as for a normal circuit. If an overshoot has to be made, the undercarriage should not be raised until a safe height

is reached. Flaps must only be selected up to a mid-position because of a nose-up change of trim, full retraction being deferred to a safe height.

(*c*) *With external stores* (*see also* 2(*b*))

(i) Manual landings should not be attempted with full drop tanks when flying in turbulent conditions and when a crosswind will be encountered on landing.

(ii) Landing with any asymmetric loading other than one empty inboard drop tank must not be attempted. Trials have shown that with a nominal 1,000 lb. weight on an inboard pylon the wings cannot be held laterally level at speeds below 180 knots. In turbulent conditions symmetrically loaded RP's must be released if practicable otherwise great care must be taken when landing and not more than 38° flap must be selected.

4. **Reselecting Power**

(*a*) If Mods. 686, 687 are not embodied, before reselecting Power the aircraft must be trimmed laterally and longitudinally, in straight and level flight at the same airspeed and approximate altitude as when Manual was selected. It is preferable to reselect elevator before ailerons.

(*b*) After reselection, irrespective of the Mod. state, check that the appropriate magnetic indicators are black.

WARNING (Pre-mods. 686, 687) :

1. If it is not possible to clear a false anchorage select Manual. Return to base and land in Manual.
2. If, when Manual is reselected following a false anchorage, the controls remain jammed, indicating that Manual reselection is impossible, the aircraft must be abandoned.

PART III

Chapter 6. TARGET TOWING

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1. Limitations

(*a*) When Mod. 765 is embodied the aircraft is cleared for use as a target tug in temperate conditions using a standard 6 ft. by 30 ft. banner target, with or without 2, or 4×100 gallon drop tanks.

(*b*) Prepared runways, with clear approaches, of not less than 2,000 yards are to be used.

(*c*) The maximum permissible A.U.W. is 21,720 lb.

(*d*) The ground snatch method of target launching is to be used.

(*e*) Speed while towing must not exceed 250 knots.

(*f*) Rate of turn while towing must not exceed Rate 1.

(*g*) If the target breaks away from the tow line, speed must be reduced to 220 knots until the cable has been jettisoned.

2. Take-off

It is recommended that 38° flap is used for take-off.

3. Precautions during towing

The airbrake must not be operated during towing, since this will release the target. Care should be taken to avoid inadvertent operation of the airbrake switch due to its close proximity to the " press-to-transmit " switch.

4. Target release

(*a*) It is recommended that the target is released at 180 knots at 600 feet with 38° flap selected. Target release is

by pressing the camera button, or the gun firing trigger or by selecting airbrake out.

(*b*) If the target fails to release, the aircraft may safely be landed with the target on tow. Alternatively increasing speed to 450 knots should break the tow cable. After the target breaks away it is advisable to decelerate in a straight line until the speed is below 220 knots.