

PART IV

HANDLING

STARTING, TAXYING AND TAKE-OFF

70. External checks

- (a) Before starting the external checks, check in the cockpit that the battery master switch is off, and that the trigger is locked in the safe position. If the aircraft is being flown solo the starboard harness must be securely fastened with the leg restraining cords pulled tight in the snubbing units.
- (b) Whilst carrying out the checks, ensure that there are no pieces of ground equipment, etc., in the near vicinity likely to interfere with engine running or taxiing. If there is excessive accumulation of fuel under or near the aircraft, have the aircraft moved.
- (c) Begin the pre-flight inspection at the cockpit port access ladder and work around the aircraft in a clockwise direction.

<i>Item</i>	<i>Check</i>
Nosewheel rear door	Security and condition.
Nosewheel leg and mounting	Condition, no signs of cracks.
Nosewheel oleo	Extension minimum $3\frac{1}{2}$ in. from grease nipple.
Nosewheel tyre	No cuts and no creep.
Nosewheel bay	Condition of all u/c and door locks. Micro switch con- tacts clean. Nosewheel jack clean, uncracked and no sign of leaks. No sign of air leaks from brake accumulator charg- ing point. Canopy switch gated centrally. All pipes for any sign of Hydraulic fluid leaks.

PART IV—HANDLING

Item	Check
	Nosewheel front door jack for signs of leaks, cracks and that it is clean. Harness apron stowage secure. Nosewheel front door for security and condition.
Nose cone	Security.
Radome	Security and condition.
G.45 camera port and pressurisation ram air hole	Condition and no obstructions.
Gun blast deflector	Security and condition.
Gun installation panel	Correct fitting, security.
Radio access hatch	Security and correct fitting.
Starboard engine intake	Condition and cleanliness of the boundary layer bleed. No dents or distortions or obstructions on or in the swirl-vanes. Condition of DME aerial.
Starboard wheel bay	All locks and micro switches for cleanliness. Door for condition and security. Door and main leg jacks for cracks, cleanliness and leaks. All fuel and hydraulic lines for leaks. Aileron accumulator gauge should read 900 lb./sq. in. min. No sign or sound of air leaks from aileron accumulators charging point or air lines.

PART IV—HANDLING

Item	Check
Starboard undercarriage leg	Main mounting to wing for signs of cracks or distortions. Security and condition of door panels. Brake lines for leaks. Brake discs for excessive scoring. Brake pads not too thin. No sign of hydraulic leaks round the maxaret unit or oleo recuperators. Minimum oleo extension is 5 in. Check it and the torque links for cracks, etc. Tyre for cuts and creep and that it is not touching the door at the rear.
Starboard wing	Leading edge and surfaces for condition. No loose articles on upper surface or jack pads on lower surface.
Starboard navigation light	Condition and security of cover and that the bulb is green.
Wing tip	Condition.
Access panels, upper and lower	Condition and security.
Radio aerial	Security and condition.
Aileron booster unit panel	Check no signs of hydraulic fluid.
Starboard aileron	Condition of surfaces and trailing edge. No pulled rivets and full free movements. If apparently locked, there is hydraulic pressure still at the jack. Security, no hinge play.

PART IV—HANDLING

<i>Item</i>	<i>Check</i>
Inboard wing trailing edge	Condition and no loose articles on top or attached underneath. Root fillet not bent.
Flap	No creep or distortions. There may be a little creep if the aircraft has been standing for long with no hydraulic pressure in the system.
Dorsal fuselage spine	Apparent security, and condition.
Dorsal aerals	Apparent security, and condition.
Ventral aerial and ventral D.M.E. aerals	Security and condition.
Starboard rear fuselage	All belly panels and doors for security and condition. Air bleeds, ducts and pipes, free from obstruction. Engine oil filler panel secure. Panels secure. Condition of air brake and tail bumper.
Fin	Condition of side, and leading edge, and I.F.F. aerial cover.
Starboard tail plane	Condition of leading edge and under surface. No deep scoring at junction of tailplane with fin at leading edge. No signs of hydraulic leaks down side of fin under tailplane.
Starboard elevator	Condition of under surface and no signs of splitting along trailing edge.

PART IV—HANDLING

<i>Item</i>	<i>Check</i>
Rear fuselage cone	Security, condition and locking catches flush with surface. No signs of cracking around internal periphery of trailing edge. Brake parachute doors correctly closed.
Jet pipe and thermo couples	Condition, security and no signs of distortion. Rear turbine for missing blades, and exhaust cone for condition. No excessive accumulations of oils and fuels inside lower rear fuselage.
Rudder	Condition of surfaces and trailing edge and note position of trim tab, i.e. compare with trim gauge in cockpit.
Trailing bullet cone	Condition, and of rear navigation light which should be colourless.
Port elevator	As for starboard.
Port tailplane	As for starboard.
Port side of fin	As for starboard. The elevator accumulator gauge should read 1,575 lb./sq. in. min.
Port rear fuselage	As for starboard, except to check security of hydraulic reservoir filler panel on top surface of port wing root.
Port wing	As for starboard except note position and condition of port aileron manual trim tab and compare position with the indications on cockpit trim gauge. Remove the pressure head cover and see that the pressure head is not bent or blocked.

PART IV—HANDLING

Item	Check
Port navigation light	As for starboard except red bulb.
Port undercarriage leg	As for starboard.
Port wheel bay	As for starboard, except security and fitting of re-fuelling connection cover.
Armament safety plug panel	Security and correct fitting, if fitted.
Port engine intake	As for starboard.
Radio access hatch	Security and correct fitting. Any sign or sound of air leaks in this area may be traced to the re-charging point for the u/c and flap emergency bottles, and for the anti-G system.
Glass over canopy external jettison	Security and condition. If missing, the engine should be checked for damage to swirl vanes and compressor blades.
Prior to climbing into the cockpit	External condition and cleanliness of windscreen panels and canopy which should be checked for cracks, chips and distortion. Whilst on the ladder, look back over all top surfaces of aircraft for loose articles.

Climb into the cockpit, carry out checks on the ejection seats, and check the canopy jettison gun pip-pin is in position.

71. Cockpit and pre-start checks

- (a) If the aircraft is being flown solo make the following checks before strapping in:—

Power control override switches (71) (72)	ON.
Flaps (68)	Selector lever in gate.

PART IV—HANDLING

Undercarriage selector (69) (70)	Both down. PUPIL override button fully in (it may be necessary to switch on the battery master switch).
Anti-G cock	OFF.
Trim control (126)	Lock in position.
Tailplane actuator circuit breaker	Closed.
(b) Strap in and then make the necessary oxygen, emergency oxygen and anti-G suit connections. Have the seat and canopy jettison safety pins removed and stowed and the radio plugs connected. Apply the parking brake. Then check:—	
Undercarriage selectors (23)	Appropriate down button fully in.
Armament switches	Safe or off.
Battery master switch (83)	ON.
Tailplane motor circuit breaker (2)	Closed.
Cockpit pressure warning switch (1)	Test warning light.
Canopy override switch	Central.
Undercarriage emergency air pressure gauge (4)	Pressure 1,800–2,000 lb./sq. in.
Flaps emergency air pressure gauge (3)	Pressure 1,800–2,000 lb./sq. in.
Cockpit temp. selector (5)	As required.
Cockpit temp. control (6)	AUTO.
Cockpit pressure master switch (7)	ON.
Flood flow control switch (9)	AUTO.
Red lamps dimmer switch (10)	OFF.
Canopy port lock indicator	In line. (With canopy shut.)
L.P. cock (40)	ON.

PART IV—HANDLING

H.P. cock (39)	Set ON and press relight button. (If serviceable an irregular clicking sound is heard.) Set OFF.
Green Salad switch panel (13)	As required.
VHF (15)	Both sets OFF. Set selector (16) as required.
Top temp. controller switch (38)	ON.
Throttle damper (14)	As required.
Throttle	Freedom. Set closed.
H.P. pump isolating switch (36)	Gated NORMAL. Light out.
Tailplane standby control switch (33)	Cover down.
GGs selector dimmer (32)	As required.
Undercarriage emergency selector (18)	Ensure selector not pulled up.
Radar ranging switch (31)	OFF.
Wheel brakes accumulator air pressure gauge (20)	Minimum pressure 750 lb./sq. in.
Brakes gauge (30)	Pressure at each wheel. If zero, check after starting.
Hydraulic pressure warning light (22)	ON.
Power control switches (45) (46)	Central. Magnetic indicators white.
Undercarriage position indicator (25) and selector buttons (23)	Day/Night switch. Three green lights. Bulb changeover. Undercarriage warning light out. Down button fully in. UP button not twisted to EMERGENCY.
Flaps emergency selector (24)	Ensure selector not pulled out.
Flaps selector (26)	UP.

PART IV—HANDLING

Braking parachute control switch (53)	OFF/JETT.
Bombs/RP switch (51)	Gated centrally.
Bomb fusing switch (52)	OFF.
Tailplane trim indicator (47)	Condition.
Machmeter	Condition.
Flap position indicator (44)	Condition.
Instrument lighting switches (54) (56)	OFF.
A/H inverter changeover indicator (55)	White.
Flight and engine instruments	Condition.
Turn and slip switch	NORMAL.
Ignition switch (79)	ON.
Generator warning lights (78)	On.
Battery master switch (83)	ON.
Starter master switch (80)	ON.
Camera master switch (82)	As required.
Pressure head heater switch (81)	OFF.
GGs switch (91)	OFF.
Accelerometer (92)	Reset.
Canopy locked indicator light (94)	On. (With canopy locked shut.)
Fire warning light (95)	Press test button.
Fuel gauges (99) (102)	Reading full.
Low pressure warning light (101)	On. <i>closed.</i>
Transfer failure magnetic indicators (98) (104)	White. Black if pressure in system.
Drop tank magnetic indicators (100) (103)	As appropriate.
DME indicator	OFF.

PART IV—HANDLING

Emergency lights switch (89)	OFF.
Booster pump switches (96) (105)	OFF warning lights on.
Centre panel lighting switches (59) (60)	OFF.
Nav. lights switch (109)	As required.
Audio warning switch (108)	Central.
Bright/dull switch (107)	As required.
Tail-plane interconnection switch (86)	OFF.
Cockpit pressure warning light (113)	Out.
Braking parachute control (110)	Central.
Cockpit altimeter (85)	Condition.
Green Salad indicator	Condition.
E2B compass lamp switch (134)	NORMAL.
E2B compass lamp dimmer control (133)	OFF.
Engine anti-icing switch (132)	SHUT, indicator (131) green.
Inverter indicators (129) (130)	STANDBY (yellow).
Pedestal lamps switch (147)	As required.
Muting switch (146)	OFF.
Oxygen emergency control	Not pulled up.
Starter circuit breaker (143)	Closed.
Inverter standby switches (144) (141)	NORMAL.
Inverter test switch	NORMAL (Down).
Anti-G cock (139)	ON. Depress button gently to test.
Canopy jettison control (137)	Fully down.
Autostabiliser switch (63)	STDBY.

PART IV—HANDLING

Oxygen	Main and emergency supplies connected. Contents and delivery. Stop cock ON. Air inlet 100% (17D) or NORMAL (17E). Test for mask leaks. Indicators operation. Emergency switch central.
Stbd. instrument panel lamp switch (64)	OFF.
Stbd. flying instruments	Serviceability.
Power control magnetic indicators (66) (67)	White.
Power control override switches (71) (72)	ON.
Flap selector (68)	UP (in gate).
Undercarriage selectors (69)	DOWN button out. UP button out, not twisted to EMERGENCY. Pupil red button in.
Anti-G system pressure gauge (115)	2,000 lb./sq. in.
GGs selector dimmer (114)	As required.
Tailplane cut out switch (128)	Cover in position.
Red lamps dimmer switch (116)	OFF.
Stbd. anti-G button (117)	Test.
Trim control (125)	Lock in position.
Emergency oxygen control (124)	Ensure not pulled up.
Intercomm amplifier switch (118)	NORMAL.
Intercomm amplifier switch (119)	As required.
Canopy stbd. lock indicator	In line. (With canopy shut.)
Oxygen	Main and emergency supplies connected. Contents and delivery. Stop cock ON. Air inlet 100%. Test for mask leaks. Blinker operation. Emergency switch central.

PART IV—HANDLING

72. Starting the engine

- (a) Starter bar Up.
H.P. cock ON.
Press the starter button without delay.
- (b) As the cartridge fires, the r.p.m. will rise rapidly to 1,500, pause and then rise again to the idling figure of $3,000 \pm 100$. The sequence should take about 30 seconds and during this time the j.p.t. may momentarily exceed the idling limit 525°C .
- (c) When r.p.m. have stabilised, check that the j.p.t. has returned to normal and the oil pressure is registering (off the stop).
- (d) *Failure to start*
 - (i) If the cartridge does not fire, close the H.P. cock immediately. It must not be assumed that the breach 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 H.P. 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 H.P. 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.
 - (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 r.p.m. 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 master switch, otherwise overspeeding of the starter may occur.

PART IV—HANDLING

73. Checks after starting

Fire warning light	Out.
Set 3,700 r.p.m. and check:—	
Canopy	Shut, green light on.
Generator warning lights	Out (covers off).
Fuel transfer indicators	Black.
Booster pumps switches	ON.
Instruments	Correct functioning. Check artificial horizon (press fast erection if necessary). Set Mk. 4FT compass and altimeter. Pressure head heater ON. Inverter indicators MAIN.
Hydraulic pressure	$2,850 \pm 150$ lb./sq. in. on both the centre needle of triple pressure gauge and on the brake acc. gauge. Pressure at each wheel brake 1,500 lb./sq. in. (min.). Warning light out.
Elevator and ailerons	Engage. Magnetic indicators black.
Tailplane actuator and tailplane interconnection	ON and test.
Rudder and aileron trimmers	Check and set neutral. Lock engaged.
Airbrake	Check operation with test switch (142)
Flaps	Check operation.
V.H.F.	Channel selected.
D.M.E.	STANDBY.

74. Taxiing

- (a) Taxiing is normal for a nosewheel aircraft.
- (b) Fuel consumption is about 15 lb. per minute whilst taxiing.

PART IV—HANDLING

75. Checks before take-off

Trim

Tailplane.

Clean aircraft—Neutral.
With 38° flap and/or in-board stores—1° Nose-up.
With 38° flap and outboard stores—½° Nose-up.
Interconnection ON.
Rudder—Neutral.
Ailerons neutral, lock on.
Spring feel—Neutral.

Autostabiliser

ON or STDBY.

Fuel

Booster pumps ON.
Warning lights out. Fuel pressure warning light out.
H.P. cock ON and locked.
L.P. cock ON.
Transfer indicators black (if fuel in outboard drop tanks).
Contents.

Flaps

Up (38° if carrying stores).

Instruments

Check and set. Pressure head heater ON.

Page 76
Oxygen
check
A.L.3

Oxygen

100% (17D) or NORMAL (17E)
Reaching mask. Emergency toggle central. Magnetic indicators operating.

Hood

SHUT. Green light on.
Indicators locked.
Cockpit pressure ON (OFF in conditions of high humidity).

Harness

Tight and locked.

Hydraulics

Pressure $2,850 \pm 150$ lb./sq. in.
Flying controls in Power.
At 4,500 r.p.m. apply full aileron and elevator and ensure that the magnetic indicators remain black.
Warning light out.

PART IV—HANDLING

76. Take-off

WARNING.—A check that the power controls indicators are black must always be made immediately before take-off at not less than 4,500 r.p.m. At any stage of a flight, if either automatic Manual reversion or any form of stick jamming occurs with Power selected ON, immediately switch Power OFF. Do not attempt to re-engage Power; return to base and land in Manual.

- Having aligned the aircraft apply the brakes, open the throttle smoothly and check that the engine is functioning correctly (see para. 63(a)). When the aircraft begins to creep forward, release the brakes and open up to full throttle. At full power check that the oil pressure is at least 15 lb./sq. in. If the aircraft creeps forward before 6,800 r.p.m. is reached, the brakes should be considered unserviceable and the aircraft should not be flown.
- Normally there is no tendency to swing. In cross wind conditions, gentle intermittent braking is necessary to keep straight until at about 90 knots the rudder becomes effective.
- Ease the nosewheel off at about 120 knots, taking care not to achieve an excessive nose-up attitude. At about 150 knots depending on weight, apply gentle back pressure to unstick.
- Until experience is gained the lightness of the ailerons may lead to over-controlling, resulting in lateral rocking as the aircraft leaves the ground.
- When comfortably airborne apply the brakes and raise the undercarriage. There is no noticeable change of trim, but the nosewheel locks up with a distinct thud. Retraction *must* be complete before 230 knots may be exceeded.
- As the aircraft accelerates to climbing speed, trim out the increasing nose-up stick force.
- When carrying stores using 38° flap the nosewheel can be eased off at 125 knots and the aircraft flown off at 145–150 knots. When safely airborne raise the undercarriage and then the flaps in 10° increments retrimming after each

PART IV—HANDLING

selection; 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 nosewheel, but the aircraft will be in trim at 160 knots.
- (ii) It is recommended that because of there being a possible hydraulic failure the undercarriage and flaps (if the latter has been used for take-off) are left down, care being taken not to exceed the maximum permissible speed.

Page 78
Para. 77
(a) (b)
A.L.3

HANDLING IN FLIGHT

77. Climbing

NOTE.—If cockpit pressure has been set to OFF to prevent misting switch it ON at about 5,000 ft.

(a) *Best rate of climb*

- (i) Climb at full throttle at the speed appropriate to the configuration (see (iii) below). 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 to the recommended speed.
- (iii) Recommended speeds are:

Clean, or with 2 × 100 gall. drop tanks	..	..	0.85M
With 4 × 100 gall. drop tanks..	..	..	0.82M

(b) *Normal climb*

If maximum rate of climb is not essential set 7,950 r.p.m. using the same airspeeds as above. It may be necessary to adjust the throttle as height is gained to maintain the selected r.p.m.

78. Flying controls

(a) *Ailerons (in power)*

The ailerons are light and effective throughout the speed and mach number range, giving a high rate of roll. (See para. 86(b).)

PART IV—HANDLING

Page 79
Para. 78
(b)
A.L.1

(b) *Elevator (in power)*

At low airspeeds and high mach numbers, the stick forces are relatively heavy; at high airspeeds the control feels light, is effective and should be used cautiously until its characteristics are known and its effectiveness appreciated. Above 0.92 M there is a marked decrease in elevator effectiveness, and the elevator angle will eventually be limited by jack stalling. Elevator effectiveness is also limited by jack stalling. This condition occurs when the air load on the elevator equals the jack output force and restricts movement of the control column rearwards. ~~When manoeuvring jack stalling will occur at a mach number in excess of 0.97. When Mod. 514 is incorporated the sensitivity of longitudinal control is reduced resulting in some deterioration of elevator feel at low airspeeds; the aiming characteristics at higher speeds are, however, improved.~~

(c) *Follow-up tailplane*

The aircraft should normally be flown with the tailplane interconnection switched ON. Its use improves the manoeuvring capabilities above 0.9 M. Handling characteristics below 0.9 M are similar with the interconnection either ON or OFF. It should be noted that the tailplane remains fully operative with the elevator in Manual but 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.

(d) *Rudder*

The rudder is light and effective at low airspeeds but becomes progressively heavier as speed increases. The application of rudder causes the aircraft to roll markedly. With the autostabiliser switched on, the effect of its control will be felt on the rudder pedals.

(e) *Trimmers*

- (i) Use the aileron spring feel trimmer to counteract any out-of-trim forces which may occur in Power. Its use when flying in Manual is not recommended because the assistance is almost negligible and unless reset to its original position when re-engaging Power it reduces the likelihood of a successful re-engagement. The aileron tab trimmer is for use in Manual only and must be locked in the neutral position when the controls are in Power.

PART IV—HANDLING

- (ii) Use the tailplane trimmer in the normal manner, the trim angle is usually between 1° and fully nose-down. When manoeuvring at high airspeed the stick forces are light and little use of the trimmer is required. For sustained flying, however, the stick forces should always be trimmed out; if this is not done and inadvertent manual reversion occurs the stick force may be too high for the pilot to hold. If the normal trimmer fails, use the standby control; this operates at about one-third the speed of the normal control. If both tailplane 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. The aircraft can be landed in Power with the tailplane at either extreme without undue difficulty.
- (iii) Set the rudder trim neutral before take-off. The control is powerful and only small amounts will be required to counteract out-of-trim forces due to asymmetric external stores.
- (f) *Airbrake*
The airbrake may be used throughout the speed range, with undercarriage up. Moderate buffeting occurs which is most marked between 0.95 M and 0.96 M.
- (g) *Flaps*
 - (i) *At high mach number*
As speed is increased from 0.9 M to 0.93 M a nose-down trim change occurs; lowering flap produces a further and marked nose-down change of trim, the degree of out-of-trim increasing with the amount of flap selected and with speed. Since elevator effectiveness decreases at speeds above 0.92 M if 0.9 M is exceeded with flap lowered, or flap is lowered inadvertently at speeds in excess of 0.9 M, 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 with flaps extended, the increasing air-loads decrease

PART IV—HANDLING

the flap angle which results in a nose-up change of trim.

- (h) *Changes of trim*
 - Increase of power Nil.
 - Operation of undercarriage Negligible except when ailerons are in Manual (see para. 97(d)).
 - Flap down Strong nose-down above 200 knots.
 - Airbrake High I.A.S. slight transient nose-down, then slight nose-up.
Above 0.98 M slight nose-up.
At low I.A.S. negligible.

79. Flying with external stores

- (a) *With drop tanks*
At speeds below the permitted maximum the handling characteristics with inboard drop tanks are similar to those for the clean aircraft. With four drop tanks, longitudinal control on the climb is very sensitive and care must be taken not to overcontrol. At high airspeeds only very light stick forces are required to exceed the maximum permitted G. When carrying outboard tanks manoeuvres in the rolling plane must not exceed 360° to avoid the build-up of excessive rates of roll.
- (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 airspeed indicator and machmeter as compared with clean aircraft. (See para. 118.)

Page 81
Para. 79
(c)
A.L.3

(c) *Practice Manual flying*

Unless Mods. 686, 687 are embodied, practice selection of the controls to Manual must not be made when carrying external stores, other than empty inboard drop tanks, because the presence of such stores increases the difficulty of re-selecting Power.

(d) *Flying with RP's*

Aileron movement becomes restricted at 0.97 M when carrying RP's. When drop tanks are carried on the inboard pylons as well it is difficult to exceed 0.98 M.

PART IV—HANDLING

Page 82
Para. 80
A.L.2

80. Flying for endurance

The recommended speed is 250 knots or 0.82M, whichever is lower.

81. Flying at reduced speed

Fly at 180–200 knots using 23° flap (2 notches down).

82. Flying in severe turbulence

The recommended speeds for flying in conditions of severe turbulence are:—

Condition	Altitude	Speed
Level flight or climbing	Below 25,000 ft.	350 knots
	Above 25,000 ft.	0.83M.
Descending (airbrake out, flap 23°)	Above 35,000 ft.	0.83M.
	Below 35,000 ft.	280 knots

83. 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, throttle fully closed are:—

(i) Full ammunition and 2,200 lb. fuel remaining (Max. landing weight approx.)

Undercarriage and flap up	..	..	140 knots
Undercarriage down and flap up	..	..	140 knots
Undercarriage down and full flap	..	..	130 knots

(ii) No ammunition and 800 lb. fuel remaining (Normal landing weight)

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

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

PART IV—HANDLING

(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 a counter-action may require full forward stick movement. Either wing may tend to drop but can 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.

(iii) A spin or spiral may develop, and in any case considerable height will be lost. Large deflections of the ailerons near the stall will cause the aircraft to yaw in the direction of the downgoing aileron and will increase the possibility of a spin or spiral developing.

(f) 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.

84. G-Stalling

(a) G-stalling is subject to the overriding limitation of +7G (accelerometer reading).

(b) During turns and pull-outs adequate stall warning is given by buffeting at all heights. If the backward pressure is continued inadvertently after the stall warning a momentary pitch-up and sudden increase in G may occur. It may occur when G is applied at speeds above 0.9M in the height band 25,000–30,000 ft. If the pitch-up occurs, however, it is still possible to maintain longitudinal control. Buffeting is considerable and wing dropping may occur.

PART IV—HANDLING

- (c) Buffeting and/or limiting G can be obtained with very little effort, particularly when ammunition is not carried.

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 0.91 M when the trim changes to nose-up and the elevator and tail-plane become 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.

85. Spinning

NOTE.—1. Intentional spinning in the clean configuration only (i.e. flaps and undercarriage up, airbrake retracted, and no external stores) is permitted up to a maximum of 4 turns before correct recovery action is initiated. The spin should not be entered below 40,000 ft. and correct recovery action must be initiated before completion of the fourth turn, or in the case of a slow hesitant spin, by 25,000 ft. The recommended entry speed from a straight stall is 120 knots and from a turn 200 knots.

2. Intentional inverted spinning is not permitted. There is no tendency for the aircraft to enter an inverted spin from the normal spin.

- (a) Inadvertent spins may result from harshly executed manoeuvres if aileron and/or rudder are applied in the presence of buffet. A normal spin will usually result. If a spin is entered with undercarriage and flap lowered these must be retracted immediately. An inverted spin can result from manoeuvres such as a loop or roll off the top if the speed on the top has become too low; thus the likelihood increases at high altitude. It is recommended that the above spin-prone conditions be avoided.

(b) Characteristics

- (i) When a normal spin occurs the first three or four turns are somewhat oscillatory in attitude due to the curvature of the flight path. Thereafter the spin becomes fairly regular and no change has been apparent in spins of up to 12 turns.

PART IV—HANDLING

- (ii) The aircraft recovers steadily within 2 turns when standard recovery action is taken—i.e. opposite rudder and stick forward, aimed at the white datum. It should be noted that there is an instinctive tendency to oppose the spin with aileron (outspin aileron) unless a conscious effort is made to hold the aileron neutral. If any outspin aileron is left on, the aircraft may not recover, the spin becomes relatively fast and regular taking about 3 seconds per turn in an attitude some 60° nose-down from the horizon; recovery, however, occurs consistently within 2 turns after the ailerons have been centralised.
- (iii) The standard of recovery is relatively insensitive to elevator position or tail-plane setting. However, the elevator position does markedly affect the steepness and rate of rotation of the spin, both increasing with forward movement of the stick.
- (iv) Due to the large variation in the time taken for one turn of a spin depending on whether the aircraft is doing the normal slow and erratic intentional spin or the faster type encountered during abortive recoveries, it is not possible to state a typical height loss per turn other than that this may vary from 1,000 to 3,000 feet. However, typical rates of descent are much less variable and average around 24,000 ft./min. when the flight path approaches the vertical. The height required to regain level flight from the time autorotation ceases is in the order of 6,000 to 10,000 feet.

(c) Normal spin

(i) Normal recovery

1. Apply full rudder opposing the direction of the yaw. (The turn needle indicates direction of yaw.)
2. Move the control column progressively forward, making sure that the ailerons are neutral by aiming at the white circular datum, until rotation ceases.
3. Immediately rotation ceases and not before, centralise the rudder.
4. Ease out of the ensuing dive.

NOTE.—As the control column is moved forward the rate of rotation usually increases momentarily before ceasing.

PART IV—HANDLING

(ii) *Emergency recovery*

If after 2 turns normal recovery action is unsuccessful take the following action:—

1. Jettison external stores.
2. Maintain full rudder opposing the yaw (the turn needle indicates the direction of the yaw) and control column fully forward.
3. Apply in-spin aileron, i.e. moving the control column laterally in the direction of the roll.
4. Maintain recovery action and be ready to centralise rudder and ailerons immediately the spin ceases.
5. Ease out of the ensuing dive.
6. If complete disorientation is experienced the controls should be released as a last resort. The spin will usually cease but the standard of recovery is marginal.
7. If recovery has not been effected by 10,000 feet abandon the aircraft.

(d) *Inverted spin—recovery*

- (i) Apply full rudder opposing the direction of yaw (as observed visually or indicated by the turn needle).
- (ii) Allow the control column to return to the neutral position fore and aft.
- (iii) Laterally deflect the stick fully in the direction of roll (i.e. in the same sense as the applied rudder).
- (iv) Maintain these actions for at least five turns or until rotation ceases.
- (v) Centralise all controls after recovery and ease out of ensuing dive.
- (vi) As a last resort stream the braking parachute and if this is ineffective jettison the hood.
- (vii) If recovery has not been effected by 10,000 feet, abandon the aircraft.

PART IV—HANDLING

86. *Flying at high airspeed*

- (a) When flying at high airspeed all control movements must be smooth and progressive, particularly when flying at aft C.G. and/or in turbulent air. Use the tailplane trimmer carefully. Care must be taken not to overstress the aircraft in rapid manoeuvres.
- (b) The maximum rate of roll increases with speed up to 380 knots or 0.9 M; at higher speeds however, the rate of roll progressively decreases due to jack stalling. Normally maximum rate of roll is not required.

87. *Flying at high mach number*

- (a) *General*
The maximum speed in level flight at full throttle is 0.93 to 0.95 M. From 40,000 feet and above the aircraft will exceed sonic speed in a 30° to 40° dive at full throttle.
- (b) *Trim changes*
As speed increases to about 0.90 M there is a progressive nose-up change of trim. Between 0.90 M and 0.94 M a nose-down trim change followed by a nose-up trim change occurs, the aircraft being almost back in trim again by 0.96 M. At higher speeds as the aircraft becomes supersonic the trim again changes to slight nose-down.
- (c) *Stick force changes and elevator effectiveness*
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 and 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 trim set at 1° nose-down and starting at not less than 0.85 M. If the follow-up tailplane is in use set the trim at 0° otherwise the full range of movement will not be available for recovery without using the trim switch. At 0.97 M very slight wing drop may occur which can easily be counteracted with aileron; if the dive angle is too shallow the aircraft will only reach a maximum speed of 0.97 M.
- (e) *Recovery from transonic dives*
The airbrake may be used; its extension causes moderate buffeting and a nose-up change of trim. It is not very

PART IV—HANDLING

effective in reducing speed. Recovery can be made without using the tailplane trim, but jack stalling may occur. As speed falls through 0.95M the elevator becomes more effective and it will be necessary to move the control column forward or trim nose-down to prevent a sudden increase of G.

88. Aerobatics

- (a) Switch the autostabiliser to STDBY.
- (b) Until experience is gained, the following speeds, in knots, are recommended:—
- | | |
|---------------|-----|
| Roll | 350 |
| Loop | 425 |
| Roll off | 450 |
| Vertical roll | 500 |

- (c) It is recommended that until experience is gained, loops are started in the height band 10,000 ft. to 15,000 ft.

CIRCUIT PROCEDURE AND LANDING

89. Circuit procedure

NOTE.—620 lb. of fuel should be allowed for a circuit, landing and possible overshoot. (But see para. 62(g).)

(a) Circuit speed

6,500 r.p.m. and 23° flap (2 notches) give a comfortable speed of 170/180 knots. To reduce speed for joining the circuit, flap, within the limitations, can be used 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 when the wings are laterally level.

(b) Checks before landing

Airbrake	IN, indicator black.
Undercarriage	DOWN below 230 knots. Three green lights.
Flaps	As required. Fully down on finals.
Fuel	Contents. Booster-pumps ON.

PART IV—HANDLING

Harness

Tight and locked.

Brakes

Pressure, operation, off.
Main supply 2,850 ± 150 lb./sq. in.
At each wheel 1,500 lb./sq. in.

NOTE.—Hold the brake lever on for 2–3 seconds.

If the system is serviceable both brake needles should 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. *Do not repeat* the check because at each operation hydraulic oil will be lost.

- (c) If misting or icing, which cannot be cleared, has formed on the front windscreen, make a curved approach keeping the runway in view through the forward quarter-panels.

(d) 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 immediate engine response maintain at least 4,500 r.p.m. 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:—

At normal landing weight

No ammunition, 800 lb. or less fuel remaining 130

At maximum landing weight

No ammunition, 2,400 lb. fuel remaining 135

Full ammunition, 2,200 lb. fuel remaining 135

90. 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

PART IV—HANDLING

latter occurs, corrective aileron may be effective in raising the wing, but will cause the aircraft to yaw markedly in the direction of the downgoing wing. The nosewheel can be held off at speeds down to about 70 knots, but the shortest run is achieved by putting the nose-wheel firmly on to the runway and applying the brakes.

(b) When carrying stores

- (i) Landing in Power with symmetric or asymmetric stores presents no difficulty.
- (ii) Enter the threshold at 140 knots and fly the aircraft on to the ground at 130 knots.

(c) Braking

NOTE.—The effectiveness of the braking system is greatly decreased on very wet or icy runways. If wind conditions are favourable it may be advantageous to use aerodynamic braking if the braking parachute is not used.

When the nosewheel has been lowered on to the runway the brakes can be used continuously and the maxaret units will prevent wheel locking; however, to prolong the efficiency and life of the brakes, braking should be judicious according to the length of landing run available. The landing can be cut to less than half normal by using continuous full brake once the aircraft is firmly on the ground, but this procedure causes rapid brake and tyre wear and should not normally be used. The aircraft must be firmly on the ground before applying the brakes. If it is allowed to touch down with the brakes on, the maxaret units will not operate and the wheels will lock; however, if once having started turning, the wheels should stop because of a skid or bounce, they will not lock unless the skid or bounce continues for more than 4 seconds. Brake overheating is liable to occur if landings, followed by normal taxiing, are made at frequent intervals. There is no restriction on roller landings but a take off following a full stop landing should not be made at an interval of less than 5 minutes after the first landing or 10 minutes after the second and subsequent landings. After a landing involving heavy braking, ten minutes should elapse before the next landing. If the intervening period of taxiing has also required prolonged use of the brakes, twenty minutes should elapse before the

PART IV—HANDLING

next landing. Observe the same precautions in brake tests. On wet runways the landing run may be decreased by lowering the nosewheel on to the runway, applying the brakes, pulling the control column right back and trimming nose up. The brakes must be in use while the back pressure is applied.

Page 94.
Para. 90
(d)
A.L.3

(d) Use of the braking parachute

The braking parachute may be used for full stop landings to assist deceleration. Once the nosewheel is firmly on the ground, stream the parachute and apply the wheelbrakes. Correct streaming will be indicated by a marked increase in deceleration and the illumination of the warning light (Mod. 850). After clearing the runway and before jettisoning the parachute set the engine to 4,000 r.p.m. to assure full voltage from the generators and to apply a pullforce to the parachute by jet efflux. Clean separation of the parachute will follow. Prolonged taxiing with a streamed parachute is not recommended.

Page 91
Para. 90
(e)
A.L.1

(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 before opening the throttle.

91. Instrument approach settings

Stage	Approx. Engine Settings	Airspeed	Action
Q.G.H. Slow descent	6,600 6,500	280 Reduce to 200	23° Flap, airbrake out Undercarriage down
Level Glide path	6,900 6,900	Reduce to 160 150/160	— Full flap down

92. Flapless landing

Make a very long shallow powered approach and cross the threshold 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 braking parachute streamed, the nosewheel lowered on, the brakes applied and, if necessary, the H.P. cock set off. The landing run is very much increased if the braking parachute is not used.

PART IV—HANDLING

93. 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 the 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 brake. If the cross-wind is gusting strongly increase the approach speed by 5 knots.

94. Checks after landing

Brake pressure	Sufficient.
Flaps	Up.
Cockpit pressure	Off.
Camera master switch	Off.
Pressure head heater	Off.
Both booster-pumps	OFF.
Tailplane	Set to neutral. Interconnection OFF.
Autostabiliser	STDBY.
D.M.E.	OFF.
V.H.F.	One set OFF.

95. Stopping the engine

Close the throttle. When the r.p.m. have stabilised at $3,000 \pm 100$ turn off the H.P. cock, then check:—

All electrics (except auto-stabiliser)	Off.
Battery master switch	Off.
Canopy	Open.
Ejection seats	Replace safety pins before leaving cockpit.

PART IV—HANDLING

FLYING IN MANUAL

96. Selecting Manual

- (a) (i) It is structurally safe to fly in Manual within the speed limitations of para. 61 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 ft. 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.

Page 93
Para. 96
(a) (ii)
A.L.3

- (ii) 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.

- (b) Provided that the aircraft is in trim in Power, the trim changes on selection of Manual are usually 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, the first selection to Manual should be made above 10,000 feet and at low airspeed.

97. 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. The aileron and rudder trimmers are effective. The former can be used to assist in applying angles of bank. At low airspeeds aircraft response to even a full deflection is slow and delayed and must be anticipated. At high airspeeds however aircraft response is rapid and positive.

PART IV—HANDLING

(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 overcontrolling is difficult to damp out. In gusty or severe cross-wind conditions consideration should be given to jettisoning the stores before attempting to land. 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 reverting from Manual to Power is increased. Should either inboard or outboard tank fail to feed, the tanks must be jettisoned if a Manual landing is to be made.

(c) *Effect of asymmetric fuel flow*

If Manual control is selected at 250 knots when one wing tank is empty and the other full, a maximum single-handed force will be required to restrain the wing-low tendency. The amount of trim to counteract this tendency varies with airspeed, little being needed at high speed but maximum at approximately 190 knots. If speed is gradually reduced below 190 knots an increasing stick force, up to a maximum of 8 lb. is required to maintain wings level. This asymmetric load condition is likely to cause false anchorages on reversion to Power. Before reselecting Power the aircraft should be trimmed hands off at 250 knots. When a correct reversion to Power is achieved the aileron trim should be set to neutral, otherwise, if an inadvertent reversion to Manual occurs, or if Manual is again selected at a later stage of the flight when the second wing tank has emptied, the previously applied trim will produce a wing-low tendency, the severity depending on the amount of trim applied and the airspeed.

(d) *Trim changes*

Increase and decrease of power	Nil.
Operation of undercarriage	Roll in either direction (depending on which main leg lowers first, see para. 98).
Flaps down	Strong nose-down especially above 200 knots.
Flaps up	Strong nose-up especially above 200 knots.
Airbrake	Negligible

PART IV—HANDLING

98. *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. When the airspeed is below 150 knots with undercarriage and full flap down, aileron buffet can be felt on the control column. If an overshoot has to be made, the undercarriage should not be raised until a safe height is reached, because of lateral control difficulties near the ground. Flaps must only be selected up to a mid-position (4 notches) because of a nose-up change of trim, full retraction being deferred to a safe height.

(b) *With external stores* (see also para. 97(b))

If the drop tanks are full or partly full they must be jettisoned before landing. 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 fired if practicable, two at a time from each side to avoid any asymmetric load building up due to rockets failing to fire from one side; if the RP's are retained great care must be taken in landing.

99. *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. Immediate re-engagement is more likely on the elevator than on the ailerons; it is therefore 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).—If a false anchorage occurs which it is not possible to clear, select Power Off. Return to base and land in Manual.

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