PART III
HANDLING

49. External checks

The outside of the aircraft should be checked 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. The main and nosewheel oleos should be checked 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. Remove the pitot head cover.

50. Management of the fuel system

(i) The L.P. and H.P. cocks and the booster pump switches must be on for starting and at all times when the engine is running.

(ii) As fuel is used, the fuel in the rear tanks transfers to the centre tanks and thence to the front tanks, which remain full until the rear and centre tanks are empty. The booster pumps in the front tanks should normally provide for equal flow from both front tanks.

(iii) If unequal emptying occurs (to the extent of 20 gallons or more) with both booster pumps ON (and circuit breakers in) adjust the fuel contents level by use of the individual booster pump switches, i.e. switching off the pump on the side with the lower fuel state. If the fault is due to failure of one pump, switch off both pumps and accept the feed provided by the tank pressurization

system. In this event the fuel pressure warning indicator may show white. Max r.p.m. may not be obtainable when flying above 20,000 ft.

(iv) The fuel transfer failure indicators should remain black throughout the flight. If one or both shows white, an air pressure failure is indicated and subsequent steep dives should be avoided due to the possibility of collapsing the tanks. Should an indicator show white before fuel transfer is complete any fuel remaining in the rear and centre tanks will be unusable and the associated contents gauge should indicate only the front tank fuel available to the engine. If in these circumstances the gauge registers more fuel than the total contents of a front tank, a faulty indicator should be suspected.

(v) If the rear tanks fail to transfer, leading to an extreme aft c.g., a landing should be made immediately.

51. **Cockpit and pre-start checks**

(i) On entering the cockpit and before strapping in, check that the flight instruments and radar supply circuit breakers are in and the test switch is at NORMAL FLIGHT (see para. 39 (iv)).

(ii) Strap in and then make the necessary ejection seat and anti-G suit connections and have the seat safety pin removed and stowed. Check emergency oxygen bottle pin removed.

(iii) Put on the battery master switch, ensure that the turn and slip indicator starts up, then check the cockpit from left to right:—

NOTE.—The starred items are directly connected with engine starting.

Item	Check
Undercarriage emergency air pressure gauge (8)	Pressure 1,800 - 2,000 lb./sq. in.
Flaps emergency air pressure gauge (9)	Pressure 1,800 - 2,000 lb./sq. in.
Wheel brakes accumulator air pressure gauge (10)	Minimum pressure 1,550 lb./sq. in.

Item	Check
Tail plane actuator and hood motor circuit breakers (6) (7)	In
Radar test switch (5)	Switch to TEST. Check aurally that the standby inverter starts up, and that the gyro instruments start erecting. Radar indicator white Switch to NORMAL Indicator black
Cockpit pressure warning test switch (4)	Switch to TEST check cockpit altimeter warning light comes on. Switch to NORMAL
Cockpit pressurization switch (3)	ON
Cockpit temperature control (2)	Auto
Cockpit temperature selector (1)	As required
*L.P. cock (12)	ON
*H.P. cock (24)	OFF
Throttle damper (16)	Adjust as required
*Throttle	Half open
Hood control switch (18) and clutch selector (17)	Clutch FREE, check manual operation of hood Clutch LOCKED Switch as required
Undercarriage emergency selector (29)	Ensure selector not pulled up
Flaps emergency selector (35)	Ensure selector not pulled out
Undercarriage position indicator (32)	Check—Day/Night switch Check — Bulb changeover switch Three green lights Undercarriage warning light out
Hydraulic pressure warning light (36)	Red

Item	Check
Hood jettison handle (40)	In
Flight and engine instruments	Condition
Rudder pedals	Adjust
Generator failure warning lights (58)	On
*Ignition switch (59)	ON (normally locked on)
Windscreen de-icing switch (46)	OFF
Fire warning light (47)	Off (pull out spring-loaded cover to test)
Cockpit audio warning switch (54)	ON
Fuel pressure warning indicator (55)	Black until engine master switch is on
Cockpit altimeter (50)	Check reading
Oxygen (56)	Main and emergency supplies connected Contents and delivery Stopcock ON Air inlet NORMAL OXYGEN Check for mask leaks Blinker operation Emergency switch central
Fuel contents gauges (68)	Check contents with ENG. ON/OFF switch at ENG. OFF Fuel transfer indicator white (if pressure is still in the system these will be black and contents gauges will read full)
*Fuel booster pump and engine starter circuit-breakers (78) (79)	All in

Item	Check
*Fuel booster pump switches (69)	ON
External light switches (88) (89)	As required
Oxygen emergency selector	Down
Anti G control (if suit in use) (73)	Switch ON, check pressure 1,800 - 2,000 lb./sq. in. Test Then as required
Hood rail locking indicator (port and starboard hood rails) (14)	Pointers in line with centre of pins

(iv) Switch on all the switches on the starter panel using the starter master bar and check aurally that the main inverter starts and the gyro instruments erect. If the instruments do not erect put off all the switches on the starter panel and have the fault investigated; if this is not done the instruments may be damaged.

52. **Starting the engine**

NOTE.—The maximum permitted j.p.t. during starting is 750°C. Should this temperature be exceeded the H.P. cock must be closed immediately.

(i) When the fuel pressure indicator shows black (fuel pressure adequate) open the H.P. cock and press the starter button without delay.

(ii) The cartridge fires over a period of approximately 4 seconds during which time light-up should occur. The throttle should be closed when the engine has lit, indicated by a rise in r.p.m. and j.p.t. The engine should accelerate to the idling r.p.m. 3,000 ± 200, in approximately 11 seconds. The starter button remains in for approximately 30 seconds after it was initially pressed.

(iii) If the cartridge fails to fire, close the H.P. cock

immediately. Allow one minute to elapse before attempting a further start. If the second cartridge fails to fire, the electrical circuit should be checked.

(iv) If the cartridge fires, but the engine fails to light up within 10 seconds providing the H.P. cock is closed without delay, the second cartridge may be fired as soon as the engine has stopped. If it is suspected that an excess of fuel has collected in the engine, the second cartridge should be fired, with the igniter switch and the H.P. cock off. In each case the engine master switch should be ON.

(v) A period of at least 10 minutes must elapse between firing the second cartridge and reloading the breech.

53. **Checks after starting**

Fire warning light	Out
Set 3,700 r.p.m. and check:—	
Hydraulic pressure	3,000 ± 150 lb./sq. in. on both central needle of triple pressure gauge and brake acc. gauge Warning light out
Flaps	Check operation
Airbrakes	Check operation with test switch
Elevator and ailerons	Selector switches gated ON Engage controls by moving the column through its full traverse (using two hands if necessary) until free movement is felt Indicators black
Generator warning lights	Out
Tailplane actuator	Test throughout full range on emergency, lower cover then check on normal and set at 1½ nose down

Rudder trimmer	Check and set neutral
Aileron trimmer	Check and set at neutral, then engage lock
Instruments	Check functioning, compare Mk. 4F compass with E2
Fuel transfer	Indicators black
Wheel brakes	Accumulator pressure 3,000 ± 150 lb./sq. in. Pressure at each wheel 1,500 lb./sq. in. (min.)

54. **Taxying**

(i) Taxying is normal for a nosewheel aircraft.

(ii) Fuel consumption is about 2 gallons per minute whilst taxying.

(iii) Whenever possible, such as delayed take-off, etc., maintain about 3,700 r.p.m. to avoid discharging the battery.

55. **Checks before take-off**

Trim	Tailplane 1½ nose down Rudder—neutral Ailerons—neutral, lock on
Fuel	Booster pumps ON Fuel pressure indicator black H.P. cock ON and locked L.P. cock ON Transfer indicators black Contents
Flap	Up (40° for shortest run)
Instruments	Check and set
Oxygen	On NORMAL—and reaching mask, blinkers operating
Hydraulic	Flying controls in power Indicators black Warning light out
Harness	Tight and locked
Hood	SHUT (not OFF) Clutch LOCKED Cockpit pressure ON

WARNING.—If heavy demands are made on the power controls accumulators by frequent control movements during taxying at low r.p.m. it is possible for the aileron and/or elevator locking pawls to become disengaged. If this occurs the appropriate indicator shows white, although the control column may still appear to have free movement. Do not take off in this condition. Move the control column laterally and longitudinally to ensure all pawls are engaged. A check that the power controls indicators are black must be made immediately before take-off (r.p.m. 4,500 minimum).

56. **Take-off**

(i) Having aligned the aircraft, release the brakes and open the throttle smoothly to full power. Settled r.p.m. at take-off may vary from 8,500 to 8,650 and there may be an overswing of +180 and an underswing of −120, which should damp out in two beats.

(ii) Normally there is no tendency to swing. In cross wind conditions, gentle intermittent braking is necessary to keep straight until at about 70 knots the rudder becomes effective.

(iii) Ease the nosewheel off at about 95 knots and hold it just off the runway, taking care not to achieve an excessive nose-up attitude. At 120 - 140 knots, depending on weight, apply gentle back pressure to unstick.

(iv) Until experience is gained the lightness of the ailerons may lead to overcontrolling, resulting in lateral rocking as the aircraft leaves the ground.

(v) When comfortably airborne apply the brakes momentarily 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.*

(vi) As the aircraft accelerates to climbing speed it will be necessary to trim out the increasing nose-up change of trim.

(vii) *Short take-off*

A shorter take-off run can be achieved by using 40° flap, opening the throttle against the brakes and releasing them when they will no longer hold. In this configuration lateral rocking is more pronounced; a strong nose-up change of trim and a small amount of sink occur when the flaps are raised. It is recommended that flaps should not be used during formation take-offs.

57. **Climbing**

(i) *Operational climb*

Climb at maximum power within the j.p.t. limit; speeds for the best rate of climb are:—

Height in feet	*Knots*
Sea Level	450
5,000	440
10,000	420
15,000	400
20,000	375
25,000	350
30,000	320
35,000	290
40,000	260
45,000	235
50,000	210

(ii) *Normal climb*

If maximum rate of climb is not essential set 8,400 r.p.m. using the same airspeeds as above. It may be necessary

to throttle back as height is gained to maintain the selected r.p.m.

(iii) When climbing above 30,000 ft. it is important that the speed is kept at or slightly above those recommended. If, above this altitude, the speed is allowed to drop off, the rate of climb will fall appreciably and the aircraft will have to be flown level until the correct climbing speed is regained.

58. Engine handling

(i) *Take-off and climb*

During the initial climb to 10,000 ft. at full power r.p.m. may increase to 8,700, but above that height a negative creep device gradually reduces r.p.m. with height to maintain j.p.t. within limits. As a result full throttle r.p.m. at 40,000 ft. will be about 8,400/8,550 and at 50,000 ft. 8,300/8,450. However, when climbing at intermediate r.p.m. above 8,000, but not at full power, it may be necessary to *reduce* the throttle setting to maintain the selected r.p.m.

(ii) *General*

The AFC is designed to give optimum engine acceleration at all altitudes. Rapid engine accelerations may be made at all altitudes without undue risk of flame-out.

(iii) *Approach conditions*

During the approach to land, if r.p.m. are maintained at 5,000, full thrust can be obtained within 5 seconds. If less r.p.m. are used the time to attain full thrust is considerably increased.

(iv) *Flame-out*

If flame-out occurs, carry out the relighting drill (see para. 72). It must not be assumed that combustion has ceased unless r.p.m. fall below 3,000.

59. General flying

(i) *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. 63(i)(b).)

(b) *Elevator (in power).* The control is light and effective up to 450 - 500 knots, but at higher speeds it becomes heavy and loses some of its effectiveness. At 0.95M and above there is a marked decrease in control effectiveness and a substantial heavying up.

(c) *Rudder.* The rudder is light and effective at low I.A.S. but becomes progressively heavier as speed increases.

(ii) *Trimmers and tailplane*

NOTE.—Do not fly with the thumb on the tailplane control switch as this may cause intermittent making and breaking of the contacts which may damage the switch. Care must also be taken not to operate the switch inadvertently during manoeuvres, as this may result in excessive G being applied.

(a) The aileron trimmer must not be used whilst the controls are in power, and it should be locked in the neutral position. (See para. 79.)

(b) If the normal tailplane trimmer fails, the standby control should be used; this operates at less than half the speed of the normal control. Should both trimmers fail, the aircraft can be controlled throughout the speed range in power with the tailplane at the fully nose-down position. With the tailplane at the fully nose-up position, the push force required becomes excessive above 250 knots or 0.87M. The aircraft can be landed in power with the tailplane at

either extreme, without undue difficulty. It should be noted that normally with the controls in power the tailplane angle will rarely be above 0° and will generally be between 1° to fully nose-down. The full traverse will, however, be required with the controls in manual.

(iii) *Airbrake*

(a) The airbrake may be used throughout the speed range, with undercarriage up. The trim changes are as follows.

(b) On selection of the airbrake at 550 knots and above a slight nose-down change of trim occurs but this reverts to a slight nose-up change and when the airbrake is fully extended the aircraft is almost back in trim.

(c) At high I.M.N. and high altitude no appreciable trim change occurs on extension of the airbrake up to 0.96M; moderate buffeting occurs, and this is most marked between 0.95M to 0.96M. Above 1.0M a slight nose-up change of trim occurs.

(iv) *Changes of trim*

Increase of power	Nil
Operation of undercarriage	Negligible except when ailerons are in manual (see para. 78)
Flap down	Strong nose-down above 200 knots
Airbrake	*High I.A.S.* slight transient nose-down, then slight nose-up Above 0.98M slight nose-up *At low I.A.S.* trim changes are negligible

60. **Flying at reduced speed**

(i) Fly at 180 - 200 knots using 20° flap.

(ii) 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.

(iii) Lateral rocking may occur between 200 - 250 knots with the flap fully down. If the rocking becomes excessive the flaps should be raised. Any lateral rocking which occurs below 200 knots is easily controlled with the ailerons.

61. **Stalling**

NOTE.—In order to obviate the possibility of entering an inadvertent spin and because the rate of descent is very high when the aircraft is fully stalled, stalls are not to be approached beyond the buffet stage, and even this stage must not be approached below 25,000 ft.

(i) Buffet speeds at 25,000 ft., throttle fully closed, are:—

(a) *Full ammunition and 260 gallons fuel remaining (Max. landing weight approx.)*

Undercarriage and flap up	130 knots
Undercarriage down and flap up ...	130 knots
Undercarriage down and full flap ...	120 knots

(b) *No ammunition and 100 gallons fuel (Normal landing weight)*

Undercarriage and flap up	... ...	125 knots
Undercarriage down and flap up	...	125 knots
Undercarriage and full flap	...	115 knots

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

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

(iv) Under approach conditions, 5,500 r.p.m., the buffet speeds quoted above are not appreciably affected, but the height lost during recovery is reduced.

(v) The full stalling characteristics are described below, to provide information for the case where a stall occurs inadvertently. As the stall is closely approached in either configuration there occurs a nose-up pitch and stick force reversal. These may be sharp or progressive, varying with altitude and from aircraft to aircraft. There is ultimately a reduction of forward speed to below 100 knots which may be rapid. Either wing may drop but may be picked up by aileron. Below 100 knots the aircraft develops a very high rate of sink. Recovery action should be taken immediately because if it is delayed beyond the nose-up pitch and/or wing drop, a spin may develop and in any case considerable height may be lost.

62. **High speed stalling**

(i) High speed stalling is subject to the overriding restriction of para. 48(iii)(a) whereby pilots must not deliberately apply more than 4G above 10,000 ft.

(ii) As in the straight stall case, the aircraft pitches up towards the stall, and this may result in momentary uncontrollable tightening in turns and pull-outs resulting in exceeding the limiting G. Pre-stall buffet gives adequate warning up to about 0.85M but at higher mach numbers the buffet may be coincident with the pitch up. In addition the degree of exceeding the desired G increases with increase of mach number.

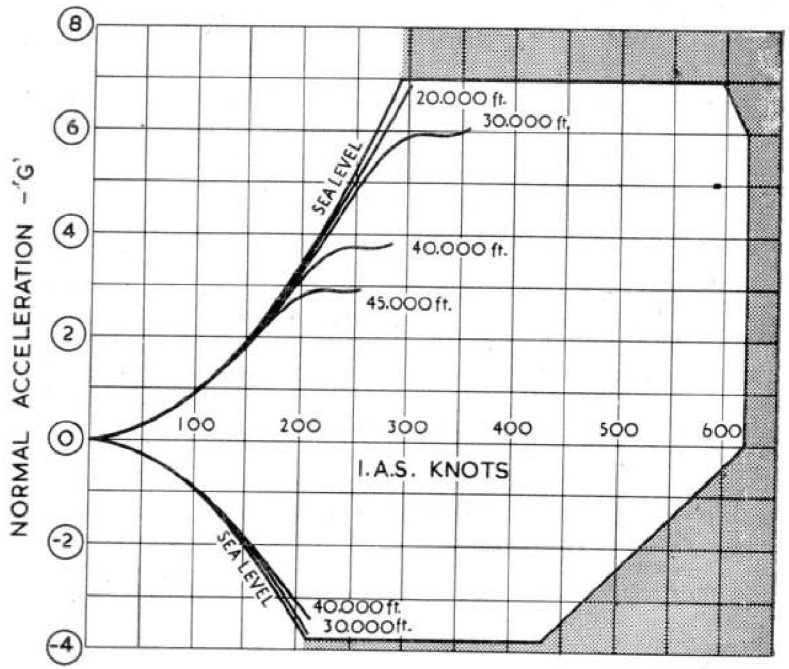
(iii) Above 30,000 ft. the pitch up is disconcerting, but at these altitudes the resulting G is of no structural significance. Normal recovery action should be taken and resumption of control is almost immediate.

(iv) At heights below 30,000 ft. the tightening up, if experienced, may be severe enough to cause structural damage. It is for this reason that a restriction on G is imposed above 10,000 ft. at any mach number.

(v) Below 10,000 ft. the uncontrollable pitch up will not occur unless the limiting G is exceeded.

63. **High speed flight**

NOTE.—The diagram overleaf illustrates the manoeuvre zones at various altitudes (see A.P.2095, Pt. 1, chap. 1). The curved lines indicate the accelerated stall speeds for various G loads. The shading at the top and bottom and to the right of the chart indicates the maximum limitations of the aircraft.



(i) *Flying at high I.A.S.*

(a) When flying at high indicated airspeed all control movements must be smooth and progressive. The tailplane trimmer must be used very carefully at high I.A.S.

(b) At the highest airspeeds the rate of roll is reduced because the hydraulic system is not powerful enough to displace the ailerons fully against the increased airflow.

(ii) *Flying at high mach numbers*

(a) *Level flight.* As speed increases there is a progressive nose-up change of trim which changes to moderate nose-down at 0.91 to 0.94M. The maximum level flight speed at full throttle is 0.93 to 0.95M.

(b) *Transonic flight.* From 40,000 ft. and above the aircraft will exceed sonic speed in a 30°- 40° dive at full throttle. Transonic dives must not be started below 25,000 ft. A nose-up change of trim occurs from 0.96 to 0.98M if the aircraft is in trim before entering the dive and at 0.97M slight wing drop may occur. At 0.98M as the aircraft becomes supersonic the nose-up change of trim disappears and the control column may move forward about 1 in. to 2 in. There may also be some rudder movement but this does not affect the directional trim.

(c) *Recovery.* Recovery from dives should be made by closing the throttle, pulling maximum elevator force and using the tailplane trimmer carefully; the airbrakes may be used if desired. Recoveries can be made without using the tailplane trimmer, although if the dive has been entered with full nose-down trim it will be necessary to retrim to about 1½ nose-down. The tailplane trimmer must be used carefully to supplement the elevator pull force, and recovery must not be effected by use of the tailplane trimmer alone. As a general rule between 1° and 2° nose-down trimmer is sufficient.

64. **Aerobatics**

(i) The following minimum speeds in knots are recommended:—

Roll	250
Loop	380
Roll off	450
Climbing roll	500

(ii) Until experience is gained care must be taken to apply only gentle back pressure after completing the first half of the loop, as the self stalling characteristics described in para. 61(v) are easily induced whilst the speed is low.

65. **Spinning**

(i) Intentional spinning is prohibited.

(ii) If a spin occurs, it must be ensured that the ailerons are *centralised* while the stick is still back: the aircraft will then recover with full opposite rudder, followed by slow forward movement of the stick. If a spin occurs with flaps and undercarriage down they should be retracted.

(iii) If the stick is held forward and away from the direction of the spin, recovery may not be possible until the ailerons are centralised, and may even require aileron towards the direction of the spin. If the stick is held over towards the direction of the spin, it assists recovery but there is a risk of immediate entry into a spiral in the same direction, which may not be recognised at first.

66. Checks before landing

Reduce speed to below 230 knots.

Brakes	Main supply 3,000 ± 150 lb./sq. in. 1,500 lb./sq. in. at each wheel
Airbrake	In. Indicator black
Undercarriage	Down. Three green lights
Flaps	As required Fully down on final
Fuel	Contents Both booster pumps ON
Harness	Tight and locked

67. Landing

(i) The recommended circuit speed is 180 knots.

(ii) Turn onto the final approach at 160 knots aiming to lower full flap on the final stages. Steep approaches are not recommended.

(iii) The recommended speeds at the runway threshold are:—

At normal landing weight

(No ammunition, 100 gallons or less fuel remaining) ... ... 125 knots

At maximum landing weight

(a) (No ammunition, 320 gallons remaining)
(b) (Full ammunition, 260 gallons remaining) ... ... } 130 knots

(iv) By maintaining 5,000 r.p.m. on the approach, full thrust is obtainable within 5 seconds of opening up for an overshoot. Under conditions of high wind or gustiness it is more comfortable if the above speeds are increased by 5 knots.

(v) Until experience is gained, it is preferable to fly the aircraft on to the runway rather than to stall it on. Holding off high may result in an excessive nose-up attitude with the subsequent possibility of dropping a wing tip on landing. It is possible to hold the nosewheel off the ground down to 70 knots, but the shortest run will be achieved by putting the nosewheel firmly onto ground and using the brakes. It is recommended that very gentle continuous braking be applied initially, increasing it carefully so as to avoid locking the wheels; this is especially important on wet runways. If wheel judder occurs towards the end of the landing run the brakes should be released momentarily.

68. Instrument approach

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

	R.P.M.	Flaps	Airspeed (knots)
Pattern Base leg Glide path	*(To be issued by amendment)*		

69. 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.

70. **Checks after landing**

Brake pressure	Sufficient
Flaps	Up
Pitot head heater	Off

71. **Stopping the engine**

When the r.p.m. have stabilised at 3,000 to 3,200, turn off the H.P. cock, then check:—

All electrics	Off
Battery master switch	Switch off
Ejection seat	Replace the safety pin before leaving the cockpit

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