PART IV

HANDLING

STARTING, TAXYING AND TAKE-OFF

52. **External checks**

(a) Before starting the external checks, look inside the cockpit and ensure that the undercarriage selector lever is fully down and that there is sufficient brake pressure and oxygen.

(b) The outside of the aircraft should be checked systematically for obvious signs of damage, security of panels, filler caps, doors, mudguards, aerials and external tanks. The engine intakes should be checked for freedom from obstructions, the jet pipe for wrinkling and the turbine for damage. The main wheel oleos should be checked for equality of extension, the tyres for cuts, wear and creep and the brake leads for damage. The pressure head cover, undercarriage ground locks and aileron clamping blocks must be removed. Check the position of the Pylon and tip tanks shut-off cocks. AH.

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

(a) Strap in and then make the necessary connections and have the seat safety pin removed and stowed.

(b) Put the ACC. ISOLATION switch ON, ensure that the turn and slip indicator starts up, then check the cockpit from left to right.

Item	*Check*
Crowbar (1), tank spanner and control locks (2)	Securely stowed.
Rebecca Mk. 7 (28)	OFF.
Cockpit pressure control wheel (3)	OFF.
Aileron trim cut-out circuit breaker (4)	In.
Undercarriage lever (18)	Fully down, safety catch engaged.

Item	*Check*
Pylon tanks and bomb jettison lever (17)	Fully down and clip engaged.
Undercarriage emergency retraction switch (5)	Wired OFF.
Emergency lamp switch (6)	On then OFF.
Cockpit lighting	As required.
Flaps selector lever (16)	Operation with handpump.
Airbrake selector lever (14)	IN.
L.P. cock (13)	ON.
H.P. cock (7)	Closed.
Throttle (10)	Closed.
Elevator trimmer (12) and indicator (27)	Operation. Set neutral.
Aileron trim switch (8)	Operate with ailerons in Manual. Trim light for correct operation. Set neutral. Light out.
Aileron power warning light (11)	On.
Relighting switch (19)	OFF.
Oil temperature gauge	Reading.
Aileron selector (20)	Operation. Selector up and locked—POWER.
Undercarriage indicator (21)	Three green lights. Test bulb changeover.
Fuel pressure warning light (25)	On.
V.H.F. (24)	As required.
Undercarriage warning light (29)	Out.
Fire warning light (31)	Out.
Fuel contents gauge (34)	Contents.
Fuel transfer indicators (36)	White.
Brakes	On. Pressure sufficient and equal at each wheel.

Item	*Check*
Cockpit pressure warning light (40)	Out.
Oxygen (41)	On. Contents. Supply. Check HIGH and LOW flow. Emergency cock wired OFF.
Anti G valve (42)	OFF.
De-icer pump (43)	Locked off.
Hood jettison lever (35)	Fully forward.
Hood seal cock (52)	OFF.
Generator failure warning lights (47)	On.
H.P. fuel pump isolating switch (55)	OFF.
Hydraulic failure audio warning switch (45)	ON.
Rebecca Mk. 7 circuit breaker (56)	In.
Other switches (49)	As required.
Generator isolating switches (61)	On.
Generator field circuit breakers (61)	In.
Oxygen selector valve (64)	Wire-locked ECON. (with type H mask). P.B. (with type J mask).
Mk. 4F compass circuit breaker (62)	In.
Wing tip tanks jettison lever (65)	Fully down and clip engaged.
Aileron spring strut adjuster (66)	Turn fully to one side and wind back $2\frac{1}{2}$ turns.

54. **Starting the engine**

(a)	Engine starter master switch (50)	ON. Mk. 4F compass and artificial horizon operating.
	Booster pump switch (54)	ON. Check fuel pressure warning light out.

(b) (i) Open the H.P. cock and press the starter pushbutton (37) to fire the cartridge. The r.p.m. will rise rapidly to approximately 1,500 r.p.m., when light-up should occur. The r.p.m. will then rise until idling speed is reached. If light-up does not occur until the r.p.m. have fallen below 1,000, excessive j.p.t. may result, in which case the H.P. cock should be set OFF before the limit is reached.

(ii) A better start can be obtained by setting the throttle about half-way open; if this is done, the j.p.t. must be watched carefully and the throttle eased back when the temperature starts to rise.

(c) If the engine does not start correctly it will be in one of the following circumstances:—

(i) *Cartridge fails to fire*
If a cartridge does not fire, close the H.P. cock and wait at least 15 seconds before re-opening it. The starter pushbutton will be held electrically in the depressed position and will return to the starting position only at the end of the automatic starting sequence. The remaining cartridge may then be fired after re-opening the H.P. cock.

(ii) *Engine fails to rotate*
If the engine does not rotate or does so at low r.p.m. and there is a heavy discharge of yellow smoke from the starter exhaust for a period of approximately 10 seconds, the safety disc has probably blown. The H.P. cock should be closed and the cause of failure rectified before attempting a further start.

(iii) *Failure to light up*
If the starter accelerates the engine normally but the r.p.m. continue to drop below 1,100 without any indication of light-up, the H.P. cock must be closed before the r.p.m. have fallen below 1,000. If the engine is allowed to light up below this speed, there is a risk of damage to the tailplane from possible torching and, in any event, the start will be slow and laboured, with a risk of exceeding the j.p.t. limitations. Also, if the r.p.m. are allowed to drop below 1,000 before closing the H.P. cock, a wet start is likely on the next attempt. If the engine rotates but the r.p.m. subsequently drop and *remain at approximately 1,200 r.p.m.* the H.P. cock must be closed at once.

(d) No attempt should be made to restart until the compressor has stopped turning.

(e) Two successive failures to start indicate a fault which should be investigated before a further start is attempted.

(f) After any failure to start, it is essential that the ground crew depress the tail and remove surplus fuel from the jet pipe; if fuel has been drained on to the ground, the aircraft should be moved to another position.

(g) The cartridge breeches should not be reloaded until they have cooled down. Expended cartridges can, however, be removed and the breeches left open to assist in cooling.

55. **Checks after starting**

Engine idling speed	2,800–3,200 r.p.m.
J.p.t.	450° idling maximum.
Engine fire warning light	Out.

To avoid draining the batteries, open up to generating r.p.m. (approx. 4,400) and then check:—

Generator warning lights	Both out.
Aileron power warning light	Out.
Flight instruments	Check and set. Compare Mk. 4F compass with E.2A.
Hydraulics	Test flaps and airbrakes.
V.H.F.	As required.
Pressure head heater	As required.
Brake pressure	Pressure 450 lb./sq. in. or sufficient for taxying and supply increasing.
H.P. pump isolating switch	Test (see para. 47 (d)).

56. **Taxying**

The brakes are powerful and must be used with care. On wet or icy surfaces it is easy to lock the wheels and great care must be used under these conditions.

57. **Checks before take-off**

Trim	Aileron: neutral. Elevator: neutral (clean or with empty tip tanks) ½ div. nose-down (full tip tanks)
Airbrakes	IN.
Fuel	H.P. and L.P. cocks on. Contents. Booster pump on. Pressure warning light out. H.P. pump isolating switch ON.
Flaps	Up, or 20° if full tip tanks are carried.
Instruments	Check and set. Mk. 4F compass switch ON. Pressure-head heater ON.
Oxygen	ON. Reaching mask.
Hood	Shut, handle locked. Lanyard (if fitted) attached to handle. Hood seal cock OFF.
Harness	Tight and locked.
Flying controls	Aileron selector in POWER. Warning light out. All controls full and correct movement.

58. **Take-off**

NOTE.—The shortest take-off run is obtained by using 20° flap and opening the throttle fully before releasing the brakes; this procedure is recommended if full tip tanks are carried. At aft C.G. positions (e.g. wing-tip tanks full), trim ½ div. nose-down. Care must be taken not to raise the nose too high during the take-off run as the aircraft may fail to accelerate.

(a) Align the aircraft on the runway with the nosewheel straight, release the brakes and open the throttle smoothly to full power.

(b) To keep straight initially, it may be necessary to use gentle braking until, at about 50 knots, the rudders become effective.

(c) Ease the nosewheel off the ground at about 80 knots, taking care not to touch the tail on the ground. The aircraft should be flown off at about 110 knots at normal load and at about 120 knots at maximum load. *Because of the possibility of a wing drop, the aircraft should not be pulled off the ground below the recommended speeds.*

(d) When comfortably airborne, apply the brakes momentarily and raise the undercarriage.

(e) Raise the flaps, if used, turn on the hood seal and cockpit pressure. If COLD is selected, open the louvre

HANDLING IN FLIGHT

59. **Climbing**

(a) The recommended climbing speeds at the various loadings, using 10,250 reducing to 10,100 r.p.m. above 25,000 ft. are:—

Altitude	Clean or with tip tanks fitted but empty		Tip tanks full		Tip and pylon tanks full	
Feet	Knots	M.N.	Knots	M.N.	Knots	M.N.
Sea level ..	360	0.54	350	0.53	320	0.48
10,000	335	0.60	320	0.59	300	0.55
20,000	305	0.66	295	0.65	275	0.61
30,000	270	0.71	260	0.70	250	0.67
40,000	220	0.71	210	0.70	210	0.70
45,000	195	0.71	185	0.70	185	0.70

(b) After take-off the aircraft may be allowed to accelerate to the recommended speed while climbing, provided that this is reached below 5,000 ft. This results in a very small increase in time to height.

(c) Above 40,000 ft., it is important that the correct speeds be maintained; should the speed fall below that recommended, the rate of climb will be severely affected and speed can only be regained by diving the aircraft.

60. **Flying controls**

(a) *Ailerons in POWER*

The powered ailerons make the aircraft light and pleasant to control laterally. As artificial feel is provided by a spring strut in the aileron circuit, the force required varies with aileron deflection and not with speed. Above 375 knots the aileron power control stalls progressively with increase in speed so that, although the initial response is immediate, the rate of roll is limited by the power control stall restricting the amount of aileron applied.

(b) *Elevator*

For small movements in the lower speed range, the elevator is light and effective but becomes very heavy with increased movements. As the mach number is increased it loses its effectiveness.

(c) *Rudder*

The rudder forces, light initially, become moderately heavy at high speeds.

(d) *Trimmers*

(i) *Ailerons*

There is practically no lateral trim change with speed; when in Power, any adjustment which is required should be made with the spring strut adjuster. The electrically-operated trim tab is used in manual control only and must be in the neutral position whenever the ailerons are in Power.

(ii) *Elevator*

The elevator trimmer increases in sensitivity as speed increases and must be used with caution at high indicated airspeeds. At high mach numbers it becomes considerably less effective.

(e) *Airbrakes*

The airbrakes are relatively ineffective at low speeds but are effective at high indicated airspeeds. Buffeting and some pitching must be expected. When pylon tanks are fitted, extension of the airbrakes produces a strong nose-up pitch and associated control column snatch.

(f) *Changes of trim*

(i) Undercarriage down	Slight nose-down.
(ii) Flaps down 0°–30°	Slight nose-up.
(iii) Flaps down beyond 30°	Strong nose-up.

The strong nose-up change of trim when flaps are lowered, necessitates a large forward movement of the control column.

(iv) Airbrakes on extension	Nose-up trim change followed by a nose-down trim change, then a return to trimmed condition.

61. **Flying at aft C.G.**

If fuel fails to transfer from the tip tanks, some instability and elevator hunting may be experienced and stick force per G will be very low at altitudes above 20,000 ft. It is recommended that, before landing, all stores *except ammunition* are expended and that the internal fuel is used down to approximately 540 lb. (68 gallons).

62. **Flying at reduced airspeeds**

Reduce speed to 150 knots and lower 30° flap.

63. **Flying with hood open**

The hood can be opened in flight provided that a speed of 150 knots is not exceeded. The hood winding handle must be grasped tightly to stop the hood from running backwards violently onto its stops.

64. **Flying in turbulent conditions**

When flying in conditions of severe turbulence, speeds should, if practicable, be kept within the following band:—

(a) Up to 15,000 feet .. 300–350 knots.

(b) Above 15,000 feet

Upper limit	0.7M
Lower limit	300 knots at 15,000 feet reducing to 200 knots (0.7M) at 40,000 ft.

NOTE.—Even within this speed band, control may be marginal above 25,000 feet.

65. **Stalling**

(a) Stalling speeds are found to vary considerably, dependent on the way the stall is approached (small amounts of G increase the stalling speed considerably) and the condition of the aircraft. The precise stalling speed at certain weights and in certain configurations is difficult to determine, because of fluctuation of the A.S.I. needle at speeds around 90 knots.

(b) The following are the approximate stalling speeds in knots for a typical aircraft:—

	U/C and flaps UP	U/C and flaps DOWN
Typical service load (Full tip tanks, full internal fuel and ammunition)	105	90–95
Typical landing weight (Empty tip tanks, 100 gallons fuel and no ammunition) ..	100	85

(c) With the throttle closed, there is little or no warning of the approach of the stall in any configuration. At the stall, the nose will drop gently and a wing may drop slowly. This may be accompanied by mild buffeting, increasing in intensity as the control column is held back, and fluctuations of the A.S.I. needle. If the aircraft is stalled with the throttle partially open, simulating typical approach conditions, considerable buffeting is usually experienced before height is lost and any wing dropping is rather more violent. There is no tendency to spin.

(d) Use of the airbrakes does not affect the stalling characteristics or speeds.

(e) At any time when G is applied, warning of the approach of a stall is given by buffeting and continued movement of the control column results in either wing dropping. Recovery is immediate on release of the backward pressure on the control column.

66. **Spinning**

Intentional spinning is prohibited but, if an unintentional spin occurs, normal recovery action is effective. The characteristics of the spin are rapid rolling about the longitudinal axis with the nose up for the first 1–1½ turns and then the nose dropping until the spin stabilises with the nose well down. When applying normal recovery action, care should be taken to ensure that the ailerons are neutral and that the control column is moved slowly and progressively forward *only until rotation ceases*. Vigorous recovery action is to be avoided. If the undercarriage and flaps are down they should be raised. The recovery from a spin to port will normally take about ½–¾ of a turn but, in a spin to starboard, the rate of rotation is faster and recovery will take longer (about 1–1½ turns). Since the principal rotation in the spin is in roll, recovery may be completed in an inverted attitude and it is for this reason that the forward movement of the control column should not be continued after rotation has ceased, otherwise the aircraft may enter an inverted spin. On recovery, if in an inverted attitude, it may be advantageous to half roll and ease the aircraft out of the ensuing dive. If the spin occurs at high altitudes, once recovery has been effected the airbrakes should be used to prevent a high mach number being reached. If an inverted spin occurs, the standard recovery should be used but again vigorous action should be avoided.

67. **High speed flying**

(a) The high mach number characteristics may vary slightly from aircraft to aircraft. They also depend, particularly at high altitude, on the angle of dive (rate of increase of speed), on G and on the condition of the aircraft.

(b) The elevator trim can be used at any combination of airspeed, mach number and height. It must, however, be used with care at high indicated airspeeds.

(c) The carriage of wing-tip and pylon tanks does not affect the high mach number characteristics.

(d) The characteristics described below may be experienced at higher or lower indicated mach numbers than those stated, because of variations in machmeter pressure error.

(e) *Behaviour above 25,000 ft.*

(i) The mach number at which the nose-up trim change occurs must not be exceeded intentionally.

(ii) This nose-up trim change will occur at approximately 0.88M above 35,000 ft. and approximately 0.86M below 35,000 ft. The typical behaviour up to 0.88M is described below:—

0.81M–0.83M	Nose-down change of trim.
0.84M	Slight right-wing heaviness, requiring only a small aileron movement to hold. Nose-down change of trim marked.
0.87M	Nose-down change of trim ceases. Slight airframe buffet commences. Slow nose-up change of trim. A push force on the control column has little effect and the mach number drops fractionally when the nose-up trim disappears.

(iii) Above 35,000 ft., if the angle of dive is steepened sufficiently to overcome the nose-up change of trim which occurs at about 0.88M, a progressive nose-down trim change occurs which is difficult to overcome, because of the poor elevator effectiveness which becomes apparent above 0.89M. With the control column held fully back, with a heavy pull force, recovery is slow. Should this condition be reached, care must be taken to ease the stick forward when the nose-up trim change with decreasing mach number (at about 0.88M) is reached, otherwise an excessive pitch-up will result.

(f) *Behaviour below 25,000 ft.*

(i) The mach number at which the nose-up trim change occurs must not be exceeded intentionally.

(ii) Similar characteristics to those given in (e) above are likely to occur but at lower mach numbers. If the angle of dive is sufficient to overcome the nose-up trim change at these altitudes, there is a possibility

that the airspeed limitation will be exceeded. This is because of the delayed recovery caused by the poor elevator effectiveness at mach numbers in excess of those at which the nose-up trim change occurs.

(g) *Recovery*

Recovery from high speed dives should in all cases be initiated by extending the airbrakes and throttling back.

68. **Aerobatics**

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

Roll	270
Loop	370
Roll off the top	370
Vertical roll	400 plus

CIRCUIT PROCEDURE AND LANDING

69. **Circuit procedure**

NOTE.—480 lb. (60 gallons) of fuel should be allowed for circuit and landing. Below this fuel state, large changes of attitude should be avoided.

(a) *Checks before landing*

Airbrakes	IN.
Undercarriage	Lever fully down and safety catch engaged. Three green lights.
Brakes	Pressures, off.
Fuel	Contents. H.P. pump isolating switch OFF (except in an emergency).
Flaps	As required.
Harness	Tight and locked.
Hood	Closed. Hood seal OFF.

(b) *Approach*

(i) R.p.m. should not be reduced below 5,000 on the approach, until certain of making a landing, since below that r.p.m. thrust response is relatively slow when the throttle is opened.

(ii) The turn onto the final approach should be made at about 130 knots. The recommended speeds, in knots, at the runway threshold are:—

At normal landing weight (empty tip tanks, fuel approx. 800 lb. (100 gallons))	100 knots
At emergency landing weight ..	105 knots

(iii) When full flap is lowered, the marked nose-up change of trim requires a large forward movement of the control column to correct it.

70. **Landing**

(a) The landing is straightforward. A large and rapid change of attitude should be avoided. After touchdown, the brakes should be applied with care to avoid locking the wheels, particularly on a wet runway. Continuous and progressive braking is recommended.

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(b) *Overshooting*

(i) Open the throttle smoothly to the power required and put ON the isolation switch. Normally the use of full power is unnecessary and 9,000 r.p.m. will generally be sufficient.

(ii) Raise the undercarriage.

(iii) Raise the flaps; the slow rate of retraction makes it easy to check any tendency to sink.

(iv) The trim change which occurs when the flaps are raised, can be held without retrimming (although the trimmer may be used if desired).

71. **Landing with one full tip tank**

Landing with a full tip tank on one side and an empty one on the other presents no difficulty. The normal threshold speed should be increased by 5 knots.

72. **Instrument approach**

The following speeds, together with the appropriate flap and approximate power settings, are recommended for use during instrument approaches with the undercarriage down. These figures apply to the aircraft with wing-tip tanks fitted but empty.

	R.p.m.	Flaps	Airspeed (knots)
Downwind	8,000	$\frac{1}{4}$	145
Base leg	8,000	$\frac{1}{2}$	120
Glide path	7,000	$\frac{1}{2}$*	115

* When the runway is visible, flaps may be lowered fully and airspeed reduced for landing.

73. **Flapless landing**

(a) The turn onto the final approach should be made at 140 knots. A long, flat approach requiring little power should be made and the runway threshold crossed at 115 ~~120~~ knots.

(b) Because of the difficulty of losing excess speed, reduce to 115 ~~120~~ knots early in the approach, to avoid the possibility of crossing the threshold at too high a speed.

(c) The landing run is not excessive if moderate braking is used.

74. **Checks after landing**

Flaps	Up.
Brakes	Pressure sufficient for taxying.
Cockpit pressure control	OFF.
Pressure head heater	OFF.
Oxygen	Off.

75. **Shut-down procedure**

Allow the engine to idle for 30 seconds and then turn off the H.P. cock. Check:—

Electrical control panel	All switches off.
ACC ISOLATING switch	OFF when generator warning lights come on.
Aileron power selector	MANUAL.
Chocks	In position.
Brakes	Off.
Ejection seat	Safety pin in position.

NOTE.—If the aircraft is to remain on the ground for a long period, the L.P. cock should be closed when the engine has stopped running. This will prevent fuel seeping through the distributor, which could cause a hot start.

FLYING IN MANUAL

76. **Selecting manual**

(a) Intentional manual reversion must only be made at speeds below 0.82M.

(b) If automatic reversion occurs above 0.82M, aileron buffet will be encountered, the severity of which will depend on the amount of G being applied. Use of the trim switch should be avoided, as response above 0.82M is slow and overcorrection is easy.

(c) If hydraulic pressure fails, the aileron control will revert to manual automatically. For practice purposes, manual control can be selected by means of the selector valve on the lower left side of the instrument panel. The valve must be pushed down and turned clockwise to lock in the MANUAL position.

77. **Flying in manual**

(a) When manual reversion takes place, a very slight longitudinal trim change may occur, as a result of the ailerons upfloating.

(b) The aileron forces in manual are very heavy. There will be slight backlash at the control column, because of the dead travel of the servodyne selector valve.

(c) The use of the aileron trimmer for manœuvring the aircraft is not recommended, as its action is so much in advance of the response of the aircraft that it is impossible to check the aircraft laterally when required. In case of malfunctioning, the trim tab actuator can be cut out by tripping its circuit breaker.

78. **Landing in manual**

Landing in manual control is straightforward but, because of the considerable force required and the slow response of the ailerons, a slightly larger circuit will have to be made.

79. **Reselecting power**

To re-select Power, pull out the selector valve and turn it anti-clockwise. Check that the warning light goes out.