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39. 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, airdrops 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 and the undercarriage ground-safety locks must be removed.

40. Management of the fuel system

- (a) The internal tanks and wing drop tanks all feed the engine automatically when the low- and high-pressure fuel cocks are on.
- (b) The booster-pump should be switched ON before starting and left on at all times when the engine is running. Below 20,000 ft. the booster-pump is not essential and failure of the pump, indicated by the fuel pressure warning light coming on, will not cause fuel starvation. Above 20,000 ft. if the light comes on it may not be possible to obtain maximum r.p.m.

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- (c) Transfer of fuel from the wing drop tanks into the fuselage tank begins when approximately 20 gallons have been used from the fuselage tank.
- (d) The capacitor-type gauge should show a fall of approximately 20 gallons, then when transfer begins, should remain constant until the wing drop tanks are empty. It should then fall at the usual rate. In aircraft not embodying Mod. 694 30 gallons are unusable; in aircraft embodying Mod. 694, 5 gallons are unusable.
- (e) With the gauges described in para. 5 (b) (five dials) there should be little, if any, fall in the contents shown by the fuselage tank until the wing drop tanks are empty. The level in the fuselage tank will then fall to the region of 50 gallons before fuel starts to drain from the inner and outer wing tanks. When about 30 gallons are shown on the fuselage tank gauge it will be observed that the level in this tank is falling but that there is no change in level of the inner and outer wing tanks. The pilot can thus tell that no more fuel is passing from the inner and outer wing tanks and that the amount of "usable" fuel remaining in the aircraft is that indicated on the fuselage tank gauge.

41. Cockpit checks

Enter the cockpit, strap in and adjust the seat and rudder pedals. Insert the V.H.F. lead in the socket and ensure that the socket is secure in its clip. Check the flying controls for full, free and correct movement, put the parking brake on and check that pressure is sufficient and, with rudder bar central, equal at each wheel. Check footstep retracted. Check that the ground starter battery is plugged in and switched on and then commence checks from left to right:—

<i>Item</i>	<i>Check</i>
Crowbar	Securely stowed
Drop tanks/bomb carriers jettison lever	Fully down
GROUND/FLIGHT switch (6)	FLIGHT

(b) Starting the engine

- (i) Open the H.P. cock and press the starter push-button, releasing it after two seconds.
- (ii) When light-up is heard, or observed on the j.p.t. gauge, switch ON the auxiliary starting switch. If difficulty is experienced in starting at temperatures below -20°C . put the switch ON *before* starting. If resonance occurs close the H.P. cock slightly and then open it again slowly.
- (iii) When idling r.p.m. $3,000 \pm 200$ are reached check that the j.p.t. does not exceed 600°C . Switch OFF the auxiliary starting switch and the starter master interlinked switches. Close the throttle if it has been set 1 in. open for starting. Have the starter battery switched off and disconnected.

(c) Failure to start

If the burners fail to light up or the r.p.m. do not accelerate to the idling speed, the engine should be shut down as follows:—

- (i) Close the high pressure fuel cock. If the cock is not in the fully closed position fuel will leak past the starter valve, giving insufficient pressure for the next start.
- (ii) Switch off the interlinked starter master switches and the auxiliary starting switch.
- (iii) Have the ground crew depress the tail and remove any fuel from the jet pipe; if fuel has drained on to the ground, have the aircraft moved to another position.
- (iv) Check that the compressor has stopped turning before making another attempt to start. Should the engine fail to start on the second attempt the cause should be investigated before further attempts are made.

43. Checks after starting

Fire warning light	Out
Idling r.p.m.	$3,000 \pm 200$
J.p.t.	600°C . max.
Generator warning light	Out
V.H.F.	As required
Flaps and airbrakes	Test
Instruments	Check altimeter setting. Synchronise Mk. 4F compass and check with E.2 compass (or switch on R.I. compass and synchronise direction indicator). Erect artificial horizon.
Brakes	Pressure. 450 lb./sq. in. or sufficient for taxiing and supply increasing.

44. Taxiing

- (a) The rudders are ineffective at normal taxiing speeds and it is necessary to use brake to turn the aircraft.
- (b) Rapid throttle opening at low r.p.m. should be avoided as it may cause excessive j.p.t. and resonance. Use of excessive power when the aircraft is stationary should be avoided as the downward inclination of the jet efflux may result in melting of tarmac surfaces.

45. Checks before take-off

Trim	Neutral
Fuel	Contents. H.P. and L.P. cocks fully on. Booster pump ON (warning light out).
Flaps	Up or take-off position Air brakes in.

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Instruments	Check and set Pressure head heater ON
Oxygen	On
Harness	Tight and locked
Hood	Lanyard attached. Hood fully closed.

46. **Take-off**

- (a) Align the aircraft on the runway. Open the throttle smoothly and fully.
- (b) When the shortest take-off run is essential, some advantage can be gained by applying the brakes after the aircraft is aligned on the runway, opening the throttle fully, and then releasing the brakes.
- (c) To keep straight initially it may be necessary to use gentle braking, then, as speed is gained, coarse rudder.
- (d) Ease the nosewheel off the ground at about 80 knots. Care must be taken not to get the nose too high or the tail may touch the ground. The aircraft should be flown off at approximately 105 knots at normal load and at approximately 115 knots at maximum load.
- (e) When comfortably airborne brake the wheels and then retract the undercarriage.
- (f) Raise the flaps if used. Turn on the hood seal and the cockpit pressure, if required.
- (g) When wing drop tanks are carried, if the undercarriage is not retracted before a speed of about 130 knots is reached, the airflow may prevent the undercarriage doors from closing. If the indicator shows that the undercarriage is not fully retracted, slight yawing of the aircraft at about 140 knots should lock it up. Where this is unsuccessful, climb to a safe height keeping the airspeed below 175 knots. Select undercarriage down, reduce speed as much as possible and select undercarriage up.

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- (h) When taking off with partially filled wing drop tanks, care must be taken to ensure that the nose is not raised too high during the take-off run and that the aircraft is not unstuck below the recommended speed.

47. **Climbing**

- (a) The recommended climbing speeds, in knots, using 10,200 r.p.m. reducing to 10,000 at 25,000 feet and above, for various configurations are as follows:—

ALTITUDE	Clean	CONDITION		
		2 × 100 Gall. drop tanks	2 × 500 or 2 × 1000 lb. Bombs	2 × 500 lb. Bombs and 8 × 60 lb. R.P's
Sea level	260	240	235	220
10,000	245	225	220	205
20,000	230	210	205	190
30,000	215	195	190	175
35,000	190	175	170	155

- (b) Whilst climbing at full power, the jet pipe temperature may slowly increase to the maximum. It may be necessary to reduce r.p.m. slightly in order to keep the temperature within the limits.

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- (c) Turn on the pressurization at 1,000 feet. If the cockpit has not been pressurized the warning light will come on at about 17,000 feet.

48. **General flying**

- (a) All controls are light, effective and well harmonised, and the aircraft is easy and pleasant to fly. The elevator is powerful throughout the speed range and relatively small stick forces may induce large accelerations. Under some conditions, the elevator is particularly light at high I.A.S. and requires careful use. When carrying wing drop tanks, or when flying without ammunition there is a tendency to tighten in turns at high altitude.

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(b) Changes of trim

Undercarriage up or down	No change
Flaps down	Marked nose-up
Flaps up	Nose-down
Air brakes out	Nose-up
Air brakes in	Nose-down

When wing drop tanks or external stores are carried, the changes of trim induced by the air brakes are more pronounced and increase with speed. At high I.A.S., the trim changes are strong.

(c) Engine handling

Movement of the throttle should normally be made slowly to avoid surging and high j.p.t. The engine may be throttled back fully at any altitude and the minimum pressure valve will ensure that the burner pressure does not fall too low to support combustion. The higher the altitude the higher will be the idling r.p.m. Use of r.p.m. between 7,800 and 8,200 and between 8,800 and 9,200 should be kept to a minimum.

49. Stalling

(a) The approximate stalling speeds in knots, power off, are as follows:—

	Under-carriage and flaps up	Under-carriage and flaps down
At maximum landing weight (10,560 lb.) (full ammo., full internal fuel. No drop tanks or external stores)	90	80
Maximum A.U.W. (13,100 lb.)	105	90

(b) The stalling characteristics are similar for all loads.

(i) With the undercarriage and flaps up, warning of the approach of a stall is given by slight buffeting some

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20 knots before the stall occurs, becoming slightly more pronounced as it approaches. At the stall the nose drops and the A.S.I. fluctuates wildly. If the control column is held back there is pronounced pitching and a tendency for either wing to drop. With power on there is less warning of the stall but an increased tendency for either wing to drop.

(ii) With the undercarriage and flaps down, there is general airframe vibration at all times but some warning is given by slight buffeting which commences about 15 knots before the stall. At the stall there is pronounced buffeting, the nose and either wing may drop sharply and the A.S.I. fluctuates wildly. Continued backward pressure on the control column results in stronger buffeting and an increased tendency for either wing to drop. With power on there is less warning of the approach of the stall but the characteristics are unaffected.

(iii) The air brakes do not noticeably affect the stalling speeds or characteristics.

(c) At all loads, warning of the approach of the stall in a steep turn or in recovery from a dive is given by buffeting and at the stall the aircraft may flick in either direction. Stick forces are light and it is relatively easy to stall the aircraft at low speeds in a steep turn particularly at high altitudes with loadings near the aft C. of G.

(d) In all cases recovery is normal.

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50. Spinning

Intentional spinning is prohibited. Should an inadvertent spin occur, normal recovery action should be initiated immediately. The ailerons must be kept neutral. Although care must be taken when moving the control column forward to avoid excessive negative acceleration it may be found on some aircraft that recovery action will not be effective unless the control column is held *fully* forward for some seconds. This will involve a very steep nose-down attitude in the ensuing dive and the pull out should be made gently. Centralize the rudder immediately rotation ceases to avoid a possible flick into a spin in the opposite direction. If the undercarriage and flaps are down they should be raised immediately. If recovery action is unsuccessful by the time that 10,000 feet is reached the aircraft must be abandoned.

51. High speed flight

NOTE.—The following is a guide to the compressibility characteristics. It is recommended that pilots investigate the effects of compressibility progressively as there may be differences in behaviour from aircraft to aircraft.

(a) General

There is a progressive nose-up change of trim with increase of speed and the trim tab may be used to reduce stick force but should not normally be used above 0.74M; careful use of the trimmer may, however, be made in recovery from high speed dives when, due to high airspeed, large stick forces are encountered.

(b) Behaviour above 25,000 ft. clean aircraft (the mach no. limitation is 0.78M)

(i) The nose-up change of trim commences between 0.71M and 0.76M and may become large enough to require a considerable push force to maintain the dive. Aileron snatching and intermittent wing dropping may also occur at these speeds, combined with a slight airframe buffet which becomes more marked as the mach number increases. The wing dropping can usually be held with aileron but may become uncontrollable about 0.04M above the speed at which it commenced.

(ii) In addition, porpoising due to reduction in longitudinal stability may occur at about 0.78M. During the porpoising the forces required to limit the movement are generally light but may become large, the nose-up part of the porpoising movement necessitating a greater restraining force than the nose-down.

(c) Behaviour below 25,000 feet, clean aircraft (between 25,000 and 15,000 feet the mach no. limitation is 0.78M; below 15,000 feet the mach no./airspeed limitation is 0.76M/435 knots)

(i) At these altitudes the characteristics are similar to those described above, but the aileron snatching is less marked and there is less likelihood of an uncontrollable wing drop. The porpoising, however, is more marked and may become severe very quickly.

(ii) In the compressibility range when airspeeds are high (usually above 400 knots) there may be a nose down trim change, which will increase the dive angle. In shallow dives recovery is immediate with the reduction of speed when airbrakes are used. In steep dives, however, the aircraft decelerates slowly and it is therefore necessary to allow ample height for recovery.

NOTE.—Because of the aggravated porpoising characteristics and the possibility of overstressing the aircraft when the stronger nose-up movement coincides with the recovery from the dive it is recommended that high mach no. practice dives should be shallow and confined to altitudes above 25,000 feet. Below this height entry speeds into dives should be kept sufficiently low to preclude the possibility of attaining mach nos. at which the above characteristics may occur.

(d) Carriage of drop tanks (the mach no./airspeed limitation is 0.65M/390 knots)

The compressibility effects set in at lower mach numbers, and the effects described above may be more severe. It should be borne in mind that, with drop tanks on, there is a marked nose-up change of trim when airbrakes are extended at high indicated airspeeds.

(e) Recovery

The recovery action is:—

(i) Airbrakes out.

(ii) Close throttle.

(iii) Pull out of dive carefully, do not attempt to pull maximum loading until any compressibility effects have ceased.

If recovery action is taken late and the aircraft is porpoising when the airbrakes are used, the porpoising will be temporarily aggravated. This has to be accepted as it is important to obtain the quickest deceleration to a speed at which the aircraft is controllable, to enable the recovery to be carried out with minimum loss of height.

NOTE.—During dives below 25,000 ft. the aircraft gains speed very rapidly. Recovery action should, therefore, be initiated well before the airspeed or mach number limitation is reached.

52. Aerobatics

(a) Until experience is gained the following minimum speeds are recommended:—

Roll	..	..	..	..	..	..	240
Loop	..	..	..	..	..	..	320
Roll off the top	..	..	..	..	..	..	340
Vertical roll	..	..	..	..	..	..	340 plus

(b) Aerobatics are prohibited when carrying external stores or wing drop tanks.

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- (c) The negative G system ensures a supply of fuel for 10 seconds inverted flight.

53. Circuit procedure

NOTE.—1. The aircraft is at the maximum landing weight of 10,560 lb. with full ammunition, full internal fuel but without underwing tanks or external stores.

2. 35 gallons (280 lb.) of fuel should be allowed for the circuit and landing.

(a) Circuit

A power setting of approximately 7,000 r.p.m. will give a circuit speed of 160 knots with undercarriage and flaps up.

(b) Checks Downwind

Brakes	Pressure—operation—off
Airbrakes	In
Undercarriage	Down (below 175 knots) Three green lights
Fuel	Contents
Flaps	As required (below 155 knots)
Cockpit pressure	OFF
Hood seal	OFF
Harness	Tight and locked

(c) Final Approach

The turn on to the final approach should be made at 130 knots and flap lowered when required. When lowered the marked nose-up change of trim necessitates a large forward movement of the control column.

The stick force is not great and can be easily held without the use of elevator trim. The artificial horizon and Mk. 4F compass (or D.I.), however, becomes partially obscured by the control column and care must

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be taken when flying on instruments to ensure that the correct direction and attitude are maintained. A powered approach is necessary to ensure a quick thrust response if it is necessary to open the throttle.

(d) Landing

The runway threshold should be crossed at the following speed:—

Max. landing weight	95 knots
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The aircraft should not be stalled on to the ground, but the rate of descent checked, and when the main wheels touch, the control column moved gently backwards to keep the nosewheel off the ground and to provide maximum aerodynamic braking. The elevator remains sensitive at low speeds and coarse movements of this control must be avoided. When the nosewheel is firmly on the ground continuous or intermittent braking may be applied.

54. Going round again

- (a) Open the throttle fully.
- (b) Retract the undercarriage.
- (c) Climb at 115 knots. Because of a tendency for the aircraft to sink, the flaps should not be raised until a height of 200-300 ft. is reached.

NOTE.—If a roller landing is made there is, on opening the throttle, some delay before full power can be obtained.

55. Checks after landing

Pneumatic pressure	Sufficient for taxiing
Flaps	UP
Pressure head heater	OFF

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56. Stopping the engine

Allow the engine to idle for approximately 30 seconds to stabilize engine temperatures, then turn off the H.P. cock and check:—

Booster pump	OFF
All switches	Off
Ground/Flight switch	GROUND, when the generator warning light comes on
Oxygen	OFF
Brakes	Off

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