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## PART 2 : SECTION 1

### CHAPTER 6

## PRE-FLIGHT CHECKS AND STARTING DRILLS

### Introduction

1. This chapter deals with the checks done before flight and the regulations, precautions, and procedures to be used for starting aircraft engines.

### Checks Before Starting

2. Before an engine is started, even for ground test purposes, the following checks must be made :—

(a) The Form 700 must be scrutinized to ensure that the engine is fully serviceable.

(b) The aircraft should, if practicable, be facing into wind. This precaution will ensure the best possible cooling in the case of piston engines, and, in the case of jet engines, it will prevent hot gases re-entering the engine.

(c) The aircraft should be standing on firm ground. The area must be free from loose objects which could either be picked up by a propeller slipstream, causing damage to the propeller and the under-surfaces of the aircraft, or drawn into the intake of a jet engine. As an additional precaution, guards may be fitted over air intakes not fitted with permanent screens. These guards must be removed before flight. In the case of a jet aircraft with low or inclined thrust lines the aircraft should preferably be standing on concrete, as the supporting surface is subjected to intense heat as well as air blast from the jet pipe.

(d) The aircraft should be so positioned that, while starting and taxiing away, the propeller slipstream or jet efflux will not cause damage by blowing dust, dirt, or other articles into buildings, vehicles, or other aircraft.

(e) Engine, propeller, jet pipe, and air-intake covers, and/or air-intake and jet-pipe blanking plates must be removed before starting. On some jet aircraft, asbestos blankets should be placed over the tailplane to prevent scorching of the surface.

(f) Chocks should be placed securely in front of the main wheels. They should be positioned so that the cords are attached to the inwards facing sides of the chocks, and the cords should then be left extended towards the wing tips (Fig.1). With nosewheel undercarriage aircraft it may be necessary to chock only the nose wheel.

(g) A fire extinguisher of adequate capacity must be at hand in case a fire occurs while the engine is being started.

(h) The cockpit must be checked to ensure that :—

(i) The undercarriage is selected "down".

(ii) The undercarriage is shown as being locked down.

(iii) Brakes are locked on.

(iv) Sufficient brake pressure is available.

(v) All ignition and master electrical switches are off.

(vi) No services are selected which will operate when the engine starts and possibly foul external starting equipment, e.g. air-brakes or flaps.

(j) Piston-engine propellers should be turned by hand through two revolutions to break down the sticky oil film which forms on the cylinder walls, particularly in cold weather. It is specially important to hand-turn radial or inverted in-line engines to prevent damage by hydraulic locks due to seepage of oil or fuel into the lower cylinders. Whenever the propeller is moved, the engine should be treated as "live".

(k) If an aircraft is fitted with an electrical starter system, a starter battery of the correct voltage should be in position. The aircraft batteries should be used for starting in an emergency only.

3. The aircraft should be started in accordance with Pilot's Notes for the particular type of aircraft. If the aircraft is to be flown, the appropriate external and internal checks should be completed before starting.

### External Checks Before Flight

4. Although the properly completed Form 700 is an assurance that the aircraft has been serviced and is in the state indicated by the various columns and pages, the pilot should systematically inspect the outside of his aircraft before flying. Not only is this good airmanship but it also assists the captain to assess the efficiency of the ground crews ; in addition, a thorough external check

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has often revealed unserviceability which, had it gone unnoticed, could have caused subsequent difficulty.

5. Pilot's Notes detail specific items for each aircraft type that should be inspected. In addition the following items should be included where applicable and practical :—

- (a) Fuselage.
- (b) Landing gear.
- (c) Landing lamps, taxi lamps, and navigation lights.
- (d) Pressure heads.
- (e) Wheels.
- (f) Tyres.
- (g) Engines.
- (h) Aerials.
- (j) Airbrakes.
- (k) Slats.
- (l) Flaps.
- (m) Propellers.
- (n) Refuelling points and drop tanks.
- (o) Cockpit hoods and other transparencies.
- (p) Wings and movable control surfaces.

If in doubt about the serviceability of any item, expert advice should be sought.

6. **Fuselage.** The fuselage should be checked to ensure that all inspection panels are secure, not forgetting those in the belly of the aircraft. Any unusual evidence of hydraulic fluid, oil, or fuel leaks should be investigated. Protuberances such as aerials should be looked at to ensure security and freedom from damage; however, anti-icing compounds should not be wiped off the aerials.

7. **Landing Gear.** The oleo-leg extension (allowing for the A.U.W.) should be checked. The whole assembly should be free from mud and slush which could interfere with the operation of micro-switches and cause other faults. Wheel doors should be secure and undamaged. Brake leads should be examined for any signs of leaks or insecurity; they should *never* be tugged to check for security.

8. **Wheels and Tyres.** The wheels should be checked briefly for cracks or other damage. The tyres should be free of cuts or other obvious damage. The amount of creep, if any, that is

present should be checked by reference to the creep marks. It is important that any doubtful feature seen on a tyre should be closely examined and expert advice obtained. Dried mud and stones should be removed to prevent the possibility of wheel unbalance and subsequent marked vibration. Chocks should be in position.

9. **Landing and Taxi Lamps, Navigation Lights.** These items should be checked to ensure that the cover glass is undamaged. Retractable lamps should be in the fully retracted position.

10. **Pressure Heads.** The cover should be removed and the item checked briefly for security and freedom from damage. Static vents, if fitted, should have their blanking plugs removed; there should be no turbulence-producing objects in the vicinity, particularly ahead, of the vent.

11. **Engines.** The height of the engine from the ground determines the number of items that can be checked. In general, all panels should be secure and there should be no evidence of excessive fuel or oil spillage. On piston engines, the exhaust stubs should be free from cracks and corrosion; radiators should be clean, and any partial clogging of the radiator matrix should be investigated. On radial engines the cylinders should present a clean appearance, free from oil and collected dust. If possible all air intakes should be examined for loose objects, and the jet pipes of gas turbines similarly checked for loose articles and any signs of wrinkling or other damage. The jet-pipe thermocouples, if visible, should show no signs of damage or burning. If reheat is fitted to a turbo-jet engine, the reheat assembly should also be free from obvious signs of damage.

12. **Airbrakes, Slats, and Flaps.** These items should be checked for superficial damage; the flaps in particular may have been damaged by slush thrown off the wheels or by excessive speed. Evidence of such damage is shown by dents, wrinkles, loosened rivets, or distortion. Automatic slats should be checked for ease of operation by moving them forward and then re-seating them—the effort required to do both should be the same for each slat.

13. **Propellers.** Beyond looking for oil leaks (on constant-speed propellers) and damage to the blades, there are no further checks for these components.

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14. **Wings and Control Surfaces.** Since the external finish of these components has a profound effect on the performance of all aircraft, particularly those capable of reaching transonic speeds, the surfaces should be clean and smooth. Badly flaked leading edges, insect remains and bird droppings can all affect the handling characteristics to a marked extent. Badly fitting inspection panels are also a source of trouble. The gap between the control leading edge and the shroud extending from the fixed surface should be constant along its length ; any obvious difference in the width of the gap can account for trimming peculiarities. All external control locks must be removed ; when, because of high winds, this cannot be done, the lock must be removed before starting to taxi and the flying controls checked for unrestricted and full movement over their entire range. Attention is drawn to the warning about spring tab installations in Vol. 1, Part 1, Sect. 1, Chap. 9, paras. 16 and 17. The control checks for powered control systems are detailed in Pilot's Notes and are vitally important.

15. **Refuelling Points and Drop Tanks.** Drop tanks should be undamaged and secure, *i.e.* there should be no movement between the tanks and their mountings. On some aircraft, unless the tank fits snugly against the airframe, control and trimming may be affected in certain conditions. Where possible refuelling points should be checked to see that they are properly closed.

16. **Cockpit Hoods and other Transparencies.** All these components should be spotlessly clean and free from cracks and scratches ; a high standard should be insisted upon and maintained. Cracks originate chiefly from the edges of the transparencies and small cracks can result in total failure of the component ; this last consideration is of utmost importance in pressure cabins.

#### Internal Checks Before Flight

17. The purpose of the internal check is to ensure that all the main and ancillary controls are checked before take-off. Particularly with jet-engined aircraft having a high rate of fuel consumption at idling power, as many of the checks as possible, including the pre-take-off checks, should be done before starting the engine.

18. Detailed check lists for each aircraft type are contained in Pilot's Notes for the type and give the order in which they should be done.

Functional checks of flight instruments, oxygen systems, etc., are contained in the relevant chapters of Volume 1 of this manual. The aircraft captain is at liberty to delegate certain checks to other members of the crew (*e.g.* the flight engineer could check the engines, propellers, and refuelling points), but such delegation of duties in no way relieves the captain of his ultimate responsibility.

#### Personnel Permitted to Start Engines

19. Provided that they have been tested and certified as competent by an engineer officer, the following personnel, in addition to pilots, are permitted to start engines ; they may not, however, taxi aircraft.

(a) Aircraft fitter and aero-engine trades—all tradesmen.

(b) Airframe trades—warrant officers, senior N.C.Os., chief and senior technicians.

(c) Instructors of any rank or trade at schools of technical training, provided that they are required to do so in the course of their duties.

#### Regulations Governing Engine Starting

20. All personnel qualified to start engines must observe the following regulations :—

(a) Whilst an engine is being started the pilot's seat must be occupied by a suitably qualified pilot or airman. This seat is not to be vacated while the engine is running, except in emergency or for the minimum period necessary for one person to hand over control to another.

(b) The occupant of the pilot's seat is responsible for the observance of all regulations and precautions for engine starting.

(c) Mechanical means for starting must not be attempted at the same time as hand cranking ; otherwise there is risk of injury to the person operating the handle and a possibility of damage to the engine.

(d) Whenever propellers are turned by hand it should be assumed that, regardless of the position of ignition or master electrical switches, the engine is "live" and liable to start.

(e) When mechanical starters are used, the propeller should not be touched during the starting operation.

(f) Loose clothing, scarves, or headgear, are not to be worn by any assisting personnel outside the aircraft during starting operations.

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(g) Personnel must keep well clear of the propellers, air intakes, and jet pipes during starting, and after engines have started. They are not to approach frontally within five yards of the propellers or air intakes, or within 100 yards directly astern of the jet pipes.

(h) Should a jet engine fail to start at the first attempt, the aircraft should be moved to a new position if the quantity and position of fuel spilt onto the ground constitutes a fire hazard.

(j) Any additional unit flying orders for particular engines must be complied with.

### Starting Drills

21. **Internal Starters.** For aircraft equipped with self-contained internal starters, *e.g.* cartridge starters, the airman or N.C.O. in charge of the starting crew should position himself in front of the aircraft at a point where he can be seen by both the pilot and the starting crew, and has himself an unrestricted view of the danger areas around the aircraft (Fig. 1). At least one

additional airman must be present to assist the airman or N.C.O. in charge to keep a constant watch on the danger areas, to assist if an engine fire or any other emergency occurs, and finally to assist in the removal of chocks. Further airmen may be needed if the particular aircraft or conditions require additional precautions.

22. **Internal Starters Requiring External Assistance to Operate.** The regulations of para. 20 apply here, with the exception that the additional airman/men in the starting crew will give the external assistance required. This assistance may vary from hand cranking to operation of an auxiliary power unit, and the number of airmen required will vary with the equipment used. Hand priming of the engine may also be necessary. The number of airmen required should be the minimum necessary, first to operate the equipment and secondly to ensure that each member of the starting crew does not alter position until the start is complete. Any equipment used must be properly positioned to avoid damage to it or to the aircraft when the engine starts.

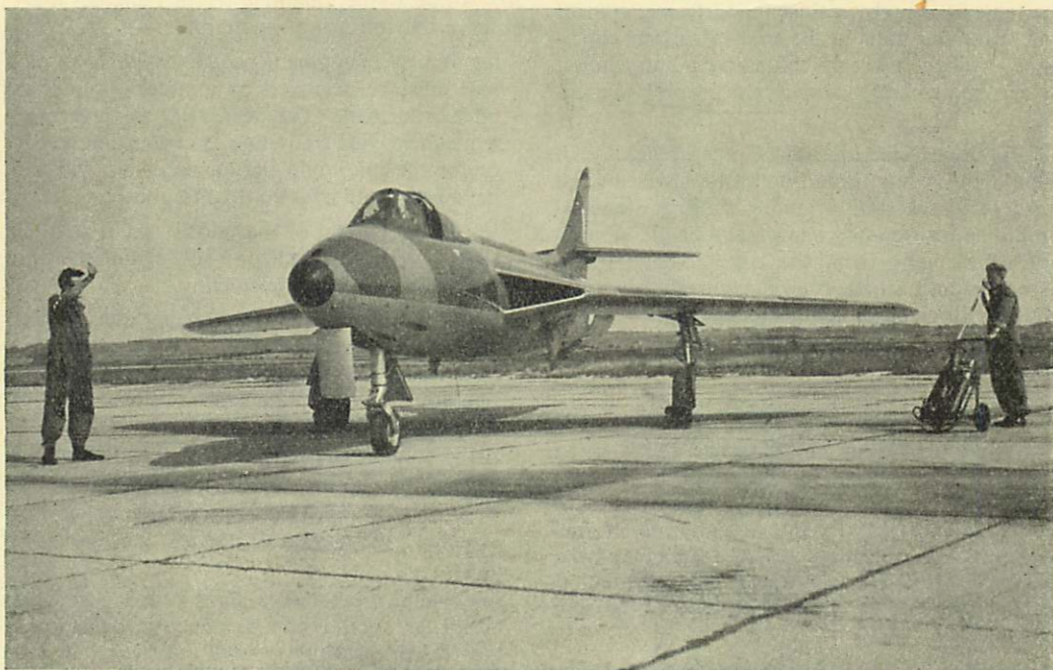


Fig. 1. Starting with a Cartridge Operated Turbo-Starter

The airman is confirming with the pilot that all is clear for starting. The second airman stands by with a fire extinguisher.

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23. **Procedure.** Before initiating the start the pilot must indicate the engine to be started and ensure that all is clear for starting by interrogation of the airman in charge of the starting crew, either verbally or by pre-arranged signal; he must then indicate, in the same way, that he is starting. The airman in charge of the starting crew is to ensure that all is clear, relay signals, and give orders to the starting crew.

24. **Failure to Start.** If the engine fails to start at the first attempt it must be switched off, if this is not done automatically by the starting system. The procedure given in Pilot's Notes for the type should then be completed in preparation for a second attempt to start; no member of the starting crew may touch the engine or propeller until the airman in charge has received assurance from the pilot that the ignition is off or that it is otherwise safe to do so. On aircraft fitted with cartridge starters additional assurance is to be obtained that a cartridge is not selected.

25. **After Starting.** After starting, any auxiliary power unit is to remain connected until otherwise ordered by the pilot. Care is to be taken that the unit is switched off before disconnecting.

### Hand-Swinging Procedure

26. Only a qualified officer or airman is allowed to swing a propeller by hand. The following precautions should be observed when an aircraft engine is started by this method :—

(a) The starting party should consist of two persons : a qualified pilot or airman should occupy the pilot's seat while another man, trained in hand-swinging, should stand in front of the propeller (Fig. 2).

(b) The aircraft should be positioned so that the person swinging the propeller can obtain a firm foothold for both feet.

(c) The propeller should not be touched until both the man at the switches and the man at the propeller are certain that the ignition switches are in the OFF position.

(d) The propeller should be grasped near the tip of the blade (Fig. 2).

(e) The direction of pull should make an angle of not less than 30° with the propeller's plane of rotation.

(f) A propeller released while one cylinder is on compression will swing back sharply, and it should not therefore be released while

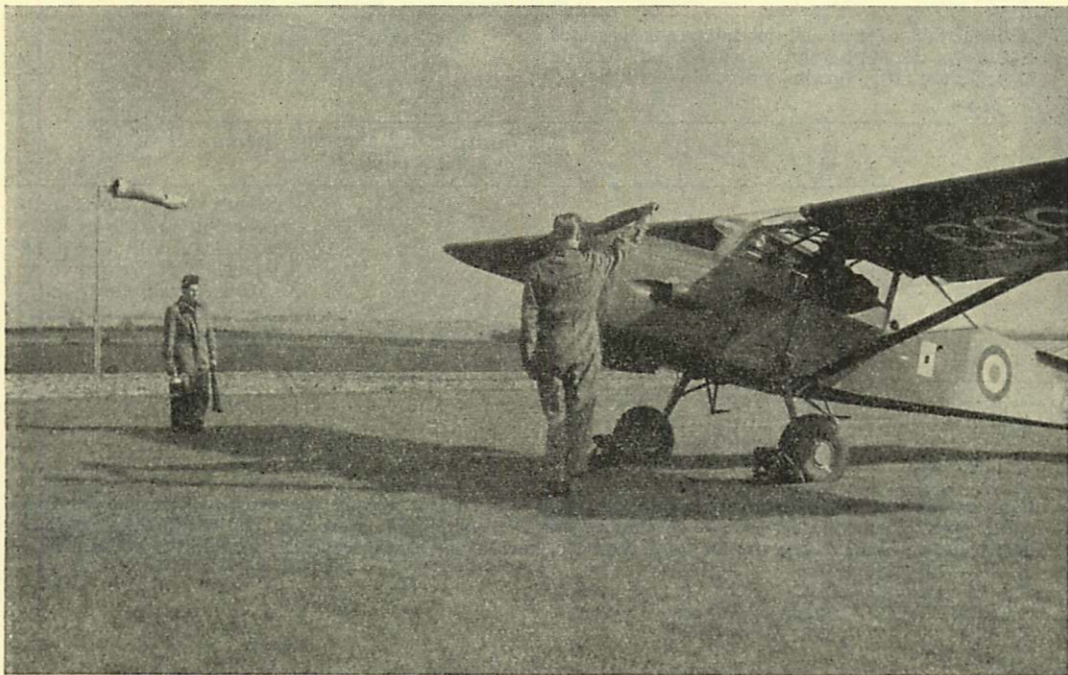


Fig. 2. Hand-Swinging an Auster Mk. 9

Notice the position of the airman about to swing the propeller, particularly the angle that the arm makes with the propeller disc.

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backward pressure is felt. The propeller should not be forced over compression by pressure from the shoulder.

(g) The man swinging the propeller should pull it firmly and quickly over compression, follow through with his hand, and move clear of the

propeller—all in one movement. His body should not enter the propeller arc during any part of the movement (Fig. 3).

(h) The following table sets out the procedure to be adopted :—

<i>Occupant of Cockpit</i>		<i>Person at Propeller</i>	
Action	Says	Says	Action
1. Checks switches off, turns fuel on, sets throttles. Thumbs down.	"Switches off, fuel on, throttle closed."		
2.		Repeats "Switches off, fuel on, throttle closed."	Thumbs down. Primes carb. and stands clear.
3.		"Contact."	Thumbs up.
4. Switches on impulse magneto switch only. Thumbs up.	Repeats "Contact" after switch is on.		
5.			Stands clear, flicks propeller over with one hand until engine fires.
6. When engine fires, switches on other magneto.			
7. If engine fails to start and ensures that both switches are OFF, opens throttle.	rich mixture is suspected. "Switches off, throttle open, blow out."		
8.		"Switches off, throttle open, blow out."	Thumbs down.
9.			Stands clear, turns propeller backwards by flicking it over with one hand until cylinders are sufficiently emptied of mixture; then stands clear. Thumbs up.
10. Closes throttle, switches on impulse magneto. Thumbs up.	Repeat "Throttle closed, contact", after switch is on.		
<p>If an engine has not been run for some time, or if it is cold, it may be necessary to have the propeller pulled over by hand for one or two revolutions with the ignition off, petrol on, and the throttle closed or nearly closed. In this case the following sequence should come before sequence No. 3 in the above drill.</p>			
11. Checks switches OFF, turns fuel ON. Sets throttle. Thumbs down.	"Switches off, petrol on, throttle closed—suck in."		
12.		"Switches off, petrol on, throttle closed—suck in."	Primes carb. Rotates propeller two or three revolutions. Stands clear.

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#### General

27. An external fire extinguisher of suitable capacity must always be positioned close to an aircraft which is being started, in case of fire. Any special precautions or procedures for

starting the engine on a particular aircraft will be given in Pilot's Notes and must be strictly observed. Immediately after starting, engine instruments must be checked to ensure that temperatures and pressures are correct and the fire warning light must be out.

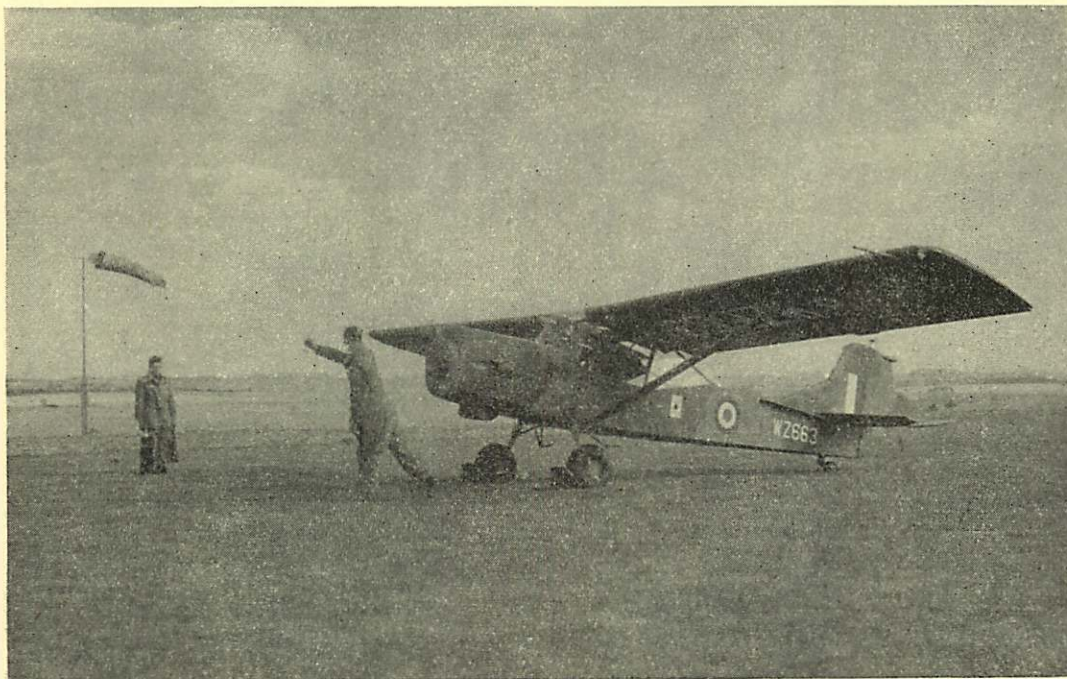


Fig. 3. Completion of the Swing

The airman has "followed through" so that his arm and body have carried clear of the propeller disc.

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