

# RESTRICTED

## PART 2 : SECTION 1

### CHAPTER 2

## REFUELLING

### Introduction

1. A pilot may have to supervise the refuelling of his aircraft. This chapter tells the pilot enough about fuels, oils, appliances, refuelling procedures and precautions for this purpose.

### Fuels

2. **Fuels.** Three types of fuel are in general use :—

- (a) **AVGAS**—Aviation gasoline.
- (b) **AVTUR**—Aviation turbine fuel (kerosene).
- (c) **AVTAG**—Aviation turbine gasoline.

AVGAS is divided into many grades, that used for a particular engine being determined by the compression ratio and maximum boost rating of the engine, the operational role in which it is employed, and the geographical locality in which it is used. The use of AVTUR or AVTAG in gas-turbine engines is determined by the design specification of the particular engine. The

majority of gas-turbine engines may be run on either of these or on AVGAS, subject to the precautions and limitations discussed in para. 9 and detailed in Pilot's Notes.

### Lubricating Oils

3. (a) All piston-engine lubricating oils in general use are labelled as AVOIL. The various grades are distinguished by the letters and grade colours superimposed on the brown colour of the containers. AVOIL uses a mineral or vegetable base and is a natural oil. It is not used in gas-turbine engines.

(b) Gas-turbine engine lubricating oil is known as AVLUB. This oil is manufactured chemically and has no natural source. It is not used in piston engines and is capable of working at much higher temperatures than AVOIL. AVLUB will strip the dope from the surface of any aircraft not provided with a specially resistant finish.



Fig. 1. Fuel Identification Markings Carried on Refuelling Vehicles

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### Identification Markings

4. (a) *Fuels.* With so many fuels and oils in common use, great care is necessary to ensure that aircraft tanks are filled with the correct grades. To facilitate this, the grade or octane number of the fuel is stencilled, in red or black figures and letters not less than one inch high, on the aircraft close to the filling point or connection.

(b) *Lubricating Oils.* Oils are identified by an inter-service designation number (e.g. OM-170, OX-38, etc.). Details are given in A.P.1464C, Vol. 2. Pilots should ensure that their aircraft are replenished with the correct fuel or oil according to the markings on the aircraft or on the travelling copy of Form 700.

5. *Refuelling Vehicles.* The markings shown in Fig. 1 are used to denote the grade of fuel carried by refuelling vehicles; only aircraft fuels are illustrated.

### Refuelling Appliances

6. *Bowser.* The mobile bowser in its various forms is the normal conveyor of fuel from storage tanks to aircraft. There are several types, but the purpose and general layout is basically the same. Fuel is pumped through delivery hoses by the vehicle's main engine or a small donkey engine housed at the rear of the bowser. Handling instructions for the donkey engine are usually printed on the inside of the housing doors. The pumps are sometimes reversible, thus providing a quick method of defuelling when necessary. When defuelling, care should be taken to see that the normally clean side of the fueller filter is not contaminated.

7. *Portable Fuel Tanks.* Portable fuel tanks, usually of 50 gallons capacity, are used in conjunction with a hand-pump for refuelling aircraft when a bowser is not available. Such a combination might be used to refuel when flying from a temporary base.

### Emergency Use of Different Fuels

8. *Piston-Engined Aircraft.* The use of fuel with a lower engine knock-rating than that quoted for a particular engine is liable to lead to detonation at high boost pressures or when using weak-mixture settings. In emergency a high-rating fuel can be used, and details reported on return to base.

9. *Jet-Engined Aircraft.* Jet-engined aircraft will normally be cleared for the use of AVTUR or AVTAG, and in some instances for emergency use of 100/130 AVGAS plus 3 per cent. AVOIL. Where the engine-speed governor is not proof against changes in density, the change in density between these fuels will lead to variation in governed r.p.m. When the density of the fuel used is lower than that for which the governors were set, the engine will tend to over-speed; and when it is higher it will be necessary to readjust the fuel-pump governor or accept a slight loss of power. The use of alternative fuels in aircraft may be subject to the embodiment of certain modifications or to changes in engine handling. Reference should therefore be made to Pilot's Notes for the type of aircraft affected.

10. *Fuel Density.* Pilots must take into account the effect on the range and endurance of their aircraft when using fuel of differing densities (specific gravities). Pilot's Notes for the aircraft type should be consulted whenever fuel of a different density is used. Whenever in doubt of the effects on aircraft performance of using alternative fuels, technical advice should be sought.

### Refuelling Procedure

11. *Refuelling from Refuelling Vehicles.* The following refuelling precautions and procedures are to be observed:—

(a) Check that the grade of fuel contained in the refuelling vehicle is the correct grade for the aircraft concerned.

(b) Check for water and sediment by draining, if necessary.

(c) Ensure that a standard filter is fitted in the fuel delivery system.

(d) Ensure that the refuelling nozzles, funnels, and other equipment used in the refuelling operation are scrupulously clean. They must be completely free from dirt, sand, and other grades of fuel.

12. *Refuelling from Packed Stocks.* It may occasionally be necessary to refuel aircraft direct from packed stocks. This usually involves decanting fuel from cans direct through a Type B refuelling funnel into the aircraft tank. These small containers may sometimes be decanted into a large tank and then pumped through a filter into the aircraft tanks. In an emergency a chamois leather may be used in place of the filter. The relevant precautions contained in para. 11 are also to be observed in full.

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13. **Filling Up with AVOIL.** All equipment must be kept free from sand or dust ; if allowed to get into AVOIL, sand and dust are very detrimental to engine life.

14. **Replenishment Direct from Packed Stock.** Procedure is basically the same as for aviation fuels but the following additional precautions are to be observed :—

(a) A funnel fitted with a gauze of appropriate mesh is to be used when replenishing direct from packed stocks.

(b) Because this filter will not stop water, aircraft oil tanks are not to be replenished by direct decanting of storage containers through the filter funnel. The methods to be used are :—

(i) Pumping (hand-pump) by means of a stand pipe direct from the storage container, through the filter funnel, into the aircraft oil tank. The last two inches of oil should not be used until it has been specially filtered and allowed to settle for 24 hours.

(ii) Decanting from the storage container into an oil can or measure, and thence through a filter funnel into the aircraft oil tank. The

oil can or measure must be scrupulously clean and careful watch kept during decanting for solid matter or water globules in the oil.

#### Refuelling Precautions

15. **Static Electricity.** Bearing in mind the fire risk that is always present during fuelling operations, it is important to check that :—

(a) The aircraft is earthed. In all aircraft, the bonding and tailwheel or nosewheel will provide a path to earth for static charges, but where such bonding is not continuous, *e.g.* aircraft on trestles, a simple electrical circuit is to be completed between the fuel tanks and the earth.

(b) The aircraft, refuelling vehicle, and delivery nozzle should be bonded together as follows :—

(i) Delivery nozzle to aircraft (Fig. 2).

(ii) Refuelling vehicle to aircraft (Fig. 3).

(iii) Refuelling vehicle to earth.

Fig. 3 shows the vehicle to aircraft bonding wire lying alongside the delivery pipe. The earthing wire, connected to an earthing spike, has been wedged securely between a wheel of the vehicle

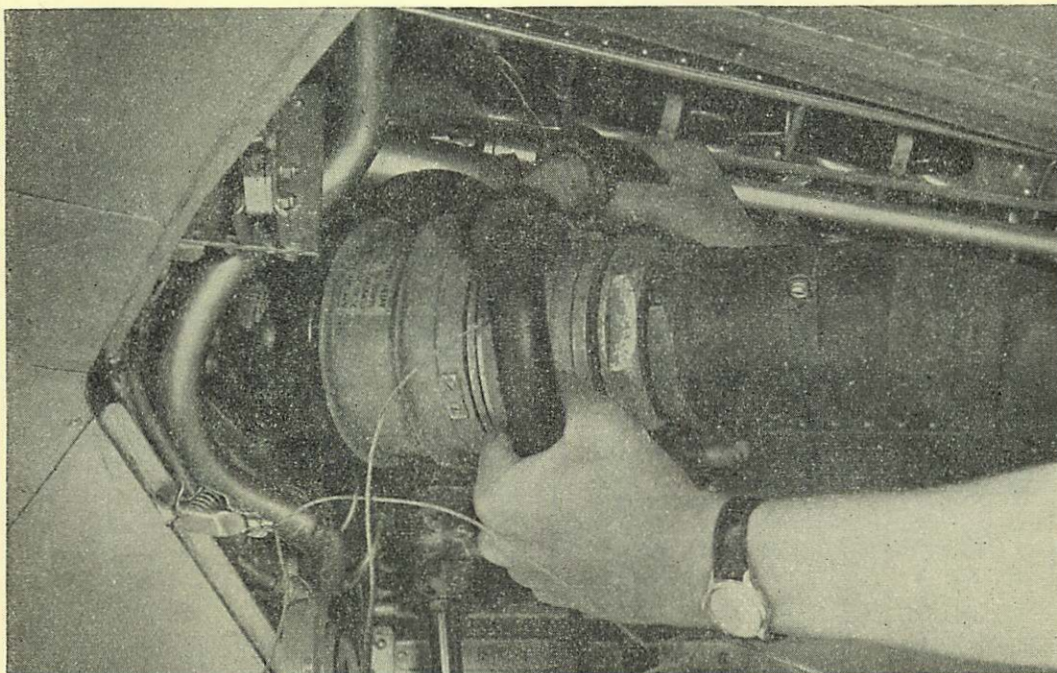


Fig. 2. Pressure Refuelling a Hunter Aircraft

The refuelling point is in the port wheel bay. Note that the bonding wire on the delivery nozzle has been clipped onto the edge of the bay.

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and the concrete surface. Alternatively, where possible, the earthing spike can be pushed into the ground. A metal chain from the bowser, hanging on the ground or the casual placing of the earthing spike on the ground, does not ensure the complete discharge of static electricity from the bowser and must not be used as a means of earthing.

(c) When a funnel is used, it has a suitable connection for bonding it to the tank. If the funnel is fitted with a chamois leather filter, there must be no loose metal parts which are not bonded to the body of the funnel.

(d) When fuelling by hand from small capacity containers, these can be connected to the funnel or some other metallic part of the aircraft which is known to be earthed.

Any temporary connections must be secure and not prone to accidental breakages while fuelling is in progress.

16. Fire. The risk of fire is a very real one during refuelling, and every precaution must be taken to prevent ignition of the inflammable mixture. In addition to the bonding precautions listed in para. 15, the following precautions should be observed :—

(a) Avoid spilling fuel, as this spreads the fire risk over a greater area.

(b) Aircraft are not to be refuelled (or defuelled) in a hangar.

(c) Aircraft are not to be refuelled (or defuelled) with engine running.

(d) Only flame-proof torches are to be used.

(e) Naked lights and smoking are not to be permitted within 100 feet of any refuelling (or defuelling) operation.

(f) Members of refuelling crews are not to carry cigarette lighters or non-safety matches on duty.

(g) Members of refuelling crews should, whenever possible, wear rubber or crepe-soled footwear.

(h) No work on radio or electrical apparatus in the aircraft is to be carried out while refuelling (or defuelling).

(j) When standing close to the aircraft being refuelled, the refuelling vehicle should face a direction that will permit a quick getaway in the event of fire (Fig. 3). A trailer type bowser must not be disconnected from its prime mover while refuelling.

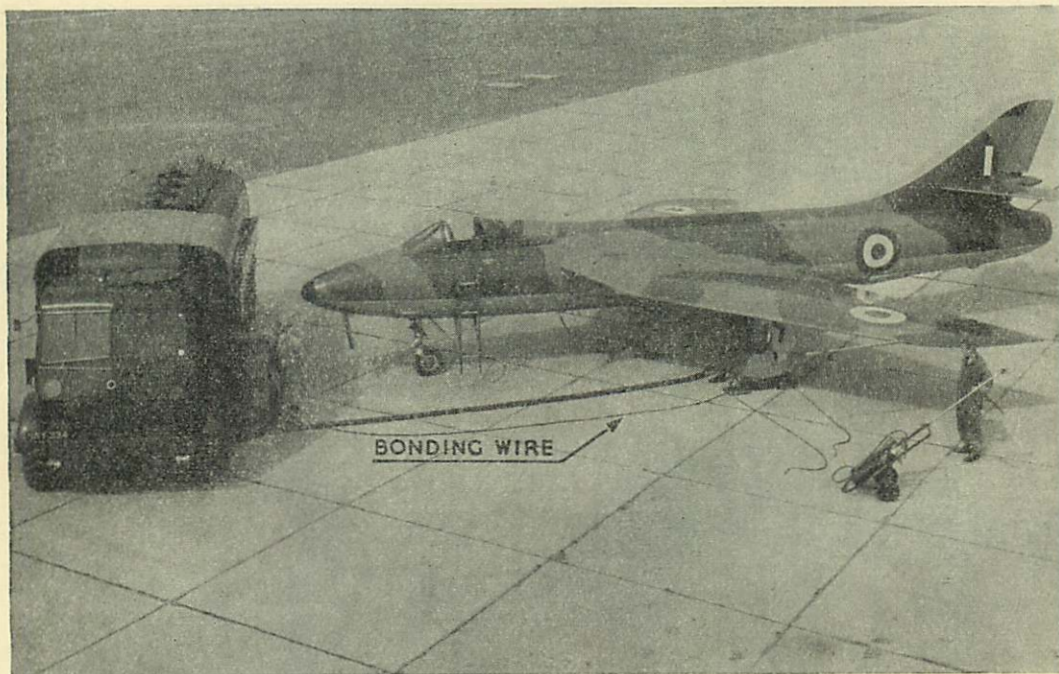


Fig. 3. Disposition of the Refuelling Crew

Note the vehicle-to-aircraft bonding wire clipped to the port undercarriage door ; the fire extinguisher ; the chocks ; and the position of the vehicle.

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17. **General.** Other simple precautions in connection with refuelling are :—

(a) Ensure that adequate and suitable fire-fighting equipment is readily available before starting to refuel.

(b) Oil tanks must not be filled to capacity, as adequate airspace must be left to allow for the expansion and frothing of the oil when heated.

(c) Fuel caps must be replaced correctly after refuelling has been completed.

#### Pressure Refuelling

18. The only basic difference between the system for pressure refuelling on the ground and that employed in flight is the position of the filling point. For either system all tanks or groups of tanks are fitted with shut-off valves, mechanically or electrically operated. The valves give positive fuel shut-off at the desired level and pressure relief arrangements are also incorporated to

protect the fuel lines in the aircraft. These fuel lines are connected together with flexible pipe couplings which allow considerable latitude of alignment, damp out vibration, and maintain a high degree of flexibility within a wide temperature range. With a good symmetrical installation all tanks will fill within seconds of each other and some method of indicating "tanks full" is incorporated.

19. When aircraft are fitted with a pressure refuelling system which can achieve an average rate of 300 gallons per minute there is a quicker turn round, with obvious advantages. However, special refuelling equipment must also be available, which tends to limit the mobility of the aircraft.

20. When pressure refuelling is used no precautions are necessary other than ensuring that the refuelling coupling is connected correctly and that the bonding is complete.

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