# PART I

# DESCRIPTION AND MANAGEMENT OF SYSTEMS

## LIST OF CHAPTERS

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 1—ELECTRICAL SYSTEM

## Contents



## Description

### 1 Generators

(*a*) The power for the electrical, instrument, radio, radar and armament equipment is supplied initially by two 28v/300 amp. engine-driven generators, connected in parallel, which also charge the aircraft battery. They are located in the inboard leading edge of each wing and are fitted with voltage regulators to control the system at 28 volts.

(*b*) The voltage regulators contain an equalising coil; thus as long as both generators are on-line, if the load on No. 1 generator exceeds that on No. 2 the load on No. 1 generator will be reduced and that on No. 2 increased until a state of voltage balance is reached. The converse applies if the load on No. 2 generator exceeds that on No. 1.

(*c*) Over-voltage protection is provided so that in high-voltage fault conditions the offending generator is disconnected from the bus-bar and the corresponding failure warning light comes on. The voltage at which a generator will trip off line is dependent upon the load imposed on the system; under normal load the generator will come off line at $32 \pm \frac{1}{2}$ volts.

(*d*) The generators cut-in at an engine speed of approximately 1,700 RPM and cut out slightly below this speed. Full output is maintained at RPM in excess of 3,000.

**2 AC supplies — inverters**

DC supplies to the system are converted to AC by six inverters, three providing 115V-400 c/s, three phase; two providing 115V-400 c/s single phase; and one providing 115V-1,600 c/s single phase. The distribution of supplies is as follows: —

(*a*) *No.* 1 *inverter*

This is the main inverter and it supplies three-phase AC to the following: —

Horizon gyro unit (HGU)
Mk. 4B compass
No. 5 inverter regulator blower motor
Zero reader (if fitted)
Bomb sight head and computor
Oil pressure indicators
Roller map
Mk. 19 Altimeter vibrator and Mk. 22C Altimeter amplifier.
◀ DV panel heater (Post Mod. 4420)

(*b*) *No.* 2 *inverter*

No 2 inverter acts as a standby for No. 1 inverter but supplies three-phase AC at 115v-400 c/s only to the Horizon gyro unit, Mk. 4B compass, oil pressure indicators, altimeters and DV panel heater (Post Mod. 4420) ▶

(*c*) *No.* 5 *inverter*

No. 5 inverter supplies single-phase AC at 115v-1,600 c/s to the IFF 10. ▶◀

(*d*) *No.* 6 *inverter*

No. 6 inverter supplies single-phase AC at 115v-400 c/s for the LABS

(*e*) *No.* 7 *inverter*

No. 7 inverter supplies single-phase AC at 115v-400 c/s for the LABS stand-by.

(*f*) *Blue Silk inverter*

A type 103A inverter supplies AC at 115v.-400 c/s to the Blue Silk equipment.

◀ NOTE: Post-Mods. 4329 and 4411, Nos. 6 and 7 inverters are removed from the aircraft. ▶

**3 Aircraft battery**

Four 12-volt, 40-amp. hr. batteries, connected in series parallel, are in the lower equipment bay, access to which is through a hinged hatch on the port side of the fuselage.

**4 External supply**

(*a*) The external supply plug is on the main electrical panel in the starboard lower equipment bay. It is connected directly to the bus-bar and all services connected to the bus-bar can be operated from the external supply. It is important that the aircraft battery master switch is set OFF before an external supply is connected.

◀(*b*) Post Mod. 4296 a power supply plug is installed in the starboard mainwheel well bay to allow connection of an external 24-volt power supply for pre-heating the Decca crystal ovens. ▶

**5 Emergency batteries**

(*a*) Two 12-volt batteries connected in series and located in the port console, are directly connected to the detonator circuits (see para. 11), so that these circuits remain operative if the aircraft battery is disconnected. This emergency supply may also be used to operate the turn-and-slip indicator if the normal supplies have failed but its use in this case must be limited to ensure that the operation of the detonator circuit is not prejudiced.

(*b*) A separate 2·4 volt battery located just forward of the rudder pedals, supplies the pilot's instrument panel emergency lamps. Used continuously, it will last approximtely two hours.

**6 Circuit breakers and fuses**

Circuit breakers are covered with their associated equipment. Fuses for individual services are behind a detachable panel on the side of the electrical control panel; behind a panel marked FUSES on the pilot's port console; in the 400 c/s fuse box on the starboard wall of the cabin and on the main electrical panel in the lower equipment bay. Lists of fuses are on the fuse block covers.

### 7 Inertia crash switches

Piston-type inertia crash switches are located one each in the port and starboard equipment bays. When triggered off they operate the fire extinguishers and isolate the aircraft battery and generators from the electrical system, with exception of the following emergency circuits, irrespective of the setting of the battery master switch:—

Inertia crash-switch circuits
Fire extinguisher circuits
Bomb jettison circuits
Navigator's hatch, Canopy, Elevator control } detonator circuits (Pre-Mod. 4072. See para. 11)

### 8 Armament safety plug

An armament safety plug, on the starboard side of the cabin aft of the entrance door controls the normal release circuits to the armament stores with the exception of LABS stores. Until it is connected the dropping/firing controls remain ineffective.

## Controls and Indicators

### 9 Generator controls

Each generator has an OFF LINE switch on the take-off panel. A field circuit breaker for each generator is on the main electrical panel in the starboard lower equipment bay. Warning lights, one for each generator, and a DC voltmeter are on the starboard side of the cabin above the entrance door. The lights illuminate when the generators are off-line or to indicate a generator failure. The DC voltmeter registers the output of whichever supply is connected to the electrical system bus-bar, i.e. generator on line — a nominal 28 volts; aircraft battery — a nominal 24 volts; external battery — a nominal 24 volts; external power supply — a nominal 28 volts.

### 10 AC supplies — inverter controls

(*a*) *No.* 1 *and* 2 *inverters*

(i) *Normal controls and failure indicator*

Nos. 1 and 2 inverters are initially controlled by the port and starboard master starting switches respectively. No. 2 inverter starts immediately the starboard master starting switch is put on. If the port master start switch is on No. 1 inverter starts as soon as an engine-driven generator comes on line; No. 2 inverter then stops. When No. 1 inverter is running normally the EMERGENCY INST. SUPPLY magnetic indicator on the main instrument

panel shows black; the indicator shows white by day and fluorescent by night if No. 1 inverter stops.

(ii) *No. 1 inverter ground test switch*

No. 1 inverter may be tested on the ground with engines stopped by setting the port engine MASTER STARTER switch and No. 1 INVERTER GROUND TEST SWITCH to ON. The test switch is on the electrical control panel to the right of and aft of the pilot's seat; a spring-loaded guard obviates inadvertent selection.

(iii) A circuit breaker for No. 2 inverter is on the lower face of the electrical control panel.

(*b*) *No. 5 inverter*

A circuit breaker, labelled 1,600 CS CONTROL, at the base of the ECP must be closed before No. 5 inverter can be started. No. 5 inverter is controlled by two switches, a START switch, and a STOP switch, on the rear face of the ECP. No. 5 inverter is electrically inter-locked with No. 1 inverter so that before it can be started No. 1 inverter must be running to operate No. 5 inverter regulator blower motor. If No. 1 inverter fails, No. 5 inverter will be automatically stopped. A circuit breaker for No. 5 inverter, not accessible in flight, is in the starboard lower equipment bay.

(*c*) *No. 6 and No. 7 inverters (if fitted)*

No. 6 and 7 inverters are controlled by a LABS A/C SUPPLY NORMAL/STANDBY inverter switch on the ECP. Two magnetic indicators adjacent to the switch, one for each inverter, show black when energised and white when de-energised.

(*d*) *Blue Silk inverter*

The Blue Silk inverter is controlled by an ON/OFF switch on the navigator's front panel.

**11 Aircraft battery controls**

The aircraft battery is controlled by a BATTERY SWITCH on the take-off panel. With this switch ON the aircraft battery is connected to the bus-bar; when switched OFF the battery is isolated from all the electrical circuits except the following:—

Fire extinguisher circuits
Inertia crash-switch circuits
Bomb jettison circuits
Navigator's hatch, Canopy, Elevator control } detonator circuits (Pre-Mod. 4072)

Post-Mod. 4072, the aircraft battery will not supply power to the detonator circuits if the battery is switched off, but they will still receive power from the generators, or if these are not functioning, from the emergency battery.

### 12 Emergency battery controls

The supply from the emergency battery to the emergency lighting is controlled by the Pilot's EMERG. LIGHTS ON/OFF switch on the coaming. The emergency supply to the turn-and-slip indicator is controlled by the guarded TURN & SLIP EMERGENCY SUPPLY switch on the flight instrument panel.

## Normal Operation

### 13 Before starting

The pre-starting and starting checks may be carried out using either the aircraft battery or an external power supply. The aircraft batteries should only be used when the battery voltage exceeds 23 volts under nominal load (one LP pump switched ON for 30 sec.). When the battery voltage is less than 23 volts under load an external power supply should be plugged in until ready to start the engines. The BATTERY MASTER switch must be ON if the checks are carried out on aircraft batteries and OFF during the period an external power supply is connected. During the external checks, ensure that the generator circuit breakers, in the starboard electrical servicing bay, are made.

NOTE: If the aircraft battery voltage is less than 22 volts under load the aircraft must be considered unserviceable.

During the cockpit checks before starting ensure that the armament safety plug is out and that the generator OFF LINE switches are on. Test Nos. 1 and 2 inverters in the following manner:—

| | |
|---|---|
| (*a*) Port master start switch ON | Turn-and-slip indicator OFF flag disappears. |
| (*b*) Starboard master start switch and No. 1 inverter ground-test switch ON | Emergency inst. supply indicator changes from white to black, Artificial Horizon and Mk.22 altimeter flags black |
| (*c*) No. 1 inverter Ground Test switch OFF. | The magnetic indicator should change to white thereby indicating that No. 2 has automatically taken over from No. 1 inverter. |

Navigator

**14 Starting up**

During the start-up the generators should cut in at approximately 1,700 RPM and the failure warning lights should go out. When a generator comes on line the No. 1 inverter will start up and the EMERGENCY INST. SUPPLY indicator will change to black. Check generator output on the DC voltmeter. Maximum output from the generators can be obtained by increasing engine RPM to 3,000, but there is sufficient power available to allow the operation of all electrical equipment at 2,750 RPM.

**15 Before flight**

The operation of Nos. 5, 6, 7 and the Blue Silk inverters may be checked by the navigator, providing a generator is on line supplying 28 volts. The inverters must not be started on load, i.e. the various services that are supplied by these inverters must be switched OFF. The equipment supplied by Nos. 5, 6 and 7 inverters must not be switched on until the associated inverter has been running for at least 10 seconds, thereby ensuring that the voltage and frequency has stabilised. The Blue Silk equipment should not be switched on until its inverter has been running for 30 seconds.

**16 During flight**

Frequent checks must be made in flight to ensure that both generators are on line maintaining 28 volts, and that the EMERGENCY INST. SUPPLY indicator remains black. To prevent corrosion due to lack of use, all inverters should be run for a period during each flight.

**17 After flight**

After landing all inverters may be switched off with the exception of the flight instruments inverters and that for the Blue Silk equipment. These inverters must be left on until reaching the final parking position in dispersal.

## Malfunction

**18 Generator failure**

(*a*) *Single generator failure*

(i) If a generator fails its warning light should illuminate and its protective devices should trip it off line automatically, but the appropriate generator switch must also

be switched off. The average load on the remaining generator must not exceed 300 amps. After load has been reduced, switch the generator on again, once only. If the generator warning light goes out, resume operation of electrical services in stages. If the generator warning light remains on, switch the generator off again.

(ii) If an engine fails or is flamed out, its generator switch must be switched off, and electrical load reduced, because the generator may not come off line at windmilling RPM; however, the voltage will be reduced and the equalising coil will lower the voltage of the other generator, causing a drain on the aircraft battery.

(iii) *Load shedding*

If a generator fails or is switched off, the average load on the remaining generator must not exceed 300 amps. *In cruise conditions proceed as follows*:

1. Do not use more than two fuel pumps continuously.

2. Switch off *one* of: Decca, Blue Silk inverter or No. 5 inverter.

3. Ensure Nos. 6 and 7 inverters and LABS are off.

*In the landing phase*:

4. Use only *one* of: Decca, Blue Silk inverter or No. 5 inverter.

5. Use two fuel pumps per side.

(iv) *Electrical loads*

A table of approximate electrical loads is given in the Flight Reference Cards under ELECTRICAL SYSTEM FAILURES.

(*b*) *Double generator failure*

(i) *General*

If double generator failure occurs, switch off both generator switches and immediately reduce electrical

load to the absolute minimum. No. 2 inverter will take over from No. 1 to supply the horizon gyro unit, Mk. 4B compass altimeters and oil pressure indicators. After reducing load, attempt to regain each generator in turn as at sub-para. (*a*) (i) preceding. Land at the nearest suitable airfield.

(ii) *Fuel considerations*

If double generator failure occurs at high altitude, height should be reduced because the LP fuel pumps will only function as long as power is available from the aircraft battery. If the battery fails there is imminent danger of flame-out without the ability to relight. Height should be reduced below 15,000 ft., if possible, so that the engines may continue to obtain fuel by gravity/suction feed if the LP pumps fail. However, if it is necessary to fly at greater altitude in order to reach the nearest suitable airfield, RPM should be restricted to 7,200 (max.), and maximum height to 35,000 ft. (AVTUR) or 25,000 ft. (AVTAG). (See also Pt. I, Ch. 2, para. 13.)

NOTE: There is a risk of double flame-out, when the battery is exhausted (LP pumps inoperative), if the LP cocks of an empty fuel tank are left on; consequently, consideration should be given to conserving sufficient battery power to switch off the LP cocks of tanks which are at low fuel states.

(*c*) *Overvolting*

Automatic protection against overvolting is provided. The voltage at which a generator will trip off line will depend on the load imposed on the system at the time, but, under normal load conditions, an offending generator should come off line at $32 \pm \frac{1}{2}$ volts. It may be possible to alleviate overvolting up to 32 volts by increasing or decreasing load in small stages.

(*d*) *Low voltage fault*

In rare circumstances, not connected with engine failure or flame-out, it is possible for a failed generator to remain on line with its warning light out. Should, therefore, the voltmeter read less than 26 volts with both engines functioning normally, set the battery master switch and one generator switch to off. If this restores the voltage to 28, leave the faulty generator off, switch ON the battery and proceed as for single generator failure. If, however, the voltage remains low, reverse the generator switches; if this cures the fault, leave the generator switches as set, switch ON the battery and proceed as for single generator failure.

## 19 No. 1 inverter failure

Failure of the No. 1 inverter is shown by the EMERGENCY INST. SUPPLY indicator on the instrument panel showing white by day and fluorescent at night. At the same time No. 2 inverter automatically takes over the supply to the horizon gyro unit, Mk. 4B compass altimeters and the oil pressure gauges. No. 5 inverter will also be switched off automatically by the breaking of the interlocking relay. If it is vital, an attempt may be made to restart the No. 1 inverter in the following manner: —

(*a*) Ensure that No. 5 inverter control switch is OFF.

(*b*) Once only, switch off the port master start switch for approximately one second, then on again. If the inverter starts up and is running normally the EMERGENCY INST. SUPPLY indicator should remain black. Normal operation of its associated equipment and the No. 5 inverter can then be resumed.

(*c*) If this procedure is unsuccessful, no further attempt should be made to restart the No. 1 or No. 5 inverter.

NOTE: If both No. 1 and No. 2 inverters fail, or there is a general power failure, there will be no supply to the AC-operated flight instruments and the oil pressure indicators. In the unlikely event of general power failure it will be necessary to switch on the emergency turn-and-slip electrical supply if under instrument flight conditions. If under visual flight conditions, the battery should be conserved by leaving it switched off until 3-4 mins. before it is estimated that instrument flight conditions will be encountered.

## 20 No. 5 inverter failure

If No. 5 inverter fails it should be switched OFF. Under these circumstances IFF and Rear Warning will be inoperative.

## 21 No. 6 inverter failure

If No. 6 Inverter fails move the LABS A/C SUPPLY switch to STANDBY to switch off No. 6 inverter and bring in No. 7 inverter.

## 22 Blue Silk inverter failure

Failure of this inverter will render the Blue Silk equipment inoperative.

PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 2—FUEL SYSTEM

## Contents



## Description

### 1 Fuel tanks

(*a*) *Fuselage tanks*

Three fuel tanks, of flexible construction, are fitted in the fuselage above the bomb bay. Numbered 1, 2 and 3 from front to rear, No. 1 and No. 2 tanks are self-sealing while No. 3 tank is a crash proof collapsible fuel bag. The tanks are vented to atmosphere through a common pipe terminating at an outlet on the fuselage starboard surface under the tailplane. Flush fitting filler caps, one for each tank, are on the port upper surface of the fuselage.

(*b*) *Wing integral tanks*

An integral tank, divided into interconnected outboard and inboard compartments, is in each wing leading edge outboard of the engine. Each compartment has an electrically heated vent valve and a flush filler-cap on its upper surface.

(c) *Wing tip tanks*

(i) Wing tip tanks may be fitted. No controls are provided, except that for jettisoning, as these tanks feed automatically (and together) under air pressure from the engine compressors, through a float valve in No. 3 tank. A flush fitting filler cap is on the outboard upper surface of each tank.

(ii) The wing tip tanks may be jettisoned by pressing in the guarded FUEL TANK JETTISON button on the port forward panel above the flap position indicator.

(d) *Overload tank*

On aircraft with Mod. 715 embodied provision is made for fitting an overload tank of 300 gallons capacity in the bomb bay. From this tank fuel is fed to No. 3 tank by two booster pumps through two cocks. Although this fuel is fed in through a float valve, owing to booster pump pressure the float valve should not be relied upon to prevent flooding. The switches (when fitted) for the interconnected booster pumps and cocks are on the miscellaneous instrument panel.

## 2 Fuel tank capacities

The effective fuel capacities are approximately:—

| | Gallons | lb. at 7·7 lb./ | lb. at 8·0 lb./ |
|---|---|---|---|
| No. 1 tank ... ... ... | 520 | 4,004 | 4,160 |
| No. 2 tank ... ... ... | 317 | 2,441 | 2,536 |
| No. 3 tank ... ... ... | 540 | 4,158 | 4,320 |
| Integral wing tanks (2 at 450 gallons) ... ... ... ... | 900 | 6,930 | 7,200 |
| *Total internal fuel* ... | ... 2,277 | 17,533 | 18,216 |
| Wing tip tanks (2 at 244 gallons) ... | ... 488 | 3,757 | 3,904 |
| *Total, all tanks* ... | ... 2,765 | 21,290 | 22,120 |
| Bomb bay overload tank ... | 300 | 2,310 | 2,400 |
| *Total overload* ... | ... 3,065 | 23,600 | 24,520 |

NOTE 1: The capacity of the No. 3 tank may be somewhat less than quoted until the bag stretches with use.

NOTE 2: If Mod. 2572 has been embodied the capacity of each integral tank is reduced by approximately 20 gallons.

### 3 Fuel recuperators

(*a*) Two fuel recuperators, one for each engine, are provided to compensate for negative 'G' conditions.

(*b*) Each recuperator comprises a flexible bag contained within a casing, the bag being connected to the fuel delivery line between the integral tank and the engine. Air is fed from the engine compressor to the casing so that it acts on the flexible bag at a constant pressure. The pressure from the booster pumps is greater than this air pressure so that the bag is charged with fuel. If the booster pumps cease to deliver fuel due to negative 'G' conditions, or for any other reasons, the air pressure will collapse the bag which then discharges its contents to the engine. The recuperator will recharge as soon as the booster pumps again start to deliver fuel. Reference to the simplified fuel system diagram will show that the integral LP cocks must be open, whether or not there is fuel in the integral tanks, for the recuperators to be effective and consequently the transfer cock must be shut (NORMAL).

(*c*) The supply of fuel in each bag will feed an engine for about 10 seconds at full power at sea level.

### 4 Fuel feed to the engines

Two electrically-driven LP pumps are fitted in each fuselage tank and one in each integral tank. The pumps on the port side of the fuselage tanks feed fuel through their associated LP cocks and a common collector box to the port engine HP pump; similarly, the pumps on the starboard side of the tanks feed the starboard engine HP pump. The pump in each integral tank feeds fuel either direct to its associated engine or to No. 3 tank, depending on the selected position of the transfer cock.

## Controls and Indicators

### 5 Fuel cock controls

(*a*) A pair of electrically-operated LP cocks is fitted for each fuselage tank. Of each pair one serves the port engine and the other the starboard engine. Two electrically-operated cocks are fitted for each integral tank, one for normal delivery to the engine and the other for transferring fuel to No. 3 tank. The integral tank LP and transfer cocks are inter-connected in such a way that when the transfer

cock is open (i.e. to transfer fuel) the LP cock is closed.

(*b*) Each LP cock and transfer cock is controlled by one of ten switches (appropriately labelled) on the take-off panel and their circuits are protected by circuit breakers on the front face of the electrical control panel.

### 6 Fuel booster pump controls

Each fuel booster pump is controlled by one of eight switches on the engine instrument panel and their circuits are protected by circuit breakers on the front face of the electrical control panel. The switches for the integral and No. 3 tanks are guarded to prevent inadvertent OFF selections.

### 7 Fuel pressure warning lights

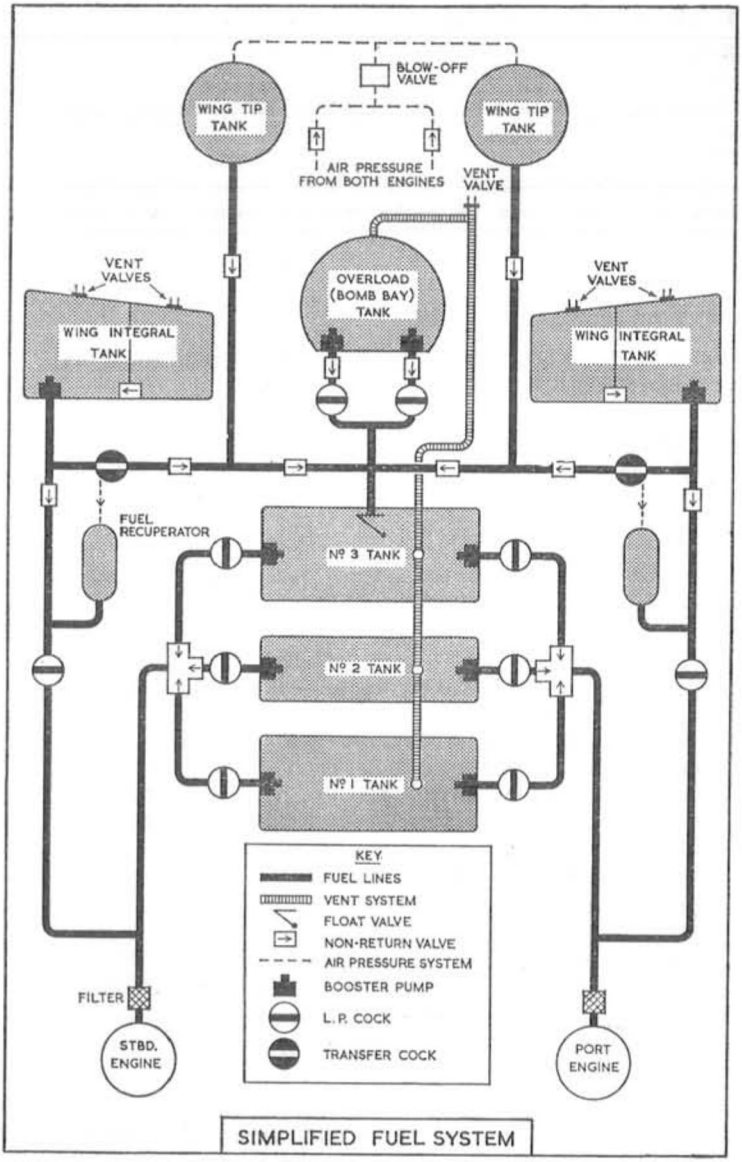
(*a*) Two fuel pressure warning lights, one for each engine, are on the engine instruments panel. They illuminate if fuel delivery pressure from the booster pumps drops below 3—3½ PSI due to pump failure, negative G or shortage of fuel in the tank(s) in use; little warning of flame-out is given.

(*b*) With Mod. 3545 or 3911 embodied the warning lights illuminate at a higher pressure, and provided the integral tank cocks are at NORMAL some 10 seconds warning of flame-out will be given, due to the discharge of the recuperators.

### 8 Fuel contents gauges

Five capacitor-type gauges calibrated in lb. are on the engine instrument panel. The upper gauge indicates the contents of No. 1 tank, the centre gauges from left to right indicate the contents of the port integral, No. 2 and the starboard integral tanks respectively, and the lower gauge indicates the contents of No. 3 tank. No contents gauges are provided for the wing-tip tanks or the bomb-bay overload tank.

NOTE: The rear fuselage tank gauge must be regarded as inaccurate. Pending Mods. 3367 and 3391, errors of up to 700 lb. overreading can occur, although by calibration and servicing the error can be kept below 500 lb. On no account should both engines be run from the rear tank only with a fuel gauge reading below 1,000 lb. When extreme range flights involving low fuel reserves are necessary an accurate estimate of fuel reserves will only be possible if a calibration card is used.




SIMPLIFIED FUEL SYSTEM

## Normal use of the Fuel System

### 9 Checks before starting

Before starting the engines see that the fuel cock and pump circuit breakers on the front face of the ECP are all on. Check the operation of the FUEL COCKS aurally and leave them ON. Set the transfer cocks to NORMAL. Check the operation of each LP pump both aurally and against the fuel pressure warning light. When an overload tank is in use, check its cocks and pumps aurally before start-up and leave the combined cock and pump switches OFF.

### 10 Fuel management drill

(*a*) Use No. 3 and integral tanks for start-up and taxying to minimise fuel venting from these tanks.

(*b*) Leave all fuel cocks (except overload tank cocks) ON throughout the flight and control the use of fuel by the transfer cocks and LP pumps in accordance with the fuel drill given at the end of this Chapter.

(*c*) *General*

(i) Deviations from the correct fuel drill can readily result in aft CG positions. This applies particularly when making repeated circuits and landings with all pumps on.

(ii) When using No. 3 tank, while the fuel from the wing-tip tanks is transferring to No. 3 tank, the fuel gauge for this tank may read full, but under certain conditions of flight the level may fall to 3,500 lb. before transfer has been completed. When the level in No. 3 tank falls steadily below 3,500 lb., it indicates that the transfer of fuel from the wing-tip tanks has ceased. The rate of transfer from each wing-tip tank may vary, giving rise to temporary lateral trim changes.

(iii) In flight, when any booster pump selection is to be made, switch ON the next pump to be selected before switching OFF the pump no longer required. When a tank is empty its booster pumps should be switched off.

(iv) When No. 1 and No. 3 tank booster pumps are on together, the rate of feeding will vary. No. 1 will normally feed faster than No. 3.

(v) Should a fuel pump of the fuel tank in use become uncovered, and no other fuel tank pump is supplying fuel to the engine, air may pass to the engine through the

uncovered pump inlet as well as fuel under gravity or suction feed from other tanks. However, if more than one pump is supplying an engine and one of these pumps is uncovered air should not be passed to the engine as long as the remaining pump remains adequately covered by fuel.

(vi) *Fuel surge*

In a steep climb, or when rapid accelerations or manoeuvres are being made, there is a risk, at low fuel levels, of fuel surge uncovering the pumps in No. 1 and No. 3 tanks. When using the normal fuel drill this fuel surge will not be dangerous, as, with the levels in Nos. 1 and 3 tank so low, No. 2 tank will be on as well. The running of both engines from one tank containing a small amount of fuel should be avoided, particularly at low altitude. Equally, running of each engine from separate tanks where each tank contains less than 500 lb. (1,000 lb. for No. 3 tank) should be avoided. When exercises involve periods of rapid manoeuvring, or concentration on visual flying, consideration should be given to selecting all fuel pumps on for the period as in landing.

(vii) *Fuel aeration or starvation*

Pending Modification 3545, the first indication of fuel aeration or starvation may be a fall in engine RPM but a rise may occur due to the effect of falling fuel pressure on the swirl vane operating mechanism. If action is taken promptly, a flame-out may be avoided by closing the throttle and restoring fuel pressure by selecting a suitable fuel tank pump. If the engine RPM stabilise at or near the normal flight idling RPM, the engine may be accelerated in the normal manner. If the RPM continue to drop below normal idling RPM, close the HP cock and relight in the approved way.

(*d*) *Use of integral tank transfer cocks*

(i) The integral tank transfer cocks must be left at NORMAL (shut), except when transferring fuel to No. 3 tank. Otherwise, with the cocks at TRANSFER, the recuperators are ineffective (see para. 3 above). ⋈

(ii) If an engine fails and cannot be re-lit, the integral fuel on that side can be used for the other engine by selecting the integral tank LP pump ON and the NORMAL/TRANSFER cock to TRANSFER and then using the integral fuel through No. 3 tank.

(iii) When transferring fuel, as the integral tank LP cock will be closed (see para. 4 above) another booster pump on that side must be on to feed the engine.

(*e*) *Reserve fuel*

The last 1,250 lb. in No. 2 tank is the minimum safe allowance for a circuit, an overshoot and a landing. The surge in No. 2 tank does not become dangerous until the level has fallen to 400 lb. but even below this level all fuel can be used provided that all manoeuvres or attitudes which might lead to fuel surge are avoided. In this condition do not rely on the recuperators to compensate for fuel surge caused by mishandling the aircraft.

(*f*) *Use of overload fuel*

When the bomb bay overload tank is full it is important to use this fuel as early as possible. During the cruise after the wing-tip tanks are empty, use No. 3 tank until it is down to 2,500 lb. and then switch on the overload tank pumps and open the cocks. When the No. 3 tank contents gauge reads 3,500 lb. switch off the overload tank pumps and cocks. Repeat this procedure until the overload tank is empty. As there is no contents gauge for the overload tank the only indication that it is empty will be when the No. 3 tank contents gauge shows a steady decrease in contents when the overload tank pumps are on. Therefore, when transferring fuel make a frequent check of No. 3 tank contents gauge, and when this shows a steady drop, switch off the overload tank pumps and continue the fuel drill in the normal manner.

## 11 Unusable fuel

Unusable fuel is not gauged but is included in the basic weight of the aircraft.

## 12 Use of different fuels

◀See Pt. II, Ch. 1, para. 3. ▶

## Malfunction

### 13 Fuel booster pump failure

(*a*) If two or three booster pumps on one side are on, no immediate indication will be given if one pump fails; but if all pumps fail, or if only one pump is on and it fails, the warning light on that side will come on. (See para. 7 above).

(*b*) The effect of booster pump failure depends on altitude, engine RPM, type, temperature and condition of the fuel, the head of fuel in the tanks and it may also vary between aircraft.

(*c*) The HP pumps are designed to operate with a positive inlet pressure; booster-pump failure will cause the HP pumps to obtain fuel by gravity feed and suction only, which may result in a reduction in fuel delivery to the engine. When operating in these conditions, a change in RPM and loss of thrust may be experienced due to swirl vane movement. If the fuel pressure at the engine inlet is sufficiently low, cavitation of the engine pump will occur causing a further loss of thrust and reduction in RPM. In an extreme case, engine surge will be experienced as low as 15,000 feet and flame extinction could occur between 20,000 and 30,000 feet depending on the conditions listed at (b) above.

(*d*) If a booster pump fails, throttle the affected engine to "idling" immediately, wait for the RPM and JPT to stabilise and then switch on another booster pump on the same side. Accelerate the engine carefully; satisfactory operation and freedom from compressor stall will be shown by the RPM and JPT rising together. If, however the JPT and RPM do not stabilise normally, shut down the engine, check that all LP cock and pump circuit breakers are made and re-light as described in Part III, Chap. 4, para. 3.

(*e*) If a double booster pump failure in one tank, or the distribution of fuel, makes necessary the use of fuel by suction and gravity feed, height should be reduced to 15,000 ft. if possible. The engine which is to be fed by suction should be throttled to "idling," the related pump and cock of the affected tank switched on and the remaining pumps/cocks on that side switched off. Accelerate the engine carefully; cruising RPM should be obtained below

15,000 feet. *Erratic running, which will lead to fuel system failure must be avoided.* If maximum range is essential level flight may be possible, using 7,200 RPM max., up to 35,000 ft. on AVTUR or 25,000 ft. on AVTAG, but altitude and RPM must be kept as low as possible. Any climbing should be done using fuel from tanks with serviceable pumps; this applies equally when landing, to avoid the possibility of having to overshoot using suction feed, which is undesirable. *Any use of gravity/suction feed must be reported.*

**14 Bombs hang-up**

(*a*) If a hang-up occurs on a forward station, keep the fuel level in No. 3 tank higher than in No. 1 by 1,000 lb. for each 1,000 lb. of bomb hang-up.

(*b*) If a hang-up occurs on the rear station, keep the fuel level in No. 1 tank higher than in No. 3 tank by 1,000 lb. for each 1,000 lb. of bomb hang-up.

(*c*) If all bombs hang-up, or a hang-up occurs on the mid-station, use the normal fuel drill.

(*d*) If internal stores on the rear station hang-up when wing stores are being carried, wing stores or tip tanks must be jettisoned.

# FUEL MANAGEMENT DRILL FOR ALL SORTIES

| CONDITION | TANK POSITION | | | | | |
|---|---|---|---|---|---|---|
| | Integrals | | No. 3 | No. 2 | No. 1 | Wing Tips |
| | Cocks | Pumps | Pumps | Pumps | Pumps | |
| 1. Start up and taxy | ON and NORMAL | ON | ON | OFF | OFF | Full |
| 2. Take-off and climb | ON and NORMAL | ON | ON | ON | ON | Full |
| 3. When No. 1 tank reads 3,500 lb., No. 2 tank reads 2,000 lb. and the integral tanks show a drop (switch off relevant pumps when figures reach those quoted) | ON and NORMAL | OFF | ON | OFF | OFF | Feeding |
| 4. When No. 3 tank reads 3,500 lb. keep No. 1 and 3 tank contents equal | ON and NORMAL | OFF | As reqd. | OFF | As reqd. | Empty |
| 5. When No. 1 and No. 3 tanks read 1,000 lb. | ON and NORMAL | ON | OFF | OFF | OFF | Empty |
| 6. When integrals read 500 lb. | ON and TRANS. | ON | ON | OFF | OFF | Empty |
| 7. When integrals are empty keep No. 1 and No. 3 tanks contents equal. ▶◀ | ON and NORMAL | OFF | As reqd. | OFF | As reqd. | Empty |
| 8. When No. 1 and No. 3 tanks read 500lb. (See Note 3) | ON and NORMAL | OFF | ON | ON | ON | Empty |

NOTE 1: For sorties which require less than full fuel load the fuel load is adjusted by varying the contents of the fuselage and wing tip tanks. The fuel carried in the fuselage tanks must be disposed proportionally to the tank capacities. The integral tanks must be filled for every sortie, except when carrying out flight trim checks in accordance with A.P.4326F, Vol. 1, Sect. 2.

NOTE 2: When carrying out LABS manoeuvres each engine should be fed by at least two fuel booster pumps to avoid the possibility of flame out if a booster pump fails. Revert to the normal fuel drill on completion of the manoeuvre.

▶◀

◀ NOTE 3: Because of fuel gauge unreliability, if mods. 3367 and▶ 3391 are not embodied, amend condition 8 above to read "When No. 1 tank reads 500 lb. and No. 3 1,000 lb".

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 3—HYDRAULIC SYSTEM

## Contents



## Description

### 1 General

A hydraulic pump on each engine draws fluid from a reservoir (capacity 2 galls.) at the starboard side of the upper equipment bay. A hand pump is installed to the right of the pilot's seat for manual operation of the services. A stack pipe in the reservoir ensures a reserve of fluid for use with the handpump. Main and brake pressure gauges are on the miscellaneous instrument panel.

### 2 Pumps and services

(*a*) The two engine-driven pumps deliver fluid to the system for operating the:—

Undercarriage
Flaps
Wheelbrakes
Airbrakes
Bomb doors

(b) The handpump works in conjunction with the hydraulic GROUND/FLIGHT cock situated near the front of the bomb bay roof on the starboard side. When the

cock is at FLIGHT the handpump can be used to operate only the undercarriage and the bomb doors and to charge the wheel brakes accumulator. With the cock at GROUND the handpump can be used to operate all services. The cock is normally wire-locked in the FLIGHT position. The handpump handle can be stowed in clips aft and above the entrance door or under the folding seat; it must be in position on the pump at all times during flight except when the folding seat is occupied, when it should be in position for taxying, take-off and landing only.

(*c*) A second GROUND/FLIGHT cock, adjacent to the wheelbrakes accumulator, is provided to permit operation of the nosewheel, independently of the main undercarriage, for servicing purposes.

### 3 Accumulators

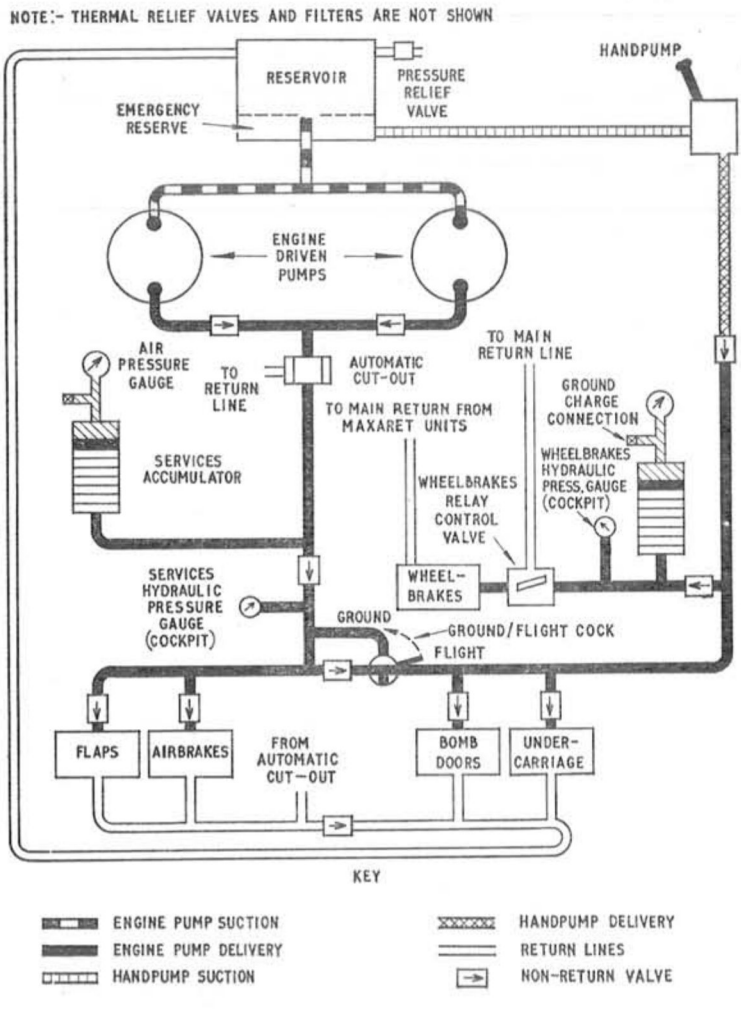
(*a*) There are two accumulators in the system; one for the wheelbrakes is in the fuselage just forward of the bomb bay and that for the undercarriage, flaps, airbrakes and bomb doors is in the starboard wing. The air pressure gauge for the brake accumulator is in the bomb bay on the forward bulkhead and that for the wing mounted accumulator is in the starboard wheel well. These gauges should read 1,350 (+50, −0) PSI at +5°C, when there is no pressure in the hydraulic system. For correct pressures at higher temperatures see Leading Particulars.

(*b*) A cut-out in the hydraulic pump delivery circuit maintains the working pressure in the accumulators and system at 2,200 to 2,700 PSI, while thermal relief valves in all circuits except the wheelbrakes operate when pressure in the line to a service increases, for any reason, to more than 3,350 to 3,550 PSI.

## Controls

### 4 Controls

The electrically-actuated selector valves for all services, other than that for the wheelbrakes which is mechanically operated, are controlled by switches in the cockpit. If electrical failure occurs provision is made for mechanical selection of undercarriage lowering and bomb doors opening. Details of these controls are given in Chapters 5 and 11.




**Simplified hydraulic system**

## Normal Management

### 5 External checks

Check the accumulator pressure gauges in the bomb-bay and starboard wheel well for minimum pressure (see para. 3(a)). The GROUND-FLIGHT cocks must be wire-locked at FLIGHT.

### 6 Before starting the engines

Check the operation of the hand-pump against the wheel-brake hydraulic pressure gauge.

### 7 Checks during starting

**WARNING:** The flaps must not be operated when external aileron locks are in position.

Start the port engine first and note that the pressure on the main and wheel-brake pressure gauges rises to 2,700-2,750 PSI Then operate a hydraulic service and note on completion of the operation that the hydraulic pressure builds up again to 2,700-2,750 PSI.

### 8 After starting

When both engines have started, check the operation of the airbrakes and flaps and note on completion of these checks that the hydraulic pressure builds up again to 2,700-2,750 PSI.

### 9 Checks during shut down

Stop the port engine first and before stopping the starboard engine operate a hydraulic service and subsequently note that the hydraulic pressure builds up again to 2,700-2,750 PSI.

## Malfunction

### 10 Hydraulic failure

(*a*) A failure may be assumed if the reading on the pressure gauge is below 2,200 PSI and fails to build up. If hydraulic failure occurs the flaps and airbrakes will be inoperative. By using the hydraulic handpump, after making the appropriate selection, the undercarriage can be lowered and bomb doors opened, and wheelbrakes pressure can be obtained. Detailed emergency drills are given in the Flight Reference Cards.

◀(*b*) *Spurious warning of hydraulic failure*
Cases have occurred, particularly at high altitude, where the main hydraulic pressure gauge reading has dropped sufficiently to suggest that hydraulic failure has occurred; on returning to low altitude the reading may build up again. If the symptom appears check the operation of the hydraulic handpump; if there are no other symptoms of hydraulic failure and there is firm resistance to operation of the handpump, it may be assumed that the hydraulic system is serviceable and the gauge faulty.▶

add

PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 4—ENGINE SYSTEMS AND CONTROLS

**Contents**



## 1 Avon Mk. 109

The Avon Mk. 109 is a turbo-jet aero engine having a twelve-stage axial flow compressor directly coupled to a two-stage turbine; it gives 7,400 lb. static thrust at sea level. The engine limitations are given in Part II, Chap. 1.

## 2 Engine fuel system

(*a*) *High pressure* (HP) *fuel pumps*

(i) The total output of the dual engine-driven HP fuel pump on each engine is limited by a servo-control system; a governor on each pump limits overspeeding of the engine.

(ii) Control of the fuel flow is effected by: —

1. The throttle, to meter fuel to the burners.
2. A barometric pressure control (BPC) to vary the pump output in relation to engine intake pressure.
3. An acceleration control unit (ACU) to prevent excess supply of fuel to the engine during periods of engine acceleration.

Both ACU and BPC are connected to the servo control system.

(iii) Each pump of the dual pump units is capable of supplying sufficient fuel for full thrust at take-off

## 3 Variable inlet guide vanes and air bleed valves

(*a*) The first row of stator blades in the engine compressor consists of variable inlet guide vanes which assist in imparting swirl to the incoming air. At low RPM the first stages of the compressor deliver more air than is acceptable to the later stages. To prevent instability of flow, i.e. surge, the surplus air is bled off through the air bleed valves and the guide vanes held closed to give an angle of flow acceptable to the first stage blades at low RPM. As the normal flight range of RPM is reached, the air bleed valves close and the guide vanes move progressively to the minimum air swirl position.

(*b*) No noticeable change in RPM or thrust occurs when the bleed valves change over nor do the guide vanes have any noticeable effect on engine operation. However, until the guide vanes reach the fully open position at about 7,400 RPM the compressor is not operating at maximum efficiency. Better specific fuel consumption, therefore, will be obtained by operating above 7,400 RPM.

## 4 Throttle controls

The two throttle levers are on the engine controls quadrant. Friction adjustment is by the larger of the two knurled knobs (turn clock-wise to increase friction) on the side of the quadrant. The starboard throttle incorporates a press-to-transmit push button.

## 5 High pressure (HP) fuel cocks

The HP cocks, one for each engine, are controlled by levers outboard of the throttles. They may be locked in either the ON (forward) or OFF position by the smaller of the two knurled knobs (turn clockwise to lock) on the side of the engine controls quadrant. In the OFF position the fuel supply to the burners is cut off. The levers each incorporate a relighting push button.

## 6 Engine starting, relighting and stopping controls

(*a*) *General*

Each engine is fitted with a triple-breech cartridge turbo-starter, using electrically-fired cartridges, and high energy ignition units. The starting cycle is automatically controlled by cartridge selector switches and time-delay switches.

(*b*) *Starter loading*

(i) After checking that the MASTER STARTING switches are OFF, unlock and open the starter fairings. Each breech cap is then unscrewed and the spent cartridge removed by unscrewing the cap, after releasing the locking ratchet by pressing on the spring-loaded stud in the cap. The cartridge case is removed from the cap by depressing the two buttons in the base. A new cartridge is fitted so that the extractor claws grip the base. The cartridge is then inserted into the barrel and the cap screwed home finger-tight only. If screwed too tight it may be difficult to unscrew subsequently and the starter may be damaged.

(ii) On no account may any work be carried out on the starter while the engine is turning.

NOTE: If Avon Mod. 843 (modified starter fairings) is not embodied do not fly the aircraft with live cartridges fitted if engine anti-icing is to be used.

(*c*) *Starting controls*

The main starting controls are on the starter panel and for each engine consist of a MASTER STARTING switch, starter push button and IGNITION switch. The MASTER STARTING switch must be ON before either the starter push button or IGNITION switches are operative.

(*d*) *Ground starting*

With the turbo-starter loaded, HP cock, master starting and ignition switches ON, pressing the starter push button initiates the following sequence:—

(i) Indexing and firing the cartridge to accelerate the engine to 1,300-1,500 RPM.

(ii) Energising the high energy ignition plugs to ignite the fuel spray and make the engine self-sustaining. The time delay switch holds the starter pushbutton in until the sequence is complete. The engines are stopped by pulling the HP fuel cock levers backwards to the OFF position.

(*e*) *Relighting in flight*

Relighting in flight is accomplished by pressing the relighting pushbutton on the HP cock levers. Pressing the appropriate button by-passes the normal starting circuit and immediately energises the high energy ignition plugs.

## 7 Oil system

Each engine has its own integral oil system of 19 pints capacity, 16 pints of which is oil sump capacity. One pressure and two scavenge pumps maintain a continuous circulation through a cooler and filters to the engine bearings and gears. The filler cap is on the port side of the engine accessible through a removable panel in the lower cowling.

## 8 Engine instruments

The fuel contents gauges, RPM indicators, oil pressure gauges and dual jet pipe temperature gauges are all on the engine instrument panel. The oil pressure gauges operate whenever AC current is available.

## 9 Engine fire extinguishers and inertia crash switches

See Part 1, Chap. 7, paras. 1 and 2.

## 10 Anti-icing system description and controls

(*a*) Hot air for engine anti-icing is ducted from the engine compressor to the double skin at the front of the engine cowl, the engine intake casing and the turbo-starter casing.

(*b*) The systems are controlled by two ON-OFF switches, one for each engine, on the port console. Magnetic indicators beside the switches show white when the systems are switched ON and black when switched OFF. Use of engine anti-icing is covered in Pt. III, Chap. 3, para. 6.

## 11 Engine handling procedures

Detailed information to cover particular aspects of engine handling on the ground and in flight is given in the relevant chapters in Part III, and in the Flight Reference Cards.

PART I
DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 5—AIRCRAFT CONTROLS

## Contents



## 1 Flying controls — general

The flying controls are conventional, and the rudder pedals are adjustable for reach by a central star wheel. The control column carries the wheelbrakes lever, parking catch, airbrakes control switch and the F.95 camera control switch. The top of the right-hand grip carries, from left to right, the G.45 camera button, a flap which may be raised to unlock the trigger on the forward face of the grip, and the bomb/RP button which is covered by a guard. On the aft face of the grip is the tailplane trimmer, covered by a spring-loaded flap. Rudder and aileron trim control switches are mounted on the pilot's port console; the flaps and undercarriage control switches are on the forward sloping part of the port console. Operation of the bomb-doors is covered in Chapter 11.

## 2 Variable incidence tailplane and indicator

(*a*) Changes of tailplane incidence are made by an electrical actuator controlled by two switches (spring-loaded off) on the control column right-hand grip. One is a cut-in switch operated by the thumb flap which covers the sliding tail-trim switch. The tail trim switch cannot be operated without first operating the thumb flap cut-in switch which controls a master relay in the tail trim actuator circuit; this

provides a double safety factor against a runaway tail plane actuator. The trimming switch is moved up to give a nose-down trim and down to give a nose-up trim change. The limits of the tailplane travel are controlled by electric limit switches.

(*b*) The amount of available tailplane trim is limited so that the aircraft is controllable under flight conditions within the limitations if the actuator runs away to the fully nose-down trim position. This applies even if the actuator has overrun the electrical limit switches and has reached the mechanical stops.

(*c*) The elevator trailing edge strips are designed to ensure that even if the tailplane actuator "runs away" to the fully nose-down position the aircraft will be controllable at any speed within the limitations.

(*d*) The tailplane position is shown on a trim indicator on the left of the main instrument panel.

### 3 Aileron trimming control and indicator

(*a*) Both ailerons are fitted with spring tabs. Lateral trimming is by an aileron bias gear, in the form of a spring, to pre-load the control column handwheel in either direction. The required amount of spring loading is applied by an electrical actuator controlled by a 3-position spring-loaded switch on the port console.

(*b*) The aileron trim position indicator is on the left of the main instrument panel.

### 4 Rudder trimming control and indicator

(*a*) The rudder is fitted with a spring tab which also operates as a trim tab. The trim tab is operated by an electrical actuator controlled by two, three-position, LEFT-OFF-RIGHT switches, mounted on the port console. One switch controls the positive supply and the other switch controls the earth return so that it is necessary to operate both switches simultaneously to obtain rudder trim movement.

(*b*) The rudder trim position indicator is on the left of the main instrument panel.

### 5 Control column snatch unit

(*a*) *Pre-Mod.* 3518

To provide unobstructed exit for the pilot in the ejection seat, when abandoning the aircraft, a spring-operated

snatch unit is connected to the control column to move it forward and hold it against the main instrument panel. A lever on the port console shielded by a flap, marked DANGER-CONTROL COLUMN RELEASE, controls the control column snatch unit. Pulling the lever upwards fires an explosive collar which severs the elevator control rod and releases the spring in the snatch unit, which pulls the control column forward against the instrument panel, thus ensuring adequate clearance for the pilot on ejection. Longitudinal control can then only be effected by means of the tail trim switch.

**◀ The CANOPY/SNATCH MASTER Switch on the ▶ take-off panel must be ON before the snatch unit control is operative.**

(*b*) *Post-Mod.* 3518

Post-Mod. 3518 the snatch unit and the elevator control tube explosive collar detonator switch are operated whenever either firing handle on the pilot's ejection seat is pulled. Pulling either firing handle fires a cartridge in a time-release-and-breech unit mounted on the ejection seat guide rail, from which gas under pressure is directed through a pipe to a small piston assembly mounted on the snatch unit: action of the piston releases the snatch unit sear and operates the detonator switch, the detonator collar being exploded before the snatch unit is fully operated. The ◀CANOPY/SNATCH MASTER switch on the port▶ console must be on to render the system live. The modification removes from the aircraft the snatch unit stirrup handle formerly mounted on the port console.

NOTE 1: In flight, accidental release of the snatch unit spring (without operating the lever and severing the elevator control rod) will have little noticeable effect. It will be indicated by the need for a small amount of nose-up trim and an increased pull force necessary to unstick on take-off.

NOTE 2: The snatch unit detonator is operative irrespective of the position of the battery master switch; if the aircraft battery fails it will be supplied by the emergency battery.

## 6 Flying controls external locking gear and picketing points

(*a*) *External locks*

All control surfaces are locked by external clamps with red flags attached. When not in use the clamps are stowed in a

valise in the rear fuselage accessible through the camera hatch.

(*b*) *Picketing*

Ring bolts are provided for picketing and are stowed with the control locking clamps. The bolts screw into sockets, covered by flaps labelled PICKETING POINT, on each main undercarriage fairing and below the fuselage aft of the rear skid. A fourth picketing attachment is provided by the radius lugs on the nosewheel strut.

## 7 Undercarriage controls and indicator

(*a*) *Controls*

Two UP-DOWN pushbuttons on the port front panel control an electrical actuator for the undercarriage selector valve. An electrically-operated lock prevents normal operation of the UP button when the weight of the aircraft is on the wheels but this lock may not function when the weight of the aircraft is low. The lock can be overridden by turning the collar on the UP button clockwise to its stop before selecting undercarriage UP in the normal way. The collar on the up button may rotate through 60° or 90°, according to the type fitted. After becoming airborne this override should only be used if required in an emergency, e.g. engine failure after take-off, as, if the undercarriage has been damaged, subsequent lowering may be prejudiced. An undercarriage SAFETY SWITCH is fitted on the take-off panel or adjacent to the undercarriage selector buttons, and it must be ON or LIVE before undercarriage UP can be selected. On some aircraft this switch is on the port front panel. At maximum RPM the undercarriage should normally retract in 15 seconds (max) and at 6,000 RPM it should lower in approximately 12 seconds.

(*b*) *Undercarriage position indicator*

A standard undercarriage position indicator is on the port front panel outboard of the MASTER SWITCH. The red nose-wheel light illuminates in flight if either throttle is less than one-third open with the undercarriage locked up.

(*c*) *Undercarriage ground locks*

Each main undercarriage leg is locked by a U-shaped sleeve which is fitted to the jack piston-road and is secured by quick-release pins. The nose-wheel is locked by a pin inserted in a hole in the lower end of the radius rod. All the locks have red flags attached.

## 8 Undercarriage emergency lowering control

(*a*) The undercarriage emergency lowering handle is a toggle handle at the top of the port front panel. If the undercarriage selector valve fails in the "up" position, because of an electrical fault, the selector can be moved mechanically to the "down" position by means of the emergency handle. The handle must be pulled fully out until it is retained in the out position by a spring clip. Failure to lock the handle fully out may result in the selector valve taking up a neutral position, thus by-passing hydraulic fluid to the return line and causing loss of hydraulic pressure. If a drop in hydraulic pressure occurs after the undercarriage is locked down by this method, check that the emergency handle is fully out and locked.

(*b*) After the emergency toggle has been used it is not possible to retract or unlock the undercarriage until it has been serviced.

(*c*) If the failure is hydraulic the undercarriage may be lowered by making a normal "down" selection and using the hydraulic handpump to pump the wheels down. If the failure to lower is due to an out-of-sequence retraction the fault *may* be overcome by prolonged use of the hand pump; in such a case considerable force may have to be exerted on the hand-pump.

## 9 Flap control and indicator

(*a*) The electrically-actuated flap selector valve is controlled by a two-position, fully UP or fully DOWN switch lever on the port front panel; the position indicator is adjacent to the switch lever. No provision is made for "in flight" operation of the flaps in the event of electrical or hydraulic failure. At 6,000 RPM the flaps should normally retract in approximately 16 seconds and lower fully in approximately 13 seconds.

(*b*) To prevent inadvertent operation of the flaps when external locks are fitted, a locking pin is inserted in the switch lever guard. When not in use this pin is stowed in a bag on the lower front face of the electrical control panel.

## 10 Airbrakes control

A three-position, IN-MID-OUT switch controlling the actuator for the airbrakes is on top of the control column. The switch is fitted with a spring loaded guard so that this must be moved before OUT can be selected. No provision is made for "in flight" operation of the airbrakes in the event of electrical or hydraulic failure.

## 11 Wheelbrakes control

(*a*) The hydraulic wheel brakes are operated by a lever on the control column. A parking catch is provided. Differential braking is obtained by movements of the rudder bar. Anti-skid (Maxaret) units are fitted to give efficient braking (see Part III, Chapter 3, para. 5).

(*b*) The left-hand gauge of the two hydraulic pressure gauges on the miscellaneous instrument panel shows the available brake pressure in the brake accumulator. Normally 2,200-2,700 PSI, this pressure allows several full applications of the brakes if the main system has failed and in this event the pressure will fall to 1,350 PSI as the brakes are used. At this point the accumulator is discharged of hydraulic fluid and pressure will drop rapidly to zero. Pressure may, however, be restored by means of the hand-pump, provided that fluid is available.

PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 6—FLIGHT INSTRUMENTS

**Contents**



## 1 Compasses

(*a*) *Mk. 4B Compass*

The Mk. 4B compass is operative whenever AC is supplied by either No. 1 or No. 2 inverter. The master indicator is above the navigator's front panel while the compass control panel is on the cabin starboard wall. The pilot's repeater, on the main instrument panel, may also be used as a directional gyro by setting the COMPASS-D.GYRO switch, on the engine starter panel, to D.GYRO. A repeater for the bomb aimer is fitted to the port wall in the fuselage nose.

(*b*) *Magnetic stand-by compass*

An E.2 standby compass is fitted centrally on the forward coaming.

## 2 Pitot and static pressure system

An electrically-heated pressure head on the nose of the aircraft, and two static vents, one on each side of the nose, supply pitot and static presure respectively for the mach-meter, ASIS, altimeters, rate of climb indicator, bomb sight computer, the AMU, and zero reader if fitted. The heater element in the pressure head is controlled by a switch on the take-off panel.

### 3 Horizon gyro unit (HGU)

A Mk. 4A or 4D horizon gyro unit on the main instrument panel provides reference data for the zero reader, if fitted. The instrument, which also fulfils the function of an artificial horizon, will be operated whenever AC is being supplied by either No. 1 or No. 2 inverter. The instrument has a fast erection button at the bottom left of the periphery. An OFF flag appears on the face of the instrument in the event of power failure.

### 4 Turn-and-slip indicator

A turn-and-slip indicator on the main instrument panel is operated from duplicated 24 volt DC supplies having automatic change-over; the two supplies are primarily controlled by the port and starboard master starting switches. Failure of both these supplies will be shown by an OFF flag appearing in the face of the instrument. Should both normal supplies fail the instrument may be connected to the emergency battery (see Part 1, Chap. 1, para. 5) by switching the guarded switch beside the indicator to EMERGENCY; the OFF flag should then disappear.

### 5 Instrument landing system (ILS)

The ILS indicator and marker lamp are on the port side of the pilot's front instrument panel. The control unit is on the navigator's port wall and the master switch is on the cockpit starboard wall above the entrance door. An independent volume control is on the front instrument panel above the machmeter. Power supplies are DC. A circuit breaker marked ILS, on the base of the ECP, must be closed before the equipment can be operated.

### 6 Zero reader system

(*a*) When Mod. 1447 is embodied a Zero-reader system is installed. The indicator is on the instrument panel above the airspeed indicator and the combined course selector and control panel is on the flight instrument panel in the place normally occupied by the radio altimeter limit switch.

(*b*) The system utilises both DC and AC current, the latter being supplied by No. 1 inverter only.

## 7 Altimeters

(*a*) *Radio altimeter*

A low level radio altimeter and associated limit lights are to the left of the flight instrument panel. The limit switch is normally placed centrally on the lower part of the flight instrument panel, but may be on the cockpit starboard wall above the entrance door if Mod. 1447 (zero reader) has been embodied.

(*b*) *Barometric altimeters*

(i) A Mk. 22 altimeter with amplifier unit is on the pilot's main instrument panel. The amplifier unit is powered by AC from No. 1 or No. 2 inverter. A yellow/black striped flag appears in the upper face of the instrument when power is not being supplied.

(ii) A Mk. 19 altimeter with vibrator unit is on the navigator's main instrument panel; the vibrator unit is actuated by AC power from No. 1 or No. 2 inverter.

## 8 Dive/roll indicator

A dive/roll indicator may be installed immediately above the flight instrument panel and an associated yaw/roll on-off switch is on the cockpit coaming.

## 9 Accelerometer

An accelerometer is below the engine instrument panel.

## 10 Outside air temperature gauge

An outside air temperature gauge is on the port side of the navigator's instrument panel. The instrument functions in conjunction with a resistance bulb which protrudes from the leading edge of the main plane between the fuselage and the port engine.

PART I
DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 7—GENERAL EQUIPMENT AND CONTROLS

**Contents**



## 1 Fire extinguishers and warning lights

(*a*) *Engine fire extinguishers and warning lights*

(i) *Engine bay fire extinguishers*

Each engine is served by two extinguisher bottles; one dual-headed extinguisher is in each mainwheel well and one single-head extinguisher is in the wing on the inboard side of each engine. Each bottle is fully discharged in one operation. The dual-headed extinguishers also serve the fuselage fuel bay in crash landing conditions (see sub para. (c) following).

(ii) *Fire warning lights and bushbutton*

Fire extinguisher pushbuttons incorporating fire warning lights, one for each engine, are on the miscellaneous instrument panel. The lights illuminate to indicate an engine fire and remain on until the fire is extinguished by operation of the appropriate extinguishers. A separate TEST ENG. FIRE WARNING pushbutton is fitted to starboard of the pushbuttons for testing the warning lights.

(*b*) *Fuselage fire extinguishers*

A single-headed fire extinguisher bottle is above the aft end of the bomb bay for protection of the fuselage fuel tank bay and, under crash conditions, one head of each dual-headed engine fire extinguisher also discharges into the fuel tank bay.

(c) *Operation of fire extinguishers*

(i) *Engine fire extinguishers*

A fire warning light will illuminate when heat from a fire in the engine bay trips one or more of the resetting fire detectors in the engine nacelles. Pressing the appropriate button will fully discharge both fire extinguishers into the affected engine. When the fire is extinguished the warning light will go out. All fire extinguishers will operate automatically if both inertia crash switches are tripped but part of the contents of the dual-headed extinguishers will be discharged to the fuselage fuel tank bay.

(ii) *Fuselage fire extinguisher*

The fuselage fire extinguisher can be discharged only by the tripping of the inertia crash switches. The dual-headed engine fire extinguishers also discharge part of their contents into the fuselage fuel tank bay when the crash switches are tripped

(d) *Hand-operated fire extinguisher*

A water/glycol hand-operated fire extinguisher is stowed on the cabin starboard wall aft of the entrance door. The extinguishant is non-toxic. It must not be used on electrical equipment carrying a voltage in excess of 600 volts, and for this reason all radio and radar equipment must be switched off before dealing with fires in the cabin. The water/glycol extinguisher is being replaced by a Type 34 BCF extinguisher, the contents of which are non-conducting and virtually non-toxic. It may be used on all classes of fires including electrical fires. ◀Post Mod. 0325/RAFG the extinguisher is on the starboard end-panel of the navigator's instruments panel. ▶

## 2 Inertia crash switches

Piston-type inertia crash switches are located one each in the port and starboard equipment bays. When triggered off they operate all the fire extinguishers and isolate the aircraft battery and generators from the electrical system, with the exception of the emergency circuits quoted in Pt. I, Chap. 1, para. 7, irrespective of the setting of the battery master switch.

## 3 Emergency equipment

A crash axe is stowed under the folding seat and asbestos gloves and a first-aid kit are on the starboard wall just forward of the entrance door. Five pressure cabin leak-

stoppers in envelopes are on the cabin roof hatch, or stowed in three envelopes at the nose station at the starboard side and two envelopes on the navigator's port wall. Three survival pack stowage crates are in the rear fuselage. Access to them is through the rear camera hatch, or, in emergency, by chopping through the fuselage at the points indicated. Post Mod. 0209/RAFG the crash axe is repositioned on the floor beneath the observer's ejection seat.

**4 Cabin window**

A small cabin window is provided on the port side of the navigator's station. A black-out curtain provided for the window is rolled up and stowed away when not in use.

**5 Folding seat**

A folding seat is secured to the cockpit starboard wall just aft of the entrance door by a hinged bracket which allows it to be folded against the wall where it is secured in position by a spring loaded catch. A trigger under the front left hand corner of the seat releases it from the down position. A safety harness is provided, the lap strap being secured to the seat and the shoulder straps to the top fuselage cross member. A head-rest is attached to the cabin coaming tube.

NOTE The folding seat is not stressed for crash-landing.

**6 External lighting**

(*a*) All external lighting circuits are protected by fuses on the electrical control panel.

(*b*) All the external lighting switches are on the pilot's port console. They are, from the left: —

(i) Navigation lights; this also controls the navigation light on the nose of each wing tip tank.
(ii) Taxying lamps switch
(iii) Landing lamp HIGH-LOW-OFF switch
(iv) Identification lights MORSE switch
(v) Identification lights STEADY switch
(vi) External lighting MASTER switch. This must be ON before any of the external lights will function.

(*c*) The taxying lamps are fitted one on each wing tip; the landing lamp is in the port main plane under-surface and the downward identification light is in the under-surface of the rear fuselage hatch.

(*d*) White, flashing, anti-collision lights are on the upper and lower surfaces of the rear fuselage. They are controlled by an ON-OFF switch on the pilot's port console. If the flasher unit fails the lights will remain on and steady until switched off.

## 7 Internal lighting

(*a*) *Nose station*

The nose station is illuminated by a dome lamp with an integral ON/OFF switch. A hand lamp with spring clip and extension lead is provided for use with the bombing instruments. One U/V lamp and associated dimmer switch, mounted over the oxygen regulator, illuminates the compass repeater, if fitted.

(*b*) *Cockpit*

(i) *Normal lighting*

1. Four U/V lamps and twelve red flood lamps are provided to illuminate the instruments and electrical and radio controls.

2. The U/V lamps are controlled by the outboard pair of four dimmer switches on the coaming panel. The port switch controls two U/V lamps illuminating the main instrument panel; the starboard switch controls two lamps illuminating the engine instrument panel and the miscellaneous instrument panel.

3. The red flood lamps are controlled by four dimmer switches, one on the port side above the oxygen regulator, one on, and one below, the port side of the coaming; and one on the starboard side of the coaming. The switch over the oxygen regulator controls three red flood lamps for the forward and aft ends of the pilot's console and the oxygen regulator. The switch on the port coaming controls four flood lamps for the main instrument panel and the standby compass. The switch under the port coaming controls the lamps for the take-off panel and trim gauges. The switch on the starboard coaming controls lamps illuminating the engine instrument panel, the miscellaneous instrument panel and the oxygen contents gauges.

(ii) *Anti-dazzle lighting*

The anti-dazzle lamps, one on each side of the cockpit coaming, illuminating the instrument panels, are con-

trolled by a BRIGHT-OFF-DIM toggle switch with a pyramid-shaped dolly mounted on the coaming panel adjacent to the emergency lights switch, and by an off-BRIGHT switch on the left of the navigator's top instrument panel. Selecting BRIGHT on the navigator's switch overrides any prior selection on the pilot's switch. Owing to the short filament life of the lamps they should only be used when operationally necessary.

(*c*) *Cabin*

General illumination of the cabin is provided by a dome lamp, with a built-in switch, over the navigator's window. A dimmer switch next to the dome lamp controls a red-flood lamp illuminating the oxygen regulator. Two dimmer switches on the navigator's instrument panel control pillar lights illuminating the panel and the starboard coaming. A dimmer switch on the starboard side of the cabin above the oxygen regulator controls an angle-poise lamp which illuminates the bomb aimer's control panels.

## 8 Emergency lighting

Two amber lights are provided for emergency lighting of the pilot's instruments. They are controlled by a switch with a luminous toggle on the cockpit starboard coaming.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 8—AIR CONDITIONING, PRESSURISING, HEATING AND DEMISTING SYSTEMS

## Contents



## 1 Air conditioning system

(*a*) Hot air from the engine compressors is used for cabin air conditioning. The initial supply from each compressor is through an electrically operated gate-valve controlled by one of two ENGINE AIR SWITCHES on the miscellaneous instrument panel.

(*b*) The temperature of the air entering the cabin is governed by a mixing valve controlled by a COLD-OFF-HOT switch, spring loaded to the mid (OFF) position, on the miscellaneous instrument panel. The setting of the mixing valve is shown on the indicator labelled CABIN AIR, above the control switch.

(*c*) With the mixing valve set to fully HOT the hot air is passed direct to the cabin. By moving the mixing valve to COLD the hot air is passed through coolers, one in each inner mainplane leading edge and a cold air unit in the port inner mainplane and thence into the cabin. The proportion of air can be varied between the two extremes by setting the mixing valve to any desired intermediate position.

(*d*) From the common delivery duct into the cabin, the conditioned air is delivered to various parts of the cabin by branch pipes terminating at four louvres, which may be shut off, and five diffusers. Three of the louvres are at the

pilot's station, one on the rudder pedal guard, one on the port front panel and one on the coaming above the entrance door; the remaining louvre is on the port wall at the navigator's station. A diffuser is located forward of each crew member's feet and of the remaining two, one is on the cockpit port wall and the other is on the inboard edge of the navigator's instrument panel. The diffusers cannot be shut off but the flow of the latter two is controllable by rotating the diffuser head.

(*e*) A supply of ventilating air is provided via a small air scoop forward of the canopy and ducted to a louvre on the inboard side of the front panel; the supply may be cut off at the louvre. The system incorporates a simple non-return valve to prevent loss of cabin pressure.

## 2 Pressurising system

(*a*) At about 10,000 feet a master unit and a combined valve unit, which regulates the outlet of air from the cabin according to static pressure, work in conjunction to allow the air conditioning system to build up cabin pressure with increasing altitude until a maximum differential pressure of 3·5 PSI is reached at about 25,000 feet; above this height the differential pressure is constant. The cabin altitude is shown on the altimeter on the miscellaneous instrument panel.

(*b*) Electrical contacts in the master unit operate a warning horn if the cabin pressure drops excessively. A guarded warning horn override switch is adjacent to the cabin altimeter.

NOTE 1: No air will be supplied for either air conditioning or pressurising unless the engine air switches are ON.

NOTE 2: If a fault develops in the air supply from an engine, or if an engine fails, or is closed down, the appropriate engine air switch should be switched OFF.

## 3 Use of air conditioning and pressurising systems

(*a*) *Pre-starting checks*

Check that the engine air switches are OFF and test the operation of the mixing valve over its full range.

(*b*) *Checks after starting engines*

Switch ON the engine air switches and set the mixing valve as required, but see (*c*) below.

(*c*) *Use of mixing valve*

There is no restriction on the ground in the use of fully HOT but if any other selection is required this is restricted to a maximum of 10 minutes and the engines must not exceed 5,000 RPM continuously. If or when the 10 minute limit is reached either select the mixing valve to fully HOT or switch OFF the engine air switches until the aircraft is airborne. In the air there is no restriction in the use of the mixing valve.

(*d*) *Use of engine air switches in flight*

In flight always keep the engine air switches ON so that air conditioning and pressurising is obtained. If an engine fails or is shut-down switch off its engine air switch.

(*e*) *Checks after landing*

After landing set the mixing valve to HOT, switch off the engine air switches and open the DV panel momentarily to relieve any residual cabin pressure before the entrance door is opened.

## 4 Malfunctioning of the pressurising system

(*a*) *Loss of cabin pressure*

A fall in cabin pressure will cause the warning horn to sound; this can be isolated by use of the guarded override switch. The following table gives the approximate operating ranges of the warning horn.

| Aircraft altitude | Cabin altitude | Cabin altitude at which warning horn sounds |
|---|---|---|
| 20,000 | 12,000 | 15,300 |
| 30,000 | 16,500 | 21,800 |
| 40,000 | 21,500 | 28,000 |
| 45,000 | 23,500 | 31,000 |

Flight may be continued at a cabin altitude of less than ◀25,000 ft. but it must be remembered that if the warning horn has been isolated a careful watch must be maintained to ensure that further loss of pressure does not cause the cabin altitude to exceed this figure. If range is not of paramount importance, it is recommended that subsequent to a partial pressurisation failure a descent is made to an actual altitude not exceeding 25,000 ft. ▶

(*b*) *Pressurisation failure above* 40,000 *ft.*
If pressurisation failure occurs at heights above 40,000 ft. altitude must be reduced to the lowest practicable, and in any case to below 25,000 ft. to avoid the effects of decompression sickness. When below 40,000 ft. the engine air switches should be put off to lessen the risk of damage. If the failure was caused by damage to the canopy or cabin, depending upon the degree of damage and fuel state, return to base or land at the nearest airfield. Except for the initial descent do not exceed a speed of 0·70M or 300 kts.

**5 Ventilated suits**

With Mod. 3243 embodied provision is made for ventilated suits as follows: —

(*a*) Air for the ventilated suit system is piped from the transverse pipe between the mixing valve and primary cooler to a shut-off valve and quick-release connection at each ejection seat. The pilot's shut-off valve is fitted adjacent to the starboard side of the pilot's seat while the navigator's and bomb-aimer's valves are on the forward face of the pressure bulkhead.

(*b*) A quick-release coupling is fitted to the starboard side of the fuselage, just aft of the navigator's position, for the connection of a ground air supply.

**6 Camera bay heating**

Hot air from the air-conditioning system is ducted to a diffuser in the F.24 camera bay through an automatically-operated temperature control valve. The heating system also prevents misting of the camera window and camera lens.

**7 Demisting system**

(*a*) *General*

The entire canopy, navigator's window and the transparent nose fairing are of the "dry-air sandwich" type. Two separate systems are provided to prevent or disperse misting, one to maintain dry air in the interspace of the transparencies and one to blow hot air from the air conditioning system on the internal surface of the canopy.

(*b*) *Transparency interspace air-driers*

Three interspace air-driers are fitted, one just aft of the nose fairing, one on the cockpit starboard wall beside the

folding seat and one on the coaming aft of the pilot's seat. Indicator windows in the casing of each air-drier enable the drying agent to be seen. When unserviceable this will appear buff-coloured in the units at the nose and at the pilot's seat, and pink in the unit on the cockpit starboard wall. There are static air-drier lines to all three transparencies, but in addition dry air is circulated in the canopy by an electrically driven fan controlled by a CANOPY DEMISTER switch on the take-off panel; this is switched on before take-off and left on until after landing.

(*c*) *Canopy internal demister*

Hot air from the air-conditioning system is fed through a control valve and diffuser on to the forward inner surface of the canopy. The flow may be regulated by means of the knurled knob above the take-off panel.

(*d*) *Bombsight window*

Conditioned air is automatically fed on to the bombsight window whenever the air-conditioning system is in use. ◀Post Mod. 0279/RAFG a rotary DEMIST ON/OFF control is provided on the port side of the nose station, to control the flow of air to the bombsight window. ▶

## 8 Direct vision (DV) panel

An electrically-heated direct vision panel is in the canopy on the port side; the heater switch is on the take-off panel. When the cabin is unpressurised the DV panel can be opened by unscrewing the knurled clamping knob and hinging the frame downwards to engage in the retaining ◀clip. Pre-Mod. 4420 power supplies to the DV panel heater are DC. Post Mod. 4420 the heater is powered by AC from No. 1 or No. 2 inverter. ▶

## 9 Use of demisting system

(*a*) *Interspace air-drier*

Check that the silica-gel crystals in the drier units are the correct colour, and the operation of the air-drier fan by switching it on then off, and listening for it running during the pre-start check. There is no restriction on the use of this system.

(*b*) *Canopy internal demister*

To obtain maximum efficiency from the internal demisting system, start demisting 10 minutes before the descent. *The internal demister should not be on at any other time than that required for the descent*

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 9—AIRCREW EQUIPMENT ASSEMBLY AND ASSOCIATED SYSTEMS

## Contents

## 1 General

(*a*) The types of ejection seats installed vary according to the modification state of the aircraft as follows: —

(i) Pre-mod. 3518 the pilot is equipped with a Type 1C ejection seat.

(ii) Pre-mod 2685 the navigator and bomb aimer have Type 1CN ejection seats.

(iii) Post-mod. 3518 the pilot has a Type 2CA1 Mk. 1 ejection seat with single lever ejection facilities. (B Mk. 6—Mod. 4064)

(iv) Post-mod 2685 the rear crew have Type 2CA2 Mk. 1 ejection seats. (B. Mk. 6—Mod. 4065).

(v) Post-mod 3776 the rear crew have Type 2CA2 Mk.2 ejection seat and single lever ejection facilities.

(*b*) Details of Type 1C series are given in the Appendix to this Chapter.

## Ejection Seats Type 2CA series

**SAFE FOR PARKING**

◀ CANOPY/SNATCH MASTER switch OFF ▶
HATCH SAFETY switches (Post-mod. 3776) OFF

Safety pins in face screen and seat-pan firing handles of each ejection seat.

⋈

## 2 Type 2CA1, Mk. 1 seat (pilot)

(*a*) *General*

The seat is equipped with leg restraint, a seat-type parachute (Type 24) with a Mk.16A parachute harness, a separate safety harness and negative-G restraint strap, a survival pack (Type M Mk. 2) in the seat-pan and an emergency oxygen set (Mk. 7J) which is fixed to the rear starboard side of the seat. Automatic facilities are provided to stabilise and decelerate the seat after ejection, release the safety harness, separate the occupant from the seat and open the parachute, at a safe speed and height.

**Fig. 1 — Ejection Seat Type 2CA Series**

(*b*) *Firing mechanism*

(i) Two firing handles are provided, one protruding from the front of the drogue container and one located at the front of the seat pan. Safety pins, each with a red disc attached, are provided for each firing handle and may be stowed on the starboard side of the seat pan. ◀Post-Mod. 4442 the red disc attached to each safety pin is replaced by an integral tally mounted in the loop on the end of the pin. New stowages are provided for the pins as follows:—

*Pilot's station*

| | |
|---|---|
| Main gun sear or face screen handle<br>Seat pan handle<br>Canopy jettison sear *<br>Canopy jettison time delay * | On the forward face of the navigator's console structure |

*NOTE: Although these pins bear the words "canopy jettison", they are not associated with the canopy jettison system. They are used, during servicing, in the control column snatch unit servo and the time release-and-auxiliary breech unit sear respectively.

*Rear crew station*

| | |
|---|---|
| Main gun sear<br>Face screen handle<br>Seat pan handle | On the rear face of the ECP (6 pins) |

Before take-off a crew check should be made to ensure that all pins are in their stowages. ▶

(ii) A combined time release and breech unit is on the rear of the seat guide rail. The breech unit fires a cartridge to force gas under pressure through a small pipe to operate the control column snatch unit and elevator control tube explosive collar detonator (see Part 1, Chapter 5, paragraph 5(b). The time release mechanism delays the operation of the ejection gun firing pin for approximately one second after firing the breech unit.

(iii) Both firing handles are connected to the breech unit sear and to the time release mechanism. Initial movement of a firing handle withdraws the sear from the breech unit thus actuating the snatch unit; further move-

ment sets the time release mechanism in operation, the ejection gun sear is withdrawn after one second delay and the ejection gun fires.

(iv) The CANOPY/SNATCH MASTER switch on the take-off panel must be ON to render the elevator control tube detonator live.

(*c*) *Seat-adjustment lever*

Seat height may be adjusted by the lever fitted with a thumb-operated spring-loaded catch on the starboard side of the seat-pan.

(*d*) *Lean-forward release*

The lock on the safety harness may be released by pulling back a spring-loaded lever on the starboard thigh-guard; the seat occupant is then free to lean forward. When the lever is released the harness is prevented from going further forward by a ratchet mechanism; as the wearer leans back the harness is locked in the position reached, and to lean forward again the lever must be operated.

(*e*) *Parachute manual controls*

The parachute is normally connected to the seat by a withdrawal line which deploys the parachute after the occupant has been tipped from the seat. Two handles are provided on the parachute waist belt to disconnect the parachute from the withdrawal line and to deploy the parachute manually. Pulling the outer, exposed, handle (the override D-ring) breaks the connection between the parachute and the seat and renders the automatic facilities ineffective; the inner handle (the rip-cord D-ring) is then exposed and must be pulled to deploy the parachute when clear of the aircraft.

(*f*) *Leg-restraint controls*

Two leg-restraint cords, fixed to the floor of the aircraft by shear-bolts, pass through snubbing units on the front of the seat pan, through D-rings on the occupant's calves, to the lugs on the shoulder straps of the safety harness. The length of the restraining cords may be adjusted by pressing the knob under each snubber unit and pulling the cords up or down. The occupant of the seat is freed from the leg restraint cords by the release of the safety harness.

(*g*) *Sequence on ejection*

The pilot ejects through the closed canopy; when he pulls either firing handle on his seat, provided that the CANOPY/SNATCH MASTER switch is ON, the control column snatch unit is automatically operated and,

approximately one second later, the ejection gun fires. The sequence of events thereafter is as follows:—

(i) As the seat ascends the guide rail, the drogue gun is armed and the leg restraint cords tighten, pulling the legs together; the barostatic time release for the seat harness is armed; the emergency oxygen supply is turned on automatically; and the main oxygen hose, AVS hose and mic-tel leads are pulled away from the aircraft connections.

(ii) Half a second after the seat ejects, the drogue gun is fired to deploy the drogue which stabilises and decelerates the seat.

(iii) If the ejection has taken place above 10,000 feet, a stabilised fall occurs until this height is reached. At this point the barostatic time release operates and, after $1\frac{1}{4}$ seconds, the safety harness is released and the scissors shackle opens, leaving the drogue line connected to the apron behind the occupant and thence via the parachute withdrawal line to the apex of the parachute. The pull of the drogues streams the parachute, which on deploying sharply checks the descent of the seat occupant, causing the seat to fall clear.

(iv) If the ejection occurs below 10,000 ft. the same sequence ensues except that the barostatic time-release unit operates $1\frac{1}{4}$ seconds after ejection, subject to the overriding influence of the 'G' controller which delays operation of the barostatic time-release unit if the speed is too high for safe parachute deployment.

## 3 Type 2CA2, Mk 1 seats (navigator and bomb aimer)

(*a*) *General*

The Type 2CA2, Mk. 1, seat is basically similar to the Type 2CA1, Mk. 1, seat described in Paragraph 2 preceding with the exception that single lever ejection facilities are *not* incorporated.

(*b*) *Controls*

(i) *Firing mechanisms*

The firing handles, as described in paragraph 2(b)(i), are connected directly to the ejection gun sear and there is no delay between pulling a firing handle and firing of the ejection gun.

(ii) *Other controls*

Other controls on the seat are as described in Paragraph 2(c)-(f).

(*c*) *Sequence on ejection*

The navigator's hatch *must* be jettisoned (see Paragraph 9) before either rear crew member ejects. There is no delay between pulling a firing handle and firing of the ejection gun. The sequence of events after the ejection gun has fired is the same as that given in Paragraph 2(g)(i)-(iv).

**4 Type 2CA2, Mk. 2 seats (navigator and bomb aimer)**

(*a*) *General*

This seat is similar to the Type 2CA1, Mk. 1, seat described at paragraph 2 preceding, but automatic facilities are provided to jettison the navigator's hatch when either firing handle on either ejection seat is operated.

(*b*) *Firing mechanism*

**WARNING:** The rear crew ejection sequence cannot be initiated unless the member ejecting has *his* HATCH SAFETY switch ON, or the hatch has been jettisoned independently of the ejection system (see Paragraph 9).

(i) On each seat, the face screen firing handle and the seat pan firing handle are connected to a bifurcated cable, one arm of which is connected to a single lever ejection (SLE) mechanism on the rear face of the pressure bulkhead, the other to the ejection gun sear. When either firing handle is operated, the ejection gun sear is removed, but the ejection gun does not fire owing to the presence of a restrictor: this prevents the ejection gun firing pin from operating until the restrictor has been withdrawn by jettisoning of the hatch, to which the restrictor is cable-connected. Simultaneously with extraction of the ejection gun sear, the other arm of the bifurcated cable actuates the SLE mechanism, permitting current to flow to the hatch detonators: the hatch jettisons, withdrawing the restrictor from the ejection gun firing pin, and the ejection gun fires $\frac{1}{2}$ second later.

(ii) The SLE mechanisms are inoperative until they have been mechanically cocked by means of a cocking lever, normally stowed on the pressure bulkhead. Under normal circumstances cocking of the SLE mechanisms is a ground crew responsibility. When the mechanisms are

cocked, a white line on the cocking link is aligned with another on the bulkhead above each seat.

(iii) Before flight a check must be made for each seat to ensure that the hatch cable is attached to the restrictor, the SLE cocking link is correctly aligned and the SLE cocking lever is in its stowage. Before take-off the HATCH SAFETY switch at both rear crew stations must be placed ON.

(*c*) *Other controls*

Other controls on the seat are as described in Paragraph 2(c)-(f).

(*d*) *Sequence on ejection*

The crew member initiating the ejection sequence must ensure that *his* HATCH SAFETY switch is on, otherwise current will not flow to the hatch detonators. When the first member has ejected the second operates either firing handle on his seat, which fires after a delay of ½ second. The sequence of events after the ejection gun has fired is the same as that given in Paragraph 2(g) (i)-(iv).

### 5 Use of seat-pan firing handle

The seat-pan firing handle travels only about 1½ inches before the seat firing sequence is initiated, and unless the occupant is prepared for this there is a danger of ejecting with the back bent or in a crouched position. The back must be kept straight, the head against the headrest and the lower part of the body must be pressed well back into the seat.

### 6 Abandoning drills

Abandoning drills for each Type and Mark of seat, including use of the manual controls should the automatic systems fail, are given in the Flight Reference Cards.

## Doors and Emergency Exits

### 7 Entrance door

(*a*) The entrance door is on the starboard side of the fuselage aft of the nose fairing. To open the door from either inside or out press the red painted plunger adjacent to the flush fitting handle; this allows the handle to spring out which is then turned anti-clockwise from the outside

and clockwise from the inside. The door should not be opened in this way in flight. The door is supported in the open position by a hinged strut which is attached to the door and located in a socket in the door aperture framing.

(*b*) The entrance door may be jettisoned by turning the crank fitted centrally above it; this releases the hinge pins allowing the door to fall outwards. The crank may be stiff to operate and four and a half turns are required.

**8 Canopy**

(*a*) The canopy is secured to the aircraft by explosive bolts which are fired electrically to jettison the canopy. A CANOPY/SNATCH MASTER switch on the take-off panel and a guarded CANOPY JETTISON switch on the pilot's port console, outboard of the HP cocks, control the electrical circuit to the explosive retaining bolts. The CANOPY/SNATCH MASTER switch must be placed on before take-off; if it becomes necessary to jettison the canopy, switch on the CANOPY JETTISON switch.

(*b*) If, inadvertently, the CANOPY / SNATCH MASTER switch is not put on before take-off it must not be switched on in the air except in emergency.

(*c*) The canopy detonators are operative irrespective of the position of the battery master switch; if the aircraft battery fails they will be supplied by the emergency battery.

(*d*) *Minimum recommended speed for jettisoning the canopy*

See Paragraph 9(d).

**9 Navigator's hatch**

(*a*) A jettisonable metal roof hatch over the rear crew station affords an emergency exit. The hatch is secured to the fuselage by explosive retaining bolts which are fired electrically to jettison the hatch. The hatch may be jettisoned either independently or, post-Mod. 3776, in conjunction with the rear crew ejection system.

(*b*) *Independent jettison*

(i) *Pre-Mod.* 3776

Pre-Mod. 3776 the hatch detonator circuits are initially controlled by the CANOPY/SNATCH MASTER switch on the pilot's take-off panel. A HATCH JETTISON switch is provided on the cabin wall at each rear

crew station. Provided the CANOPY/SNATCH MASTER switch is ON, switching on either HATCH JETTISON switch completes the circuits to the hatch detonators and the hatch is blown off.

(ii) *Post-Mod.* 3776

Post-Mod. 3776 two independent circuits supply current to the hatch detonators, and the hatch may be jettisoned either by the navigator or by the bomb aimer. Each circuit is controlled initially by a HATCH SAFETY switch on the cabin wall at each rear crew station. With this switch ON, switching on the *adjacent* guarded HATCH JETTISON switch completes a circuit to the detonators and the hatch is jettisoned. As the hatch jettisons it withdraws the restrictor on each ejection seat firing mechanism (see paragraph 4(b) (i)), and the seats can then be fired by the normal method, if necessary; the time delay of $\frac{1}{2}$ second between pulling a firing handle and firing of the ejection gun still occurs. The full drill for jettisoning the hatch is given in the Flight Reference Cards.

(*c*) *Jettisoning the hatch in conjunction with the ejection system* (*Post-Mod.* 3776)

Post-Mod. 3776, a single lever ejection mechanism is mounted behind each seat on the aft face of the pressure bulkhead. The SLE mechanism is cable-connected to its associated ejection seat firing mechanism, and is actuated when either firing handle on the seat is operated. Provided that the HATCH SAFETY switch on the same side of the cabin as the seat is ON, pulling either seat-firing handle actuates the mechanism to complete the electrical circuit to the hatch detonators and the hatch is jettisoned; the ejection seat is automatically fired when the hatch is jettisoned by this method (see paragraph 4).

(*d*) *Minimum speed for jettisoning the navigator's hatch and pilot's canopy*

When jettisoned, the navigator's hatch and the pilot's canopy will come away cleanly at speeds down to 90 knots. However, at speeds below 150 knots, they may strike the tail assembly. If, therefore, it is not intended to abandon

the aircraft, keep speed above 150 knots whilst jettisoning the hatch or canopy.

(*e*) *Operation of detonator master switches*
Both the HATCH SAFETY switches (Post-Mod. 3776) must be switched on before take-off. If, inadvertently, these switches are not placed on before take-off they must not be switched on in the air except in emergency.

## Oxygen System

### DESCRIPTION

**10 Oxygen supplies and contents gauges**

Oxygen is carried in two 2,250 litre and five 750 litre bottles stowed in the upper equipment bay. A connection in the lower equipment bay, accessible through a hinged hatch on the port side of the fuselage, allows the bottles to be charged in situ. The bottles are arranged in two banks each having a separate supply line; these lines, after passing through stop valves (normally wire-locked ON), one on each side of the rear pressure bulkhead outboard of the ejection seats, are interconnected through non-return valves so that, while each bank can supply all the regulators independently, fracture of one supply line will not cause a total loss of oxygen. Two gauges on the miscellaneous instrument panel indicate the contents of each bank of cylinders.

**11 Oxygen regulators and supply points**

(*a*) The supply of oxygen to the crew supply points is controlled by Mk. 17E or 17F regulators. The pilot's regulator is on the cockpit port wall, the navigator's is above the instrument panel at his station and, of the bomb-aimer's two, one is on the starboard wall at his rear station and the other is on the starboard wall at the nose station. Each regulator incorporates:—

(i) A regulator pressure gauge (normal pressure 200-400 PSI).

(ii) An ON/OFF valve, normally wire-locked ON.

(iii) A magnetic flow indicator which shows white when inhaling.

(iv) A NORMAL/100% OXYGEN air inlet switch.

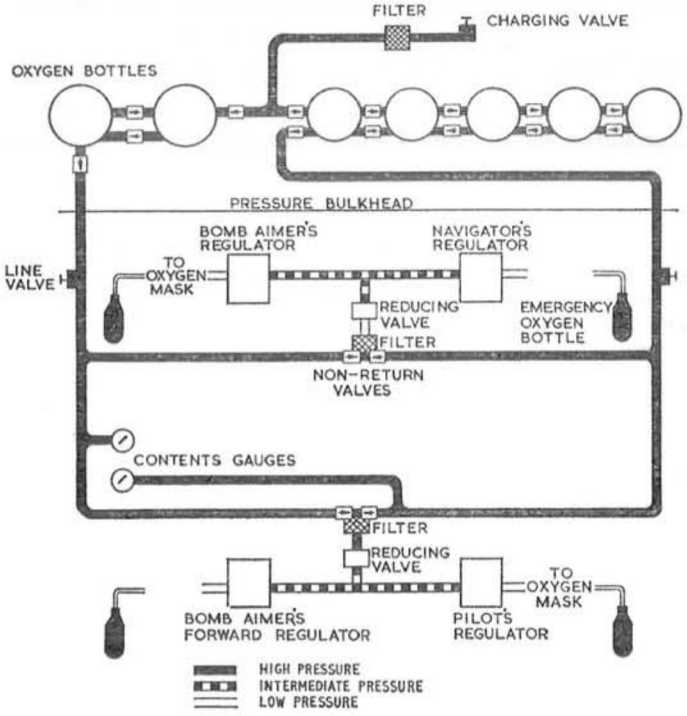



**Fig. 2. Oxygen system simplified**

(v) An emergency toggle switch. Moving the switch to left or right gives a safety pressure below 12,000 ft. and an increased safety pressure above this height. Pushing the switch in, in the central position, gives high pressure for testing mask seal before take-off.

(*b*) Two remote magnetic indicators are fitted; one on the miscellaneous instrument panel to indicate to the pilot whether the bomb-aimer (either seated or in the nose station) is receiving oxygen, whilst the other on the pilot's instrument panel shows the pilot whether his supply is being maintained.

(*c*) *Bomb-aimer's supplies*

In addition to the supplies at the nose and rear stations provision is made for a supply of oxygen to the bomb-aimer whilst moving between these stations. The flexible supply tube from the forward regulator terminates at a quick-release socket located in a clip on the starboard wall at the bomb-aimer's rear station. This allows him to disconnect from his ejection seat supply and connect to his nose station supply before leaving his seat.

**12 Oxygen emergency supplies**

(*a*) Each ejection seat parachute pack carries an emergency oxygen bottle which is connected by pipe to the quick-release socket of the oxygen mask tube before flight. The duration of the emergency oxygen bottle is approximately ten minutes. Post-Mods. 3518 and 2685, the emergency oxygen bottle is fixed to the rear starboard side of each ejection seat. A safety pin, fitted in the head of the bottle, must be removed before flight.

(*b*) An emergency oxygen bottle is also fitted at the bomb-aimer's nose station.

**13 Associated equipment**

Pressure demand oxygen masks must be worn.

OXYGEN SYSTEM — NORMAL OPERATION

**◀ 14 Checks before flight**

(*a*) Ensure that the contents gauges show sufficient oxygen for the flight. Connect the mask tube to the main and emergency oxygen supply pipes.

(*b*) On each regulator check:

ON/OFF switch ON and wired
Air inlet switch at NORMAL
Pressure 200-400 PSI
Magnetic indicators (MI's) functioning correctly
(Check remote indicators also)

(*c*) To test the regulator and check the face mask for leaks:—

(i) Put the toggle on the mask harness to the down position and press in the EMERGENCY PRESS TO▶

◀ TEST MASK button on the regulator. During this test the breath should be held and an increased pressure should be felt in the mask; if there are no leaks the flow indicators should remain black. If leaks are felt or the indicators show white the mask harness should be tightened by the adjusting screws on either side until a satisfactory seal is made.

(ii) Return the mask harness toggle to the normal up position and check for leaks when the EMERGENCY button is moved to the right or left. After this test return the button to the central position. If a satisfactory seal cannot be obtained on both of these tests the mask must be considered unserviceable.

(iii) All four crew-position regulators must be checked as above and the remote oxygen flow indicators checked for correct operation. ▶

### 15 During flight

During flight frequent checks of contents and crew supply should be made by reference to the contents gauges and flow indicators.

## OXYGEN SYSTEM — EMERGENCY USE

### 16 Loss of cabin pressure

The oxygen system automatically caters for decreased cabin pressure. It is not therefore necessary to change the selection on the regulator if cabin pressure is lost. However the oxygen mask toggle should be pulled down to prevent leaks from the mask.

### 17 Toxic fumes in cockpit

Move the selector control to EMERGENCY and tighten oxygen mask by pulling down on the toggle on the mask harness. When EMERGENCY is selected on the regulator the air mix switch must be at 100% OXYGEN.

### 18 Flow indicator failure

If the magnetic flow indicator ceases to operate, check all

oxygen connections, pressure in the regulator gauge, and the main oxygen contents gauge; ⋈ move the air inlet switch to 100% OXYGEN. If these checks show no faults, depress the regulator EMERGENCY switch momentarily. A flow of oxygen under increased pressure indicates that the regulator is serviceable but the flow indicator defective; flight may be continued on 100% OXYGEN. If there is no flow when the EMERGENCY switch is depressed the regulator is unserviceable; the emergency oxygen bottle should be operated and descent to a safe altitude should be commenced.

### 19 Partial system failure

Partial system failure or a leak in one half of the supply system will be indicated by a more rapid fall in the reading of the associated contents gauge. Oxygen will still be available but the duration of the oxygen supply will be reduced; the flight time must be curtailed accordingly and if necessary, the flight level adjusted to make a smaller demand on the remaining oxygen supply.

### 20 Oxygen failure

If symptoms of anoxia are felt indicating lack of oxygen or if oxygen failure occurs at altitude, operate the emergency oxygen bottle and descend to a safe altitude. With the emergency bottle in use the oxygen main connection will have to be disconnected to allow free breathing. In the different crew positions the emergency oxygen bottle is operated as follows:—

(*a*) *Ejection seat position*

Pull up on the operating cable conduit or down on the ball on the operating cable, both on the right-hand side of the seat pan. As it is more easily accomplished, the former method is recommended. The emergency bottle is operated automatically when the ejection seat is fired. Post-Mods. 3518 and 2685 the emergency oxygen bottle may be operated manually by pulling up on the black/yellow striped knob to starboard of the ejection seat.

(*b*) *Bomb aimer position*

Pull the red toggle on the emergency bottle lanyard. If returning to the ejection seat, remove the emergency bottle

from its stowage below the chest cushion by supporting the bottle in the left hand and releasing the clip with the right hand.

## Normal Use of the Aircrew Equipment Assembly

**21 Strapping in procedure (Type 2C seats)**

(*a*) Ensure that the seat is "safe for parking" and carry out the safety checks given in the Flight Reference Cards for the type of seat before strapping in.

(*b*) Sit in the seat and adjust seat height to the flight position. Fasten leg restraint garters just below each knee ensuring the D-rings are to the inside rear. To facilitate easy reach of the restraint cords at a later stage of the strapping-in procedure pass the left hand cord through the right garter D-ring, and the right hand cord through the left garter D-ring, and allow them to hang loose temporarily.

(*c*) Connect survival pack lanyard to life jacket quick-release connection on the right so that the lanyard lies outside the right thigh.

(*d*) Connect the quick-release fittings on the sides of the survival pack to the two corresponding fittings on the life jacket.

(*e*) Connect the parachute harness shoulder straps to the quick-release fitting. The shoulder straps should lie under the life jacket stole. When an inertia proof quick-release fitting is incorporated in the parachute assembly, it is necessary to turn the disc knob until the yellow line passes the dots on the body of the fitting, hold it in this position, and insert the first lug. Repeat this procedure when inserting the remaining lugs.

(*f*) Pass the parachute leg-straps through the leg-loop and attach them to the quick-release box. Adjust the box so that it lies centrally with the waist-belt close to the body.

(*g*) Tighten the shoulder straps so that the parachute quick-release box will lie clear of and above the safety harness quick-release when this is assembled. Tighten the parachute harness leg straps.

(*h*) Connect the air supply hose to the air ventilated suit, if worn.

◀(*j*) (i) *Pre-Mod. ES.*3107. Fasten the lap straps of the safety harness but do not tighten.

(ii) *Post Mod. ES.*3107. Draw the negative G restraint strap up between the legs ensuring that it lies to the rear of, and *not* through, the seat pan firing handle.

(*k*) (i) *Pre-Mod. ES.*3107. Draw the negative G restraint strap up between the legs and tuck the V-shaped end under the safety harness. Ensure that the strap is clear of the seat pan firing handle.

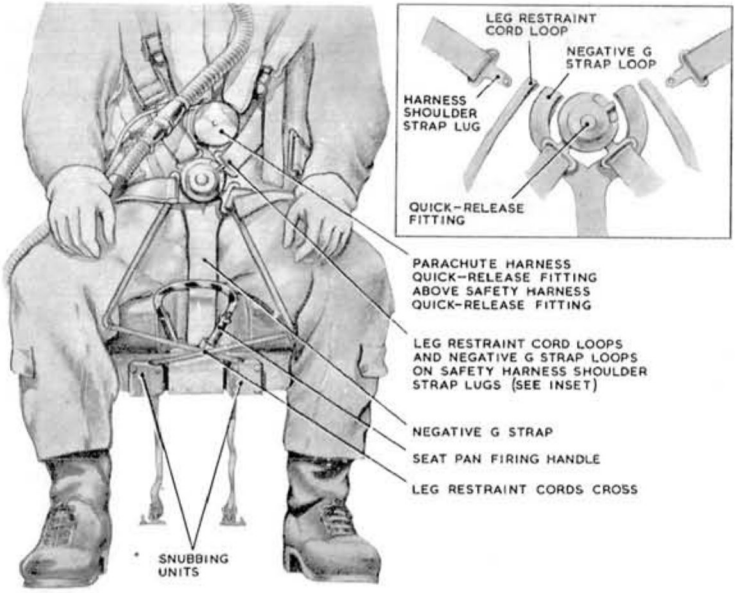
(ii) *Post-Mod. ES.*3107. Insert the lug of the left-hand lap strap through the loop of the negative G restraint strap. Ensure that the negative G restraint strap end fitting is located behind the larger diameter of the quick release fitting before fastening the harness. If correctly fitted, the negative G restraint strap end should be a loose fit over the end of the lap strap. Give each lap strap a jerk to ensure that they are correctly engaged in the quick release fitting. Do not tighten the lap straps at this stage.

(*l*) Ensure that the loop of the right restraining cord is passed through the D-ring on the left garter and threaded under the left-hand side of the safety harness lap-strap. Pass the lug of the left shoulder strap of the safety harness through the loop in the end of the leg restraint cord (and, Pre-Mod. ES.3107 only, through the left loop of the negative G restraint strap) and insert the lug into the safety harness quick release box.

(*m*) Proceed similarly for the left restraint cord and, Pre-Mod. 3107, the right loop of the negative G restraint strap. ▶

◀(*n*) To adjust the length of the leg restraint cords, press and hold the plunger under the snubbing unit and draw the cord upwards. If there is too much, draw any excess downwards through the unit (it is unnecessary to press the plunger in this instance).

**Figure 3**



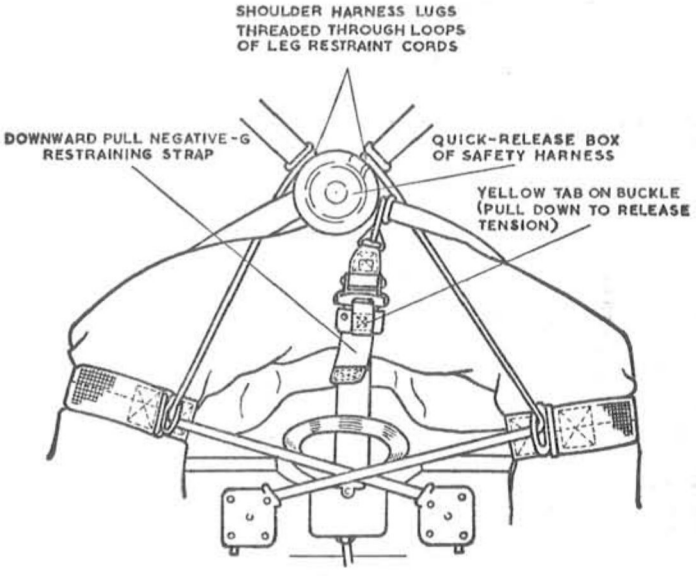

**Ejection seat Type 2CA**
**Arrangement of negative G and leg restraint straps**
**(Pre-Mod. ES.3107)**

(*o*) (i) *Pre-Mod. ES.*3107. Tighten the lap straps of the safety harness, ensuring that the quick release fitting is positioned as low as possible against the body and that it is not covering the parachute harness quick release box. Tension the negative G strap.

(ii) *Post Mod. ES.*3107. Tighten the lap straps of the safety harness. Tighten the negative G restraint strap by pulling downwards on the free end of the blue strap. Move the body about inside the harness and then retighten the lap straps and negative G strap.▶

◀Repeat until the straps are as tight as possible. The G strap can be loosened by pulling down on the yellow tab attached to the snubbing lever.

**Figure 4**




**Ejection seat type 2CA**
**Arrangement of negative G and leg restraint straps (Post-Mod. ES.3107)**

(*p*) Tighten the safety harness shoulder straps. Do not over-tighten as this may arch the back, resulting in possible injury on ejection. ▶

(*q*) Put on the helmet and protective helmet, connect the mic-tel lead and fasten the chin straps of both helmets.

(*r*) Connect the oxygen mask tube to the main oxygen supply pipe and adjust the pipe in its clip or loop on the right lap strap of the safety harness to allow full and free movement of the head.

(*s*) Pass the emergency oxygen supply pipe under the lap-strap of the safety harness, over the parachute harness, and connect it to the oxygen mask tube.

(*t*) Connect the oxygen mask tube locating chain to the D-ring on the life jacket.

(*u*) Check that the face screen handle can be reached with both hands together.

(*v*) Have the safety pin(s) removed and stowed.

### 22 Normal exit from the seat

(*a*) Make the seat "safe for parking".

(*b*) Disconnect the main and emergency oxygen supply and the mic/tel lead.

(*c*) Disconnect the air ventilated suit, if worn.

(*d*) Release the safety harness; pull out the safety pin clip, if fitted, and release the parachute harness.

(*e*) Disconnect the personal survival pack from the life jacket and allow the lanyard to drape over the right hand side of the seat-pan.

(*f*) Remove leg restraint cords and negative G restraint strap, if fitted.

(*g*) Leave the seat.

## Modifications

### 23 Changes to Type 2CA series ejection seats

(*a*) In order to minimise the possibility of back injuries during ejection, Ejection Seat Modifications ES.3241, ESA.9, ESA.10 and ESA.11 have been authorised. When embodied these modifications have the following effect:—

(i) *Mod. ESA.*9 introduces a modified ejection gun assembly with a slightly reduced charge. Because of an associated parachute modification which allows faster deployment of the parachute, the limitations for Type 2CA seats, given in Pt. II, Ch. 3, Para. 2 are not changed.

(ii) *Mod. ESA*.3241 introduces a modified drogue assembly with an anti-squid line and lengthens the exposed drogue lines.

(iii) *Mod. ESA*.11 increases the drogue gun time delay (see para. 3(*g*)(ii)) from $\frac{1}{2}$ second to one second.

(iv) *Mod. ESA*.10 increases the barostatic time release delay (see para. 3(*g*)(iii) and (iv)) from $1\frac{1}{4}$ to $1\frac{1}{2}$ seconds.

(*b*) When Mod. ESA.10 has been embodied the nomenclature of Type 2C series seats is changed as follows:—

Type 2CA1 Mk. 1 becomes Type 2CA1 Mk. 2
Type 2CA2 Mk. 1 becomes Type 2CA2 Mk. 3
Type 2CA2 Mk. 2 becomes Type 2CA2 Mk. 4

# APPENDIX TO PART I, CHAPTER 9
# EJECTION SEATS TYPE 1C SERIES

## 1 General

(*a*) Pre-Mods. 3518 and 2685 the pilot is provided with a Type 1C seat, and the navigator and bomb-aimer with Type 1CN seats. The Type 1C and 1CN seats are basically similar, but the Type 1CN seat has an 80 FPS ejection gun in lieu of 60 FPS. Ejection seat Mods. 544, 545 and 577 introduce leg restraint, strengthened thigh guards and canopy breakers to the 1CN seat, and the foot rests are deleted.

(*b*) Automatic facilities are provided to release the safety harness after ejection and to open the parachute at a suitable height. Incorporated in the seat are a type Z safety harness, a seat-type parachute and personal survival pack, and an emergency oxygen bottle (see para. 10). A safety pin, to prevent inadvertent operation of the firing handle, is fitted through a canvas strap on the firing handle and may be stowed on the starboard side of the seat.

## 2 Controls

(*a*) *Firing handle*

The ejection gun is fired by a handle immediately above the headrest, fitted with a flexible blind to protect the face. The blind must be pulled down to the full extent of its travel to fire the ejection gun. No alternative firing handle is fitted.

(*b*) *Seat-adjustment lever*

Seat height may be adjusted by the lever fitted with a thumb-operated spring-loaded catch on the starboard side of the seat -pan.

(*c*) *Lean-forward release*

The lock on the safety harness may be released by pulling back a spring-loaded lever on the starboard thigh-guard; the seat occupant is then free to lean forward. When the lever is released the harness is prevented from going further forward by a ratchet mechanism; as the wearer leans back the harness is locked in the position reached, and to lean forward again the lever must be operated.

(*d*) *Manual parachute controls*

A unit to provide disconnection of the parachute static line from the barometric release, and a manual rip-cord knob are on the waistbelt of the parachute harness.

(i) *Static line disconnect unit*
This allows the parachute static line to be disconnected so that the wearer can leave the aircraft if the ejection seat fails to fire. To operate the disconnect unit, pull off the brass cap and turn the key. *Once the key has been turned the parachute can only be operated by the manual rip-cord knob.* When strapping in to the parachute harness check that the cap on the disconnect unit is in place. If it has been disturbed the static line disconnection will have to be reset and the parachute repacked.

(ii) *Manual rip-cord*
This is the lower of the two controls on the parachute waist belt and is for use when a manual escape is made or if the parachute fails to stream automatically.

(*e*) *Leg-restraint controls*
Two leg-restaint cords, fixed to the floor of the aircraft by shear-bolts, pass through snubbing units on the front of the seat pan, through D-rings on the occupant's calves, to the lugs on the shoulder straps of the safety harness. The length of the restraining cords may be adjusted by pressing the knob under each snubber unit and pulling the cords up or down. The occupant of the seat is freed from the leg restraint cords by the release of the safety harness.

**3 Sequence on ejection**
The pilot ejects through the closed canopy after operating the control column snatch unit. The navigator and bomb-aimer must jettison their hatch before ejection. There is no delay between pulling the face blind firing handle and firing the ejection gun. The sequence of operations after pulling the firing handle is as follows: —

(*a*) The ejection gun is fired.

(*b*) As the seat ascends the guide rail the leg restraint cords are tightened in the snubbing units and freed from the aircraft floor. The emergency oxygen bottle is automatically operated; the main oxygen supply hose, AVS supply hose and mic-tel lead are pulled away from the aircraft connections.

(*c*) When the seat is clear of the aircraft a static line from the drogue gun to the aircraft fires the drogue gun to deploy the parachute which slows down and stabilises the seat.

(*d*) The ejection of the seat starts a safety harness release delay mechanism which releases the safety harness after $2 \pm \frac{1}{2}$ seconds. When the shoulder straps of this harness are undone the top ends of the leg restraint cords are free to pass down through the D-rings on the legs. The occupant must then kick himself away from the seat.

(*e*) A static line from the seat then operates the parachute barometric release which is set to open the parachute at 13,000 feet. If the ejection height is below 13,000 feet the parachute will be opened $3\frac{1}{2}$ to $4\frac{1}{2}$ seconds after the separation of seat and occupant.

## 4 Strapping in procedure

The strapping-in procedure for Type 1CN seats is given in AP.1182.

## 5 Abandoning drills

Abandoning drills are given in the Flight Reference Cards.

SYSTEMS
PART I — DESCRIPTION AND MANAGEMENT OF

# Chapter 10—RADIO, RADAR AND NAVIGATION EQUIPMENT

## Contents



### 1 Intercommunication

(*a*) Intercomm. is provided by a Type A.1961 amplifier. Provision is made to use the amplifiers of the radio sets if the A.1961 amplifier fails. Intercomm. is controlled by an I/C ON/OFF switch and an I/C NORMAL/EMERGENCY changeover switch on the take-off panel. If the A.1961 amplifier fails, the changeover switch should be put to EMERGENCY to obtain intercomm. via the amplifier of the VHF or UHF set, whichever is in use. Post-Mod. 4319 the V-UHF/UHF STBY. switch should normally be at V-UHF to obtain intercomm. when EMERGENCY is selected on the changeover switch.

(*b*) There are five mic/tel sockets, one on the left of each ejection seat, one to the right of the pilot's seat for use with the folding seat and one at the bomb aimer's nose station. An extension lead from the nose station socket is clipped to the oxygen wander lead so that the bomb aimer can remain on intercomm. when moving to and from the nose station. An additional external intercomm. socket is provided in the rear fuselage.

### 2 Radio Installation (Pre-Mod. 4319)

Radio communication is provided by two VHF sets and one UHF set. A VHF/UHF changeover switch on the starboard instrument panel is provided to change from the VHF to the UHF system. A press-to-transmit switch is provided for

the pilot on the starboard throttle lever. This operates the transmitter on VHF or UHF, whichever system is in use. Further details of the individual systems are as follows:—

(*a*) VHF *installation*

The VHF installation consists of two 10-channel transmitter/receivers, TR 1985 and TR 1986. The channel selectors and changeover switch are on the starter panel.

(*b*) UHF *installation*

The UHF installation consists of one transmitter/receiver type TR5/ARC52, which can be selected to operate on any one of eighteen automatically pre-set frequencies, 1,750 manually selected frequencies, and one guard channel. Power supplies are DC. The UHF control unit is mounted on the starboard instrument panel and carries all the UHF controls. The TONE and PRESS-TO-MUTE switches are also on the starboard instrument panel. The UHF control unit provides the following services:—

(i) A four-position function switch labelled OFF-T/R-T/R+G and ADF. At the T/R position the equipment is switched on for operational purposes; at the T/R+G position the guard receiver is available in addition to the transmitter/receiver. The ADF position is inoperative.

(ii) CHANNEL selector switch. This has 20 positions. Those numbered 1-18 are for selecting the required pre-set frequency. The remaining positions are labelled M and G. M is used to switch frequency selection to manual control, and G enables the transmitter-receiver to be used on the guard frequency independent of the guard receiver.

(iii) MANUAL. The four controls in the manual service are used to select any one of the 1,750 channels as required.

(iv) A volume control.

## 3 Radio installation (post-Mod. 4319)

(*a*) *General*

When Mod. 4319 is embodied the VHF and UHF sets are replaced by a combined V/UHF set (ARI.23143/1-PTR.175) and a standby UHF set (ARI.23057). PTR.175 provides transmission/reception facilities on 3,500 UHF and 370 VHF frequencies. Nineteen frequencies, including the guard channel, may be pre-set for immediate selection, the remainder being selected manually. An emergency battery is pro-

vided for operation of the standby UHF if the main airrcaft electrical supply fails.

(*b*) *Selection of services*

Controls for selecting PTR.175 or standby UHF are on the starboard instrument panel and consist of:—

(i) A POWER NORMAL/STBY switch. When placed at STBY power is fed from the emergency battery to the standby UHF.

(ii) A V-UHF/UHF STBY switch for selection of PTR.175 or standby UHF.

(*c*) PTR.175 *controller*

The PTR.175 controller is on the starboard instrument panel and consists of the following:—

(i) A seven-position function switch labelled OFF/TR/TR+G/ADF/DL/DL-T/TR-ON DL-OFF. The last four positions of the switch are inoperative. At the TR position the equipment is switched on for operational purposes; at the TR+G position the guard receiver is available in addition to the transmitter/receiver.

(ii) A channel selector switch. This has 20 positions. Those numbered 1 to 18 are for selecting the required pre-set frequency. The remaining positions are labelled M and G. M is used to switch frequency selection to manual control, and G enables the transmitter/receiver to be used on the guard frequency independent of the guard receiver.

(iii) Three rotary manual switches which are to select any channel as required. The frequency selected is displayed above the switches.

(iv) A volume control.

**WARNING:** Interference may occur to ILS, Rebecca and the radio compass, causing incorrect indications, when transmitting on UHF.

(*d*) *Standby* UHF

Standby UHF (ARI.23057) is installed to provide intercomm. and transmission/reception on the guard frequency if failure of PTR.175 or main power failure, occurs. Power supplies are controlled by the NORMAL/STBY switch (see paragraph (*b*)(i)), and selection by the V-UHF/UHF STBY switch (see paragraph (*b*)(ii)). A frequency switch

◀on the starboard instrument panel, is normally kept in the gated position at GUARD, the CHANNEL A position being provided for testing purposes on a frequency adjacent to the GUARD frequency.

(*e*) *Miscellaneous controls*

The TONE control for UHF and a press-to-mute switch are on the starboard instrument panel. The pilot's press-to-transmit switch is on the starboard throttle lever.

(*f*) *Malfunction*

(i) *Failure of* PTR.175

If PTR.175 fails:—

Put the V-UHF/UHF STBY switch to UHF STBY.

(ii) *Failure of aircraft normal electrical supply*

1. Put the POWER NORMAL/STBY switch to STBY.
2. Put the V-UHF/UHF STBY switch to UHF STBY.
3. If an emergency call is to be made ensure that the CHANNEL A/GUARD switch is at GUARD.

NOTE: The standby set will operate from the emergency battery for about 30 minutes. Care must be taken to conserve the battery; it should not be used for ground testing.

(iii) *Failure of the A.*1961 *intercomm. amplifier*

1. Select EMERGENCY on the I/C NORMAL/EMERGENCY switch (paragraph 10).
2. Put the V-UHF/UHF STBY switch to V/UHF.▶

**4 Decca**

The control unit for the Decca equipment, decometers and lane identification meter are on the navigator's instrument ◀panel. The equipment operates on DC. An external 24-volt DC supply may be plugged in for pre-heating the crystal ovens (see Pt. I, Ch. 1, para. 4(b)).▶

**5 Roller map**

A roller map is installed at the navigator's station. It is connected to the remote transmitter below the navigator's table by a wander lead via a plug and socket on the wall of the pilot's seat platform. It may also be used at the nose station on a mounting to the port side of the bomb-sight. No. 1 inverter must be running to operate the roller map.

**6 Blue Silk**

(a) The Blue Silk control panel is on the navigator's instrument panel. One switch on the navigator's instru-

ment panel controls the Blue Silk inverter, and one the equipment. The spring-loaded switch which controls the equipment cannot be switched ON until after the inverter is switched ON and the inverter is running. An impulse counter is to the right of the Blue Silk control panel. During pre-taxying checks switch ON No. 8 inverter and, after 30 seconds, the Blue Silk equipment. After landing do not switch off No. 8 inverter or the equipment until the aircraft is parked.

(*b*) G.P.I. Mk. 4A for use in conjunction with Blue Silk is on the port side of the navigator's instrument panel. It is powered by DC.

## 7 API and AMU

The AMU control panel and the API are on the port side of the cabin. The panel includes the AMU main ON/OFF switch and a ground test push switch. An indicator lamp below the face of the panel shows when the AMU is operating satisfactorily, and an adjustable screen, marked BRIGHT, DIM and OUT, fitted over the lamp can be adjusted to control the illumination from it. Both the AMU and API operate from a common DC power supply.

## 8 IFF 10

An ON/OFF switch, an I/P switch, the transmitter-receiver control and coder control unit are on the port wall at the navigator's station. The equipment receives its power through No. 5 inverter. If SIF is fitted IFF must be switched off during low level high speed sorties (below 3,000 ft. and above 250 knots).

## 9 Periscopic sextant

A periscopic sextant Mk. 2A and carrying case is introduced by Mod. 4325. The sextant and case are stowed on the navigator's floor adjacent to the port wall. When required for use the periscopic sextant is fitted into a mounting in the navigator's hatch.

SYSTEMS
PART I—DESCRIPTION AND MANAGEMENT OF

# Chapter 11—ARMAMENT AND CAMERA CONTROLS

## Contents



## 1 General

(*a*) The aircraft is designed to operate as a bomber or interdictor as required, the armament installation being readily adaptable to either role. When required for bombing duties the whole of the bomb-bay and the pylon mounting under each wing are available to carry the armament stores. In the interdictor role a gun pack, mounting four 20 mm. guns, is installed in the rear of the bomb bay, the forward portion being occupied by a flare carrier, and the underwing pylons may carry either rockets or bombs.

(*b*) A gun-sight is provided at the pilot's station and a bombsight is in the nose of the aircraft. Three cameras may be carried; one G.45 or G.90 in the starboard mainplane, one F.95 in the nose, and one F.24 in the rear fuselage. Armament controls are on the control column right-hand grip; on an armament panel at the navigator's normal station; and in the nose of the aircraft.

## 2 Armament safety plug

An armament safety plug is in the cabin above the entrance door. When this plug is disconnected the circuits to all normal bomb release, rocket and gun firing controls

are broken. The flare-dropping circuits are *not* isolated by this plug. The plug should be disconnected and the warning pennant (Mod.4329) attached to the cable at all times when the aircraft is on the ground. When not in use the pennant is stowed in a container mounted on and at the lower part of the entrance door.

**3 Armament supplies circuit breakers**

The bomb-release and RP firing circuits are protected by a circuit breaker beside the armament panel at the navigator's station. The gun firing and flare release circuits are protected by a circuit breaker on the ECP.

**4 Gunsight**

A Mk. 3N reflector gunsight is mounted on the coaming above the flight instrument panel. A dimmer switch is on the sight. Also on the coaming panel are a NORMAL-ALTERNATE switch and a GUNSIGHT warning lamp. ◀Post Mod. 0248/RAFG the Mk. 3N gunsight is replaced by an SFOM gunsight. ▶

**5 Gun firing controls**

The four 20 mm. guns in the rear of the bomb-bay are fired by a folding gun trigger on the right-hand grip of the control column. The trigger is released into the firing position by raising a safety catch covering the trigger. Safety cut-outs in the wiring system ensure that the guns cannot be fired with the nosewheel down, the bomb doors open or when the armament safety plug is removed. Mod. 4231 introduces a GUN SELECTOR switch box, mounted on the LABS distribution box, to permit selective firing of inboard or outboard guns; INNER and OUTER LIVE/SAFE switches on the selector must be put to LIVE before the gun firing circuits are operative for the inboard and outboard guns respectively.

**WARNING:** Post-Mod. 0216 and 0217/RAFG, gun port transit covers and empty-case chute transit covers may be fitted; ensure that these have been removed before air-firing sorties.

**6 Bomb/flare doors control and indicators**

(*a*) The electrically actuated bomb/flare doors selector valve is controlled by a three-position OPEN/SHUT/AUTO switch on the port console. If, after the doors have been opened, the switch is put to AUTO, the doors will close automatically after release of the stores in the bomb

bay. A magnetic indicator inboard of the control switch, normally black, shows white when the doors are fully open. This indicator is duplicated on the armament panel at the navigator's station.

(*b*) To prevent inadvertent closing of the doors on the ground a locking pin, stowed in a bag on the lower front face of the ECP when not in use, is inserted in the control switch guard with the switch at the OPEN position.

**7 Bomb/flare doors emergency control**

(*a*) Should the bomb/flare doors selector valve fail to operate electrically it may be moved to the "open" position mechanically by pulling down on the gated BOMB DOORS EMERGENCY CONTROL lever on the cockpit port wall. However, as the doors cannot then be closed again until serviced it must be established that the fault is in the selector valve and not due to hydraulic failure.

(*b*) If the failure is hydraulic and, provided that fluid is available, the doors may be opened and closed by means of the hand pump and normal selection on the control switch. It should be noted, however, that such action by using the emergency reserve fluid may prejudice subsequent lowering of the undercarriage, and wheel braking.

**8 Bombsight**

The bombsight is mounted on a spigot over the clear view panel in the plastic nose; (it is an alternative fitting to the F.95 camera). The bombsight computor and the air control cock are on the port side of the nose station.

**9 Flare release**

The flare release circuits are controlled by a flares master switch and either the flare release pushbutton on the armament panel or the flare release switch on the cockpit coaming. A flares-gone indicator is on the armament panel.

**10 Bomb controls**

In the bomber role, bomb fuzing and selector switches are at the bomb aimer's rear station. The bombs may be released by a pushbutton on a flexible lead, at the nose station, or by the bombs/RP button on the control column right hand grip. A revised weapon control panel fitted on

the starboard wall of the bomb aimer's rear station is introduced by Mods. 4329 and 4411.

**11 Bomb release safety lock**

(*a*) A bomb release safety lock panel is on the port console. The lock provides a positive safety mechanism to prevent inadvertent release of the 1,650 lb. bomb, and consists of a catch which, when locked, engages in the bomb release unit. The lock is controlled by a double pole two-way switch, marked LOCKED and UNLOCKED, having two adjacent indicator lamps; in the LOCKED position the green indicator lamp will show and in the UNLOCKED position the amber lamp will come on. The switch is normally wired in the LOCKED position.

(*b*) The operating circuits of the bomb release safety lock are duplicated. If a false light indication is suspected it may be checked by pressing in simultaneously both indicator lamps; the indication for the alternative circuit will then be given.

**12 Bomb/flare emergency jettison**

(*a*) *Pre-Mod.* 3732

(i) The pilot may jettison the bombs or flares in the bomb bay by means of a guarded switch, labelled PILOT'S EMERGENCY JETTISON, on the port console. When this is switched ON the normal bomb-doors control circuit is by-passed, the bomb doors are opened and the bombs or flares are jettisoned, safe. Switching OFF the jettison switch will remake the normal circuit and the bomb/flare doors will close.

**WARNING:** 1. If the aircraft is equipped for the bomber, as distinct from the night interdictor role, use of this switch will also jettison any underwing armament stores, SAFE or LIVE, as selected on the fuzing selector switch.
**WARNING: 2.** 25 lb. practice bombs carried on light series carriers in the bomb-bay cannot be jettisoned by *this* switch.

(ii) Should the bomb/flare doors fail to open when the jettison switch is set ON, then by leaving the jettison switch ON and opening the bomb doors as at para. 6 or 7 the bombs will be jettisoned when the bomb doors are fully open.

(*b*) *Post-Mod.* 3732

Post-Mod. 3732 the PILOT'S EMERGENCY JETTISON switch is re-named as the BOMB/FLARE JETTISON

switch. Its function is similar to that given in sub para. (a) (i) and (ii) above, *with the exception that there is no jettison facility for the* 1,650 *lb. bomb.* If for any reason it is not possible or practicable to release the 1,650 lb. bomb by the normal method, or by the secondary release facility available to the navigator, the pilot can release the bomb by pressing the bomb release push-button on the control column, provided that the appropriate selections have been made on the navigator's control panel, and the bomb release safety lock is UNLOCKED.

### 13 Underwing bomb and RP controls

(*a*) The underwing bombs or rockets are released by a pushbutton covered by a safety flap on the right hand grip of the control column. Bombs may also be released by a pushbutton, on a flexible lead, stowed in a clip on the starboard side at the nose station. Selection and fuzing of underwing stores is carried out by means of five switches on the armament panel. These comprise:—

(i) A bomb/RP selector switch.
(ii) A pair of wing bomb ON/OFF selector switches.
(iii) A wing bomb fuzing switch.
(iv) An RP selector switch, which enables quarter, half or full load to be selected.

(*b*) *Practice bomb facility*

A practice bomb facility from the wing pylons for use with or without simulator type 105 is introduced by Mods. 4345 and 4346. A modified control box is fitted on the bomb aimer's rear station starboard wall.

### 14 Underwing stores jettison

Underwing stores may be jettisoned by means of the guarded EMERGENCY WING STORE JETTISON switch on the pilot's port console.

### 15 Camera controls

(*a*) *G.45 or G.90 camera*

(i) A G.45 or G.90 camera is installed in the mainplane inboard of the starboard engine. The camera MASTER switch and SUNNY/CLOUDY switch are

on the navigator's armament panel. The camera operates automatically when the guns are fired and may be operated independently by a pushbutton on the right-hand grip of the control column.

(ii) Provided that the camera MASTER switch is ON operation of the pilot's pushbutton starts the camera. When the pushbutton is released the camera will continue to run for 1½ seconds. When the BOMBS/RP selector switch is set to RP the camera will run after pressing and releasing the camera pushbutton and continues to run for 1½ seconds after the BOMBS/RP push-switch is pressed. If rocket firing does not take place and the BOMBS/RP push switch is not pressed then the BOMBS/RP selector switch must be set to BOMBS to stop the camera.

(*b*) *F.24 camera*

An F.24 camera may be installed in a bay in the rear fuselage, aft of the bomb bay. A control unit and switch box for the camera is above the navigator's table. A master ON/OFF switch controlling the power supplies is on the armament panel.

(*c*) *F.95 camera*

(i) With Mod. 2695 embodied an F.95 camera may be fitted in the nose of the fuselage adjacent to the bomb-sight spigot and aligned to operate through the clear view panel. The camera is an alternative to the bomb-sight. The camera controller is on the fuselage port wall at the navigator's normal station.

(ii) A switch on the left-hand grip of the control column provides independent control of the camera for the pilot providing the camera selector switch is set to MANUAL.

**16 Air sampling ducts**

If Mod. 3525 is incorporated air sampling ducts may be fitted to pylons under the mainplanes. The ducts are controlled by switches on the armament panel. The switches are labelled OPEN/SHUT and magnetic indicators adjacent to them show the state of the ducts.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

# Chapter 12—CANBERRA B Mk. 6 AIRCRAFT WITH SRIM'S 2951 or 2696 EMBODIED

**(First issued with Amendment List 3)**

## Contents



## 1 Introduction

This Chapter gives details of systems on the Canberra B Mk. 6 with SRIM's 2951 or 2696, which differ from those in the B(I) Mk. 6 described in the preceding Chapters. Part

III of the Notes is generally applicable to both types of aircraft, but special Check lists/Emergency drills have been issued for the B.Mk. 6; the Flight Reference Cards are applicable only to the B(I) Mk. 6.

## Electrical System

### 2 Generators

The DC power system is similar to that described in Part I, Chap. 1.

### 3 AC supplies

DC supplies are converted to AC by seven inverters. The distribution is as follows:—

| *Inverter No.* | *Type* | *Associated service* |
|---|---|---|
| 1 | 103A (115v/400 c/s) | Green Satin |
| 2 | 100A (115v/400 c/s) | Standby for No. 3 |
| 3 | 100A (115v/400 c/s) | Artificial horizon<br>G4B compass<br>Oil pressure gauges |
| 5 | 201 (115v/1,600 c/s) | Blue Shadow<br>IFF and SIF |
| 6 | 103A (115v/400 c/s) | Blue Shadow blower motor<br>Electronic regulator blower motor<br>C.11 Compass<br>Radio Compass |
| 7 | 4F (115v/400 c/s) | Additional equipment<br>Standby for No. 8 |
| 8 | 108A (115v/400 c/s) | Tacan<br>Standby for IFF |

NOTE: Nos. 5, 6 and 7 inverters may be used to supply services additional to those enumerated above. The exact fit should be determined from local technical sources.

### 4 Controls and indicators

(*a*) The armament safety plug, No. 1 inverter ground test switch, and phase failure indicator are not fitted.

(*b*) *Nos.* 2 *and* 3 *inverters*
Nos. 2 and 3 inverters are initially controlled by No. 1 and No. 2 engine master start switches (EMSS) respectively. When No. 1 EMSS is switched on, No. 2 inverter starts up to supply the services normally served by No. 3 inverter, and the EMERGENCY INST. SUPPLY indicator shows white. When No. 2 EMSS is switched on, No. 3 inverter starts up to supply the services shown at para. 3 above, No. 2 inverter shuts down automatically and the EMERGENCY INST. SUPPL indicator shows black. Thereafter, if No. 3 inverter fails No. 2 automatically starts up and supplies the transferable load. During the checks before starting listen for No. 2 inverter starting up when the No. 1 EMSS is put on, and check that the EMERGENCY INST. SUPPLY changes from white to black when No. 2 EMSS is switched on.

(*c*) *Nos.* 1, 5, 6, 7 *and* 8 *inverters*
These inverters are controlled by switches and circuit breakers at the navigator's station.

## 5 Electrical system failures

(*a*) *No.* 3 *inverter failure*
If No. 3 inverter fails, No. 2 inverter will automatically start up and supply the artificial horizon, G4B compass and oil pressure gauges. If No. 2 inverter also fails, and it becomes vital, an attempt to restart No. 3 inverter may be made by switching No. 2 EMSS off for one second, then on again. If this procedure is unsuccessful no further attempt to start No. 3 inverter should be made.

(*b*) *Generator failure*
(i) *Single generator failure*
The drill for single generator failure is given in the Check Lists (ELECTRICAL FAILURES). If no generator controls are accessible, load shedding is the only remedial action which can be taken; although this is automatic on some aircraft for services supplied by Nos. 5, 6 and 7 inverters, it is advisable to switch these inverters off whenever generator failure has occurred.
(ii) *Double generator failure*
The drill is given in the Check Lists. The fuel considerations quoted in Part I, Chap. 1, para. 18(*b*)(ii) for the B(I) Mk. 6, apply equally to the B Mk. 6.

## Flight Instruments

### 6 General

The zero reader and dive/roll indicator are not installed.

### 7 Artificial horizon

The horizon gyro unit is not fitted. A Mk. 3c artificial horizon is on the main instrument panel and functions whenever AC power is being supplied by No. 2 or No. 3 inverter. The instrument has a fast erection push button; an OFF flag appears in the face of the instrument if power fails.

### 8 C.11 compass

(*a*) Only the direction gyro facility of the C.11 compass is available. Two indicators are installed, one on the navigator's instrument panel and one at the pilot's station either on his flight instrument panel or near the UHF radio selector box on the starboard instrument panel. The latitude control box is on the port wall of the navigator's station. The C.11 and its integral lighting, is automatically switched on when No. 6 inverter starts and the compass gyro reaches full speed in approximately three minutes.

(*b*) After a running time of 3 minutes, the latitude control is set and the navigator synchronises his repeater with the Mk.G4B compass. The pilot then synchronises his C.11 repeater with the Mk.G4B. With changing longitude, transport wander occurs and the C.11 will underread by as much as 8° with a 10° change of longitude on easterly headings, and overread on westerly headings. Therefore synchronisation should be carried out every 15 minutes. The main use of the C.11 as currently installed is to monitor the Mk.G4B during and after turns in areas of magnetic instability. A check of synchronisation should be made before each turn, and after completion of the turn the C.11 heading should be flown. The Mk.G4B should then be synchronised with the C.11 and may then be used until the next turn.

## General Equipment and Controls

### 9 Emergency equipment

The crash axe is stowed below the starboard instrument panel and the first aid kit is on the starboard wall aft of the entrance door. No leak stoppers are carried.

**10 Folding seat**

The folding seat is not installed.

**11 Internal lighting**

⋈

Aircraft fitted with twin PTR 175 installations have two rheostats mounted below the main instrument panel. These control the internal lighting of the V/UHF controllers and the Type 7681 control unit. The wander lamp is positioned on the lower starboard instrument panel.

## Air Conditioning System

**12 Ventilated suits, camera bay heating and bombsight window**

Pt. I, Ch. 8, paras. 5, 6 and 7(d) are not applicable to the B.Mk.6.

## Aircrew Equipment Assembly and Associated Systems

**13 Ejection seats**

The types of ejection seat installed vary according to the modification state of the aircraft. See Pt. I, Chapter 9.

**14 Emergency exits**

If, in a crash landing, the entrance door is obstructed, the pilot may not be able to escape via the navigator's hatch. In a crash landing therefore, the pilot is recommended to open his DV panel before landing, so that a convenient hand-hold is available should he find it necessary to jettison the canopy after landing.

**15 Oxygen system**

The oxygen system is as described in Pt. I, Ch. 9, para. 10-20, but no provision is made for the nose position, and the contents gauges are over the main entrance door.

## Radio, Radar and Navigation Equipment

**16 General**

Decca, roller map, Blue Silk, API and AMU are not fitted.

Green Satin, Blue Shadow and Tacan are provided. All controls are at the navigator's station and power supplies are as indicated at para. 2 preceding.

### 17 Radio selector box

An ARI 18089 radio mixing system and twin PTR 175 V/UHF are installed. The controllers for the V/UHF sets are on the lower starboard instrument panel. Two Type 7681 control units for the ARI 18089 system are positioned, one for the pilot above his port console, and one at the navigator's station. These control units permit the crew members to listen to any or all radio facilities simultaneously. Separate volume controls are provided for each service. To transmit, the SPEAK/LISTEN switch must be selected to the required service. Unless the navigator's volume control is turned up on the V/UHF set in use he will not be able to hear the pilot.

### 18 Aerial switch

An aerial switch is fitted adjacent to the UHF controls. This switch selects either upper or lower UHF aerial.

### 19 Radio compass

A Radio Compass (type 7092) is fitted. Indicators are on the navigator's instrument panel and on the pilot's flight instrument panel. All the controls are on the port wall of the navigator's station. The Radio Compass is the only facility not available in the mix position on the radio control box. All crew members have to switch to the Radio Compass position on their control box if they require audio Radio Compass. The instrument operates whenever the battery master switch is ON. DF is available whenever No. 6 inverter is ON.

## Armament

### 20 General

No armament or camera equipment is carried. Attention is drawn to para. 22(*a*) following.

## Limitations

### 21 Engine limitations

Engine limitations are as for the Canberra B(I) Mk. 6.

### 22 Airframe limitations

Airframe limitations are as for the Canberra B(I) Mk. 6 with the following exceptions:—

(*a*) Bomb doors must *not* be operated in flight.

(*b*) At maximum all up weight, extreme care should be exercised when taxying, owing to the maximum aft position of the C of G.

**WARNING:** The rear fuselage hatch should not be entered, when all fuel tanks are full, unless the tail support strut is in position.

(*c*) In tropical climates (ambient temperature above +30°C) below 5,000 ft. aircraft speed is not to exceed 365 Knots EAS, with or without tip tanks, except in emergency. If this limitation is exceeded the radome must be inspected for damage before the next flight.

## Handling

### 23 Taxying

Attntion is drawn to the need to taxy slowly at high AUW because of the tendency for the nose to rise.

### 24 Threshold speeds

The short runway threshold speeds shown in Fig. 1 of Part III, Chapter 3 are not to be used for the Canberra B.Mk.6.

### 25 General

Handling of the aircraft in flight is generally similar to that given in Part III of the Notes. Checks should, however, be carried out in accordance with the check lists for the B. Mk.6.

## Emergency Procedures

### 26 General

Emergency drills are given in the Check Lists for the B.Mk.6.