PART 1

DESCRIPTION AND MANAGEMENT OF SYSTEMS

LIST OF CHAPTERS

PART 1

CHAPTER 1 — ELECTRICAL SYSTEM

Contents

DESCRIPTION

1 Generators

(a) Power for the electrical services and aircraft main battery charging is provided by two Type P3, 6kW DC generators operating in parallel. Each generator is in the inboard leading edge of the mainplane and coupled to a two-speed gearbox which, in turn, is coupled to the accessories gearbox of its respective engine. The maximum load for continuous operation of a single generator is 175 amperes.

(*b*) Output of each generator is controlled by a voltage regulator, a Type D circuit breaker and a Type A differential cut-out; all of which are on the main electrical panel (MEP) in the starboard equipment bay. A master voltage regulator, also on the MEP, balances and maintains the output of both generators at 28 volts.

(*c*) A differential cut-out operates to bring its associated generator on line when generator voltage exceeds battery voltage and to disconnect it from the busbar when battery voltage exceeds generator voltage.

(*d*) The generators cut in at an engine speed of about 1700 RPM and cut out slightly below this figure. Full output is available at RPM in excess of 3000.

(*e*) A field circuit breaker for each generator is on the electrical control panel (see para 6).

2 AC Supplies — Inverters

DC supplies to the system are converted to AC by rotary inverters (No 1, 2 ▶◀ and 6) and one static inverter (No 7). The distribution of supplies is as follows:

(*a*) *No* 1 *Inverter (Type* 100*A)*
This is the main flight instrument inverter; it supplies 115 volt, 400 Hz, 3-phase or single-phase AC to the following:

Mk 4B compass
Horizon gyro unit
Zero reader flight computer
Radio compass (if fitted)
DV window heater control units

(*b*) *No* 2 *Inverter (Type* 100*A)*
No 2 inverter serves as a standby to No 1 inverter.

▶◀

(*c*) *No* 6 *Inverter (Type* 108*)*

No 6 inverter supplies 115 volt, 400 Hz, single-phase AC to the Tacan, IFF/SSR and Automatic Height Encoding (AHE).

(*d*) *No* 7 *Inverter (Type E*221*)*
No 7 inverter provides an alternative 115 volt, 400 Hz, single-phase AC supply for operation of IFF/SSR and AHE.

CANBERRA WH 844 AC SUPPLIES

1. No 1 Inverter

A 103A Inverter is fitted to cater for the increased demand caused by adding ILS/VOR and the Mk 6 horizon. It supplies 115v/400 c/s 3 phase AC for ;-
G4B compass, Mk 4B and Mk6 artificial horizon, Vibrator (Mk 19F altimeter), AC voltmeter amplifier (Mk 22D altimeter) VOR azimuth repeater unit power factor transformer (providing 26v DC for ILS/VOR).

2. No 2 Inverter

A standard 100A Inverter serves as a standby for the No 1 Inverter and all loads are transferred on failure of the 103A. The overload is acceptable in an emergency

3. No 3 Inverter

A 108A Inverter supplies TACAN and SSR.

NB. NO OTHER INVERTERS ARE FITTED;

4. Cooling

Both the No 1 and No 2 Inverters are cooled by ram-air entering through ducts on the starboard fuselage aft of the main door.

AC CONTROLS AND INDICATORS

1. When a generator comes on line and
No 1 Inverter starts up, it takes over
ffom the No 2 Inverter and the EMERGENCY
INST. SUPPLY indicator shows black. The
No 2 Inverter is automatically shut down.

2. No 3 Invetter
Control of the No 3 Inverter is effec
by a suitably labelled switch on the gener
switch panel

3. Circuit Breakers
The inverter circuit breakers are on
port shelf and are clearly labelled.

3 Aircraft Battery

Four 12 volt, 40 ampere-hour batteries, connected in series parallel, are in the battery compartment, access to which is through a hinged hatch on the port side of the fuselage.

4 External Supply

The external supply plug is on the MEP. It is connected directly to the busbar and all services connected to the busbar can be operated from the external supply. As no flash-back protection is provided, it is important that the aircraft battery switch is set to OFF before an external supply is connected.

5 Emergency Batteries

(a) Two 12 volt, 4 ampere-hour batteries, connected in series, completely independent of the main electrical system, are in the upper equipment bay. They are utilised for emergency operation of the turn-and-slip indicator and the detonator circuits for elevator control tube severance, canopy jettison and hatch jettison, if the supply from the main system fails.

(b) A 2·4 volt battery supplies the pilots' instrument panel emergency lighting; it is in the nose, below and forward of the pupil's rudder pedals.

(c) A 24 volt battery, in the port equipment bay, is provided for emergency operation of the Standby UHF if the main electrical supply fails.

6 Electrical Control Panel (ECP)

(a) The ECP is on the starboard wall at the navigator's station. The face of the panel consists of two hinged doors carrying the following controls:

(i) *Forward Panel*

LP cock and pump circuit breakers.
Fuel pump ammeter socket and test switches.
Generator test sockets.

(ii) *Aft Panel*

No 6 inverter (108 INVERTER) START and STOP switches.
IFF/SSR aerial position switch.
Circuit breakers for generator fields, ILS, inverters and pilot's services.

▸◂

(b) The main banks of fuses are behind the doors of the ECP.

7 Inertia Crash Switches

Two inertia crash switches are embodied in the fire circuits; one is in each lower equipment bay. If both switches trip during a crash landing, all the fire extinguishers are discharged and the aircraft battery is isolated from the main busbar. The following emergency circuits, being supplied directly from the aircraft battery, are unaffected:

Inertia crash switch circuits.

Fire extinguisher circuits (via the inertia crash switches only).

Canopy jettison
Elevator control tube severance } Detonator circuits
Hatch jettison

CONTROLS AND INDICATORS

8 Generator Controls

Each generator has a GEN (1 and 2) — ON/OFF switch and an adjacent generator failure warning light on the generator control panel on the cockpit port wall. The switches are of the pull-to-unlock type and are gated to lock their dollies at both selective positions. Some aircraft may also have duplicate warning lights on the engine instrument panel. The lights come on when the generators are off-line or to indicate generator failure. A field circuit breaker for each generator is on the ECP, and a DC voltmeter is adjacent to the generator switches.

9 AC Supplies — Inverter Controls

(a) No 1 *and No* 2 *Inverters*

(i) No 1 and No 2 inverters are initially controlled by the starboard (No 2) and port (No 1) MASTER STARTING — ON/off switches respectively; the switches are on the engine starter panel.

(ii) When No 1 MASTER STARTING switch is selected to ON, No 2 inverter starts up to supply the items listed in para 2 *(a)*. At the same time the EMERGENCY INST SUPPLY magnetic indicator (MI), on the flight instrument panel, changes from black to white.

(iii) Subsequently, when No 2 MASTER STARTING switch is selected to ON, No 1 inverter starts up and takes over from No 2 inverter, the EMERGENCY INST SUPPLY MI then changes to black and No 2 inverter is automatically shut down.

(iv) Therefore, No 2 inverter remains off unless No 1 inverter fails, in which case No 2 inverter restarts and takes over the supply from No 1 inverter and the EMERGENCY INST SUPPLY MI then changes to white.

(b) No 6 Inverter

No 6 inverter is controlled by two switches labelled 108 INVERTER—START and STOP; they are on the ECP. The switch dollies are spring-loaded to their central positions.

(c) No 7 Inverter

An IFF SUPPLY — NORMAL/EMERGY switch is adjacent to the IFF/SSR control unit on the navigator's instrument panel. When the switch is set to EMERGY, No 7 inverter is switched on and connected to the IFF/SSR and AHE.

10 Aircraft Battery Control

The aircraft battery is controlled by an ON/OFF switch covered by a guard labelled AIRCRAFT BATTERY on the generator control panel on the cockpit port wall. With this switch ON, the aircraft battery is connected to the main busbar; when switched OFF, the battery is isolated from all the electrical circuits except those listed in para 7.

Note: Post-mod 5098, a pull-to-unlock type of switch is fitted in place of the non-locking type and its guard. The switch is gated to lock its dolly at the ON (up) position.

11 Emergency Batteries Controls

(a) 24 Volt Emergency Battery

The emergency supply to the turn and slip indicator is controlled by a TURN & SLIP EMERGENCY SUPPLY switch on the engine instrument panel.

(b) 2·4 Volt Emergency Lighting Battery

The supply to the emergency lighting is controlled by an EMERG LIGHTS—ON/off switch on the coaming panel.

(c) 24 Volt Standby UHF Emergency Battery

See Chapter 6, para 12 *(b)* (i).

NORMAL OPERATION

12 Before Starting the Engines

The **Internal Checks** may be carried out using either the aircraft battery or an external power supply. The aircraft battery should only be used when the battery voltage exceeds 23 volts under nominal load (one LP pump switched ON for 30 seconds). 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. If the aircraft battery voltage is less than 22 volts under load, the aircraft must be considered unserviceable. The battery switch must be ON if the checks are carried out using the aircraft battery and OFF during the period an external power supply is connected.

13 Starting the Engines

During engine starting, the first generator comes on-line at about 1700 RPM. The second generator comes on-line at slightly higher RPM. As each generator comes on-line its failure warning light goes out. Maximum output from the generators can be obtained by increasing engine RPM above 3000.

14 During Flight

(a) The equipment supplied by No 6 inverter must not be switched on until the inverter has been running for at least 10 seconds, to ensure voltage and frequency have stabilised.

(b) Frequent checks must be made in flight to ensure that both generators are on-line and maintaining 28 volts, and that the EMERGENCY INST SUPPLY MI remains black. ▶◀

15 After Flight

After landing, switch off No 6 inverter. No 1 and No 2 inverters are controlled by the engine master starting switches which are switched off during the **Shutdown Checks.**

MALFUNCTION

16 Generator Failure

(a) Single Generator Failure

If a generator fails, as indicated by its associated failure light, or if it has to be switched OFF (eg when flying on one engine), the average load on the remaining generator must be reduced to not more than 175 amperes for continuous operation. Drills for generator failure and load shedding are given in the FRC under **Electrical System Failures.**

(b) Failure of Both Generators

If both generators fail, switch them both OFF and reduce electrical load to the absolute minimum compatible with aircraft safety. The AC-operated flight instrument inverter will be supplied from the aircraft battery. Attempt to regain each generator in turn (see FRC as in *(a)* above). If neither generator can be regained, confine electrical loads to essentials only and land at the nearest suitable airfield. Use the tailplane trim as little as possible because of the heavy load it places on the aircraft battery.

(c) If both generators fail at high altitude, altitude 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. Altitude should be reduced to below 15,000 feet, if possible, so that the engines may continue to obtain fuel by gravity/suction feed if the LP pumps cease to operate. However, if it is necessary to fly at greater altitude in order to reach the nearest suitable airfield, RPM should be restricted to 7200 ◀(maximum), and altitude to 35,000 feet (Avtur or Avcat)▶ or 25,000 feet (Avtag). (See also Chapter 2, para 11.)

Note: If the LP cocks of an empty tank are left open, there is a risk of flame-out of both engines when the battery is exhausted and the LP pumps are inoperable. Therefore, sufficient battery power should be conserved to close the LP cocks of tanks which are at very low fuel states.

(d) Failure of the Type A Differential Cut-Out

If the voltage output of a generator is low, it should automatically come off-line due to the action of the Type A differential cut-out. If, however, the cut-out contacts weld together it will not trip off-line and the serviceable generator may pass current down the faulty generator line. The serviceable generator is then overloaded and comes off-line due to the tripping of its Type D circuit breaker. The aircraft battery then passes current down the generator line having the faulty cut-out and the battery rapidly loses its charge as indicated by a rapid drop in voltage on the DC voltmeter. If this occurs in flight:

(i) Switch OFF the generator which has its warning light out.

(ii) Reduce electrical load.

(iii) Attempt to reset the generator which had its warning light on originally.

(e) Overvolting

Faulty regulation may result in overvolting which in turn, if prolonged, will overcharge and damage the aircraft battery. If overvolting occurs, take the following action:

(i) *After Starting.* If after the initial surge up to 32 volts the voltage is:

29 *to* 30 *Volts.* Continue with **After Start Checks** and then if still overvolting keep the engine running and call an electrician to rectify the fault.

30 *Volts and Above.* Shut down the engines immediately and report the defect.

(ii) *In Flight*

28 *to* 29 *Volts.* Continue the sortie and maintain a close watch on the DC voltage.

29 *to* 30 *Volts.* Land as soon as practicable.

Over 30 *Volts*

1. Reduce electrical load.

2. Switch OFF each generator in turn and check voltage. If one generator gives less than 30 volts isolate the other and return to base.

3. If after the independent check, voltage is 30 to 34, leave both generators ON and switch OFF the battery until about to land. Land at the nearest suitable airfield.

4. If after the independent check, the voltage is over 34 volts, switch OFF both generators, reduce electrical loads to a minimum, switch ON the battery and land at the nearest suitable airfield.

17 No 1 Inverter Failure

If No 1 inverter fails, the EMERGENCY INST SUPPLY MI shows white. When this occurs No 2 inverter automatically starts up and takes over from No 1. One attempt to restart No 1 may be made by re-setting its circuit breaker, if this has tripped, and switching the No 2 MASTER STARTING switch off for one second.

18 No 6 Inverter Failure

If No 6 inverter fails, the IFF/SSR SYSTEM FAILURE light comes on, the Tacan indicators failure flags appear and the navigator's Mk 30A altimeter failure flags appear. If these indications occur, select the IFF SUPPLY switch to EMERGY. This switches on No 7 inverter and connects its output to the IFF/SSR and AHE.

19 Electrical Loads

A table showing the approximate loads imposed by the more important items of equipment is given in the FRC under **Electrical System Failures.**

Intentionally Blank

WH 844 ELECTRICAL LOADING CONSIDERATIONS

1. With all services on, the total continuous loading in Canberra WH 844 is 243 amps.

2. As the maximum capacity of any one generator is 200 amps (6 KW), the total loading must be reduced by some 43 amps if a generator fails.

3. The recommended load shed is to switch off either the No 3 Inverter - 55 amps (and so lose TACAN and SSR) or the No 1 Inverter - 55amps less 10 amps when the No 2 Inverter starts up- and so lose the double safety given by using the No 2 Inverter as a back-up for the No 1 Inverter. If the No 1 Inverter is selected off (by tripping the CB or momentarily selecting the starboard engine master switch OFF then ON again), it is essential to check that the No 2 Inverter is working (by observing that the flight instrument warning flags do not appear).

CONSIDERATIONS

If TACAN or SSR is not required to complete the flight, select the No 3 Inverter and its associated services OFF.

PART 1

CHAPTER 2 — FUEL SYSTEM

Contents

DESCRIPTION

1 Fuel Tanks

(a) Fuselage Tanks

Three fuel tanks are fitted in the fuselage above the bomb bay. They are numbered 1, 2 and 3 from front to rear. No 1 and No 2 tanks are rigid self-sealing structures 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 Tip Tanks*

(i) Jettisonable wing tip tanks may be fitted. No fuel cocks or pumps are provided. The tanks feed automatically (and together) under air pressure from the engine compressors into No 3 tank via a float valve. A flush-fitting inward venting 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 console.

2 Fuel Tank Capacities

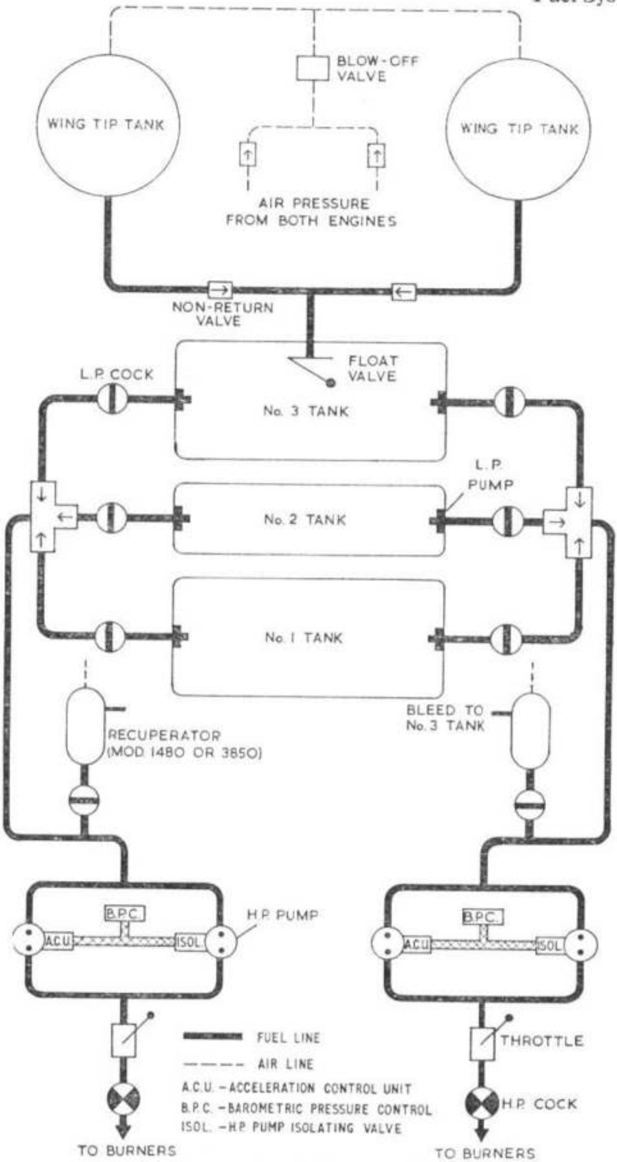
The effective fuel capacities are approximately:

	Gallons	*lb Avtag at 0·77SG*	*lb Avtur at 0·80SG*	*lb Avcat at 0·82SG*
No 1 tank	520	4004	4160	4264
No 2 tank	317	2441	2536	2600
No 3 tank	540	4158	4320	4428
Total internal fuel	1377	10,603	11,016	11,292
Wing tip tanks (2 at 244 gal)	488	3757	3904	4002
Total all tanks	1865	14,360	14,920	15,294

3 Fuel Recuperators

(*a*) If Mod 1480 or 3850 has been embodied, two fuel recuperators, one for each engine, are provided to compensate for negative-g flight conditions.

(*b*) Each recuperator comprises a flexible bag contained within a casing, the bag being connected to the fuel delivery line between the common collector box and the engine. Air is fed from the engine compressor to the casing so that it acts on the flexible bag at constant pressure. The pressure from an LP pump is greater than this air pressure so that the bag is charged with fuel. If an LP pump ceases to deliver fuel due to negative-g flight conditions, or for any other reason, the air pressure will collapse the bag which discharges its contents to the engine. The recuperator will recharge as soon as an LP pump again starts to deliver fuel.



1 — 2 Fig 1 Fuel System Simplified

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

(*d*) If mod 3850 is embodied, fuel flows to each recuperator through electrically operated cocks controlled by switches on the engine instrument panel. These switches should always be placed ON before flight.

4 Fuel Feed to the Engines

Two electrically-driven LP pumps are fitted in each fuselage 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 pumps; similarly the pumps on the starboard side of the tanks feed the starboard engine HP pumps.

CONTROLS AND INDICATORS

5 LP Cock and Pump Controls

(*a*) A pair of electrically-operated LP cocks is fitted for each fuselage tank. Of each pair, one cock serves the port engine and the other the starboard engine. Each LP cock is controlled by its associated LP fuel pump switch on the engine instrument panel. The switches have three positions:

	COCK	*PUMP*
Up	OPEN	ON
Middle	OPEN	OFF
Down	CLOSED	OFF

The switches are guarded so that while the up and middle positions can be selected with the guard in place, the guard must be lifted before a down selection can be made. In flight, the down position (LP cock CLOSED) should only be selected in an emergency.

(*b*) Each fuselage tank cock and pump circuit is protected by a circuit breaker on the ECP.

6 Fuel Pressure Warning Lights

Two fuel pressure warning lights, one for each engine, are on the engine instrument panel. They come on if fuel delivery pressure from the LP pumps drops below 6 PSI due to pump failure, negative g or shortage of fuel in the tank(s) in use. If no recuperators are fitted, brief warning of flame out is given; if recuperators are fitted, some 10 seconds warning is given.

7 Fuel Contents Gauges

Three capacitor-type gauges calibrated in lb are on the engine instrument panel. They indicate, from top to bottom, the contents of No 1, No 2 and No 3 tanks. No contents gauges are provided for the wing-tip tanks.

NORMAL USE OF THE FUEL SYSTEM

8 Checks of Fuel Pumps and Cocks

(a) Before flight ensure that all fuel cock and pump circuit breakers are made. Check the operation of each LP pump both aurally and against the appropriate fuel pressure warning light.

(*b*) If recuperator switches are fitted switch them ON before take-off.

9 Fuel Management Drill

(a) General

(i) The CG limits may easily be exceeded if the correct fuel drill is not followed. 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, the fuel gauge may read full but under certain conditions of flight the level may fall to 3500 lb before transfer has been completed. When the level in No 3 tank falls steadily below 3500 lb, it indicates that the transfer of fuel 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 LP 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 pumps should be switched OFF.

(iv) When No 1 and 3 tank 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 by fuel and no other 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.

(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 No 1 and 3 tanks 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 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.

(b) Fuel Drill

Use fuel from No 3 tank for starting the engines and for taxying. Thereafter, under all normal conditions, control the use of the fuel by means of the LP pumps in accordance with the following drill.

Condition	Tank		
	No 1 Pumps	*No 2 Pumps*	*No 3 Pumps*
1 Start-up and taxy ...	OFF	OFF	ON
2 Take-off to 2000 ft ...	ON	ON	ON
3 2000 ft until tip tanks empty	OFF	OFF	ON
4 Tip tanks empty and cruise	Maintain balanced amounts in No 1 and No 3 tanks As reqd	OFF	As reqd
5 When No 1 and 3 tanks read 500 lb each ...	All ON		
6 Landing	All ON (See Note)		

Note: When carrying out circuit practice, condition 6 may be modified to read 'Minimum of two pumps per engine ON as long as No 1 and No 3 tanks read above 500 lb each'.

▸◂

(c) Reserve Fuel

An overshoot followed by an instrument approach and landing requires about 1250 lb fuel which should, preferably, be retained in No 2 tank. The fuel surge in No 2 tank does not become dangerous until the contents has fallen to about 400 lb, but all the fuel can be used provided that manoeuvres or attitudes which might lead to fuel surge are avoided. In this condition do not rely on the recuperators (if fitted) to compensate for fuel surge caused by mishandling the aircraft.

10 Use of Different Fuels

See Part 2, Chapter 1, para 3 *(a)*.

11 Fuel LP Pump Failure

(a) If two or three LP pumps on one side are on, no immediate indication will be given if one pump fails; but if all pumps fail, or if one pump is on and it fails, the warning light for that side will come on. (See para 6 above.)

(b) The HP pumps are designed to operate with a positive inlet pressure. LP pump failure will cause the HP pumps to obtain fuel by gravity feed and suction only, which may result in 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 inlet guide vane movement. If the fuel pressure at the HP pumps inlet is sufficiently low, cavitation of the HP pumps will occur causing 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.

(c) Following a reduction in fuel pressure each HP pump servo piston moves the pump camplate to the full stroke position in an attempt to produce the normal working pressure; restoration of low pressure fuel in these circumstances may lead to over-fuelling. Therefore, if an LP pump fails, throttle the affected engine to 'idling' immediately, wait for the RPM and JPT to stabilise and then switch on another LP 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 and relight using the drills given in the FRC. Fuel from the tank with a failed pump is available for use by the other engine.

(d) If both LP pumps in one tank fail or if the distribution of fuel makes necessary the use of fuel by suction and gravity feed, altitude should be reduced to 15,000 feet if possible. The engine which is to be fed by gravity suction should be throttled to 'idling', the related cock/pump of the affected tank switched to cock OPEN — pump OFF and the remaining cocks/pumps on that side switched to cock CLOSED — pump 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 7200 RPM maximum up to 35,000 feet with Avtur or Avcat or up to 25,000 feet with 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.*

Note: If recuperators are fitted, the recuperator serving the affected engine will discharge, and will not recharge, under gravity/suction feed.

PART 1

CHAPTER 3 — HYDRAULIC SYSTEM

Contents

DESCRIPTION

1 General

A hydraulic pump on each engine draws fluid from a reservoir (capacity 2 gallons) at the starboard side of the upper equipment bay. A handpump is installed between the pilots' seats for manual operation of the services. A stack pipe in the reservoir ensures a reserve of fluid for use with the handpump. The wheelbrakes system hydraulic pressure gauge is on the miscellaneous instrument panel. Post-mod 1178 a main system hydraulic pressure gauge is fitted next to the wheelbrakes gauge.

2 Pumps and Services

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

Undercarriage
Flaps
Airbrakes
Bomb doors
Wheelbrakes

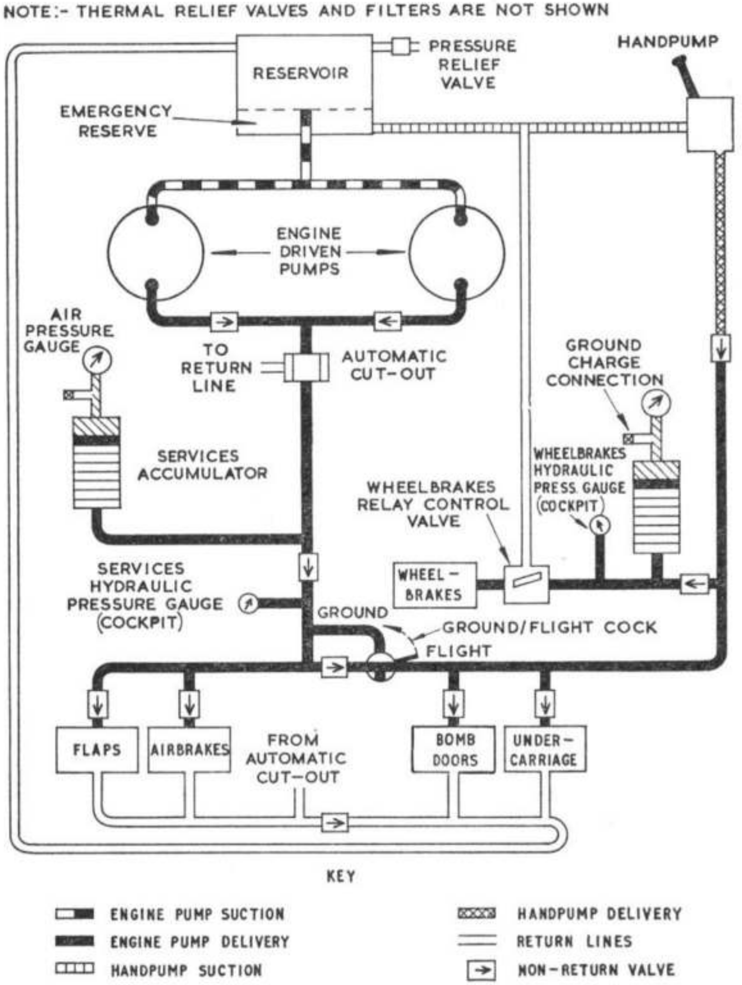
(*b*) The handpump works in conjunction with the hydraulic GROUND/FLIGHT cock situated near the front of the bomb bay roof on the starboard side. When the cock is at FLIGHT the handpump can be used to operate only the undercarriage and the bomb doors and to charge the wheelbrakes accumulator. With the 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 is permanently mounted in the pump socket and may be stowed by sliding its hand grip forward and folding back the handle.

(*c*) A second manually-operated ground selector cock is on the forward face of the rear bulkhead on the port side of the battery bay. It has two positions UP and FLIGHT and is normally wire-locked in the FLIGHT position. When in the UP position it enables the nose undercarriage unit to be retracted by means of the handpump during servicing operations.

3 Accumulators

(*a*) The main accumulator is in the starboard mainplane leading edge; it maintains a reserve of power, prevents hammering of the cut-out and provides initial power for movement of the jacks when a service is selected. A second accumulator for the wheelbrakes is on the bulkhead just forward of the battery bay and maintains an independent reserve of power for the brakes. The air pressure gauge for the main accumulator is in the starboard wheelwell and the gauge for the wheelbrakes accumulator is in the bomb bay on the forward bulkhead. These gauges should read 1350 $^{+50}_{-0}$ PSI at +15°C when there is no pressure in the hydraulic system. For correct pressures at other temperatures see Leading Particulars.

(*b*) A cut-out valve is fitted in the pressure line and connects to the return line, providing an idling circuit; it is set to cut-out when the accumulator pressure reaches 2500 $^{+0}_{-100}$ PSI and cut-in at a minimum of 2000 PSI. Thermal relief valves in all circuits, except the wheelbrakes, open when pressure in the line to a service increases, for any reason, to 3450 ± 100 PSI; these valves



1 — 3 Fig 1 Hydraulic System Simplified

reseat when pressure falls to 3100 PSI (minimum). An additional valve relieving at 3100 PSI is transposed between the sequence valve and transfer valve of each main undercarriage circuit; to ensure satisfactory operation of these valves, a valve relieving at 3500 ± 100 PSI is fitted in the brake differential control valve.

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 Chapter 5.

NORMAL MANAGEMENT

5 External Checks

Check the accumulator pressure gauges in the bomb bay and starboard wheelwell for minimum pressure (see para 3 (*a*)). Ensure that the hydraulic cock~~s~~ in the bomb bay is ~~and battery bay are~~ wire-locked at FLIGHT.

6 Before Starting the Engines

Check the operation of the handpump by pumping until at least 1350 PSI is indicated on the wheelbrakes hydraulic pressure gauge.

7 Checks During Starting

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

Start the port engine first and note that the pressure on the main and wheelbrakes pressure gauges rises to 2400 to 2500 PSI. Then operate a hydraulic service (normally the bomb doors) and note on completion of the operation that the hydraulic pressure builds up again to 2400 to 2500 PSI.

8 After Starting the Engines

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 2400 to 2500 PSI.

9 Checks During Shutdown

Stop the port engine first and before stopping the starboard engine operate a hydraulic service (normally the bomb doors) and subsequently note that the hydraulic pressure builds up again to 2400 to 2500 PSI.

MALFUNCTION

10 Hydraulic Failure

(*a*) A failure may be assumed if the reading on the main pressure gauge (mod 1178) is below 2000 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; wheelbrakes pressure can also be obtained, provided that hydraulic fluid is available. Detailed emergency drills are given in the FRC.

◀ (*b*) Hydraulic 'cycling', ie repeated fluctuation of the main hydraulic pressure (mod 1178) between 2000 and 2500 PSI when no hydraulic service is in use, may indicate an internal or external leak. If 'cycling' occurs at intervals of less than 15 minutes, the possibility of loss of fluid and consequent hydraulic services failure must be considered and the undercarriage should be lowered as soon as practicable. ▶

(*c*) *Spurious Indication of Hydraulic Failure*

Cases have occurred, particularly at high altitude, where the main hydraulic pressure gauge (mod 1178) 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 and there are no other symptoms of hydraulic failure, check the operation of the handpump. If there is firm resistance to movement of the handpump, it may be assumed that the hydraulic system is serviceable and the gauge reading is inaccurate.

PART 1

Chapter 4 — ENGINE SYSTEMS AND CONTROLS

Contents

1 Avon Mk 1

The Avon Mk 1 is a turbo-jet which features a twelve-stage axial flow compressor directly coupled to and driven by a two-stage turbine; it gives 6500 lb static thrust at sea level. The engine limitations are given in 2—1 Para 1.

2 Engine fuel system

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

(i) The total output of the two engine-driven HP fuel pumps 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 engine during periods of rapid engine acceleration between idling RPM and 5000 RPM up to 5000 ft.

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

(*b*) HP *fuel pumps isolating valve*

(i) A solenoid-operated isolating valve is incorporated in the upper HP pump of each engine. When energised it ensures that a fuel flow equal to at least maximum delivery from one pump is available in the event of a pump failure or a defect in the fuel pump servo control system. Either pump is capable of supplying sufficient fuel at full stroke to permit 60 per cent of take-off thrust to be obtained at low altitudes, rising progressively to full thrust at 12000 feet and above.

(ii) The HP pump isolating valve of each engine is energised by setting the appropriate switch on the port console to ISOL (up); the use of these switches is covered in 3—2 Para 5(*c*).

3 Variable inlet guide vanes and air bleed valves

(*a*) The first row of stator blades in the engine compressor consists of variable incidence 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 are at the closed (+40°) position 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 open (0°) position and produce a minimum of swirl.

(*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, the compressor is not operating at maximum efficiency and best specific fuel consumption is not obtained until the guide vanes are fully open.

(*c*) The guide vanes leave the 0° (open) position at 7250 ± 50 RPM (Mod 5278) or 7000 ± 50 RPM (pre-Mod 5278) on deceleration and leave the +40° (closed) position at 5850 ± 100 RPM (Mod 5278) or 5300 ± 100 RPM (pre-Mod 5278) on acceleration.

(*d*) The air bleed valves are set to open and close at 6300 ± 50 RPM (Mod 5278) or 6050 ± 50 RPM (pre-Mod 5278).

4 Throttle controls

The throttle control levers are duplicated and coupled together. The pupil's are in the engine controls quadrant at the forward end of the port console; the quadrant is marked SHUT/OPEN (forward) to correspond to the position of the throttle valve. The instructor's are in the engine controls quadrant on the cockpit starboard wall. Friction adjustment is provided on the instructor's levers only and the control consists of the smaller of two knurled knobs on the side of the quadrant.

5 HP cock controls

As with the throttle controls, the HP cock control levers are duplicated and coupled together. The pupil's are outboard of the throttle controls, the quadrant is marked OFF/ON (forward); the instructor's are inboard. Friction adjustment is provided on the instructor's levers only, and the control consists of the larger of two knurled knobs on the side of the control quadrant. Each lever incorporates a relight pushbutton.

NOTE: The throttle nut must be adjusted before the HP friction nut as the latter locks the throttle adjustment so that it cannot be altered subsequently.

6 Engine starting, relighting and stopping controls

(*a*) *General*

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

(*b*) *Starter loading*

(i) Check that the MASTER STARTING switches are off. Then unscrew the breech cap after releasing the locking ratchet by pressing on the spring-loaded stud in the cap. Remove the cartridge case from the cap by depressing the two buttons in the base. Fit a new cartridge so that the extractor claws grip the base. Insert the cartridge into the barrel and screw the cap home finger-tight only; if screwed in 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.

(*c*) *Starting controls*

The main starting controls are on the engine starter panel below the flight instrument panel and for each engine consist of a MASTER STARTING switch, IGNITION switch, and a STARTER pushbutton. The MASTER

STARTING switch must be on before either the STARTER pushbutton or IGNITION switch is operative.

(*d*) *Ground starting*

With the battery master switch on, the LP fuel pumps ON, the HP cock open, the turbo-starter loaded and the master starting and ignition switches ON, pressing the starter pushbutton operates a time-delay switch which fires the cartridge to accelerate the engine and, through a relay, actuates the high-energy ignition units for approximately 30 seconds, giving the engine time to become self-sustaining. If, after a failure to start, a 'blow through' is necessary to remove excess fuel, the same procedure is followed excepting that the LP pumps, HP cock and ignition switch are left OFF.

(*e*) *Relighting in flight*

The relight pushbuttons on the HP cock levers are for relighting the engines in flight. Pressing the appropriate button by-passes the normal starting circuit and immediately energises the high energy ignition units, provided that the master starting and ignition switches are ON.

(*f*) *Stopping an engine*

An engine is stopped by pulling back the HP cock lever to close the HP cock.

7 Oil system

Each engine has its own integral system of 19 pints capacity, including oil sump capacity of approx 16 pints. 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

RPM indicators, oil pressure gauges and jet pipe temperature gauges are all on the engine instrument panel. The oil pressure gauges operate whenever DC is available.

9 Engine fire extinguishers and inertia crash switches

See 1—7, Paras 2 and 4.

10 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 3 and in the FRCs.

PART 1

CHAPTER 5 — AIRCRAFT CONTROLS

Contents

1 Flying Controls — General

(a) The duplicated flying controls are conventional in operation, the control runs consisting of push-pull tubes and levers. The rudder, port elevator and both ailerons are fitted with spring tab mechanisms. The rudder pedals are adjustable for reach by a central star wheel.

(b) The equipment on each control column handwheel is as described in sub-para (i) and (ii) below.

(i) *Pupil's*

Centrally	Wheelbrakes lever Brake parking control Airbrakes control switch
Right-hand grip ...	Tailplane incidence control switch Tailplane incidence control cut-in switch

On some aircraft the tailplane incidence control switch and cut-in switch are replaced by a control switch covered by a thumb-operated flap which acts as a cut-in switch. The incidence control switch cannot be operated without first lifting the flap, thus operating the cut-in switch.

Press-to-transmit pushbutton

(ii) *Instructor's*

Centrally	Wheelbrakes lever Airbrakes control switch
Left-hand grip ...	Tailplane incidence control switch Tailplane incidence control cut-in switch Press-to-transmit pushbutton

2 Variable-Incidence Tailplane and Indicator

(a) Changes in tailplane incidence are made by an electrical actuator controlled by either of the two tail-trim switches, operating in the natural sense, one on each control column handwheel; the instructor's switch overrides that of the pupil. The normal limits of the tailplane travel are controlled by electrical limit switches.

(b) A master cut-in switch is positioned just forward of each tail-trim switch. These switches, which are spring-loaded to the off position, control an isolating relay in the power circuit of the tailplane actuator, so that the actuator cannot function unless either cut-in switch is operated.

(c) The amount of available tailplane travel is limited and the elevator trailing-edge strips are trimmed so that the aircraft is controllable under any flight conditions within the limitations if the actuator runs away to the fully nose-down position. This applies even if the actuator has overrun the electrical stop and has reached the mechanical stop.

(d) The tailplane position is shown on a trim indicator on the left-hand side of the engine starter panel.

(e) Whenever an aircraft component which affects longitudinal trim is renewed or adjusted, the flight trim check specified in AP 101B-0404-1A, Section 3, Chapter 4, Appendix 1 is to be carried out.

3 Rudder and Aileron Trims Indicators

(a) Rudder Trim

The spring tab fitted to the rudder also operates as a trim tab. An electrical actuator alters the position of the spring tab relative to the rudder. The actuator is controlled by either of two pairs of switches, one pair at each pilot station. Of each pair, one switch controls the positive feed and the other the earth return so that the actuator cannot function unless both circuits are made by operation of either pair of switches. The instructor's switches override the pupil's switches. The pupil's pair of switches is on the port console and the instructor's is on the starboard wall above the engine control quadrant.

(b) Aileron Trim

Trim tabs are not fitted to the ailerons, but lateral trim is effected by an aileron bias gear, in the form of a spring, which pre-loads the control column handwheels in either direction. The required amount of spring loading is applied by an electrical actuator controlled by either of two switches, one at each pilot station, adjacent to the rudder trim switches. The instructor's switch overrides the pupil's switch.

(c) Indicators

Position indicators for the rudder and aileron trims are on the left-hand side of the engine starter panel.

4 Control Columns Snatch Unit

(a) To ensure adequate clearance for the pilots during ejection, a spring-operated snatch unit is connected to the control columns to move them forward and hold them against the instrument panels. An explosive collar, fitted to the elevator control tube, is fired in conjunction with the snatch unit and severs the tube. Operating either seat firing handle on either pilot's seat detonates a cartridge in a breech firing unit on the rear of the seat guide rails. Gas pressure releases the snatch unit sear and operates the detonator microswitches to explode the detonators in the canopy attachment bolts (see Chapter 10, para 14) and the elevator control tube severance unit. The tube is

severed before the snatch unit is fully operated. The CANOPY/SNATCH MASTER switch, on the cockpit port wall, must be ON to make the system live.

(b) The detonator circuits are supplied direct from the battery busbar and operate irrespective of the position of the battery switch. If the main battery fails, the circuits are automatically transferred to the emergency battery.

5 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 rear fuselage hatch. On some aircraft they are stowed in a metal box on the inside of the battery compartment hatch.

(b) Picketing

Ring bolts are provided for picketing and are stowed in the rear fuselage on the port side above the rear hatch. ◀The bolts screw into sockets, on each main undercarriage leg, under each mainplane and below the fuselage, aft of the tail skid. When not in use, the main undercarriage sockets are covered by flaps in the leg fairings and the others are closed by screw plugs. All points are marked PICKETING POINT. A nose picketing point is provided by the nose undercarriage where a lashing is placed over the stay-link lugs. ▶

6 Undercarriage

(a) General

Undercarriage raising and lowering is effected by hydraulic jacks and an electrically-operated hydraulic selector valve. Sequence valves in the hydraulic circuits ensure that the undercarriage doors operate in their correct sequence. Provision is made for emergency lowering of the undercarriage in the event of main hydraulic failure or electrical failure of the selector valve (see para 7).

(b) Normal Controls

The selector switch unit on the port front panel controls an electrically-operated actuator for the up-down hydraulic selector valve. The UP and DOWN buttons on the switch unit are spring-loaded, pressure on one releasing the other. When the UP button is depressed, the selector valve moves to the up position and the undercarriage units retract. When the units have locked in the up position, a sequence valve is actuated to permit the undercarriage doors to close. When the DOWN button is depressed, the undercarriage doors open fully before lowering of the undercarriage units commences. At maximum RPM the undercarriage should normally retract in 15 seconds (maximum) and at 6000 RPM it should lower in about 12 seconds.

WARNING: To ensure that the electrical contacts are made when the switch unit is operated, the UP or DOWN button must be pressed *fully* in.

(c) Safety Devices

A number of safety devices are incorporated to prevent inadvertent retraction of the undercarriage on the ground. They consist of:

(i) *Undercarriage Master Switch*

A guarded 2-position switch marked U/C MASTER SWITCH — LIVE/SAFE is on the left side of the engine starter panel. At the SAFE position the power supply for operation of the selector valve is switched off. This switch must be at SAFE at all times when the aircraft is on the ground, except immediately prior to take-off when it must be selected to LIVE.

Note: Post-mod 5098, a pull-to-unlock type of switch is fitted in place of the guarded switch. The switch is gated to lock its dolly at both selective positions.

(ii) *Solenoid Lock*

A solenoid-operated mechanical lock in the selector switch unit prevents the UP button from being operated while the main undercarriage legs are compressed. When the legs extend on the aircraft becoming airborne or on being jacked up, a microswitch on the starboard leg closes and the solenoid is energised (irrespective of the position of the master switch); this releases the mechanical lock to allow UP to be selected. This safety device should not be relied upon when the weight of the aircraft is low. The lock can be overridden by operation of the UP button override (see para 7).

(iii) *Undercarriage Safety Clip*

An undercarriage safety clip is provided for fitting around the UP button, behind the override collar, to prevent accidental operation of the button on the ground. The clip must be removed before flight and replaced after landing.

(iv) *Undercarriage Ground Locks*

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

(*d*) *Undercarriage Position Indicators*

(i) Two type D or D1 indicators are fitted one on the port front panel and the other on the miscellaneous instrument panel; they are operated in parallel by micro-switches in the main and nose undercarriage bays. The indications given are as follows:

Three green lights	—	All undercarriage units locked down
Any red light	—	Undercarriage unit unlocked
No lights	—	All undercarriage units locked up

(ii) It should be noted that there is no indication that the main undercarriage doors are locked up. The nose undercarriage red light comes on if the throttle levers of either engine are less than one third open with the undercarriage in any position other than all three units locked down.

(iii) If failure of a green light is suspected, reserve green lights can be brought into operation by turning the changeover switch at the centre of the dial. For night flying, the intensity of the lights can be reduced by turning the larger winged knob at the centre of the dial. A fuse for the indicators is in the ECP (68).

7 Undercarriage Malfunctions

(*a*) *Emergency UP Selection*

When the aircraft is on the ground the undercarriage can be selected up in emergency, provided that the master switch is at LIVE, by rotating the override collar on the

UP button clockwise until it reaches a stop and then pressing the UP button. The override collar will move through 60° or 90° according to the type fitted. The override should not normally be operated in the air because if the undercarriage has been damaged subsequent lowering may be prejudiced.

(b) Emergency Lowering of the Undercarriage

If the undercarriage fails to lower by the normal method the fault may be hydraulic, electrical or mechanical.

(i) *Hydraulic Failure*

If hydraulic failure occurs (indicated by the main pressure gauge (post-mod 1178) reading below 2000 PSI and failing to build up again or by lack of resistance to handpump operation (pre-mod 1178)), the undercarriage can be lowered by making a normal down selection and pumping with the hydraulic handpump until three green lights are obtained. Normally the undercarriage can be pumped down in about 5 minutes (about 130 strokes); however, this largely depends on the nature of the failure and exceptionally up to 30 minutes and considerable physical effort may be required.

(ii) *Electrical Failure*

◀ If the undercarriage is not felt or heard to lower and no indicator lights are showing, try to reselect undercarriage up again:

1 If the UP button *will not* depress, the solenoid of the UP button mechanical lock is not energised; this is an indication of failure of the control fuse in the MEP through which the solenoid and the selector valve are energised. The selector valve can be moved mechanically to the down position by pulling out the undercarriage emergency lowering handle at the top of the port front panel. The handle must be pulled fully out until it is locked in position by a spring clip. Failure to lock the handle fully out may result in the selector valve taking up a neutral position, thus bypassing fluid to the return line and causing a loss of hydraulic pressure. If a drop in hydraulic pressure occurs after lowering the undercarriage by this ▶

method, check that the emergency handle is fully out and locked. When the undercarriage is lowered by this method, it cannot be raised again until it has been serviced.

2 If the UP button *does* depress, the control fuse has not failed. Reselect, several times, the UC master switch to SAFE and then back to LIVE and the UC selector buttons from UP to DOWN in an attempt to clear a possible switch contacts fault. If the undercarriage still does not lower, then an electrical failure of the selector valve is the probable cause of the malfunction. Pull the emergency lowering handle to operate the selector valve mechanically, as in 1 above.

(iii) *Mechanical Failure*

In cases where a main undercarriage unit has failed to lower due to an out-of-sequence retraction, the hydraulic lock so caused can be overcome and the unit lowered by relieving the valve fitted in the main undercarriage circuit (see Chapter 3, para 3 (*b*)); this is achieved by prolonged and vigorous use of the handpump. For other mechanical failures, use of the handpump and application of positive g and yaw may succeed in lowering the undercarriage.

(*c*) Full emergency drills for undercarriage malfunction are given in the FRC.

8 Flaps Controls and Indicator

(*a*) The electrically-operated hydraulic selector valve for the flaps is controlled by two switch levers, one, for the pupil, on the port front panel and the other, for the instructor, on the miscellaneous instrument panel. The pupil's switch lever has two positions, UP and DOWN, and the instructor's switch lever has three positions UP/TO PUPIL/DOWN. Until the instructor's switch lever is selected to TO PUPIL, the pupil's switch lever is inoperative. At 6000 RPM the flaps should normally retract in about 16 seconds and lower fully in about 13 seconds.
(*b*) To prevent inadvertent operation of the flaps when aileron control locks are fitted, the instructor's switch lever is selected UP and a locking pin is inserted in the switch lever guard.

(*c*) A flap position indicator is on the left lower corner of the flight instrument panel.

(*d*) No provision is made for 'in-flight' operation of the flaps in the event of electrical or hydraulic failure.

9 Airbrakes Controls

(*a*) The electrically-operated hydraulic selector valve for the 2-position airbrakes is controlled by two switches, one on each control column. The pupil's switch has two positions, IN/OUT, and the instructor's three positions, IN/PUPIL/OUT. The pupil's switch is inoperative until the instructor's switch is set to PUPIL.

(*b*) No provision is made for 'in-flight' operation of the airbrakes in the event of electrical or hydraulic failure.

10 Wheelbrakes Controls

(*a*) The hydraulic wheelbrakes are controlled by two levers, one on each control column. A parking catch is provided on the pupil's control column. Differential braking is obtained by movement of the rudder pedals.

(*b*) The pressure in the brakes accumulator is shown on a gauge on the miscellaneous instrument panel; normal pressure is 2000 to 2500 PSI. If the hydraulic system has failed, pressure will fall to 1350 PSI as the brakes are used. At this point the accumulator is fully discharged of hydraulic fluid and the pressure will drop rapidly to zero. Pressure may, however, be restored by means of the hydraulic handpump, provided that fluid is available.

(*c*) If a leak occurs in the wheelbrakes system while taxying (indicated by a loss of pressure on the brake pressure gauge (brake and main hydraulic gauges post-mod 1178)) it may be necessary to raise the undercarriage to stop the aircraft. The brakes must be released before making an emergency UP selection. The handpump may have to be used to assist in raising the undercarriage.

11 Bomb Doors Controls and Indicator

(*a*) The electrically-operated hydraulic selector valve for the bomb doors is controlled by an OPEN/SHUT switch lever on the port console. Immediately aft of the control switch is a red light which comes on when the bomb doors are fully open.

(*b*) To prevent inadvertent closing of the bomb doors on the ground, a locking pin is inserted in the control switch guard with the switch in the OPEN position. When not in use the pin is stowed in a bag on the cockpit starboard wall.

(*c*) *Emergency Operation of Bomb Doors*

(i) Should the bomb 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 bomb 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.

(ii) If the failure is hydraulic and provided that fluid is available, the bomb doors can be opened and closed by means of the handpump 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 wheelbraking.

PART 1

CHAPTER 6 — FLIGHT INSTRUMENTS RADIO AND RADAR

Contents

FLIGHT INSTRUMENTS

1 Compasses

(a) Mk 4B Compass

The Mk 4B compass operates whenever AC is supplied by either No 1 or No 2 inverter. The master indicator is on the navigator's instrument panel and the compass control panel is on the cabin starboard wall. The gyro unit is on the pilots' flight instrument panel; it can also be used as a directional gyro by setting the COMPASS/D GYRO switch on the engine starter panel, to D GYRO.

(b) Magnetic Standby Compass

An E2B standby compass is fitted centrally below the canopy coaming. The integral lamp is controlled by the adjacent port RED dimmer switch.

2 Pitot and Static Pressure Systems

(a) An electrically-heated pressure head on the nose of the aircraft, and two static vents, one on each side of the nose (the forward hole of each two-vent plate), supply pitot and static pressure respectively to the following:

Machmeter (P and S)
Airspeed indicators (3) (P and S)
Vertical speed indicator (S)
Mk 29B altimeter (S)
Zero reader computer (S)
Air mileage unit (P and S)
Pressure error corrector unit (P)

The heater element in the pressure head is controlled by the PRESS HEAD—ON/OFF switch on the port console.

(b) The aft hole of each static vent plate supplies pressure to the cabin pressure controller (see Chapter 8).

(c) Two static vents, one on either side of the fuselage just above the lower equipment bay doors, provide static pressure to the pressure error corrector unit and the navigator's Mk 30A altimeter.

3 Horizon Gyro Unit (HGU)

A HGU is on the flight instrument panel; it provides pitch and roll signals for the zero reader system and also fulfils the requirements of an artificial horizon. The instrument will be operated whenever AC is being supplied by either No 1 or No 2 inverter. Failure of the power supply to the instrument is indicated by the appearance of an OFF flag in the face of the instrument. A fast-erection button is at the bottom left of the instrument.

4 Altimeters

(a) Mk 30A Altimeter

(i) A Mk 30A altimeter is on the navigator's instrument panel. The altimeter is the master instrument of the automatic height encoding (AHE) system. It operates in conjunction with a pressure error corrector unit and provides an electrical output to operate the pilot's Mk 29B altimeter when that instrument is in the servo mode and an encoded altitude output to the IFF/SSR transponder for altitude reporting on Mode C. Power supplies are DC and AC; the AC is supplied by No 6 inverter or No 7 inverter (see Chapter 1, para 2).

(ii) The altimeter dial is marked from 0 to 1000 feet in 50 feet intervals; it is swept by a single pointer. Inset on the left of centre is a 3-digit counter which indicates altitude in 100 feet intervals over the range minus 900 to plus 60,500 feet. The 10,000 feet wheel is marked with diagonal black/white hatching at altitudes below 10,000 feet and with red/white hatching at negative altitudes. A setting knob, on the bottom left of the instrument, enables altitude to be displayed relative to the selected barometric pressure which is displayed on a millibar counter, behind a window in the dial.

(iii) If a fault occurs in the pressure error corrector, a warning flag, annotated PE, appears in a window at the top centre of the instrument dial. In this event, both altimeters continue to function but will indicate uncorrected altitude only and the encoder output is disconnected. If a servo malfunction or power failure occurs, a failure flag, marked with diagonal red/black hatching, drops over the altitude counter and all outputs are disconnected.

(iv) A reference datum pressure of 1013·2 mb is used for the outputs to the pilot's Mk 29B altimeter and the IFF/SSR transponder; this will not be affected by changes to the millibar counter setting.

(b) Mk 29B Altimeter

(i) A Mk 29B altimeter is on the pilot's flight instrument panel. The altimeter is servo-operated by electrical outputs from the navigator's Mk 30A altimeter with reversion to pressure capsule operation either by selection or automatically after power or other failure.

(ii) The altimeter dial is marked from 0 to 1000 feet in 50 feet intervals; it is swept by a single pointer. Inset on the left of centre is a 3-digit counter which indicates altitude in 100 feet intervals over the range minus 1000 to plus 60,000 feet. The 10,000 feet wheel is marked with diagonal black/white hatching at altitudes below 10,000 feet and with red/white hatching at negative altitudes. A setting knob, on the bottom left of the instrument, enables altitude to be displayed relative to the selected barometric pressure which is displayed on a millibar counter, behind a window in the dial.

(iii) A standby/reset knob marked S←→R, on the bottom right of the instrument, provides for manual selection of the standby 'S' or servo 'R' mode of operation; the knob is spring-loaded to the central position. When 'S' is selected momentarily, the altimeter reverts to pressure capsule operation, an integral vibrator starts to operate and a flag marked STBY appears in the window above the altitude counter. When 'R' is selected for about 3 seconds, with system power supplies available, the altimeter resets to servo operation, the flag clears and the vibrator stops working.

(iv) *Operating Procedure*

When the altimeter is being operated in the servo (reset) mode, there is a risk that an unsignalled (no warning flags) fault in the system could cause the same incorrect altitude to be indicated on both altimeters. To safeguard against the possible flight safety hazards of such errors, particularly at low level, the following procedure is recommended:

(1) *Pre-Take-Off*

Select the altimeter to 'S' and check that the flag shows STBY.

(2) *After Take-Off*

When passing transition altitude in the climb, select the altimeter to 'R' and check that the flag clears.

(3) *At the Top of Climb, After Changing Flight Level and Periodically (15 minutes) During Cruise*

Select the altimeter to 'S', check the flag shows STBY and compare readings with the Mk 30A altimeter; reselect 'R' and check that the flag clears.

(4) *Descent*

At the top of the descent select the altimeter to 'S' and check that the flag shows STBY.

5 Turn-and-Slip Indicator

A turn-and-slip indicator on the flight instrument panel is operated from duplicated DC supplies having automatic changeover. Each supply is primarily controlled by its associated engine master starting switch. Should both normal supplies fail, indicated by the OFF flag appearing in the face of the indicator, the indicator can be connected to the emergency battery by selecting the guarded TURN & SLIP EMERGENCY SUPPLY—normal/EMERGENCY switch beside the indicator to EMERGENCY. When checked on the ground, the OFF flag should disappear within 5 seconds. If the time exceeds 10 seconds, the emergency batteries may require recharging; they should be replaced and a further check carried out.

Note: Post-mod 5098, a pull-to-unlock type of switch is fitted. The switch is gated to lock its dolly at both selective positions.

6 Zero Reader System

(a) A zero reader system is installed and is supplied with DC when the battery switch is on. AC is supplied to the system by No 1 inverter, with No 2 inverter as a standby.

(b) The indicator is on the flight instrument panel and the combined heading selector and control unit is on the top of the engine instrument panel.

7 Accelerometer

An accelerometer designed to operate over the range minus 5g to plus 10g is on the cockpit coaming above the flight instrument panel.

8 Outside Air Temperature Gauge

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

9 Air Mileage Unit and Air Position Indicator

The AMU is in the port wheelwell and the control panel is on the cabin port wall. The API is fitted into the navigator's instrument panel. Power supplies are DC.

RADIO AND RADAR

10 Intercommunication

(a) Intercom Amplifier

(i) A Type A 1961 amplifier provides amplification of crew intercom and audio signals from the V/UHF, Standby UHF, ILS, Tacan and radio compass. The system is controlled by an I/C — ON/OFF switch and an I/C — NORMAL/EMERGY switch on the starter panel. (See Note to para 12).

(ii) When the switches are set at ON and NORMAL, all microphone and telephone lines are connected to the amplifier and all selected audio services are routed via the amplifier. Pressing either pilot's press-to-transmit switch transfers all the microphone lines from the amplifier to the selected transmitter and cuts off the ILS or Tacan audio input to the amplifier.

(iii) If the amplifier fails, all audio reception is lost. Setting the NORMAL/EMERGY switch to EMERGY transfers the crew's microphone and telephone lines to the audio circuits of the V/UHF or Standby UHF, whichever is selected; this restores crew intercom and VHF or UHF reception. ILS or Tacan and radio compass audio signals cannot be restored to the crew, but the navigator can still receive radio compass audio signals by selecting the BEACON/MIX switch to BEACON.

(iv) Switching the amplifier OFF has the same effect as selecting EMERGY but in addition the power supply to the amplifier is switched off.

(b) Microphone/Telephone Sockets

A mic/tel socket is fitted on the left of each ejection seat and an external socket is on the side of the fuselage in the starboard wheelwell.

WM 844 RADIO AND NAV FIT

1. VHF RADIO

A Marconi civil communication box (range 115,0 to 135,9 Mc/s) is fitted on the lower instrument panel.

2. SELECTION OF SERVICES

A standard control box 7681 is fitted at each station and permits the selection of;-

OFF* ADF STBY UHF VHF Civil PTR 175

SBY UHF is controlled by an ON/OFF switch and a ground/alternative switch on the panel above the V/UHF box.

3. TACAN

The TACAN control panek is on the front lower instrument panel. Two indications are fitted - one at the navs station, and one above the engine instrument panel. The coding may be checked by selecting TACAN on the intercom box. Power supplies come from the No 3 Inverter.

4. SSR

SSR Cossor 1520 is fitted. The controller is below the TACAN cotroller and an IFF/IP switch is in the ILS/VOR panel above the V/UHF box

11 V/UHF

(a) General

A combined V/UHF set (ARI 23143/1 — PTR 175) is fitted. The set provides transmit and receive facilities on 3500 frequency channels in the UHF band of 225·0 to 399·95 MHz and 370 frequency channels in the VHF band of 117·5 to 135·95 MHz all channels at 50kHz spacing. A separate receiver in the transmitter/receiver unit allows a preset frequency of 243·0 MHz to be superimposed on any selected channel. The set is automatically connected to a UHF aerial on the upper surface of the rear fuselage or a VHF whip aerial on the port bomb door, depending on the selected frequency.

(b) Miscellaneous Controls

(i) A V-UHF/UHF STBY changeover switch, on the starter panel; this is used to select the required transmitter/receiver. (See Note to para 12.)

(ii) Two press-to-transmit switches, one in the crook of each control column handwheel.

(iii) Three press-to-mute the PTR 175 switches; the switches for the pilots are on the cockpit port and starboard walls and a switch for the navigator is on his instrument panel.

(iv) A TONE switch for the PTR 175 is on the coaming panel, right-hand side.

(c) PTR 175 Control Unit

The PTR 175 control unit is on the engine starter panel; it has the following controls:

(i) A 7-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. The TR position provides normal transmit and receive facilities on the frequency selected. At the TR+G position an independent guard receiver operating on 243 MHz only is switched on in addition to the normal transmitter/receiver.

(ii) A 20-position CHANnel selector switch. The positions numbered 1 to 18 select the preset frequencies. The M position is used to switch frequency selection to manual control. The G position selects the preset guard frequency and thus enables the main receiver to be used on the guard frequency independent of the guard receiver.

(iii) Three rotary MANUAL switches which are used to select a frequency. The frequency selected is displayed in a window above the switches.

(iv) A VOLume control.

12 Standby UHF

(a) General

A Standby UHF set (ARI 23159 (D403M)) is installed for use if the PTR 175 or its power supply fails. The set provides transmit and receive facilities on the guard frequency (243·00 MHz) and on another adjacent frequency known as channel A. It can also provide emergency intercom (see para 9 *(a)*). The set is transistorised and requires no warm-up time. An independent battery in the port equipment bay provides for emergency operation of the set for up to 5 hours. The set is connected to its own UHF aerial, the aft one of two aerials on the port bomb door.

(b) Controls

The press-to-transmit switches used with the PTR 175 are also used with the Standby UHF. The set is controlled by three switches on the starter panel:

(i) A POWER — NORMAL / STANDBY switch (guarded). When set to the NORMAL (guarded) position, power is supplied from the aircraft DC supply. If this supply fails, the set can be supplied from its own emergency battery by lifting the switch guard and selecting the STANDBY position. (See Note below.)

(ii) A CHANNEL — A/GUARD switch (guarded). This switch is normally left in the GUARD position with the guard in place. The CHANNEL A position is normally used for ground testing purposes. (See Note below.)

(iii) A V-UHF/UHF STBY changeover switch (see para 11 (*b*)). When set to the UHF STBY position, the set is switched on and connected for use.

Note: Post-mod 5098, the two I/C switches (para 10 (*a*) (i)), the V-UHF/UHF STBY switch (para 11 (*b*) (i)), and the UHF standby POWER and CHANNEL switches with their guards (para 12 (*b*) (i) and (ii)) are replaced by pull-to-unlock type switches. These switches are gated to lock their dollies at the up positions

13 Instrument Landing System (ILS)

The ILS indicator, marker light and ON/OFF switch are on the flight instrument panel. The channel selector is on the port wall at the navigator's station. The power supply is DC and it is fed via a circuit breaker on the ECP. An AUDIO — ILS/TACAN changeover switch and ILS VOLUME control are on the starter panel.

14 Radio Compass (AD 7092D)

On some aircraft a radio compass is installed. The receiver controller, loop controller, and an ADF—ON/OFF switch are on the port wall at the navigator's station. A relative bearing indicator is on the navigator's instrument panel and another is on the pilots' flight instrument panel. A volume control, to vary the level of audio signals, is on the engine starter panel. An additional IC/MIX/BEACON switch may be fitted at the navigator's station to enable him to isolate incoming RT when tuning the radio compass. A press-to-call navigator switch, on the generator panel, enables the pilot to call the navigator if he has selected BEACON. Power supplies are DC and AC, the AC is supplied from No 1 or No 2 inverter.

15 Sonar Projector

When NSM 3004 is embodied, a Sonar Projector, Type 17161 (ARI 23240/1), is fitted near the top of the unused seat guide rail in the cabin. The projector is an aid to the location of a sunken aircraft. On submersion, the unit is automatically activated at a pre-determined depth and it transmits an acoustic signal which can be received by ship or airborne sonar equipment.

16 IFF/SSR — Description

(a) IFF/SSR (Cossor 1520) is installed to provide identification and information for military purposes and civilian secondary surveillance radar.

(b) Location of Controls and Equipment

Item	*Location*
Aerials (2)	One projecting above and one beneath the rear fuselage (shark fin type)
Transponder Aerial switching unit No 6 inverter (Type 108) No 7 inverter	Upper equipment bay
Control unit SYSTEM FAILURE light (amber) LAMP CHECK switch IFF SUPPLY—NORMAL/EMERGY switch	Navigator's station port side
AERIAL POSN switch 108 INVERTER (No 6) — START and STOP switches	Aft panel of the ECP

(c) Aerial Position Switch

The AERIAL POSN switch, marked UPPER/FLIGHT/LOWER, is for ground testing the system aerials. It is covered by a spring-loaded guard which locks down when the switch is at the FLIGHT position.

Note: Post-mod 5098, a pull-to-unlock type of switch is fitted in place of the non-locking type and its guard. The switch is gated to lock its dolly at the FLIGHT position.

(d) Control Unit

The control unit carries the following switches:

(i) A rotary function switch marked OFF/SBY/LOW/NORM/EMGY-PUSH. The switch must be pushed in before it can be turned to the EMGY position.

(ii) MODE selection switches Modes 1, 2, C and D (inoperative) have toggle switches. Mode 3/A or Mode B are selected by a rotary switch with a central OFF position.

(iii) Rotary code selector switches for use with Modes 1 and 3/A/B.

(iv) A CIVIL/MIL toggle switch used in conjunction with the EMGY position.

(v) An I/P toggle switch.

(vi) A self-TEST switch and light (green).

17 IFF/SSR — Testing

(a) Self-TEST Switch and Light

(i) When pressed with the equipment switched on, the self-TEST facility of the transponder checks the receiver sensitivity, transmitter power output level and the mode serviceability. The green light comes on if these checks are satisfactory with the rotary control switch in the NORM or EMGY position.

(ii) Because of reduced receiver sensitivity when the function switch is at LOW, the green light will not come on during self-TEST but the SYSTEM FAILURE light comes on steady; to cancel the fail light, select NORM and press the self-TEST switch again. When the function switch is at SBY, the green light will not come on during self-TEST but the SYSTEM FAILURE light flashes.

(b) System Failure Light

The SYSTEM FAILURE light comes on automatically under the following conditions:

(i) When the function switch is set to OFF.

(ii) When the function switch is set to SBY and the transponder is being interrogated but unable to reply (flashing light).

(iii) Transponder unserviceable when under interrogation.

(iv) Self-TEST check not satisfactory.

(c) The LAMP CHECK switch is provided for testing the filaments of the self-TEST and SYSTEM FAILURE lights.

18 IFF/SSR — Operation

(a) Confirm that the AERIAL POSN switch is at FLIGHT.

(b) Select the IFF SUPPLY switch to NORMAL and the No 6 inverter switch to START.

(c) *Use of the Rotary Function Switch*

(i) At the OFF position the system is inoperative. Power is supplied only to the SYSTEM FAILURE light and the self-TEST light.

(ii) At SBY, the transponder accepts interrogations but replies are inhibited. After 40 to 50 seconds delay the transponder is ready for full operation when selected.

(iii) At LOW, the transponder accepts selected interrogations and transmits information but receiver sensitivity is reduced.

(iv) At NORM, the transponder accepts selected interrogations and transmits information.

(v) At EMGY the transponder accepts Modes 1, 2, 3/A and B interrogations irrespective of their selection and transmits code information and emergency replies. The transponder immediately attempts emergency replies when switched directly from OFF to EMGY, the 50-second warm-up delay is accompanied by a steady SYSTEM FAILURE light. The code information in the emergency reply for a Mode 3/A (Military and Civil) or Mode B (Civil) interrogation depends on the position of the CIVIL/MIL switch, thus:

CIVIL ... ... Code 7700
MIL ... ... The selected code

(d) *Use of MODE Switches*

(i) Any one or more of the mode switches can be operated. Mode D is inoperative.

(ii) When Modes 1 and 3/A or B are selected, the transponder accepts interrogations in the appropriate mode(s) and transmits information selected on the code selector(s).

(iii) When Mode 2 is selected, the transponder accepts Mode 2 interrogations and transmits information selected before flight by switches on the transponder.

(iv) When Mode C is selected, the transponder accepts Mode C interrogations and transmits altitude information received from the AHE facility in the Mk 30A altimeter.

(e) Code Switches

(i) The MODE 1 and MODE 3/A/B code selection switches are used to select the 4-digit code for replies on those modes. They show 0000 to 7777 giving 4096 codes. To select a code, use the left-hand selector for the first digit, eg code 76 shows as 7600.

(ii) Mode 2 code information is set on the transponder before flight. The code is allocated to the particular aircraft to which it is fitted.

(f) I/P Switch

This switch operates the identification of position facility in the transponder. The switch is biased to return to the central off position. When switched up, the I/P facility operates and continues to operate for 20 seconds after the switch is returned to the central off position.

19 Tacan

(a) Tacan is an airborne navigational system operating over the frequency band 962 to 1213 MHz in 126 channels. It functions only with complementary surface transponder beacons. The equipment provides:

(i) Continuous meter indications of the magnetic bearing of the aircraft to/from the beacon.

(ii) Continuous meter indications of the distance of the beacon.

(iii) Aural indication of the identity of the beacon to which the equipment is channelled.

(iv) A flag alarm circuit which actuates in the absence of correct distance signals.

(b) The Tacan installation comprises the following main units:

(i) *Aerial*

A 'shark fin' type aerial is fitted beneath the nose of the aircraft.

(ii) *Transmitter/Receiver*

The T/R is on the port side of the navigator's seat.

(iii) *Coupling Unit*

The coupling unit is electrically coupled to the T/R and operates two indicators. The unit is above and to the right of the navigator's instrument panel. The verniers are readily visible to the navigator.

(iv) *Control Unit*

The control unit, Type 9273, is on a panel between the navigator's instrument panel and the port wall. The unit has the following switches:

1. *Power ON/OFF Switch.* This controls the power supplies to the T/R.

2. *BRG/DIST BRG Switch.* When BRG is selected the equipment is switched on so that bearing information only is indicated. When DIST BRG is selected the whole equipment is switched on so that bearing and distance information are indicated.

3. *Channel Selectors.* Four pushbuttons, arranged vertically in pairs to increase and decrease the 'tens' (left pair) and 'units' (right pair) digits of the channel number.

4. *Volume Control.* The VOL control is used to adjust the level of the identity tone in the headsets.

▸◂

(v) *Indicators*

Two indicators, Type 9547, are fitted one on the pilots' flight instrument panel, and the other above the Tacan control unit. Each indicator presents information of the magnetic bearing of a beacon from the aircraft and its reciprocal by means of a pointer arrow head and tail respectively and on the slant distance of the aircraft from the beacon by means of a two-digit counter. When the T/R unit is not 'locked-on' to the beacon to which it is tuned, the bearing pointer continuously rotates ~~clockwise~~ around the dial and the distance counter also rotates but is partially obscured by a flag. When the T/R 'locks-on' and the distance is greater than 99 NM a figure 1 on the flag appears at the left-hand side of the distance counter so that the indicator is capable of showing distance up to 195 NM (Bearings can be obtained in excess of this figure).

(c) ILS/Tacan Audio Switch

An AUDIO — ILS/TACAN switch is on the right-hand side of the starter panel. When TACAN is selected, the volume is controlled by the VOL switch on the Tacan control unit.

(d) Power Supplies

Power supplies are DC and AC. The AC supply is taken from No 6 (Type 108) inverter.

Intentionally Blank

PART 1

CHAPTER 7 — GENERAL EQUIPMENT AND CONTROLS

Contents

▸◂

1 Entrance Door

The entrance door is on the starboard side of the fuselage, aft of the nose fairing. When the door is correctly closed, the handle on the outside of the door lies flush in its recess and the handle on the inside lies in the 2 o'clock/8 o'clock position with about two inches of the shaft visible. To open the door from either outside or inside, press the plunger adjacent to the handle, this allows the handle to spring outwards, and then turn the handle anti-clockwise from the outside or clockwise from the inside. This inside handle should not be used to open the door in flight. (See Chapter 10, para 11 — Jettisoning the Entrance Door). The door is supported in the open position by a strut which is attached to the door via a pivot and located in a socket in the door aperture framing.

2 Engine Fire Protection

(a) Engine Fire Detection

Fifteen, resetting, fire-detector switches are installed in the engine bays, seven in the port and eight in the starboard. The switches are electrically connected to the engine fire warning lights and in the event of fire complete the circuit to operate the appropriate warning light. When the fire is extinguished the switches automatically reset themselves and extinguish the warning light.

(b) Engine Bay Fire Extinguishers

Two fire extinguisher bottles with dual operating heads are fitted, one in the port wheelwell serving the port engine and one in the starboard wheelwell serving the starboard engine. Each bottle is fully discharged in one operation. These extinguishers also serve the fuselage fuel tank compartment in crash landing conditions (see para 3).

(c) *Engine Fire Warning Lights and Pushbuttons*

Two fire extinguisher pushbuttons with integral fire warning lights, one for each engine, are above the engine instrument panel. A separate TEST ENG FIRE WARNING pushbutton is above the port engine fire extinguisher pushbutton; it is used to test the supply fuses to the fire-detector switches and the filaments of both warning lights.

(d) *Engine Fire Extinguisher Operation*

A warning light comes on when heat from a fire in the engine bay trips one or more of the resetting fire detectors in that bay; pressing the appropriate button fully discharges the fire extinguisher into the affected engine bay. When the fire is extinguished the warning light will go out.

3 Fuselage Fire Protection

(a) *Fuselage Fire Extinguishers*

A fire extinguisher bottle is above the aft end of the bomb bay. It is discharged into the fuselage fuel tank compartment and bomb bay if the inertia crash switches are tripped. This is the only method of operation for this extinguisher. Part of the contents of the engine fire extinguisher is also discharged into the fuel tank bay if the inertia crash switches are tripped.

(b) *Hand-Operated Fire Extinguishers*

Two Type 34H BCF hand-operated fire extinguishers are provided; one is stowed on the cabin starboard wall, just aft of the entrance door and the other on the dummy seat guide rail adjacent to the navigator's station. BCF is a non-conducting extinguishant which is virtually non-toxic and may be used on all classes of fires, including electrical fires. Indication that an extinguisher has been used is given by a discharge indicator or pin which pierces or distorts a disc in the head of the extinguisher when it is operated.

4 Inertia Crash Switches

Two inertia crash switches are embodied in the fire circuits; one is in each lower equipment bay. If both switches trip during a crash landing they operate all the fire extinguishers and isolate the aircraft battery from the electrical system with the exception of the emergency circuits quoted in Chapter 1, para 7, irrespective of the setting of the battery switch.

5 Emergency Equipment

Stowages for asbestos gloves, a first-aid kit and a crashaxe are on the cabin starboard wall aft of the entrance door. Cabin pressure leak stoppers are stowed on the roof at the navigator's station. Three survival packs may be carried in stowage crates on the roof of the rear fuselage. Access to them is through the rear fuselage hatch or, in emergency, by chopping through the fuselage at the points indicated.

6 External Lighting

(a) All external lighting circuits are protected by a circuit breaker labelled PILOT'S SERVICES on the ECP.

(b) All the external lighting switches are on the pilots' port console. They are, from right to left:

(i) EXTNL LIGHTS MASTER—ON/OFF switch. This must be ON before any external lights will function.

(ii) IDENTIFICATION LIGHT STEADY — ON/OFF switch.

(iii) IDENTIFICATION LIGHT MORSE—ON/OFF switch (pre-SEM/055/STC) or LANDING LIGHT — ON/OFF switch (post-SEM/055/STC).

(iv) TAXY LIGHT — ON/OFF switch.

(v) ANTI-COLLISION LIGHTS — ON/OFF switch.

(vi) STEADY NAV'N LIGHTS — ON/OFF switch.

(vii) LANDING LAMP — OFF/LOW/HIGH switch (pre-SEM/055/STC). Switch removed (post-SEM/055/STC).

(c) Two white anti-collision (flashing) lights are fitted one above and one below the rear fuselage. If the flasher unit fails the light will remain on and steady until switched off. Post-SEM/057/STC, two red rotating anti-collision lights are fitted in place of the white lights and the flasher unit is removed.

(d) The taxying lamps are fitted one in each wing tip, the landing lamp is in the port mainplane under-surface and the downward identification light is in the fuselage under-surface below the lower equipment bay.

7 Internal Lighting

(a) Cockpit, Normal Lighting

(i) Illumination of the cockpit port console is provided by an adjustable red cockpit lamp on the port wall and controlled by a dimmer switch just below the lamp.

(ii) General illumination of the pupil's station (port wall, port front panel and flight instrument panel) and the instructor's station (engine and miscellaneous instrument panels, accelerometer, aileron trim switch and canopy jettison switch) is provided by ten red floodlamps and four ultra-violet lamps. The lamps are controlled by five dimmer switches (three RED and two U/V) on the coaming panel. The port RED dimmer additionally controls the E2B compass lamp, the voltmeter pillar lamp and the altimeter bridge lamps. The inboard starboard RED dimmer additionally controls the integral lamps of the V/UHF control unit. The outboard starboard RED dimmer controls only the aileron trim switch lamp. ▶

(b) Cockpit, Emergency Lighting

◀ Two amber emergency lamps, illuminating the main instrument panel, are supplied from the 2·4 volt emergency battery. They are controlled by a guarded EMGY LIGHTS—ON (up)/off switch on the forward coaming. ▶ To assist identification in the dark, a luminous spot is on the switch plate or the switch dolly is luminous. Post-SEM/011/STC, two vertical luminous 'Betalight' strips are on the switch plate, one each side of the switch dolly.

◀ Note: Post-mod 5098, a pull-to-unlock type of switch is fitted in place of the non-locking type and its guard. The switch is gated to lock its dolly at both selective positions. ▶

(c) Cabin Lighting

(i) General illumination of the cabin is provided by two dome lamps, each having an integral switch and 2-pin socket. Individual panels are illuminated by two adjustable lamps each controlled by a dimmer switch. ◀ Post-SEM/052/STC, illumination of the navigator's hatch switch unit is provided by a red floodlamp above the switch unit and controlled by the port adjustable lamp dimmer switch. ▶

(ii) An IFF/TACAN DIMMER switch, on the IFF/SSR and Tacan control unit panel, controls the brightness of the control units integral lighting.

(d) Inspection Lamp

An inspection lamp may be stowed in a bag at the starboard side of the navigator's station. When required for use it is plugged into the integral 2-pin socket of either dome lamp. An extension lead is also provided and stowed in a bag near the lamp stowage.

▶◀

PART 1

CHAPTER 8 — AIR CONDITIONING, PRESSURISING, 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 gatevalve controlled by one of two ENGINE AIR TO CABIN — ON/OFF switches on the miscellaneous instrument panel.

(b) The temperature of the air entering the cabin is governed by a mixing valve controlled by a CABIN AIR — COLD/off/HOT switch (spring-loaded to off) on the miscellaneous instrument panel. The setting of the mixing valve is shown on the indicator, labelled CABIN AIR, on the left of 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 plane leading edge, and a cold air unit in the port inner plane 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 louvres and diffusers in various parts of the cockpit and cabin. The louvres may be turned off but, of the diffusers, only that on the inboard edge of the navigator's table has any form of control, ie the diffuser head may be rotated to give either a jet or diffused flow.

(e) A supply of ventilating air to the cabin is provided by a small airscoop on the fuselage, immediately forward of the canopy. A duct directs the air into the common delivery duct. A non-return valve in the duct prevents loss of cabin pressure. The system is inoperative whenever the air conditioning system is in use.

2 Pressurising System

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

(b) Electrical contacts in the pressure controller operate a warning horn if the cabin pressure falls excessively. A CABIN WARN HORN — ON/OFF/TEST override switch is on the miscellaneous instrument panel. The switch is spring-loaded to OFF from TEST.

Note: No air will be supplied for either air conditioning or pressurising unless one or both engine air switches are on.

3 Use of Air Conditioning and Pressurising Systems

(a) Pre-Starting Checks

With the engine air switches off test the operation of the mixing valve over its full range against the indicator, leaving it set to HOT.

(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; the use of any other setting while the aircraft is stationary is restricted to a maximum of 10 minutes and the engines must not exceed 5000 RPM continuously. Damage may be caused to the cold air unit if these limits are exceeded. It is permissible, however, to use the cold air unit whilst taxying. 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 a fault develops in the air supply from an engine or if an engine fails or is shut down, switch off its engine air switch.

(e) Checks After Landing

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

Note: Rain entering the cabin through the port DV panel has, on occasions, penetrated the bomb door selector switch subsequently causing 'cycling' of the bomb doors in flight. Opening of the panel to relieve cabin pressure after landing should be restricted therefore to a small angle and the panel should then be closed again.

4 Malfunction 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 selecting the warning horn switch (see para 2 *(b)*) to OFF. The following table gives the approximate operating ranges of the warning horn.

Aircraft Altitude	*Cabin Altitude*	*Cabin Altitude (feet) 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 feet 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 aircraft altitude not exceeding 25,000 feet.

(b) Pressurisation Failure Above 40,000 *feet*

If pressurisation failure occurs above an altitude of 40,000 feet, altitude must be reduced to the lowest practicable, and in any case to below 25,000 feet to avoid the effects of decompression sickness. When below 40,000 feet the engine air switches should be selected to OFF to lessen the risk of damage; if the failure was caused by damage to the canopy or cabin, depending on 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 knots. The full drill for this emergency is given in the FRC.

5 Demisting System

(a) Canopy and Navigator's Window

The entire canopy and the navigator's window are of the 'dry air' sandwich type. A static drier for the canopy is on the coaming behind the instructor's seat and a drier for the canopy circulation system and navigator's window is on the coaming behind the pupil's seat. Air in the closed canopy/air drier circuit is circulated by an electrically-driven blower controlled by a CANOPY DEMIST—ON/OFF switch on the port console. Small indicator windows in the drier casings enable the drying agent (silica-gel crystals) to be seen; when unserviceable the crystals are pink.

(b) Direct-Vision (DV) Panels

Two electrically-heated DV panels are fitted, one in each side of the canopy; the heaters are controlled by a WINDSCREEN — ON/OFF switch on the port console. When the cabin is unpressurised, the panels can be opened by unscrewing the knurled clamping knob on each panel and hinging the frame downwards to engage in the retaining clip. Power supplies for the control units are AC from No 1 or No 2 inverter; power supplies for the heater elements are DC.

(c) Canopy Internal Demister

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

6 Use of the Demisting System

Ensure that the canopy internal demister is off during the **Internal Checks.** It must not be used in flight except for the period necessary for a descent from high altitude.

PART 1

Chapter 9 — OXYGEN SYSTEM

Contents

Illustration

Description

1 Oxygen supplies and contents gauges

(*a*) Oxygen is carried in one 2,250 and five 750 litre bottles stowed in the upper equipment bay. A charging valve on the forward frame in the battery compartment, accessible through the battery access door 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, are inter-connected at two points 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 flight instruments panel indicate the contents of each bank of cylinders.

◀ (*b*) From the two inter-connecting points the supplies pass via filters to pressure reducing valves, which incorporate 450-500 PSI safety relief valves, and thence to the regulators. One line supplies the pilots' regulators and the other supplies the navigator's regulator. (See Fig 1). ▶

2 Oygen regulators and supply points

(*a*) The supply of oxygen to the crew supply points is controlled by Mk 17 E or F regulators. The pilots' regulators are below the flight instrument and engine instrument panels and the navigator's is on the cabin port wall.

(*b*) Each regulator incorporates

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

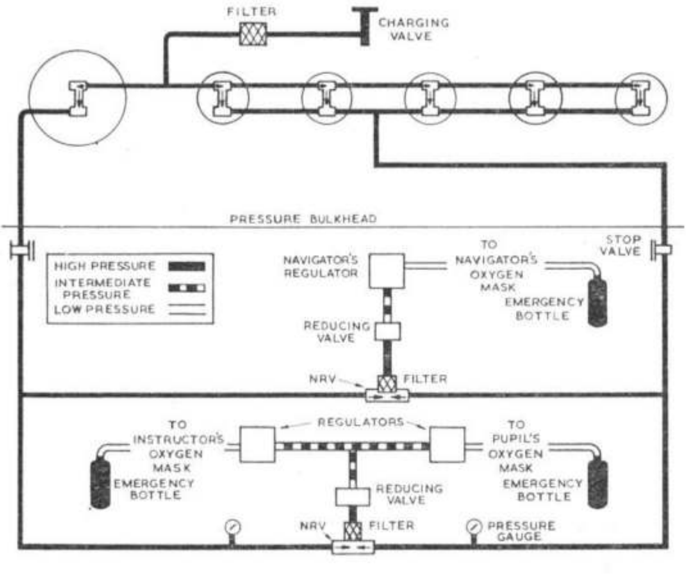
(ii) An ON/OFF valve, normally wire-locked ON.

(iii) An oxygen flow magnetic indicator which shows a vertical white line when the user inhales.

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

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

(*c*) An oxygen remote flow magnetic indicator is provided on the left of the navigator's instrument panel.



1—9 Fig 1 Oxygen System Simplified

3 Oxygen emergency supplies

(*a*) An emergency oxygen bottle is attached to the rear starboard side of each ejection seat, and must be connected to the oxygen mask tube before flight. The bottle is operated by pulling up the yellow/black striped knob to starboard of the ejection seat. To allow free breathing the mask tube must be disconnected from the main supply when using the emergency oxygen bottle. The emergency supply will last for approximately 10 minutes.

(*b*) A safety pin in the head of each emergency oxygen bottle must be removed before flight.

(*c*) The emergency oxygen bottle is brought into action automatically when ejection takes place. Emergency oxygen is not available after the occupant separates from the seat.

4 Associated equipment

Pressure demand oxygen masks must be worn.

Normal Operation

5 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 functioning correctly.
(Check navigator's remote indicator 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 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 three crew position regulators must be checked as above and the navigator's remote oxygen flow indicator checked for correct operation.

6 During flight

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

Malfunction

7 General

Drills for oxygen failure, regulator flow-indicator failure, and toxic fumes in the cockpit are given in the Flight Reference Cards.

8 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.

9 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.

NOTE: With the air inlet at NORMAL a change of altitude has little effect on the rate of oxygen consumption. However, if it becomes necessary to use 100% oxygen a smaller demand will be made on the remaining oxygen supply by flying at a cabin altitude of 25,000 feet.

PART 1

CHAPTER 10 — EJECTION SEATS AND ESCAPE SYSTEMS

Contents

Illustrations Fig

GENERAL

1 Ejection Seats

(a) The pilots and navigator are each provided with an ejection seat; the types and marks of seat are as follows:

Pilot (pupil)	Type 3CT 1 Mk 3
Pilot (instructor)	Type 3CT 2 Mk 3
Navigator	Type 2CA 2 Mk 4

(b) The pupil's and instructor's seats are basically similar, but the instructor's seat is hinged at the top to swing forward and backward to permit access to the other seats.

(c) All the seats have a ground-level ejection capability in straight and level flight at speeds above 90 knots.

(d) Fully automatic facilities are provided to release the safety harness and leg restraint after ejection, separate the occupant from the seat and deploy the parachute at a safe speed and altitude.

2 Associated Aircrew Equipment

The associated aircrew equipment consists of the following items:

Seat-type parachute assembly with harness.

Separate 4-piece safety harness with negative-g restraint strap.

Personal survival pack.

Emergency oxygen set.

3 Associated Escape Systems

(a) When either pilot operates a firing handle on his seat, the elevator control tube is severed, the control columns are snatched forward against the instrument panels and the canopy is jettisoned, immediately before the seat is ejected.

(b) When the navigator operates a firing handle on his seat, the hatch over his station is jettisoned, immediately before the seat is ejected.

(c) The canopy can be jettisoned independently of the pilots' seats, and the hatch independently of the navigator's seat.

4 Ejection Seats and Escape Systems Safety Pins and Stowages

(a) Safety pins with integral red labels are provided for rendering safe the seats and escape systems. The face screen or main gun sear safety pin of each seat has an orange/red painted metal tally attached through the integral red label.

(b) Stowages are provided for the pins as follows:

Crew Position	*Pin*	*Stowage*
Pupil	Face screen/main gun sear Seat pan firing Canopy jettison sear	On the cockpit port wall above console
Instructor	Face screen/main gun sear Seat pan firing	On the cockpit starboard wall above the entrance door
Navigator	Face screen or gun sear Seat pan firing	On the right-hand edge of the folding table

(c) During the **Pre-Take-Off Checks**, a crew check must be made to ensure that all safety pins are in their stowages.

5 Controls

(a) Pupil's Station

(i) *Pre CM*/0561/*STC*

A CANOPY/SNATCH MASTER — ON/off switch and a CANOPY JETTISON — ON/off switch are together on a black/yellow diagonally striped switch unit on the cockpit port wall; the unit is marked CANOPY JETTISON SWITCH UNIT — DANGER DETONATORS. The JETTISON switch only is protected by a guard.

(ii) *Post CM*/0561/*STC*

◀ A CANOPY/SNATCH MASTER — ON/off switch is on a switch unit on the cockpit port wall. Pre-mod 5098, the switch is protected by a guard enabling 'up' for ON selection; post-mod 5098, a pull-to-unlock type of switch is fitted in place of the guarded switch. The switch is gated to lock its dolly at both selective positions. A CANOPY JETTISON — ON/off switch is on a black/yellow diagonally striped switch unit on the port console marked DANGER DETONATORS; the switch is covered by a spring-loaded flap. The flap will only lie flush when the switch is off; the dolly of the switch can then be seen through a hole in the flap.

(b) Instructor's Station

A CANOPY JETTISON — ON/off switch is behind a black/yellow diagonally striped panel on the starboard wall marked DANGER DETONATORS. The panel has a spring-loaded flap which will only lie flush when the switch is off; the dolly of the switch can then be seen through a hole in the flap. ▶

(c) Navigator's Station

A HATCH SAFETY — ON/off switch and a HATCH/JETTISON — ON/off switch are together on a black/yellow diagonally striped switch unit marked DANGER DETONATORS; the unit is on the port wall. The SAFETY switch is protected by a guard and the JETTISON switch is covered by a spring-loaded flap. The flap will only lie flush when the switch is off; the dolly of the switch can then be seen through a hole in the flap.

6 Control Column Snatch Unit

The control column snatch unit operates automatically when either firing handle on either pilot's ejection seat is operated, provided that the CANOPY/SNATCH MASTER switch is ON. The unit is described in Chapter 5, para 4.

7 Pilots' Canopy

(*a*) The canopy is secured to the aircraft by explosive bolts which are detonated electrically when the canopy is to be jettisoned.

(*b*) *Independent Jettison*
To jettison the canopy independently of the ejection system:

(i) Confirm that the CANOPY/SNATCH MASTER switch is ON.

(ii) Switch ON the pupil's or the instructor's CANOPY JETTISON switch.

(*c*) *Jettisoning in Conjunction with the Ejection Systems*
Provided that the CANOPY/SNATCH MASTER switch is ON, the canopy is automatically jettisoned when either firing handle on either pilot's seat is operated.

8 Navigator's Hatch

(*a*) A jettisonable metal roof hatch over the navigator's station affords an emergency exit. The hatch is secured to the fuselage by explosive retaining bolts which are detonated electrically when the hatch is to be jettisoned. The hatch may be jettisoned either in conjunction with or independently of the ejection system.

(*b*) *Independent Jettison*
To jettison the hatch independently of the ejection system:

(i) Confirm that the HATCH SAFETY switch is ON.

(ii) Lift the flap and switch ON the HATCH JETTISON switch.

(*c*) *Jettisoning in Conjunction with the Ejection System*
Provided that the HATCH SAFETY switch is ON, the hatch is automatically jettisoned when either firing handle on the navigator's seat is operated.

9 Minimum Speed for Jettisoning the Canopy or Hatch

When jettisoned, the canopy or hatch comes 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 the speed above 150 knots whilst jettisoning the canopy or hatch.

10 Power Supplies to the Detonator Circuits

(*a*) Power supplies to the detonator circuits which sever the elevator control tube and jettison the canopy are routed through the CANOPY/SNATCH MASTER switch. Supplies to the hatch detonator circuits are routed through the HATCH SAFETY switch.

(*b*) All detonator circuits are operative irrespective of the setting of the battery master switch. If the aircraft battery fails, they are automatically supplied from the emergency battery.

(*c*) Post SEM/Canberra/06/STC, two JETTISON TEST press-to-test lights are on the pilot's port console; one light is labelled HATCH and the other CANOPY. A fuse is adjacent to each light. When pressed, the lights come on to indicate the existence of a power supply at the supply side of the CANOPY/SNATCH MASTER and HATCH SAFETY switches.

(*d*) The CANOPY/SNATCH MASTER and HATCH SAFETY switches must be switched ON before take-off. If either switch is inadvertently left off, it must not be switched ON in the air except in an emergency.

11 Jettisoning the Entrance Door

The entrance door may be jettisoned by turning clockwise 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. It may be necessary to strike the door after operating the crank.

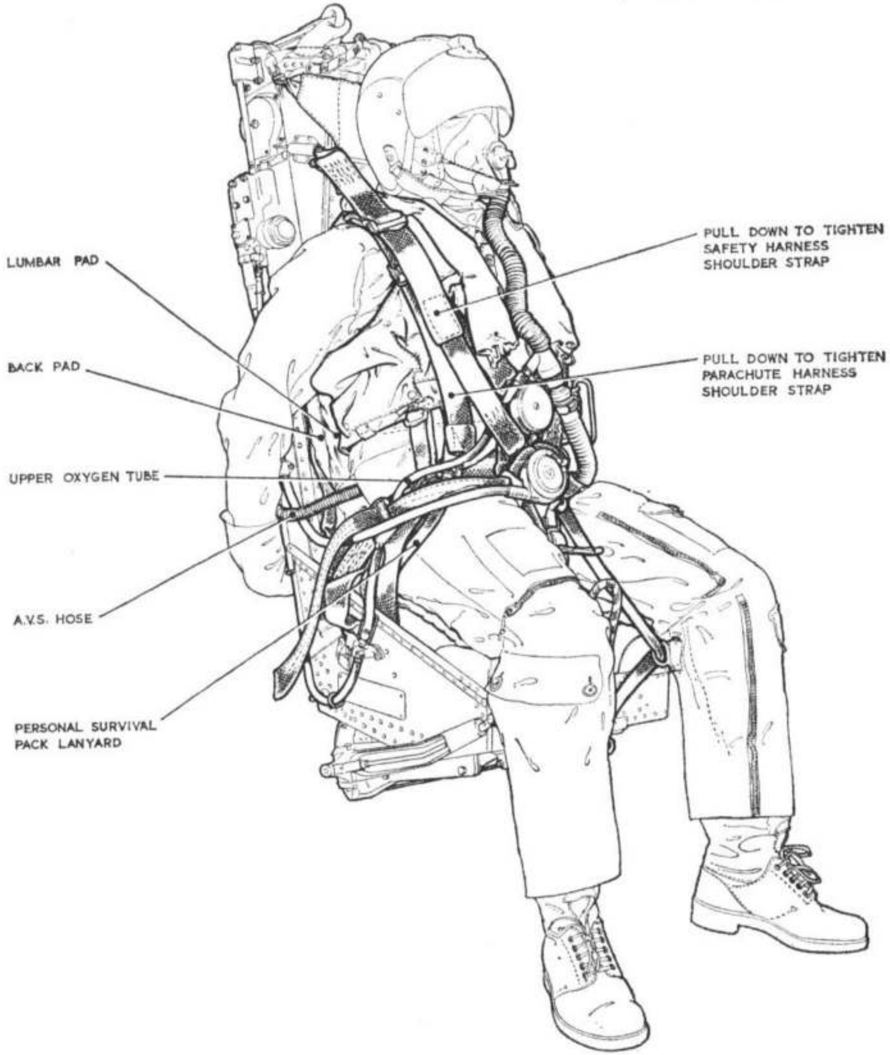
PILOTS' EJECTION SEATS (TYPE 3CT 1 & 2 Mk 3)

12 Controls on the Seat

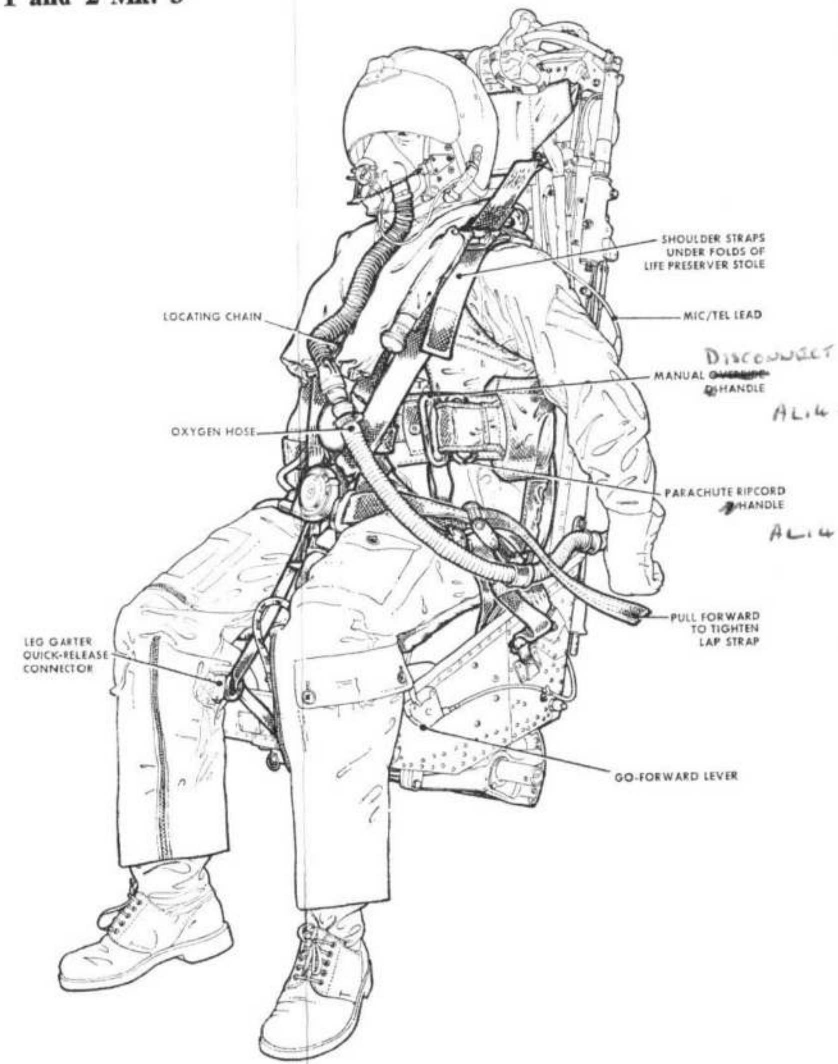
(*a*) *Seat-Height Adjustment*

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

Ejection Seat Type 3CT 1 and 2 Mk. 3



1 — 10 Fig. 1 Starboard Side



1 — 10 Fig. 2 Port Side

(*b*) *Leg Restraint*

Two leg-restraint lines are attached to the bottom of the seat guide rail by lugs; each lug fitting incorporates a shear rivet. The lines then pass through snubbing units, under the front of the seat pan, which allow them to slide freely downwards but not upwards. A release ring is provided at the front of each snubbing unit to permit the line to be slid against the snubbing action when strapping-in, if adequate length for full rudder pedal movement is not available. The lines are then crossed and threaded through D-rings attached to garters worn by the occupant and are finally looped around the shoulder strap lugs of the safety harness; the lines are released whenever the safety harness is undone.

(*c*) *Go-Forward Lever*

A spring-loaded go-forward lever on the port side of the seat pan releases the safety harness shoulder straps permitting the occupant to lean forward when the lever is moved backwards. Release of the lever relocks the mechanism. As the occupant leans back his shoulder straps are automatically locked in the position reached.

(*d*) *Firing Handles*

(i) Two firing handles are provided, one at the top of the seat attached to the face screen and another on the front of the seat pan. Both handles have safety pins. The face screen safety pin is placed in the sear of the ejection gun time-delay mechanism when the seat is 'Safe for Servicing'.

(ii) Only a short upward movement of the seat pan firing handle is necessary to fire the seat; it is important to ensure that posture is correct before operating the handle. The face screen and seat pan firing handle safety pins must be in position on the seat before the occupant moves into or out of the seat.

(*e*) *Instructor's Seat, Additional Controls*

(i) The instructor's ejection seat guide rail is hinged at the top to the canopy coaming cross-tube and the seat is free to be swung with the aid of spring assistors, forward 5° and backward 20° from the normal flying position to facilitate cabin entrance and exit for crew members. A locking mechanism, incorporated in the seat guide rail, is operated by one of three levers, one on each side of the guide rail and one at the back of the rail. The mechanism locks the guide rail to attachment brackets on the cabin floor at each position.

(ii) Before moving the seat from the aft position to the fully forward position the external elevator control locks must be removed, the seat pan must be fully up and the control columns should be held forward from the pupil's seat. A retaining device is provided to hold the control columns forward whilst arranging the position of the instructor's seat.

13 Parachute Manual Controls

(*a*) The parachute is connected to the seat by a withdrawal line which deploys the parachute as the occupant is separated from the seat. If the automatic system fails after ejection, or if the seat fails to fire, it is essential, first to break the connection between the withdrawal line and the parachute, and then operate the safety harness quick-release fitting (QRF) and deploy the parachute manually.

(*b*) Pulling the outer, exposed, manual disconnect handle on the parachute waist belt, breaks the connection between the withdrawal line and parachute. After operating the safety harness QRF, and pushing away from the seat if necessary, the inner, parachute ripcord handle on the waist belt must be pulled to deploy the parachute, when clear of aircraft and seat and at a safe height.

14 Single Lever Ejection System (SLE)

(*a*) Either pilot can initiate the automatic sequence of canopy jettison, snatch unit operation and ejection. The additional components of the SLE system consist of a cross-shaft mechanism passing above both seats, a time-delay mechanism incorporated in the top of the ejection gun on each seat, a canopy breech unit aft of the cross-shaft on the pupil's seat and a bank of four microswitches clamped to the base of the snatch unit to complete the electrical circuits to the canopy jettison and elevator control tube severance unit detonators.

(*b*) (i) When either firing handle on either ejection seat is operated, the cross-shaft mechanism rotates to with-draw the sear in the canopy breech unit and the sear in the ejection gun time-delay mechanism on the seat which is being operated.

(ii) The canopy breech unit drives gas under pressure to the control column snatch unit to release the snatch unit sear and simultaneously to close the connection to the detonator microswitches. The detonators are fired, the canopy is jettisoned, the control column tube is severed and the snatch unit spring operates to pull the control columns fully forward.

(iii) Simultaneously with (ii), withdrawal of the time-delay mechanism sear allows the ejection-gun firing pin to operate after a 1-second delay, and the gun is then fired.

(iv) When the second pilot operates his firing handle there is also a delay of 1 second before his seat fires.

NORMAL PROCEDURES (TYPE 3CT 1 & 2 Mk 3)

15 Safe for Parking and Ejection Seat Checks

These are given in the FRC.

16 Strapping-In Procedure

(a) Lock the instructor's seat in the forward position to allow the navigator to enter the aircraft. After the navigator has entered, lock the seat in the aft position to allow the pupil to enter. The instructor follows and straps-in with the seat in the aft position. Strap-in as follows:

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

(ii) Connect the survival pack lanyard to the life-preserver quick-release connection. ▶◀

(iii) Connect the parachute harness shoulder straps to the parachute QRF. The shoulder straps should lie under the lifepreserver stole. To fit a harness lug into an inertia-proof QRF 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.

(iv) Pass the parachute leg straps down through the leg loop, turn them back over and attach them to the parachute QRF. Adjust the box so that it lies centrally with the waist belt close to the body.

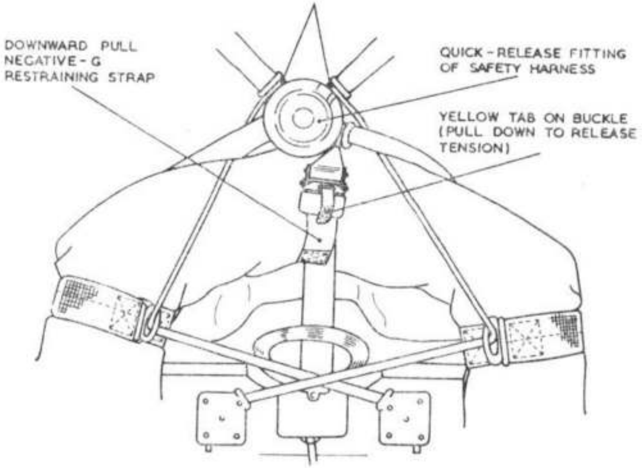
(v) Adjust the shoulder straps so that the parachute QRF will lie clear of and above the safety harness QRF when this is assembled. Tighten the parachute harness leg straps.

(vi) 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. 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 QRF before fastening the harness. If correctly fitted, the negative-g restraint strap end fitting should be a loose fit over the end of the lap strap lug. Give the lap strap a jerk to ensure that it is correctly engaged in the QRF. Do not tighten the lap straps at this stage.

(vii) Ensure that the loop of the right restraint line is passed through the D-ring on the left garter and threaded under the left-hand side of the safety harness leg strap. Pass the lug of the left shoulder strap of the safety harness through the loop in the end of the leg-restraint line and insert the lug into the safety harness QRF.

(viii) Proceed similarly for the left restraint line.

(ix) To adjust the working length of a leg-restraint line, press and hold the plunger under the snubbing unit and draw the line upwards. If there is too much, draw any excess downwards through the unit.



1—10 Fig 3 Arrangement of Negative-g Restraint Strap and Leg-Restraint Lines

(x) 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 negative-g strap can be loosened by pulling down on the yellow tab attached to the snubber lever.

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

(xii) Put on the helmet and/or protective helmet and fasten the chin strap(s); connect the mic-tel lead.

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

(xiv) Pass the emergency oxygen tube over the parachute harness but under the right-hand shoulder strap of the safety harness and connect it to the oxygen mask tube assembly.

(xv) Connect the oxygen mask tube locating chain to the D-ring on the lifepreserver.

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

(xvii) Ensure that the safety pins are removed and stowed before flight.

(b) When strapped-in, remove the control columns retaining device. The instructor then moves his seat to the operational position, taking care not to foul the main oxygen tubes, and retightens all his straps.

(c) The instructor should ensure that his seat is correctly locked in the flying position by checking the vertical movement available at the end of the locking control lever on the left-hand side of his seat. If the seat is correctly locked, this movement will be a maximum of one inch, but if the seat is not correctly locked there will be about six inches of movement. Confirmation that the seat is correctly locked should also be sought from the ground-crew.

17 Normal Exit from the Seat

(a) Make the seat **Safe for Parking.**

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

(c) Release the safety harness and parachute harness.

(d) Disconnect the personal survival pack lanyard from the lifepreserver and drape it over the side of the seat pan.

(e) Remove the leg-restraint lines and negative-g restraint strap.

(f) Move the instructor's seat to the aft position, leave the cockpit and move the seat to the forward position so that the navigator can come out.

ESCAPE PROCEDURES (TYPE 3CT 1 & 2 Mk 3)

18 Pilots' Abandoning Drills

The **Abandoning Drills** are given in the FRC but particular attention is drawn to the following points:

(a) If time permits, simultaneous or near simultaneous ejections should be avoided.

(b) If, due to high asymmetric power, a heavy foot load is being held when the decision to abandon the aircraft is made, throttle back the live engine before ejecting, circumstances permitting, to prevent a high rate of roll developing before the seats have left the aircraft.

(c) The hydraulic handpump handle may foul either seat as it ejects, unless it is folded back.

(d) If ejection is attempted with the CANOPY/SNATCH MASTER switch off, the control column snatch unit will not operate and severe injury may result.

(e) If it becomes necessary to eject after independent jettisoning of the canopy, and the face screen firing handle is used, care must be taken when reaching for the handle so that the inner side of the outboard forearm is not exposed to the slipstream.

19 Sequence on Ejection

After the ejection gun fires, the sequence is as follows:

(a) As the seat ascends the guide rail:

The drogue gun is armed.
The leg-restraint lines tighten, pulling the legs together and back until the rivets in the line fittings shear.
The barostatic time-release unit (BTRU) is tripped.
The emergency oxygen supply is turned on.
The main oxygen hose and mic/tel lead are pulled away from the aircraft connections.

(b) One second after the seat ejects, the drogue gun is fired to deploy the drogues which stabilise and decelerate the seat.

(c) If the ejection has taken place above an altitude of 10,000 feet, a stabilised fall occurs until this altitude is reached. At this point the BTRU operates and after 1·25 seconds the safety harness is released and the scissor 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. On release, the drogues pull on a lifting line which disconnects the face screen and deploys the parachute. The occupant is momentarily prevented from leaving the seat by two sticker straps clipped to the seat pan, until the pull of the parachute lifts him clear.

(d) If the ejection occurs below 10,000 feet, the same sequence ensues except that the BTRU operates 1·25 seconds after ejecting subject to the overriding influence of the g controller which delays operation of the BTRU if the speed is too high for safe parachute deployment.

Note 1: If the seat pan firing handle has been used to initiate ejection, it must be released before man/seat separation takes place as the handle remains with the seat.

Note 2: A BTRU which operates at an altitude of 5000 metres (about 17,000 feet) may be fitted to allow for safe operation over mountainous terrain. The operating altitude is marked on the unit.

20 Failure of Automatic Systems

Failure of the automatic system after ejection and failure of the seat to fire are covered by drills in the FRC.

NAVIGATOR'S EJECTION SEAT (TYPE 2CA2 Mk 4)

21 Controls on the Seat

(a) Seat-Height Adjustment

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

(b) Leg Restraint

Two leg-restraint lines are attached to brackets on the aircraft floor by lugs on the end of the lines; each lug fitting incorporates a shear-rivet. The lines then pass through snubbing units, on the front of the seat pan, which allow them to slide freely downwards but not upwards. A release button is provided under each snubber unit to permit the line to be slid against the snubbing

1—10 Fig 4 Ejection Seat Type 2CA Series

(*Terminology Amended*)

action when strapping-in, if adequate working length is not available. The lines are then crossed and threaded through D-rings attached to garters worn by the occupant and are finally looped around the shoulder strap lugs of the safety harness; the lines are released whenever the safety harness is undone.

(c) Go-Forward Lever

A spring-loaded go-forward lever on the starboard thigh-guard releases the safety harness shoulder straps permitting the occupant to lean forward when the lever is pulled back. Release of the lever re-locks the mechanism. As the occupant leans back his shoulder straps are automatically locked in the position reached.

(d) Firing Handles

Two firing handles are provided, one at the top of the seat attached to the face screen and another on the front of the seat pan. Each handle has a safety pin. The seat is fired by pulling either handle (see para 23). Only a short upward movement of the seat pan firing handle is necessary to fire the seat; it is important to ensure that posture is correct before operating the handle. The face screen and seat pan firing handle safety pins must be in position before the occupant moves into or out of the seat.

22 Parachute Manual Controls

See para 13.

23 Single Lever Ejection System (SLE)

(a) The navigator's ejection sequence cannot be initiated unless the HATCH SAFETY switch is ON or the hatch has already been jettisoned independently (see para 8).

(b) Firing Mechanism

The face screen firing handle and the seat pan firing handle are connected to a bifurcated cable. One arm of the cable is connected to the sear of a hatch-jettisoning mechanism on the rear face of the pressure bulkhead and the other is connected to the sear of the BTDU fitted in the ejection gun. The BTDU has a restrictor mechanism which prevents the sear from being withdrawn. The safety pin of the restrictor is connected to the hatch by a cable. When either firing handle is operated, the sear is extracted from the hatch jettisoning mechanism and the hatch leaves the aircraft, extracting the safety pin from the restrictor in the BTDU; continuing the pull on the firing handle then withdraws the sear from the BTDU and the ejection gun fires 0·5 second later. The length of time taken for the hatch to remove the restrictor safety pin is extremely short and the operator would probably not notice the brief hesitation.

(c) The SLE mechanism is inoperative until it has been mechanically cocked by means of a cocking lever, normally stowed on the pressure bulkhead. Cocking of the mechanism is a ground crew responsibility. When the mechanism is cocked, a white line on the cocking link is aligned with another on the bulkhead above the seat.

(d) Before flight a check must be made to ensure that the hatch cable is attached to the restrictor safety pin, the SLE cocking link is correctly aligned and the cocking lever is in its stowage.

NORMAL PROCEDURES (TYPE 2CA2 Mk 4)

24 Safe for Parking and Ejection Seat Checks

These are given in the FRC.

25 Strapping-In Procedure

The navigator straps-in in accordance with the instructions given for the pilots' seats (see para 16).

26 Normal Exit From the Seat

(a) Make the seat **Safe for Parking.**

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

(c) Release the safety harness and parachute harness.

(d) Disconnect the personal survival pack lanyard from the lifepreserver and drape it over the ▶◀ side of the seat pan.

(e) Remove the leg-restraint lines and negative-g restraint strap.

(f) Leave the seat.

(g) Raise the seat to the fully-up position.

ESCAPE PROCEDURES (TYPE 2CA2 Mk 4)

27 Navigator's Abandoning Drills

(a) The **Abandoning Drills** are given in the FRC.

(b) If the hatch does not jettison when the navigator operates his seat, proceed as follows:

(i) Check that the HATCH SAFETY switch is ON, switch ON the HATCH JETTISON switch, the hatch should jettison.

(ii) Re-pull the seat firing handle, the seat should then fire 0·5 second later.

(c) If the hatch is jettisoned independently of the ejection system, and ejection subsequently becomes necessary, the seat fires 0·5 second after operation of either firing handle.

28 Sequence on Ejection

The sequence on ejection is the same as for the pilots' seats (see para 19).

29 Failure of the Automatic Systems

Failure of the automatic systems after ejection, and failure of the seat to fire are covered by drills in the FRC.

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18