

AP 101B-0407-15

CANBERRA PR Mk 7

AIRCREW MANUAL

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June 1975
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RESTRICTED

AP 101B-0407-15

CANBERRA PR Mk 7

AIRCREW MANUAL

BY COMMAND OF THE DEFENCE COUNCIL



Prepared by Procurement Executive, Ministry of Defence

RESTRICTED

(AL3)

NOTES TO USERS

1. This Manual is complementary to the Canberra PR Mk 7 Flight Reference Cards (AP 101B-0407-14A). Reference must also be made to the Operating Data Manual (AP 101B-0407-16).

2. This Manual is divided by marker cards, as follows:

- Preliminary Matter
- Part 1 Description and Management of Systems
- Part 2 Limitations
- Part 3 Handling
- Part 4 Emergencies
- Part 5 Illustrations

Where applicable the parts are divided into chapters, as listed on the marker cards. Each page is identified by a part, chapter, page reference at the foot of the page. Thus, a page bearing the reference: 1 — 2 Page 5 is Page 5 of Part 1, Chapter 2.

3. The limitations quoted in Part 2 are mandatory and are not to be exceeded except in an emergency. Instructions containing the word 'must' are also mandatory.

4. This Manual and its associated Flight Reference Cards aim to provide the best operating instructions and advice currently available. Although they provide guidance for most eventualities, they are not substitutes for sound judgement and good airmanship; moreover, they assume an adequate knowledge of the pertinent volumes of AP 3456 Series (Flying). Furthermore, circumstances might require aircrew to depart from or modify the prescribed procedures and drills. Consequently the Manual and Flight Reference Cards should not be regarded as documents which are to be adhered to inflexibly at all times—other than as explained in para 3 above.

5. Amendments are issued as necessary and each amendment list instruction sheet states the main purpose of the amendment and includes a list of modifications covered in the text. New or amended matter of importance is indicated by ◀ ▶ for insertions and ▶◀ for deletions. Sheets issued by amendment bear the AL number at the bottom of the odd-numbered pages and any amendment marks on either side of the sheet relate to that amendment list. However, when a new chapter is issued or an existing chapter is completely revised, the fact is indicated within the heading of the chapter and the amendment marks do not appear on the pages.

6. The following conventions are observed throughout the Manual:

- a. The actual markings on controls are indicated in the text by capital letters.
- b. Unless otherwise stated all airspeeds, mach numbers, accelerations, temperatures and altitudes quoted are indicated values.
- c. **WARNINGS** are inserted only when the serious consequences of not following a certain procedure might otherwise be overlooked.
- d. Information which requires to be emphasised is in italics.
- e. Notes are inserted to clarify the reason for a procedure or to give information which, while not essential to the understanding of the subject, is useful to the reader.
- f. Cross references given in the text refer to chapters in the same part, unless otherwise stated.

7. Modification numbers are only referred to in the text when it is necessary to differentiate between pre- and post-mod states. For ease of reference, a list of the modifications mentioned in the text is included in the preliminary pages with a cross reference to the location in the text of the modification details.

IMPORTANT

**Comments and suggestions should be forwarded to the Officer Commanding,
Royal Air Force Handling Squadron, Boscombe Down, Salisbury, SP4 0JF.**

AMENDMENT RECORD SHEET

To record the incorporation of an Amendment List in this publication, sign against the appropriate A L No and insert the date of incorporation.

A L No	AMENDED BY	DATE
1	CA. Butcher	14/7/76
2	L.A. Davies	13/5/79
3	JARVIS	14.10.80
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◀ ANA No 1 is already incorporated ▶

LIST OF PAGES

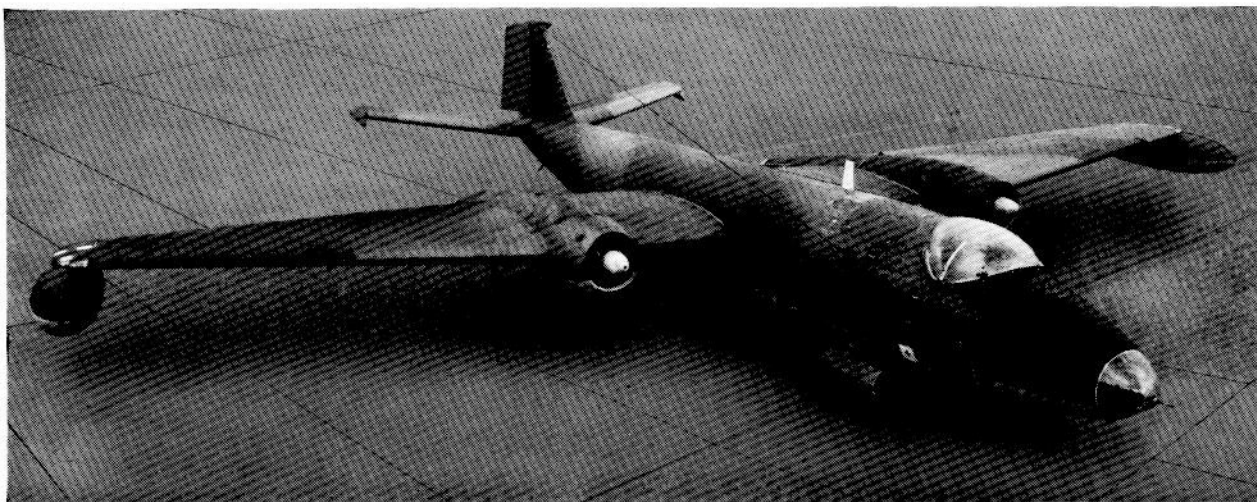
This list shows all the sheets which should be present in this Manual when AL No 3 is incorporated. Sheets which should have manuscript amendments are marked with an asterisk.

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MODIFICATION NUMBERS MENTIONED IN THE TEXT

<i>Mod No</i>	<i>Title</i>	<i>Location in Text (Part Chapter Para)</i>		
CANBERRA MOD				
4127	To reposition the oxygen charging valve (satisfied by Command Mod Canberra 1065)	Preliminaries Page 4		
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SEM/059/STC	To introduce a Monte Carlo stopwatch	1	6	13
SRIM				
◀ 4012	To introduce ARI 18017/4 (Tacan)	1	11	28 ▶



INTRODUCTION

Canberra PR Mk 7

General

1. The Canberra PR Mk 7 is a twin-engined photographic reconnaissance aircraft powered by two Avon Mk 109 engines.

2. *Operational Equipment.* The aircraft may be equipped for day or night photography. Photoflashes are carried in a bay in the belly of the fuselage. There are three camera bays, one forward and two aft of the flare bay. Four cameras can be carried in the forward bay, two in the centre bay and one in the rear bay. An additional, forward facing, camera can be carried in the nose.

3. *Crew Accommodation.* The cabin is pressurised and sealed off from the rest of the fuselage by a pressure bulkhead. It provides accommodation for a crew of two, a pilot and a navigator, seated in ejection seats. A folding seat is provided on the starboard side of the cabin for occasional use.

4. *Entrance Door and Emergency Exits.* Entrance to the cabin is through a door on the starboard side. The door is jettisonable and also serves as an emergency exit. The canopy above the pilot's station and the hatch above the navigator's station are jettisonable and provide emergency exits.

5. *Equipment Compartments.* Three bays for various items of aircraft equipment are immediately aft of the cabin pressure bulkhead. The upper equipment bay is above the nose undercarriage well and access to it is by means of a hinged hatch on top of the fuselage. The port and starboard equipment bays are on either side of the nose undercarriage well, with hinged access doors in the fuselage wall.

6. *Flying Controls.* The ailerons, elevator and rudder are all manually operated. The variable-incidence tailplane, aileron trim and rudder trim are all electrically operated.

Layout of Controls and Instruments

7. *Pilot's Station.* The layout of the flying controls is conventional; other controls and instruments are grouped as follows:

a. To the left of the pilot on the port wall (which includes the take-off panel), on the port console and on the engine control quadrant.

b. In front of the pilot on the sloping port front panel, on the main instrument panel, on the coaming panel above the main panel and on the engine starter panel below it. The main instrument panel is divided into three sections, from left to right: flight instrument panel, engine instrument panel, miscellaneous instrument panel.

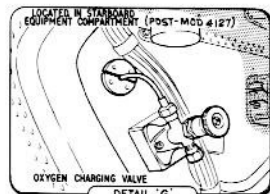
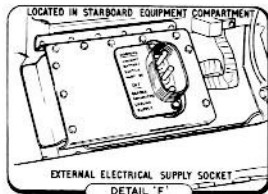
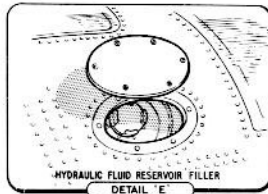
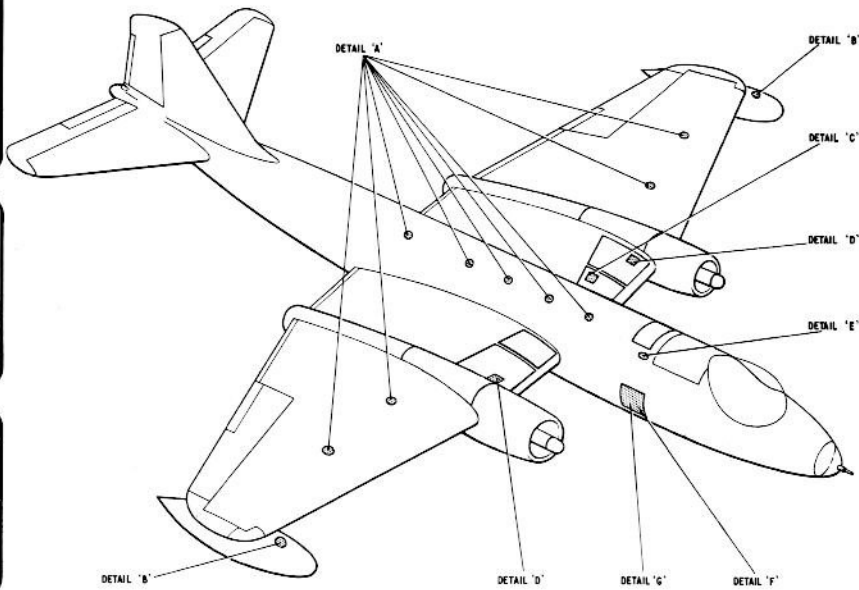
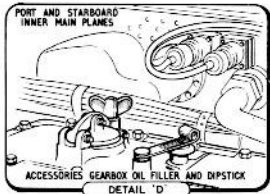
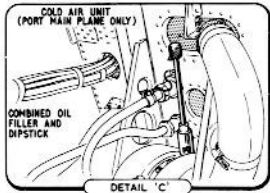
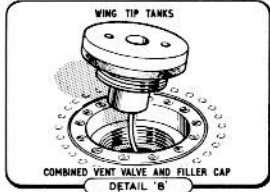
c. To the right of the pilot on the front face of the electrical control panel (ECP) situated in the walkway between the pilot's station and the navigator's rear station.

8. *Navigator's Stations.* The navigator's controls and instruments are grouped around him as follows:

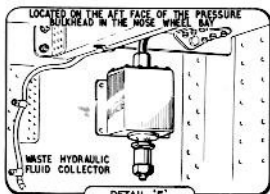
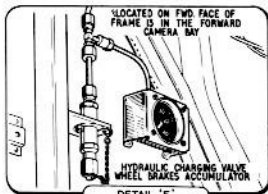
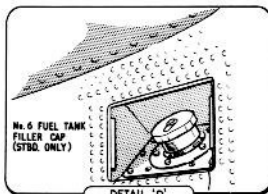
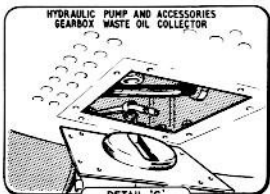
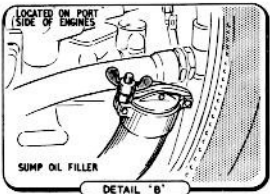
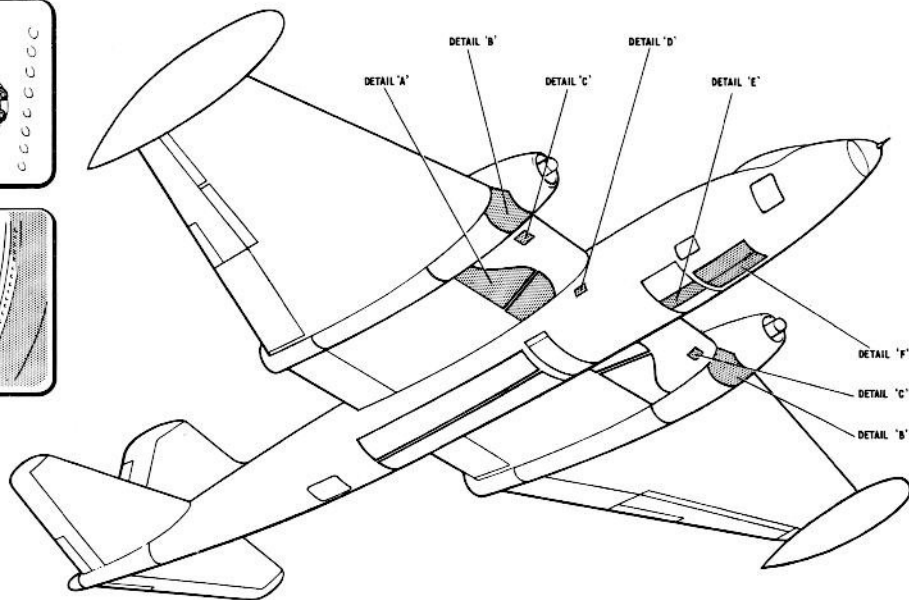
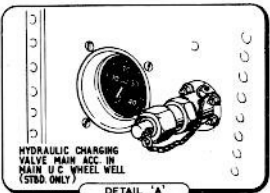
a. *Rear Station.* On the port wall, on the forward instrument panel and on the starboard wall.

b. *Nose Station.* On the walls, roof and floor of the nose station.

9. The location of all controls and instruments is given relative to the above positions.



LOCATED IN FORWARD CAMERA BAY (PRE-MOD 4127)



◀ Servicing Points (Mod 4127 Incorporated) ▶

LEADING PARTICULARS

Principal Dimensions

					<i>feet</i>	<i>inch</i>
Span without wing-tip tanks	...	...	...	...	64	0
Span with wing-tip tanks	...	...	...	...	65	6
Length overall	...	...	...	...	66	8
Height to top of fin	...	...	...	...	15	7
Height to top of canopy	...	...	...	...	8	8

Undercarriage

Mainwheel Units (two)

Type	...	...	...	...	...	Single wheel, inwards retracting
Shock absorber	...	...	...	...	...	Oleo pneumatic
Air pressure	...	...	...	...	...	Refer to AP 101B-0407-1
Fluid	...	...	...	...	...	OM-15 (NATO H-515)
Capacity	...	...	...	...	...	12 pints
Tyre pressure	...	...	...	...	...	Refer to AP 101B-0407-5

Brakes:

Pressure at reducing valve inlet	...	...	...	...	2700	$\begin{smallmatrix} +50 \\ -0 \end{smallmatrix}$ PSI
Pressure at brakes	...	...	...	...	1500	$\begin{smallmatrix} +150 \\ -0 \end{smallmatrix}$ PSI

Nosewheel Unit

Type	...	...	...	...	...	Twin wheel, non-steerable, castering, rearward retracting
Shock absorber	...	...	...	...	...	Levered suspension, liquid spring
Pressure (wheels off ground)	...	...	...	...	1500	PSI
Fluid	...	...	...	...	...	OM-15 (NATO H-515)
Capacity	...	...	...	...	...	1½ pints
Tyre pressure	...	...	...	...	...	Refer to AP 101B-0407-5

Hydraulic System

General

Fluid	...	...	...	...	...	OM-15 (NATO H-515)
Capacity of system	...	...	...	...	...	33 pints (approx)
Capacity of tank	...	...	...	...	...	2 gallons
Pumps (two)	...	...	...	...	...	Lockheed Mk 9
Accumulator charging gas	...	...	...	...	...	Nitrogen
Thermal relief valve setting	...	...	...	...	...	3450 ± 100 PSI (see Part 1, Chapter 3, para 6)
Accumulator inflation pressure (main and wheel-brakes)	...	...	...	...	...	1350 $\begin{smallmatrix} +50 \\ -0 \end{smallmatrix}$ PSI at +5°C 1400 $\begin{smallmatrix} +50 \\ -0 \end{smallmatrix}$ PSI at +15°C
Cut-out valve setting	...	...	...	...	...	Cut out 2700 $\begin{smallmatrix} +50 \\ -0 \end{smallmatrix}$ PSI Cut in 2200
Flaps relief valve setting	...	...	...	...	...	2850 $\begin{smallmatrix} +50 \\ -0 \end{smallmatrix}$ PSI
Header tank relief valve setting	...	...	...	...	...	12 to 17 PSI

Power Units

Engines (two)

Name	...	...	...	...	...	...	Avon Mk 109 (ECU Mk 10901)
Type	...	...	...	...	...	...	Straight flow turbojet
Fuel	...	...	...	...	...	...	} See Part 2, Chapter 1, para 3
Oil	...	...	...	...	...	...
Complete system oil capacity	...	...	...	...	...	...	19 pints (each engine) including sump capacity
Oil sump capacity	...	...	...	...	...	...	16 pints (each engine)
Oil consumption	...	...	...	...	...	...	1 pint per hour max (each engine)

Starting System

Type	...	...	...	...	...	...	BTH turbo, type TBS 720, Mk 3
Cartridge	...	...	...	...	...	...	No 10 Mk 3

Accessories Gearboxes

Oil	...	...	...	...	...	...	OX38 (NATO O-149)
Oil sump capacity	...	...	...	...	...	...	3½ pints (each)

Electrical System

Voltage	...	...	...	...	...	...	28
Generators (two)	...	...	...	...	...	...	Type 519 (9 kW)
Aircraft battery	...	...	...	...	...	...	1 × 24 volt, 35 ampere hour (alkaline)
Emergency battery	...	...	...	...	...	...	2 × 12 volt, 4 ampere hour (lead acid), connected in series
Standby UHF emergency battery	...	...	...	...	...	...	1 × 24 volt, 7 ampere hour (alkaline)
Emergency lighting battery	...	...	...	...	...	...	1 × 2.4 volt (alkaline)

Fuel System

Types of fuel	...	...	...	...	...	...	See Part 2, Chapter 1, para 3
Fuel tank capacities	See Part 1, Chapter 2, para 4

PART 1**DESCRIPTION AND MANAGEMENT OF SYSTEMS****List of Chapters**

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PART 1

CHAPTER 1—ELECTRICAL SYSTEM

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Electrical System Simplified	Fig 1

DESCRIPTION**Generators**

1. Power for the electrical services and aircraft main battery charging is provided by two Type 519, 300 ampere, DC generators, operating in parallel. Each generator is in the inboard leading edge of the mainplane and driven from the accessories gearbox of its respective engine.

2. Output of each generator is maintained at 28 volts by a voltage regulator. The regulators contain an equalising coil; thus as long as both generators are on-line, if the load on No 1 generator exceeds

that on No 2 the load on No 1 generator will be reduced and that on No 2 increased until a state of balanced output is reached. The converse applies if the load on No 2 generator exceeds that on No 1.

3. Over-voltage protection is provided so that in high-voltage fault conditions the affected generator is disconnected from the busbar and the associated failure warning light comes on. The voltage at which a generator trips off-line is dependent upon the load imposed on the system; under normal load the generator comes off-line at about 32 volts.

4. A differential cut-out is provided for each generator; this operates to connect the generator to the

busbar when generator voltage exceeds busbar voltage and to disconnect it when busbar voltage exceeds generator voltage. The generators cut in at an engine speed of approximately 1700 RPM and cut out slightly below this speed. Full output is available at RPM in excess of 3000.

AC Supplies — Inverters

5. DC supplies are converted to AC by four inverters (five inverters post-SRIM 4012). The distribution of supplies is as follows:

a. *No 1 Inverter.* No 1 inverter is a rotary inverter (Type 103A) which supplies 115 volt, 400 Hz, three-phase or single-phase AC to the following load:

- *Mk 4B compass
- *Horizon gyro unit
- *Radio compass
- *DV panel heater control unit
- *Oil pressure gauges
- Zero reader flight computer
- GPI Mk 4A
- Doppler control indicator



b. *No 2 Inverter.* No 2 inverter is a rotary inverter (Type 100A) which serves as an automatic standby for No 1 but it supplies only those items marked with an asterisk in sub-para a.

c. *No 6 Inverter.* No 6 inverter is a static inverter (Type 208) which supplies 115 volt, 400 Hz, single-phase AC to the IFF/SSR, automatic height encoding system, radar altimeter and HF (SSB).

d. *No 7 Inverter.* No 7 inverter is a static inverter (Type 208) which normally supplies 115 volt, 400 Hz, single-phase AC to the Doppler transmitter/receiver and aerial assembly, VOR transformer and DME transformer. The VOR transformer supplies 26 volts AC to the compass master indicator, VOR adapter unit, VOR bearing indicators and DME/VOR/ADF indicator for compass card drive. The AC outputs of the DME transformer are used in the drive of the pilot's DME distance indicator. By use of a changeover facility, all the equipment normally supplied by No 6 inverter can be supplied by No 7 instead of its normal load.

e. *No 8 Inverter (Post-SRIM 4012).* No 8 inverter is a static inverter (Type 208) which supplies 115 volt, 400 Hz, single-phase AC to the Tacan system.

Aircraft Battery

6. A 24 volt, 35 ampere hour battery is in the port equipment bay. The battery is protected against

overcharging by a thermostatic device which operates when the battery temperature exceeds a safe figure. The battery is automatically brought back on line if the busbar voltage falls below the battery voltage. This action ensures that the battery is available for output whatever the thermostat switch condition.

External Supply

7. The external supply plug is on the main electrical panel in the starboard equipment bay. 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.

Emergency Batteries

8. a. Two 12 volt, 4 ampere hour batteries, connected in series, completely independent of the main electrical system, are under the forward end of the pilot's port console. They are provided for the emergency operation of the E2B compass light, the turn and slip indicator, and the detonator circuits for elevator control tube severance, canopy jettison and hatch jettison.

b. A 2.4 volt alkaline battery for emergency lighting of the pilot's instrument panels is in the floor well, forward of the rudder pedals.

c. A 24 volt, 7 ampere hour alkaline battery for emergency operation of the Standby UHF is in the upper equipment bay.

Circuit Breakers and Fuses

9. The front face of the ECP carries circuit breakers for fuel cocks and pumps and for camera control circuits. The rear face carries circuit breakers for pilot's services (see Chapter 7, para 12), ILS and No 2 inverter. All other circuit breakers are covered in the description of their associated equipment. Fuses which can be changed in flight are behind a detachable panel on the side of the ECP and behind a panel labelled FUSES, on the port console. A list of fuses is on the back of each panel.

Inertia Crash Switches

10. 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, the generators are shut down, and the generators and aircraft battery are isolated from the busbar. The following emergency circuits, being supplied direct from the aircraft battery, are unaffected:

Belly tank explosion protection circuits

Inertia crash switch circuits

Fire extinguisher circuits (via the inertia crash switches only)

Note: The detonator circuits for elevator control tube severance, canopy jettison and hatch jettison are automatically transferred to the emergency battery when the supply to the busbar is disconnected by operation of the inertia switches.

CONTROLS AND INDICATORS

Generator Controls

11. Each generator has an OFF LINE—ON/OFF switch on the take-off panel, and a field circuit breaker on the main electrical panel in the starboard equipment bay. When a switch is selected to OFF, its associated generator is off-line. Warning lights, one for each generator, are on the pilot's coaming panel. The appropriate warning light comes on when a generator is off-line or to indicate a generator failure.

12. A DC Voltmeter, on the pilot's coaming panel, indicates the voltage of the supply connected to the busbar as follows:

Generator(s) on line	— A nominal 28 volts
Generators off, battery on	— A nominal 24 volts
External battery	— A nominal 24 volts
External power supply	— A nominal 28 volts

AC Supplies — Inverter Controls

13. *No 1 and No 2 Inverters.*

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

b. When the starboard engine MASTER STARTING switch is selected to ON, No 2 inverter starts immediately, provided that No 2 inverter circuit breaker on the ECP is made. The EMERGENCY INST SUPPLY magnetic indicator (MI), on the pilot's coaming panel, remains at white.

c. Provided that the port MASTER STARTING switch is ON, No 1 inverter starts as soon as either generator comes on line. The MI then shows black and No 2 inverter is automatically shut down.

d. Thereafter No 2 inverter remains off unless No 1 inverter fails or both generators fail, in which case No 1 inverter is automatically shut down and No 2 is started. The MI then shows white.

14. *No 1 Inverter Ground Test Switch.* No 1 inverter may be tested on the ground with engines stopped by selecting the port engine MASTER STARTING switch and the No 1 INV TEST switch to ON. The test switch is on the rear face of the ECP.

15. *No 6 and No 7 Inverters.* The DC supply to No 6 and No 7 inverters is fed via two circuit breakers on the main electrical panel in the starboard equipment bay. No 6 is controlled by the No 6 INV — ON/OFF switch and No 7 is controlled by the No 7 INV—OFF/ON/CO switch; both switches are on the rear face of the ECP. When an inverter is selected to ON, an AC supply is available to operate the associated equipment (see sub-para 5. c. and d.). See para 30 for use of the CO position of No 7 INV switch.

16. *No 8 Inverter (Post-SRIM 4012).* The DC supply to No 8 inverter is fed via a circuit breaker on the main electrical panel and a DC-operated relay which is controlled by the No 8 INV TACAN — ON/OFF switch on the rear face of the ECP. When the switch is ON, an AC supply is available to operate the Tacan equipment. ▶

Aircraft Battery Control

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

Belly tank explosion protection circuits

Inertia crash switch circuits

Fire extinguisher circuits (via the inertia crash switches only)

Note: When the battery switch is OFF, power to the detonator circuits of the elevator control severance unit, canopy jettison and hatch jettison is still available from either the generators (if running) or the emergency battery.

Emergency Batteries Control

18. a. *24-volt and 2.4-volt Emergency Batteries.* The emergency power supply to the turn and slip indicator is controlled by a TURN & SLIP — NORMAL/STANDBY switch. The emergency supply to the E2B compass lamp and the supply to the pilot's emergency lighting are both controlled by a COMP & EMGY LGTS—NORMAL/STANDBY switch. The switches are both together on the far right of the pilot's coaming panel. To help locate the COMP & EMGY LGTS switch in

the darkness, a 'Betelight' strip is immediately above it.

b. *24-volt Standby UHF Emergency Battery.* See Chapter 11, para 10.

NORMAL OPERATION

Before Starting the Engines

19. During the **External Checks**, ensure that the generator circuit breakers on the main electrical panel are made. The **Internal Checks** and **Starting 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 used. If the aircraft battery voltage is less than 22 volts 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.

Starting the Engines

20. During engine starting, the generator of the first engine comes on line at about 1700 RPM, No 1 inverter starts and the EMERGENCY INST SUPPLY MI changes from white to black. If external power has been used, have it disconnected before starting the second engine, then select the battery switch to ON and check that the DC voltage is 28 volts. The generator of the second engine comes on line at slightly higher RPM than the first. As each generator comes on line, its failure warning light goes out. Maximum output from the generators can be obtained by increasing engine RPM to 3000, but there is sufficient power available to allow the operation of all electrical equipment at 2750 RPM.

Before Flight

◀ 21. The operation of No 6, No 7 and No 8 (post-SRIM 4012) inverters can be checked by the navigator before flight provided that a generator is on line supplying 28 volts. ▶

In Flight

22. 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.

After Flight

◀ 23. After landing, No 6, No 7 and No 8 (post-SRIM 4012) inverters may be switched off. ▶

MALFUNCTIONS

Generator Failure

24. *Single Generator Failure.*

a. If a generator fails, its protective devices should trip it off line automatically and its warning light should then come on. Its line switch should be selected to OFF and the electrical load reduced to below 300 amperes (see para 26).

b. An attempt to bring a generator back on line may be made by selecting the line switch to ON after a delay of not less than 30 seconds. If the generator remains off line, select the line switch to OFF and leave it OFF.

c. If an engine fails or is shutdown, its generator line switch must be set to OFF immediately and the electrical load reduced because the generator may not immediately come off line owing to the windmilling engine; however, the voltage will be reduced and the equalising coil will lower the voltage of the other generator which may cause a drain on the aircraft battery. Once a generator is off line, its equalising coil is inoperative.

d. In rare circumstances, not connected with engine failure or flame-out, it is possible for a failed generator to remain on line with its warning light out. Should, therefore, the voltmeter read less than 26 volts with both engines functioning normally, set the battery switch and one generator switch to OFF. If this restores the voltage to 28, leave the faulty generator switch at OFF, switch ON the battery and proceed with load shedding (para 26). If, however, the voltage remains low, reverse the generator switches and check that the voltage reads 28. Leave the generator switches as set, switch ON the battery and proceed with load shedding.

25. *Failure of Both Generators.*

a. *General.* If both generators fail, both generator line switches must be set to OFF and electrical load reduced immediately to a minimum. No 2 inverter automatically starts up and takes over from No 1 (see para 5 b).

b. *Fuel Drill Considerations.*

(1) If both generators fail at high altitude, altitude should be reduced because the LP fuel pumps will function only 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 re-light. Altitude should be reduced to below 15,000 feet, if possible, so that the engines can 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 maximum altitude to 35,000 feet (Avtur or Avcat) or 25,000 feet (Avtag). (See also Chapter 2, para 28.)

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

26. *Load Shedding.* If a generator fails or is switched off, the average load on the other generator must not exceed 300 amperes. Proceed as follows:

- a. Do not use more than two LP pumps continuously.
- b. Use the tailplane trim and radios economically.
- c. In the landing condition, use two LP pumps per side.

27. *Overvolting.* Automatic protection against overvolting is provided. Under normal load conditions a faulty generator automatically comes off line at about 32 volts. If the DC voltmeter continually shows over 30 volts, switch OFF the battery except for the landing period.

No 1 and No 2 Inverter Failure

28. Failure of No 1 inverter is shown by the EMERGENCY INST SUPPLY MI on the panel showing white. At the same time No 2 inverter automatically starts up and takes over the supply to the starred items listed in para 5 a. If No 2 inverter fails, check and if necessary reset, once only, its circuit breaker. If it is vital, an attempt may be made to restart No 1 inverter, as follows:

- a. Switch the port engine MASTER STARTING switch OFF for one second, then ON. If the

inverter starts up and is running normally the EMERGENCY INST SUPPLY MI should show black. Normal operation of its associated equipment can then be resumed.

- b. If this procedure is unsuccessful, no further attempt should be made to restart.

29. If No 1 and No 2 inverters fail or if there is a general power failure, there will be no supply to the AC-operated flight instruments and the oil pressure gauges. In the unlikely event of complete power failure it will be necessary to switch on the emergency turn-and-slip electrical supply if in IMC. If in VMC, the battery should be conserved by leaving the switch off until 3 to 4 minutes before it is estimated that IMC will be encountered.

No 6 Inverter Failure

30. If No 6 inverter fails, its load can be transferred to No 7 inverter by selecting No 7 inverter switch to CO (changeover). The AC supply to the equipment normally supplied from No 7 inverter is then switched off. No 7 inverter switch may subsequently be selected to either ON or CO according to the particular equipment required.

No 7 Inverter Failure

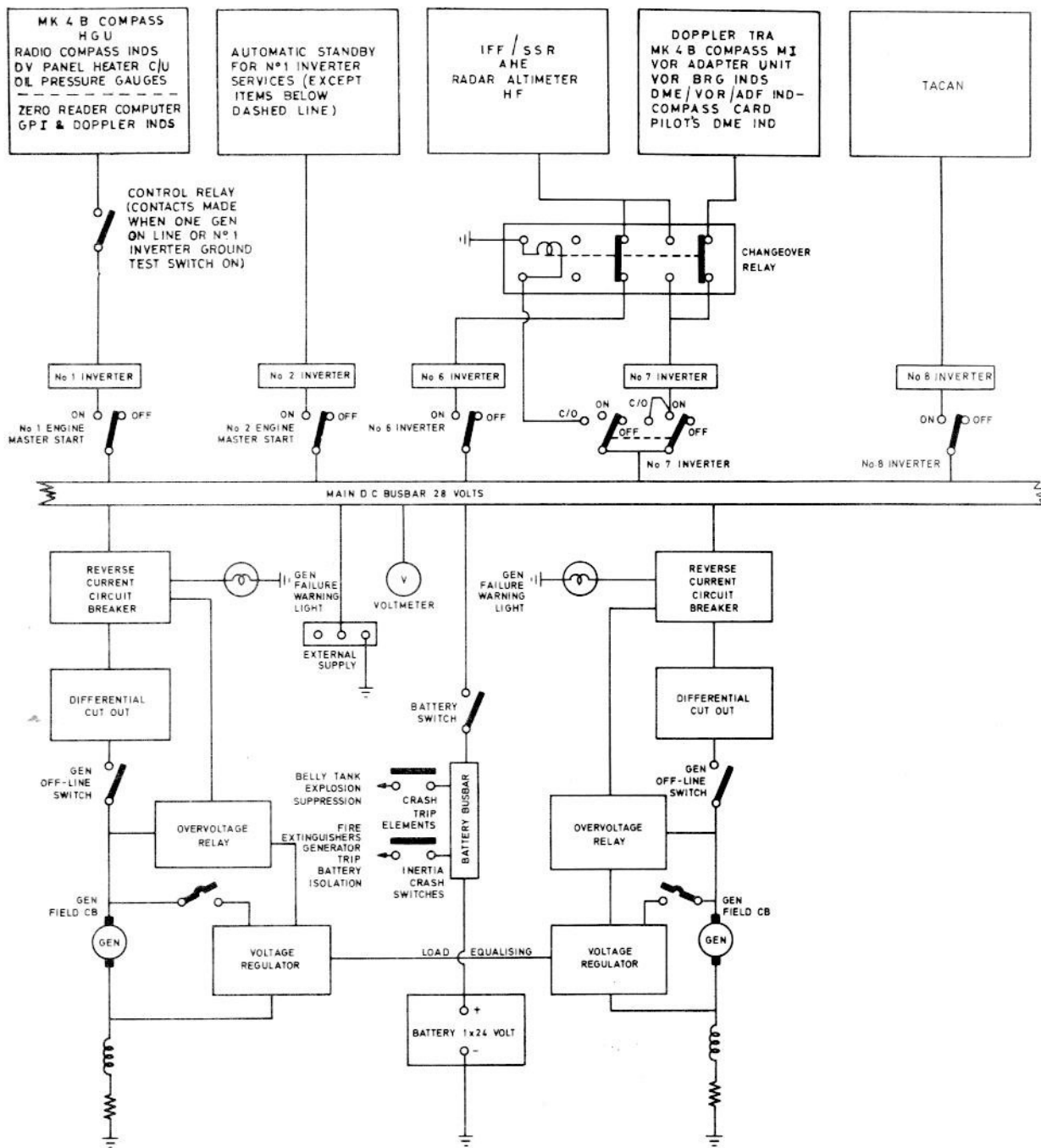
31. If No 7 inverter fails, all the equipment that it supplies (see para 5 d) is inoperable.

◀ No 8 Inverter Failure (Post-SRIM 4012)

32. If No 8 inverter fails, the Tacan equipment is inoperable. ▶

Electrical Loads

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



1 - 1 Fig 1 Electrical System Simplified
 ◀ (SRIM 4012 (Tacan) Incorporated) ▶

PART 1

CHAPTER 2 — FUEL SYSTEM

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DESCRIPTION

Fuel Tanks

1. *Fuselage Tanks.* Six fuel tanks are installed in the centre fuselage. Five are crash-proof collapsible tanks in the upper fuel bay (the four forward of the main spar are referred to as No 1 to 4 or top tanks and the one aft of the spar is referred to as No 5 or rear tank) and the sixth is an all-metal tank, fitted below the top tanks (referred to as No 6 or belly tank). A collector box is fitted to the rear end of the belly tank; this serves the top tanks in addition to the belly tank. Flush fitting filler caps, one for each of the top tanks and the rear tank are on the starboard upper surface of the fuselage; the filler cap for the belly tank is on the starboard side of the fuselage beneath the wing. All the tanks are vented to atmosphere through a common pipe terminating in a short pipe on the fuselage under the starboard tailplane.

2. *Wing Integral Tanks.* An integral tank, divided into interconnected outboard and inboard compartments, forms part of the structure of each wing outboard of the engine. Each compartment has an electrically-heated vent valve and a flush-fitting filler cap on its upper surface. The vent-valve heaters are controlled by a single switch on the take-off panel.

3. *Wing-tip Tanks*

a. 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.

b. The wing-tip tanks may be jettisoned by pressing in the guarded FUEL TANK JETTISON button on the port front panel.

Fuel Tank Capacities

4. The effective fuel capacities are approximately:

	Gallons	<i>Avtag</i> (7.7 lb/gal) lb	<i>Avtur</i> (8.0 lb/gal) lb
Top tanks ...	960	7392	7680
Rear tank ...	540	4158	4320
Belly tank (including collector box)	417	3210	3336
Wing integral tanks (2 at 428 gallons)	856	6591	6848
<i>Total internal fuel</i>	2773	21,351	22,184
Wing-tip tanks (2 at 244 gallons)	488	3758	3904
<i>Total all tanks ...</i>	3261	25,109	26,088

Note 1: The capacity of the top and rear tanks may be somewhat less than quoted until the bags stretch with use.

Note 2: Owing to its shape, the belly tank contains 30 gallons of unusable fuel. This is not included in the capacity nor is it shown on the gauge.

Fuel Recuperators

5. Two fuel recuperators, one for each engine, provide a fuel supply during negative-g flight conditions.

6. Each recuperator comprises a flexible bag contained within a casing, the bag being connected to the fuel delivery line between the integral tank and the engine. Air is fed from the engine compressor to the casing so that it acts on the flexible bag at a constant pressure. The pressure from an LP pump is greater than this air pressure so that when an LP pump serving the same engine is running, the bag is charged with fuel. If the LP pump ceases to deliver fuel due to negative-g flight conditions, or for any other reason, the air pressure collapses the bag and discharges its contents to the engine. The recuperator recharges as soon as an LP pump again starts to deliver fuel. To prevent an air lock developing in the system, a constant fuel bleed from the fuel bag allows a small quantity of fuel to pass continuously through the recuperator to a pipe leading to the rear tank. The integral LP cock must be open for the recuperator to be effective and consequently the transfer cock must be shut (NORMAL).

7. The supply of fuel in the bag feeds the engine for about 10 seconds at full power at sea level.

Fuel Feed to the Engines

8. Fuel delivery to the engines from the rear tank, the belly tank collector box and the integral tanks is effected by six electrically-operated LP pumps, two in the rear tank, two in the belly tank collector box and one in each wing integral tank. The pumps on the port side feed the port engine and those on the starboard side feed the starboard engine. The fuel in the wing integral tanks may also be transferred to the rear tank. Fuel from the top tanks is fed under gravity to the belly tank collector box. The fuel from the wing-tip tanks is automatically fed into the rear tank by air pressure from the engine compressors, the flow being controlled by a float valve in the rear tank. The foregoing is shown in the fuel system illustration (Fig 1).

Belly Tank Explosion Protection System

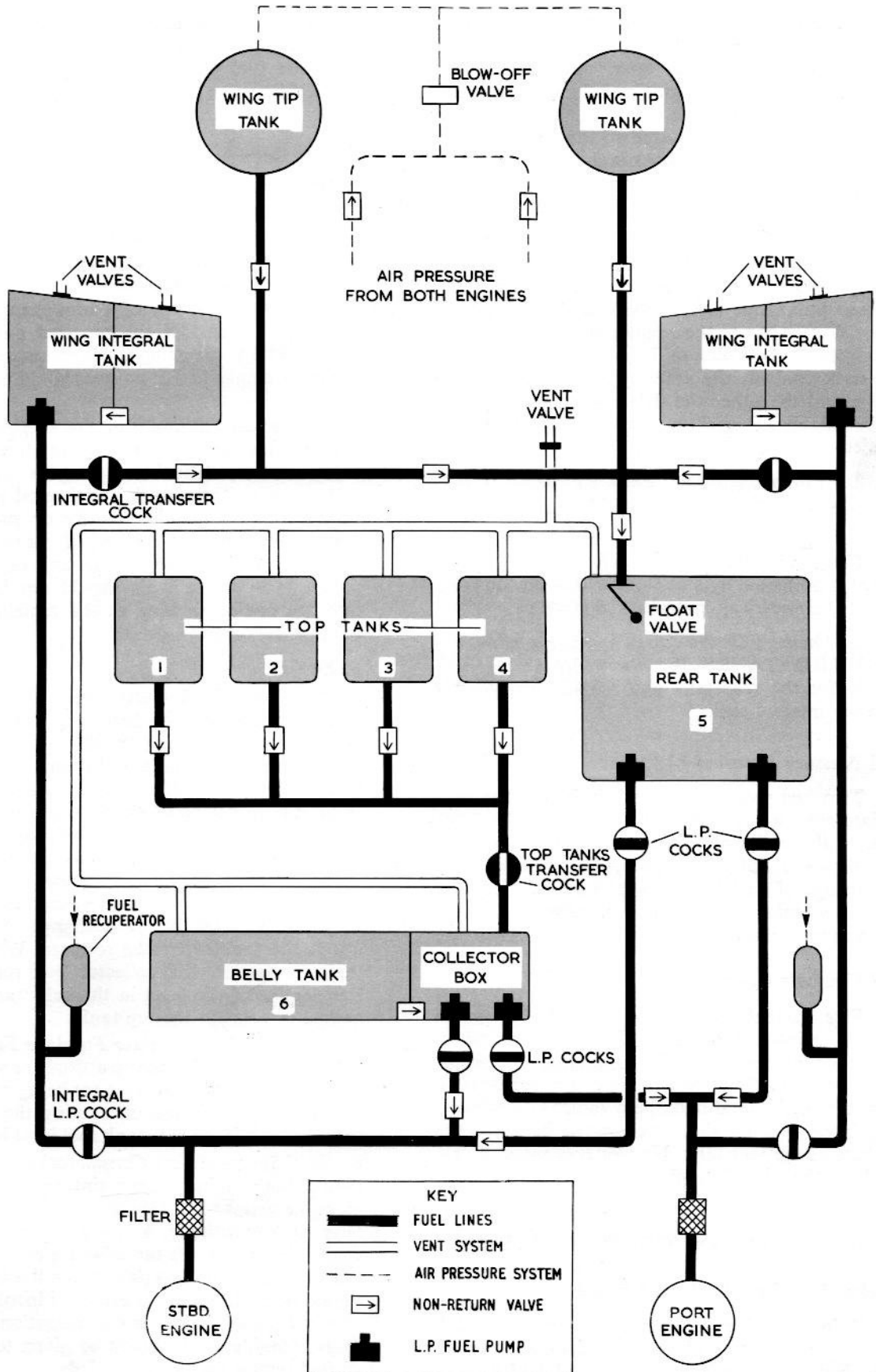
9. The explosion protection system comprises four explosion suppression units complete with detonators in the belly tank and four crash trip elements fitted in pairs on the underside of the fuselage. Each crash trip element has two sets of contacts which when closed (eg during a crash landing) operate the detonators; this causes a suppressing agent to disperse in the belly tank, thus preventing an explosion by rendering inert the highly explosive vapour. Permanent indication that the suppression units have fired is given by a match-head indicator fuse behind a viewing window on the forward bulkhead in the flare bay. When the units fire, the fuse operates to ignite the match-head and this allows red oxide powder to be dispersed over the clear envelope of the fuse.

10. The system is initially controlled by two ganged, FLIGHT/RESET/TEST switches on the forward bulkhead in the flare bay. Prior to flight the switches must be set at FLIGHT; the RESET and TEST positions are for servicing purposes only. A press-to-test warning light is adjacent to the switches. The light should normally be out. If the light is on, it indicates that the suppression units have fired. Pressing the light checks the supply fuse and light filament. The fuse is on the main electrical panel and the supply is taken direct from the aircraft battery.

CONTROLS AND INDICATORS

LP Fuel Cock and Pump Controls

11. *Top Tanks Transfer Cock.* An electrically-actuated transfer cock, controlling the gravity flow of fuel from the top tanks to the belly tank collector box, is controlled by an ON/OFF switch on the engine instrument panel.



1-2 Fig 1 Fuel System Simplified

12. *Wing Integral Tanks LP and Transfer Cocks.* Two electrically-actuated cocks are in the fuel lines from each wing integral tank, one controls the delivery of fuel to the engine and the other controls the transfer of fuel to the rear tank. The two cocks are electrically interconnected so that, when fuel is being transferred, the LP cock is shut irrespective of the position of the LP cock switch. Each LP cock and transfer cock is controlled by a suitably labelled switch on the take-off panel.

13. *Fuselage Tanks LP Cocks.* Two pairs of electrically-actuated cocks are provided for the fuselage tanks, one pair in the lines from the belly tank collector box to the engines and one pair in the lines from the rear tank to the engines. Of each pair, one cock controls the delivery of fuel to the port engine and the other the delivery to the starboard engine. Each LP cock is controlled by a suitably labelled switch on the take-off panel.

14. *LP Pump Controls.* Each LP pump is controlled by an ON/OFF switch on the engine instrument panel.

15. *Circuit Breakers.* Each LP pump and cock circuit is protected by a circuit breaker on the front face of the electrical control panel (ECP).

Note: On the ECP the circuit breakers are labelled FORWARD TANKS for the belly tank, AFT TANK for the rear tank and WING TANKS for the wing integral tanks.

Fuel Pressure Warning Lights

16. 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. Some 10 seconds warning of flame-out is given while the recuperator(s) discharge.

Fuel Contents Gauge

17. Five contents gauges, calibrated in lb, are on the engine instrument panel. The upper gauge indicates the total contents of the top tanks; the centre gauges indicate, from left to right, the contents of the port wing integral tank, belly tank and starboard wing integral tank; the lower gauge indicates the contents of the rear tank. No contents gauge is provided for the wing-tip tanks.

NORMAL USE OF THE FUEL SYSTEM

Checks of LP Fuel Cocks and Pumps

18. Before starting the engines, aurally check the operation of the top tanks transfer cock and the LP cocks; leave the transfer cock OFF and the LP cocks

ON. Set the integral tanks transfer cocks to NORMAL and then check each LP pump aurally and against the fuel pressure warning light; leave the pumps OFF.

Fuel Management

19. General

a. 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.

b. In flight, when any LP pump changeover is to be made, switch ON the required pump before switching OFF the pump no longer required. When a tank is empty its LP pumps should be switched off.

c. Should an LP pump of the fuel tank in use become uncovered by fuel, and no other fuel tank pump is supplying fuel to the engine, air may pass to the engine through the uncovered pump inlet rather than 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 injected into the engine so long as the remaining pump remains adequately covered.

20. Fuel Surge

a. *Fuel Surge in the Belly Tank.* The belly tank collector box takes its fuel level from the belly tank when the top tanks cock is OFF; therefore, at low fuel levels of the belly tank the collector box contains a relatively small quantity of fuel. A prolonged period of nose-down attitude or deceleration will prevent the collector box from being replenished from the belly tank at low fuel levels. If both engines are being fed from the belly tank, the small quantity of collector box fuel may be exhausted before a change of condition allows the fuel level to be restored. With the top tanks cock ON, the collector box remains full irrespective of the level in the belly tank so long as fuel remains in the top tanks.

b. *Fuel Surge in the Rear Fuselage Tank.* In a prolonged period of nose-up attitude or when rapid accelerations or manoeuvres are being made, there is a risk of fuel surge uncovering the pumps in the rear tank if the rear tank fuel level is low.

c. *Fuel Surge—Safety Considerations.* The running of both engines from a single 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 (1000 lb for the belly tank) should be avoided. When exercises involve periods of rapid manoeuvring or concentration on visual flying, consideration should be given to selecting all fuel pumps on for the period.

21. *Use of Wing Integral Tank Transfer Cocks*

- a. The wing integral tank transfer cocks must be left at NORMAL (shut), except when transferring fuel to the rear tank. Otherwise, with the cocks at TRANSFER, the recuperators are ineffective (see para 6).
- b. When transferring fuel, the integral tank LP cocks are shut. Therefore, another LP pump on each side must be on to feed its associated engine.
- c. If an engine fails and cannot be relit, the fuel in the integral tank on the same side as the failed

engine can be made available to the other engine, via the rear tank, by selecting the integral tank LP pump ON and the NORMAL/TRANSFER cock to TRANSFER.

22. *Fuel Drill.* Use only the wing integral and belly tanks for starting and taxiing (to minimise fuel venting from the integral tanks and fuel seepage through the belly tank filler cap; the latter causes misting of the rear camera windows). Leave all LP fuel cocks ON throughout the flight and control the use of fuel by operation of the transfer cocks and LP pumps in accordance with the following drill:

FUEL MANAGEMENT DRILL FOR ALL SORTIES

CONDITION	TANK POSITION					
	Wing Integral Tanks		Top Tanks	Belly Tank	Rear Tank	Wing-Tip Tanks
	Cocks	Pumps	Cock	Pumps	Pumps	—
1 Start up and taxi	ON and NORMAL	ON	OFF	ON	OFF	Full
2 Take-off and climb	ON and NORMAL	ON	ON	ON	ON	Feeding
3 When top and integral tanks show a drop	ON and NORMAL	OFF	ON	OFF	ON	Feeding
4 When rear tank reads 3500 lb	ON and NORMAL	OFF	ON	ON	OFF	Empty
5 When top tanks read 4000 lb	ON and NORMAL	OFF	ON	ON (see Note 2)	ON (see Note 2)	Empty
6 When top tanks read 1500 lb and rear tank reads 1000 lb	ON and NORMAL	ON	ON	OFF	OFF	Empty
7 When integral tanks read 500 lb each (see Note 3)	ON and TRANSFER	ON	ON	ON	ON	Empty
8 When integral tanks are empty and for landing	ON and NORMAL	OFF See Note 4)	ON	ON	ON	Empty

Note 1: For sorties which require less than full fuel load, the fuel load is adjusted by varying the contents of the fuselage and wing-tip tanks; fuel carried in the fuselage tanks must be disposed proportionally to the capacity of those tanks. For structural reasons the wing integral tanks must be filled for every sortie, except when carrying out flight trim checks in accordance with AP 101B-0407-1A, Section 3, Chapter 4, Appendix 1.

Note 2: Use one or two pumps per tank to maintain 500 lb more in the top tanks than in the rear tank.

Note 3: In condition 7 above, the recuperators are inoperative.

Note 4: An integral tank pump may be selected ON for landing if the associated tank contains more than 500 lb of fuel.

23. *Reserve Fuel.* The last 1250 lb of fuel in the belly tank is the minimum safe allowance for an overshoot, instrument approach and landing.

Use of Different Fuels

24. See Part 2, Chapter 1, para 3.

MALFUNCTIONS

LP Fuel Pump Failure

25. When two or three LP pumps serving one engine are on, no immediate indication is given if one pump fails; but if all pumps fail, or if only one pump is on and it fails, the fuel pressure warning light for that engine comes on before the recuperator discharges.

26. The engine dual HP fuel pump is designed to operate with a positive inlet pressure; LP pump failure results in the HP pump having to obtain fuel by gravity and suction feed only, which may cause a reduction in fuel delivery to the engine. When operating in these conditions, a change in RPM and loss of thrust may be experienced due to engine inlet guide vane movement. If the fuel pressure at the HP pump inlet is sufficiently low, cavitation of the pump occurs 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 a flame-out could occur between 20,000 and 30,000 feet.

27. Following a reduction in fuel pressure, the HP pump servo system moves the dual pumping mechanisms to full stroke in an attempt to produce the normal working pressure; restoration of low-pressure

fuel in these circumstances may lead to over-fueling. 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 for the same engine. Accelerate the engine carefully; satisfactory operation and freedom from compressor stall will be shown by the RPM and JPT rising together. If, however, the RPM and JPT do not stabilise normally, shut down the engine and then relight again using the drills given in the FRC. Fuel from the tank with the failed pump, except the wing integral tanks, is available for use by the other engine.

28. If both LP pumps in one tank fail or if the distribution of fuel makes necessary the use of fuel by gravity and suction feed, altitude should be reduced to 15,000 feet or below if possible. The engine which is to be fed by gravity/suction should be throttled to 'idling', the related cock of the affected tank switched on and the remaining pumps and cocks on that side switched off. Accelerate the engine carefully; cruising RPM should be obtained at or 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 on Avtur or 25,000 feet on Avtag (see Note below), but altitude and RPM must be kept as low as possible. Any climbing should be done using fuel from tanks with serviceable pumps; this also applies when landing so as to avoid the possibility of having to overshoot using gravity/suction feed, which is undesirable. *Any use of gravity/suction feed must be reported.*

Note: If suction feeding from the belly tank with the top tanks off or empty, the altitudes quoted for maximum range will be decreased by 5000 feet.

PART 1

CHAPTER 3—HYDRAULIC SYSTEM

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DESCRIPTION**General**

1. A hydraulic pump on each engine draws fluid from a reservoir (capacity two gallons) in the upper equipment bay. A handpump for manual operation of the services is on the right of the pilot's seat. A stack-pipe in the reservoir ensures a reserve of fluid for use with the handpump. The wheelbrakes and main system hydraulic pressure gauges are on the pilot's miscellaneous instrument panel.

Pumps and Services

2. The two engine-driven pumps deliver fluid to the system for operating the following services:

- Undercarriage
- Flaps
- Flare bay doors
- Airbrakes
- Camera doors
- Wheelbrakes

3. The handpump works in conjunction with the hydraulic GROUND/FLIGHT cock situated near the front of the flare bay roof. When the cock is at FLIGHT the handpump can be used to operate only the undercarriage and the flare bay 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. A stowage clip and socket for the handpump handle is just aft of the entrance door.

4. A second manually-operated selector cock is on the aft bulkhead in the port equipment 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 nosewheel to be retracted by means of the handpump during servicing operations.

Accumulators

5. The main accumulator is in the starboard main-plane 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 rear bulkhead in the forward camera bay; it 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 on the bulkhead below the accumulator. These gauges should read $1400 \pm_{0}^{+50}$ PSI at $+15^{\circ}\text{C}$ when there is no pressure in the hydraulic system. For correct pressures at other temperatures see **Leading Particulars**.

6. 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 $2700 \pm_{0}^{+50}$ PSI and cut-in at a minimum of 2200 PSI. Thermal relief valves in all circuits, except the wheelbrakes, open when pressure in the line to a service increases, for any reason, to more than 3450 ± 100 PSI; these valves reseal when pressure falls to 3100 PSI (minimum). An additional valve relieving at 3100 PSI is interposed between the sequence valve and transfer valve of each mainwheel undercarriage circuit. A pressure relief valve relieving at 3500 ± 100 PSI is fitted in the wheelbrakes circuit.

Controls

7. 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 flare bay doors opening. Details of these controls are given in Chapters 5 and 12.

NORMAL MANAGEMENT

External Checks

8. Check the accumulator pressure gauges in the forward camera bay and starboard wheelwell for minimum pressure (para 5). Ensure that the GROUND/FLIGHT cock in the flare bay is wire-locked at FLIGHT.

Before Starting the Engines

9. Check the operation of the handpump by pumping until at least 1400 PSI is indicated on the wheelbrakes hydraulic pressure gauge.

Checks During Starting

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

10. Start the port engine first and note that the pressure on the main and wheelbrakes pressure

gauges rises to 2700 to 2750 PSI. Then operate a hydraulic service (normally the flare bay doors) and note on completion of the operation that the hydraulic pressure builds up again to 2700 to 2750 PSI.

After Starting the Engines

11. 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 2700 to 2750 PSI.

Checks During Shutdown

12. Stop the port engine first and before stopping the starboard engine operate a hydraulic service and subsequently note that the hydraulic pressure builds up again to 2700 to 2750 PSI.

MALFUNCTIONS

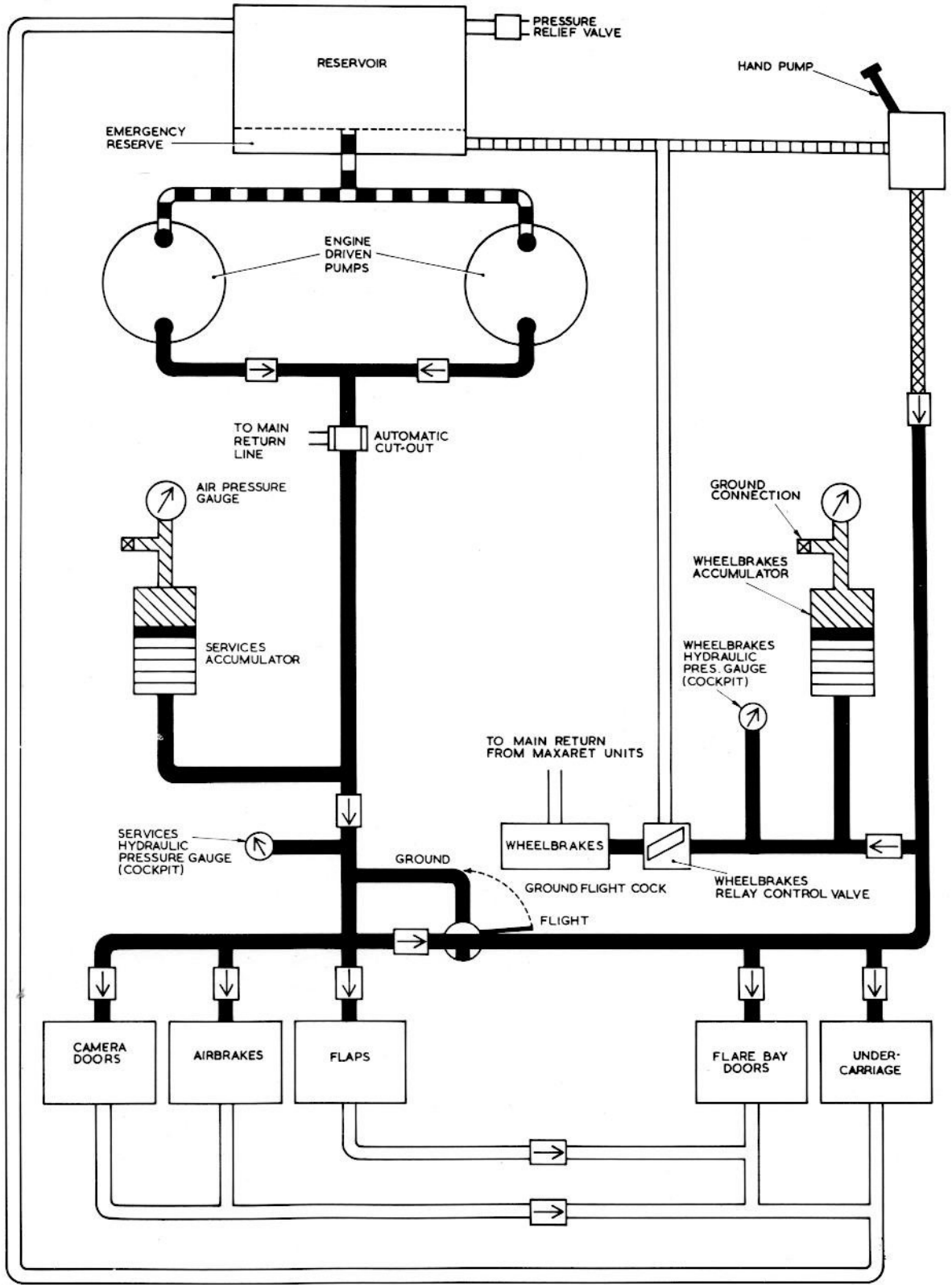
Hydraulic Failure

13. A failure may be assumed if the reading on the main hydraulic pressure gauge is below 2200 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 the flare doors opened; wheelbrakes pressure can also be obtained, provided that hydraulic fluid is available. Detailed emergency drills are given in the FRC.





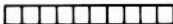

14. Hydraulic 'cycling', ie repeated fluctuation of the main hydraulic pressure between 2200 and 2700 PSI when no hydraulic service is in use, may indicate an internal or external leak. If 'cycling' occurs at intervals of less than 15 minutes, the possibility of loss of fluid and consequent hydraulic services failure must be considered and the undercarriage should be lowered as soon as practicable.

Spurious Indication of Hydraulic Failure

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



KEY

	ENGINE PUMP SUCTION		HAND PUMP DELIVERY
	ENGINE PUMP DELIVERY		RETURN LINES
	HANDPUMP		NON-RETURN VALVE

1-3 Fig 1 Hydraulic System Simplified

PART 1

CHAPTER 4—ENGINE SYSTEMS AND CONTROLS

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Avon Mk 109

1. The Avon Mk 109 is a turbo-jet aero-engine which features a twelve-stage axial flow compressor directly coupled to and driven by a two-stage turbine; it gives 7400 lb static thrust at sea level. The engine limitations are given in Part 2, Chapter 1, para 1.

Engine Fuel System

2. *High Pressure (HP) Fuel Pumps*

- a. The total output of the dual engine-driven HP fuel pump on each engine is limited by a servo-control system; a governor on the pump limits overspeeding of the engine.
- b. 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 inlet pressure.
 - (3) An acceleration control unit (ACU), to prevent excessive overfuelling of the engine during periods of rapid engine acceleration. The ACU is sensitive at all altitudes. Control is also maintained up to the governed RPM of the engine.

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

c. Each pumping mechanism of the dual pump unit is capable of supplying sufficient fuel for full thrust at take-off.

Variable Inlet Guide Vanes and Air Bleed Valves

- 3. The first row of stator blades in the engine compressor consists of variable-incidence inlet guide vanes (IGV) 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, ie surge, the surplus air is bled off through the air bleed valves and the IGV are held at the closed (plus 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 IGV move progressively to the open (minus 2°) position and produce a minimum of swirl.
- 4. No noticeable change in RPM or thrust occurs when the bleed valves change over nor do the IGV 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 IGV are fully open.
- 5. The IGV leave the minus 2° (open) position at 7450 ± 50 RPM on deceleration and leave the plus 40° (closed) position at 6400 ± 100 RPM on acceleration.
- 6. The air bleed valves should be fully open at 5850 ± 50 RPM on deceleration and fully closed before 6200 RPM on acceleration.

Throttle Controls

7. The two throttle levers are on the engine control quadrant. Friction is adjusted by turning the larger

of the two knurled knobs (clockwise to increase friction) on the side of the quadrant.

High Pressure (HP) Cock Controls

8. The HP cocks, one for each engine, are controlled by levers outboard of the throttles. They may be locked in either the ON (forward) or OFF position by turning the smaller of the two knurled knobs (clockwise to lock) on the side of the engine control quadrant. In the OFF position the fuel supply to the burners is cut off. Each lever incorporates a relight pushbutton.

Engine Starting, Relighting and Stopping Controls

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

10. *Starter Loading.*

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

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

11. *Starting Controls.* The main starting controls are on the starter panel and for each engine consist of a MASTER STARTING switch, STARTER pushbutton and IGNITION switch. The MASTER STARTING switch must be ON before either the STARTER pushbutton or IGNITION switch is operative.

12. *Ground Starting.* With the battery switch ON, the LP fuel cocks ON, the LP fuel pumps ON, the HP cock ON, the turbo-starter loaded and the master starting and ignition switches ON, pressing the starter button operates a time-delay switch which fires the cartridge to accelerate the engine and, through a relay, actuates the two 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 except that the LP pumps, HP cock and ignition switch are left OFF.

13. *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 master starting, ignition and time-delay switches and feeds a direct supply to close a relay which connects supplies to actuate the high-energy ignition units.

14. *Stopping an Engine.* An engine is stopped by pulling back the HP cock lever to the OFF position.

Oil System

15. Each engine has its own integral oil system of 19 pints total capacity, including oil sump capacity of 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 and is accessible through a removable panel in the lower cowling.

Engine Instruments

16. RPM indicators, oil pressure gauges and dual jet pipe temperature gauges are all on the engine instrument panel. The oil pressure gauges operate whenever AC is available from No 1 or No 2 inverter.

Engine Fire Extinguishers and Inertia Crash Switches

17. See Chapter 7, para 1 to 4 and 6.

Engine Anti-Icing System, Description and Controls

18. Hot air for engine anti-icing is ducted from the engine compressor to the double skin at the front of the engine cowling, the engine air-inlet casing, the spokes of the casing, the hollow IGV and the turbo-starter casing.

19. The systems are controlled by two ON/OFF switches, one for each engine, on the port console. Magnetic indicators beside the switches show white when the systems are switched ON and black when switched OFF.

Engine Handling Procedures

20. 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 FRC.

PART 1

CHAPTER 5 — AIRCRAFT CONTROLS

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Flying Controls — General

1. The 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. Centrally, the control column handwheel carries the wheelbrakes lever, parking catch and airbrakes control switch; the left-hand grip carries the pilot's camera switch and the right-hand grip carries the tailplane trim and cut-in switches and a press-to-transmit switch. Rudder and aileron trim control switches are on the pilot's port console.

Variable-Incidence Tailplane and Indicator

2. Changes of tailplane incidence are made by an electrical actuator controlled by two switches (spring-loaded to off) on the control column right-hand grip. The actuator cannot be operated by the trim switch without first operating the cut-in switch, in front of it, which controls an isolating relay in the tailplane actuator circuit; this provides a double safety factor against a runaway tailplane actuator. The trim switch is moved forward to give a nose-down trim change and aft to give a nose-up trim change. The normal limits of the tailplane travel are controlled by electrical limit switches.

3. 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 trim position. This applies even if the actuator has overrun the electrical stop and has reached the mechanical stop.

4. The tailplane position is shown on a trim indicator on the left side of the flight instrument panel.

5. Whenever an aircraft component which affects longitudinal trim is renewed or adjusted, the flight trim check specified in AP 101B-0407-1A, Section 3, Chapter 4, Appendix 1 is to be carried out.

Aileron Trim Control and Indicator

6. 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 handwheel in either direction. The required amount of spring loading is applied by an electrical actuator controlled by a switch labelled AILERON TRIM — L/off/R (spring-loaded to off), on the port console.

7. The aileron trim position indicator is on the left side of the flight instrument panel.

Rudder Trim Control and Indicator

8. 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 a pair of switches labelled

RUDDER TRIM—L/off/R (spring-loaded to off) on the port console. It is necessary to operate both switches together to obtain rudder trim movement.

9. The rudder trim position indicator is on the left side of the flight instrument panel.

Control Column Snatch Unit

10. To ensure adequate clearance for the pilot during ejection, a spring-operated snatch unit is connected to the control column to move it forward and hold it against the flight instrument panel. An explosive collar fitted to the elevator control tube is fired in conjunction with the operation of the snatch unit and severs the tube. Operating either of the seat firing handles detonates a cartridge in the control column snatch firing unit on the rear of the seat guide rail. Gas pressure from the cartridge releases the snatch unit sear and operates the detonator switch to explode the detonator in the elevator control tube severance unit. The tube is severed before the snatch unit is fully operated. The **CANOPY/SNATCH MASTER** switch on the take-off panel must be **ON** to make the system live.

11. The power supply to the severance unit detonator is taken from the main busbar. If the supply to the busbar from the generators or the aircraft battery fails for any reason, the detonator circuit is automatically connected to the emergency battery.

Flying Controls External Locking Gear and Picketing Points

12. *External Locks.* All control surfaces are locked by external clamps with red flags attached. When not in use the clamps are stowed in a canvas holdall in the rear fuselage, accessible through the rear hatch.

13. *Picketing.* Ring bolts are provided for picketing; they are stowed in the rear fuselage on the port side above the rear hatch. The bolts screw into sockets covered by flaps labelled **PICKETING POINT** on each main undercarriage leg-fairing and below the fuselage aft of the rear skid. A fourth picketing point is the nose undercarriage where a lashing is placed over the stay-link lugs on the leg. ▶

Undercarriage

14. *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 19).

15. *Normal Controls.* The selector switch unit, on the port front panel, controls an electrically-operated actuator for the up-down 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.

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

a. *Undercarriage MASTER Switch.* A guarded 2-position **LIVE/SAFE** switch is adjacent to the **UP** and **DOWN** buttons. At the **SAFE** position the power supply for operation of the selector valve and solenoid lock (see sub-para b. below) 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**.

b. *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, provided that the master switch is at **LIVE**, the solenoid is energised; 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 solenoid lock may be overridden by operation of the **UP** button override (see para 18).

c. *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.

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

17. *Undercarriage Position Indicator.*

a. A type D or D1 indicator on the port front

panel is operated by microswitches in the nose-wheel and mainwheel bays. The indications given are as follows:

- 3 green lights — Undercarriage locked down
- Any red light — Undercarriage unit unlocked
- No lights — Undercarriage locked up

b. 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 either throttle is less than one third open with the undercarriage in any position other than all three units locked down.

c. 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 indicator is in the ECP.

Undercarriage Malfunctions

18. *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 through 60° until it reaches a stop and then pressing in the UP button. The override should not normally be operated in the air, because if the undercarriage has been damaged subsequent lowering may be prejudiced.

19. *Emergency Lowering of the Undercarriage.* If the undercarriage fails to lower by the normal method the fault may be hydraulic, electrical or mechanical.

a. *Hydraulic Failure.* If hydraulic failure occurs, indicated by the main pressure gauge reading below 2200 PSI and failing to build up again, 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 (approx 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.

b. *Electrical Failure.*

(1) If no indicator red lights are showing, try to reselect undercarriage up again. 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 circuit fuse (52) in the ECP. Select the undercarriage master switch to SAFE, change the fuse and

reselect the master switch to LIVE. The undercarriage should now lower.

(2) If no indicator lights are showing and the UP button does depress or if the undercarriage still remains up after changing the control circuit fuse or if there are any red lights, then electrical failure of the selector valve is the probable cause of the malfunction. The 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.

c. *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 Part 1, Chapter 3, para 6); 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.

20. *Emergency Drill.* Full emergency drills for undercarriage malfunctions are given in the FRC.

Flaps Control and Indicator

21. The electrically-operated hydraulic selector valve for the flaps is controlled by a 2-position, fully UP or fully DOWN switch lever on the port front panel; the position indicator is adjacent to the switch lever. No provision is made for 'in flight' operation of the flaps in the event of electrical or hydraulic failure. At 6000 RPM the flaps should normally retract in about 16 seconds and lower fully in about 13 seconds.

Airbrakes Control

22. A 3-position IN/MID/OUT switch controlling the electrically-operated hydraulic selector valve and cock for the airbrakes is on top of the control column. The switch is fitted with a spring-loaded stop which must be moved to the left before OUT can be selected. No provision is made for operating the airbrakes in flight after electrical or hydraulic failure.

Wheelbrakes Control

23. The hydraulic wheelbrakes are operated by a lever on the control column. A parking catch is provided. Differential braking is obtained by movement of the rudder pedals. Anti-skid (Maxaret) units are fitted to give efficient braking (see Part 3, Chapter 3, para 13 to16).

24. The pressure in the brakes accumulator is shown on a gauge on the miscellaneous instrument panel; normal pressure is 2200 to 2700 PSI. If the hydraulic system has failed, pressure will fall to 1400 PSI as the brakes are used. At this point the accumulator is fully discharged of hydraulic fluid

and the pressure drops rapidly to zero. Pressure may, however, be restored by means of the hydraulic handpump, provided that fluid is available.

25. If a leak occurs in the wheelbrakes system while taxiing (indicated by a loss of pressure on the brake and hydraulic pressure gauges), 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.

Flare Bay Doors Control

26. See Part 1, Chapter 12, para 8 and 9.

PART 1

CHAPTER 6 — FLIGHT INSTRUMENTS

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Compasses

1. *Mk 4B Compass.* The Mk 4B compass is operated 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 pilot's gyro unit is on the flight instrument panel; it may be used as a directional gyro by setting the COMP/D-GYRO switch on the engine starter panel to D-GYRO. On some aircraft a compass repeater is also fitted at the nose station; this requires synchronising with the pilot's or navigator's indicator before use, a special key is required.

2. *Magnetic Standby Compass.* An E2B standby compass is on the left of the pilot's coaming panel.

Pitot and Static Pressure Systems

3. 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)
- Pilot's ASI (P and S)
- Navigator's ASI (P and S)
- VSI (S)
- Pilot's altimeter (S)
- Air mileage unit (P and S)

The heater element in the pressure head is controlled by the PRESSURE HEAD — ON/OFF switch on the take-off panel.

b. The aft hole of each static vent plate on the nose 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 navigator's Mk 30B altimeter.

Horizon Gyro Unit (HGU)

4. A Mk 4A or Mk 4D horizon gyro unit 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 is operated by an AC supply from 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.

Zero Reader System

5. A zero reader system is installed and is supplied with DC when the battery master switch is ON. AC supplied to the system by No 1 inverter.

6. The indicator is on the top right-hand side of the flight instrument panel and the combined heading selector and control unit is on the bottom right-hand side of the panel.

Turn-and-Slip Indicator

7. 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 instrument, the instrument can be connected to the emergency battery (see Chapter 1, para 8) by selecting the TURN & SLIP switch, on the far right of the coaming panel, to STANDBY. The OFF flag should disappear within 5 seconds. If, when checked on the ground, the time exceeds 10 seconds, the emergency batteries may require recharging; they should be replaced and a further check carried out.

Outside Air Temperature Gauge

8. 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.

Altimeters

9. Navigator's Altimeter.

a. A Mk 30B altimeter is on the navigator's instrument panel. The altimeter is the master instrument of the automatic height encoding system; it 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 (see Chapter 1, para 5 and 29).

b. 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. 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.

c. 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.

instrument panel. The altimeter is servo operated by electrical outputs from the navigator's Mk 30B altimeter with reversion to pressure capsule operation either by selection or automatically after power or other failure.

b. 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.

c. A standby/reset knob marked S \leftrightarrow 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.

d. *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 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 30B altimeter; reselect 'R' and check that the flag clears

(4) *Descent/Recovery.* At the top of the descent for recovery, select the altimeter to 'S' and check that the flag shows STBY.

10. Pilot's Altimeter.

a. A Mk 29B altimeter is on the pilot's flight

Accelerometer

11. An accelerometer is on the left-hand side of the

pilot's coaming panel. It covers the range minus 5g to plus 10g and has three pointers. One pointer indicates instantaneous accelerations; the other two record maximum plus and minus readings, until reset by the PUSH TO SET knob.

Air Mileage Unit (AMU)

12. The AMU is in the port wheelwell. The control panel and air mileage indicator are on the lower left of the navigator's instrument panel.

◀ 13. Stopwatch

When SEM/059/STC is embodied, a 24 hour Monte Carlo stopwatch is fitted on the blast shield to the left of the E2B compass. Elapsed time is indicated by a thin seconds hand, a minutes hand (arrow headed) and an hour disc (0 to 12) which is visible through a window in the bottom of the dial. A wind/start/stop button is at the top of the housing with a pushbutton to the right side which is used, after stopping the watch, to zero the hands and the hour disc. ▶

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PART 1

CHAPTER 7 — GENERAL EQUIPMENT AND CONTROLS

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Engine Fire Protection

1. *Engine Fire Detection.* Fifteen, resetting, fire-detector switches are 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.

2. *Engine Bay Fire Extinguishers.* Four fire-extinguisher bottles are fitted, two in the port wheelwell serving the port engine bay and two in the starboard wheelwell serving the starboard engine bay. Each bottle is fully discharged in one operation. Two of the extinguishers (one each side) are fitted with dual operating heads so that they can also serve the fuselage fuel tank compartment in crash landing conditions (see para 5).

3. *Engine Fire Warning Lights and Pushbuttons.* Fire extinguisher pushbuttons incorporating fire warning lights, one for each engine are on the pilot's coaming panel. A separate ENGINE FIRE WARNING TEST pushbutton for testing the warning lights is immediately above the two pushbuttons.

4. *Engine Fire Extinguisher Operation.* A warning light comes on when heat from a fire in the engine bay trips one or more of the fire detectors in that bay; pressing the appropriate button fully discharges both fire extinguishers into the affected engine bay. When the fire is extinguished the warning light goes out.

Fuselage Fire Protection

5. A fire extinguisher bottle is on the rear face of

the fuselage frame immediately aft of the rear tank. It is discharged into the fuel tank compartment and flare bay if the inertia crash switches are tripped. This is the only method of operation for this extinguisher. Part of the contents of the dual-headed engine bay fire extinguishers is also discharged into the fuel tank compartment and flare bay when the inertia crash switches are tripped.

Inertia Crash Switches — Operation

6. For operation of the inertia crash switches, see Part 1, Chapter 1, para 10.

Hand-Operated Fire Extinguishers

7. Two bromochlorodifluoromethane (BCF) hand-operated fire extinguishers are provided; one is stowed on the starboard wall aft of the entrance door and the other is stowed on the port wall below the navigator's side window. BCF is non-conducting and virtually non-toxic. It may be used on all classes of fire 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.

Emergency Equipment

8. An axe, asbestos gloves and first-aid kit are on the starboard wall aft of the entrance door. Two survival pack stowage crates are in the rear fuselage. Access to them is through the rear hatch or, in emergency, by chopping through the fuselage at the points indicated.

Entrance Door

9. The entrance door is on the starboard side of the front fuselage. 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 Part 1, Chapter 10, para 9 — 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 frame.

Cabin Windows

10. Small windows are provided; one in the cabin port wall and two in the navigator's escape hatch. A black-out curtain is provided for each window; the curtains may be rolled-up and secured with straps when not in use.

Folding Seat

11. A folding seat is secured to the starboard wall, immediately aft of the entrance door, by a hinged bracket which allows the seat to be folded against the wall where it is secured by a strap. A webbing back-rest and a safety harness for use with the seat are also provided. The lap straps are secured to the seat and the shoulder straps are secured to the fuselage top cross-member. The seat is not stressed for a crash landing.

External Lighting

12. All external lighting circuits are protected by the PILOTS SERVICES circuit breaker on the rear face of the ECP.

13. All the external lighting switches are on the pilot's port console. They are, from the left:

- a. NAV'G LIGHTS — ON/OFF
- b. TAX'G LIGHTS — ON/OFF
- c. LANDING LIGHT — HIGH/LOW/OFF
- d. EXT LTS MASTER — ON/OFF. This must be ON before any of the external lights can function
- e. IDENTIFICATION MORSE — ON/OFF (spring-loaded to OFF)
- f. IDENTIFICATION STEADY — ON/OFF
- g. ANTI-COLL LIGHTS — ON/OFF/UPPER

14. The taxiing lamps are fitted one in each wing tip. The landing lamp is in the port mainplane undersurface; it is spring-loaded and at speeds above 175 knots, the air pressure will force it to retract. The downward identification light is in the fuselage undersurface just aft of the rear hatch. The white

flashing anti-collision lights are fitted one above and one below the rear fuselage. The UPPER position of the control switch is provided to allow the upper light only to be on when photography is in progress. If the flasher unit fails, the lights will remain on and steady until switched off.

Internal Lighting

15. Cockpit Lighting

a. *Instrument Panels.* The normal lighting for the pilot's instrument panels is by pillar lamps disposed locally around the instruments. The lamps are controlled by four dimmer switches grouped on the coaming panel. Each switch is associated with the lamps on a particular panel and identified accordingly:

COAMING, MISC INST, INST PANEL,
ENGINE INST

b. *Console Lighting.* Four red floodlamps illuminate the port console and oxygen regulator, and two red floodlamps illuminate the take-off panel, engine control quadrant and port front panel. They are respectively controlled by two dimmer switches, on a panel above the aft end of the console, one is labelled CONSOLE LIGHTS and the other PANEL LIGHTS.

c. *Frequency Card Lighting.* Two red floodlamps are above the frequency card holder on the port side of the canopy coaming. A FREQUENCY CARD LIGHTS — ON/OFF switch, between the console dimmer switches, controls the lights in conjunction with the PANEL LIGHTS dimmer switch.

d. *Anti-dazzle Lamps.* Two anti-dazzle lamps are fitted, one on each side of the coaming, to illuminate the pilot's instrument panels. They are controlled by an ANTI-DAZZLE — BRIGHT/off/DIM switch with a pyramid-shaped dolly on the coaming panel, and by an ANTI-DAZZLE LIGHTS — OFF/BRIGHT switch on the navigator's instrument panel. Selecting BRIGHT on the navigator's switch overrides any setting of the pilot's switch. Owing to the short filament life of the lamps, they should only be used when operationally necessary.

e. *Emergency Lighting.* Illumination of the pilot's main instrument panel in an emergency is provided by two lamps fitted below the coaming. They are controlled by the COMP & EMGY LGTS — NORMAL/STANDBY switch on the coaming panel. The switch also acts as a normal/standby supply changeover switch for the E2B compass lamp. With the switch at STANDBY, the emergency lights are on and the standby supply is connected to the E2B compass lamp. (See Part 1, Chapter 1, para 8.)

16. *Cabin Lighting*

a. *General Illumination.* General illumination of the navigator's cabin is provided by a dome lamp with an integral switch and 2-pin socket above the table, and two angle-poise lamps, one on the starboard wall with an adjacent dimmer switch and the other above the instrument panel with its dimmer switch next to the dome lamp.

b. *Instrument Panel and Control Units.* Illumination of the navigator's instrument panel is provided by a combination of red pillar and bridge lamps and one red floodlamp; all these lamps and the integral lamps of the DME indicator are controlled by the PANEL LIGHTS dimmer switch on the left-hand side of the panel. The integral lighting of the VOR, DME and V/UHF control units is controlled by the CU LIGHTS dimmer switch, which is adjacent to the panel lights dimmer switch.

c. *ECP Lighting.* Illumination of the rear face of the ECP is provided by a red floodlamp which is controlled by the ECP LIGHT — ON/OFF switch, on the left-hand side of the instrument

panel, in conjunction with the adjacent CU LIGHTS dimmer switch.

17. *Nose Station.* General lighting at the nose prone position is provided by a dome lamp and an angle-poise lamp, both on the roof, the dimmer switch for the angle-poise lamp is on the frame on the port side. Additional lighting is provided by two white floodlamps, one on either side of the nose; they are controlled by a dimmer switch on the port side of the floor channel.

18. *Servicing Lamps.* Seven dome lamps are fitted for servicing operations, as follows: one in the starboard equipment bay, two in the forward camera bay, two in the flare bay, one in the centre and one in the rear camera bay. The power supply to the lamps is fed via the third (small) pin on the aircraft external power plug and is only available when a ground supply socket is inserted.

19. *Inspection Lamp.* An inspection lamp and an extension lead, which can be plugged into the 2-pin socket of a dome lamp, are stowed in two bags aft of the entrance door on the cabin starboard wall.

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PART 1

CHAPTER 8 — AIR CONDITIONING, PRESSURISING
AND DEMISTING SYSTEMS

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Air Conditioning System

1. Hot air from the engine compressors is used for cabin air conditioning. The initial supply from each compressor is through an electrically-operated gate-valve controlled by one of two ENGINE AIR TO CABIN — on (up)/off switches on the miscellaneous instrument panel.

2. 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, below the control switch.

3. 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.

4. Conditioned air from the system is passed into the cabin via four louvres, which may be shut off, and four diffusers. One louvre is on the rudder pedal guard, the second on the port front panel, the third above the entrance door and the fourth on the port wall adjacent to the navigator's instrument panel. A diffuser is forward of each crew member's feet and of the remaining two, one is just aft of the pilot on the cockpit port wall and the other at the inboard edge of the navigator's instrument panel. The

diffusers cannot be shut off but the flow of the latter two is controllable by rotating the diffuser head.

5. A supply of ventilating air is provided via a small air scoop, on the fuselage, immediately forward of the canopy and ducted to a louvre on the inboard side of the port front panel; the supply may be controlled at the louvre. The system incorporates a simple non-return valve to prevent loss of cabin pressure.

Pressurising System

6. At about 10,000 feet a pressure controller and a combined valve unit (which regulates the outlet of air from the cabin according to static pressure) work in conjunction to allow the air-conditioning system to 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 the altimeter on the miscellaneous instrument panel.

7. Electrical contacts in the pressure controller operate a warning horn if the cabin pressure falls excessively. A CABIN PRESS WARNING HORN — ON/OFF/TEST switch (spring-loaded to OFF from TEST) is on the miscellaneous instrument panel. The switch must be ON during flight; it also provides a means of switching off and testing the horn.

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

Use of Air Conditioning and Pressurising Systems

8. *Pre-Starting Checks.* With the engine air switches off, check the operation of the mixing valve over its full range against the indicator, leaving it set to HOT.

9. *Checks After Starting Engines.* Switch on the engine air switches and set the mixing valve as required, but see para 10 below.

10. *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 while taxiing. In the air there is no restriction in the use of the mixing valve.

11. *Use of Engine Air Switches in Flight.* In flight always keep the engine air switches ON so that air-conditioning and pressurising is obtained. If an engine fails or is shut down, switch OFF its engine air switch.

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

Malfunctioning of the Pressurising System

13. *Loss of Cabin Pressure.* A fall in cabin pressure causes the warning horn to sound; this can be isolated by selecting the switch to OFF (see para 7). The following table gives the approximate operating ranges of the warning horn.

<i>Aircraft Altitude (feet)</i>	<i>Cabin Altitude (feet)</i>	<i>Cabin Altitude (feet) at Which Warning Horn Sounds</i>
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.

14. *Pressurisation Failure Above 40,000 feet.* If pressurisation failure occurs above 40,000 feet, altitude must be reduced to the lowest practicable, and in any case to below 25,000 feet to avoid the effect of decompression sickness. When below 40,000 feet the engine air switches should be switched 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.

Camera Bay Heating

15. Hot air from the air-conditioning system is ducted to diffusers in the camera bays through an automatically-operated temperature control valve. The heating system also prevents misting of the camera windows.

Demisting Systems

16. *Transparency Interspace Air-Driers.*

a. *General.* The pilot's canopy, navigator's side window, nose fairing and nose observation window are of the sandwich type and are provided with dry air demisting. There are two separate systems, one serves the pilot's canopy and navigator's side window; the other serves the nose fairing and nose observation window. Each system comprises a static air-drier, a circulating air-drier, an electrically-driven blower and a filter.

b. *Static Air-Driers.* The pilot's canopy static air-drier is on the starboard side of the canopy coaming cross-tube and is connected to the inner sheet of the canopy. The nose fairing static air-drier is on the port side of the nose and is connected to the port side of the inner sheet of the nose fairing.

c. *Pilot's Canopy Circulating Air-Drier.* The circulating air-drier is on the port side of the canopy coaming tube. Its inlet is connected to the port side of the inner sheet of the canopy and to the navigator's side window; its outlet is connected to the blower inlet. The blower, located below the drier, draws air from the canopy and side window interspaces, through the drier and returns the air via the filter, located in the roof of the nose, to the canopy interspace, at the front; there is no feedback to the side window. The blower is controlled by the CANOPY DEMIST — ON/OFF switch on the take-off panel.

d. *Nose Fairing Circulating Air System.* The circulating air-drier, blower and filter are located in the nose, under the floor. The blower draws air through the starboard connection on the nose

- ◀ fairing and a connection on the observation window, through the drier and returns the air, via the filter, to the fairing interspace through the port connection; there is no feedback to the observation window. The blower is controlled by ▶ the NOSE DEMIST — ON/OFF switch on the take-off panel.

17. *Internal Surface Demisting System.*

- a. *Canopy.* Hot air from the air-conditioning system is fed through a control valve and a diffuser on to the forward inner surface of the canopy. The flow through the control valve can be regulated by means of the DEMIST-ON knob above the take-off panel. This system should be used only during descent from high altitude.
- b. *Nose Fairing.* Conditioned air from the air-conditioning system is automatically fed, through a diffuser, onto the lower inner surface of the nose fairing.

Direct Vision (DV) Panel

18. An electrically-heated DV panel is in the canopy on the port front side; the heater switch labelled WINDSCREEN — ON/OFF is on the take-off panel. When the cabin is unpressurised, the DV panel can be opened by unscrewing the knurled knob and hinging the frame downwards to engage in the retaining clip. Rain entering the cabin through the DV panel can cause 'cycling' of the flare bay doors in flight. Opening of the panel to relieve cabin pressure after landing should, therefore, be restricted in wet weather to a small angle and the panel should then be closed again. The power supply to the heater element is DC; the control unit is operated by AC supplied from No 1 or No 2 inverter.

Use of the Demisting System

19. Check the operation of the canopy and nose fairing demister blowers during the **After Strapping-In Checks**. There is no restriction on the use of the circulation systems.

20. Close the DV panel and switch ON its heater before take-off; in flight keep the panel closed at altitudes where pressurisation is obtained. After landing switch off the heater and open the panel (refer to para 18).

21. The canopy internal surface demisting system must not be used on the climb. To obtain maximum efficiency from this system, start demisting 10 minutes before the descent. The system should not be on at any other time than that required for the descent.

Air Ventilated Suit System

22. On some aircraft an air ventilated suit system is fitted to provide a continuous supply of cooled air to special crew suits. The supply is taken from the air-conditioning system, between the primary cooler and the mixing valve, to a control valve and quick-release socket at each crew station. The control valve and socket for the pilot are at the top of the forward face of the ECP and the navigator's are on the bulkhead to the right of his seat and on the right-hand side of his nose station.

23. When the aircraft is stationary an air supply can be provided to the crew stations through a breakaway charging connection on the port side of the fuselage. When the ground supply is disconnected, the connection is automatically sealed.

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PART 1

CHAPTER 9 — OXYGEN SYSTEM

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Oxygen System Simplified	Fig 1

DESCRIPTION

Oxygen Supplies and Contents Gauges

1. Oxygen is carried in one 2250 litre and six 750 litre cylinders in the upper equipment bay. An additional 2250 litre cylinder may be carried in the forward camera bay. A charging valve on the forward bulkhead of the forward camera bay, allows the cylinders to be charged in situ. In some aircraft the charging valve is in the starboard equipment bay. The cylinders are connected in two banks, each bank having a separate supply line (see Fig 1). When fitted, the additional 2250 litre cylinder is connected into the bank of four 750 litre cylinders. The supply lines pass through the pressure bulkhead to stop valves (normally wire-locked on), one on the port wall at the navigator's rear station and the other on the forward face of the pressure bulkhead, starboard side. From the stop valves the lines pass forward and are interconnected at two points, via non-return valves. This arrangement allows each bank of cylinders to supply all the regulators independently and safeguards against the total loss of oxygen due to the fracture of one supply line. From the two interconnecting points the supplies pass via filters to pressure reducing valves, which incorporate 450 to 500 PSI safety relief valves, and thence to the regulators. One line supplies the regulators at the pilot's station and the navigator's station in the nose;

the other line supplies the regulator at the navigator's rear station. Two gauges on the miscellaneous instrument panel indicate the contents in each bank of cylinders.

Oxygen Regulators and Supply Points

2. The supply of oxygen to the crew supply points is controlled by Mk 17F regulators. The pilot's regulator is on the cockpit port wall, and of the navigator's two, one is above the instrument panel at his rear station and the other is on the starboard wall at his nose station.

3. Each regulator incorporates:

- a. A regulator pressure gauge (normal pressure 200 to 400 PSI).
- b. An ON/OFF valve, normally wire-locked ON.
- c. An oxygen flow magnetic indicator (MI) which shows a vertical white line when the user inhales.
- d. A NORMAL/100% OXYGEN air-inlet shutter control.
- e. An emergency 3-position button. Moving the button to left or right gives a safety pressure below an altitude of 12,000 feet 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.

4. Five remote oxygen flow MI are provided, one (for the pilot) on the flight instrument panel, two (for the navigator's nose and rear stations) on the miscellaneous instrument panel and two (for the pilot and navigator) on the navigator's instrument panel.

5. A supply tube from the pilot's regulator and the navigator's rear station regulator terminates at a connector on the floor to the right of the respective ejection seat. The connector incorporates a break point to which a flexible tube is connected so that it will disengage when the seat is ejected. The other end of the flexible tube has a quick-release socket for connecting the oxygen mask tube.

6. A supply tube from the regulator at the nose station is connected to a flexible tube which terminates in a quick-release socket. The tube passes aft and the end is stowed in a clip on the roof at the navigator's rear station. This enables the navigator to change over supplies when preparing to move to his nose station.

Oxygen Emergency Supplies

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

8. A safety pin in the head of each emergency oxygen cylinder must be removed before flight.

9. The emergency oxygen cylinder is operated automatically when ejection takes place; no emergency oxygen is available after the occupant separates from the seat.

Associated Equipment

10. Pressure demand oxygen masks must be worn.

NORMAL OPERATION

Checks Before Flight

11. Ensure that the contents gauges show sufficient oxygen for the flight. Connect the mask tube to the main and emergency oxygen supply tubes.

12. On each regulator check:
ON/OFF switch ON and wired
Air-inlet control at NORMAL
Pressure 200 to 400 PSI
MI functioning correctly
(Check remote MI also)

13. To test the regulator and check the face mask for leaks:

a. Put the toggle on the mask harness to the down position and press, fully in, the EMERGENCY-PRESS TO TEST MASK button on the regulator. During this test the breath should be held and an increased pressure should be felt in the mask; if there are no leaks the flow MI should remain black. If leaks are felt or the MI shows white, the mask harness should be tightened by the adjusting screws on either side until a satisfactory seal is made.

b. 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.

c. All three regulators must be checked as above and the remote oxygen flow MI must also be checked for correct operation.

During Flight

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

MALFUNCTION

General

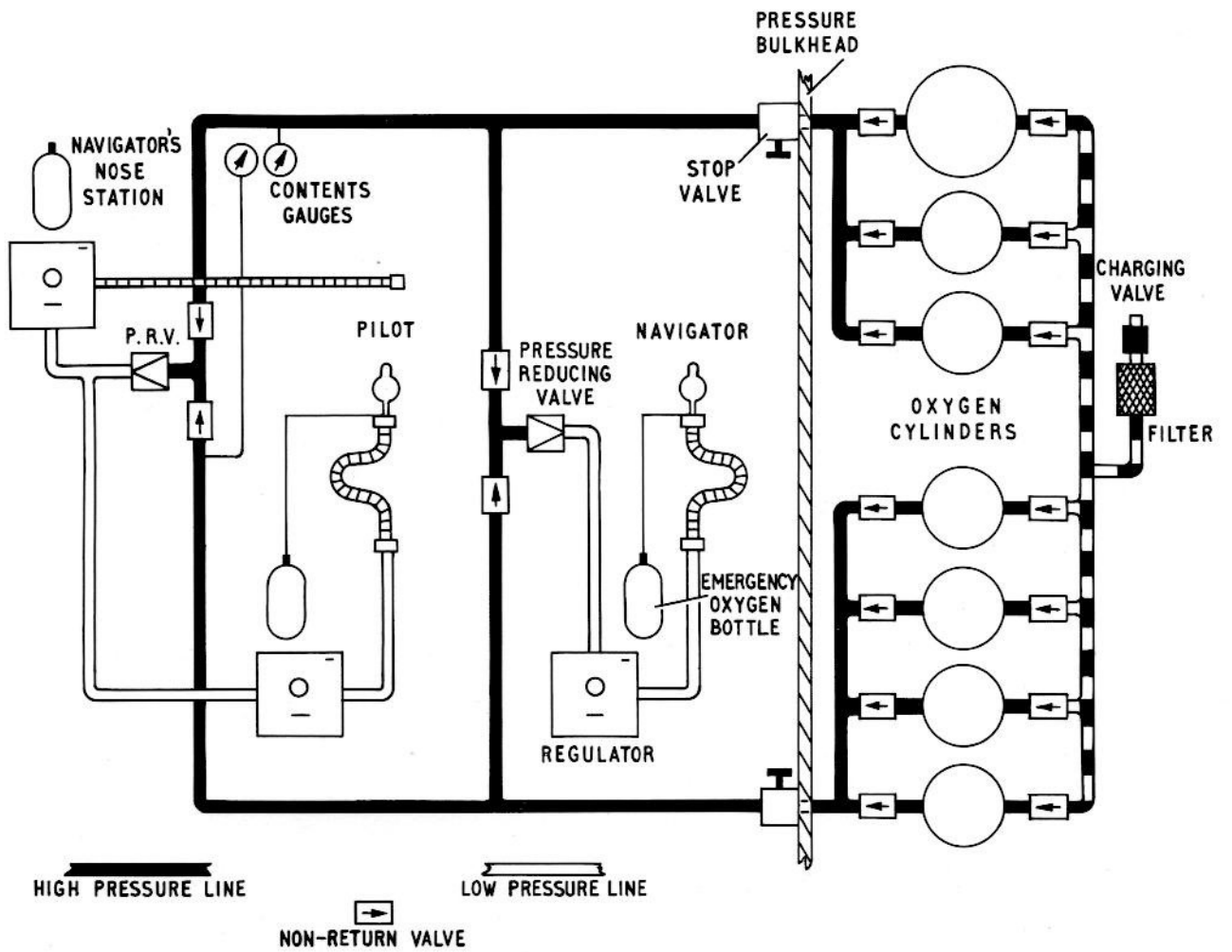
15. Drills for oxygen failure, regulator flow MI failure, and toxic fumes in the cabin are given in the FRC.

Loss of Cabin Pressure

16. 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.

Partial System Failure

17. 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 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. With the air inlet at NORMAL a change of altitude has little effect on the rate of 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.



1-9 Fig 1 Oxygen System Simplified

PART 1

CHAPTER 10 — ESCAPE SYSTEMS AND EJECTION SEATS

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General

1. Both crew members have ejection seats. The pilot normally ejects through the canopy, the control column snatch unit being operated automatically. The navigator's hatch is jettisoned automatically before he ejects. Facilities are provided to jettison the navigator's hatch independently of his ejection system, and the pilot's canopy.

ESCAPE SYSTEMS**Location of Controls**

2. a. CANOPY/
SNATCH
MASTER —
ON/OFF switch
- On the take-off panel. Protected by a guard painted with black/yellow stripes.

- b. **CANOPY JETTISON** — ON/OFF switch Under a spring-loaded black/yellow striped flap on the port console. The flap will only lie flush when the switch is off.
- c. **HATCH SAFETY** — ON/off switch
HATCH JETTISON — ON/off switch Both switches are on a black/yellow striped switch unit, marked DANGER DETONATORS, on the cabin port wall. The SAFETY switch is protected by a guard. The JETTISON switch is covered by a spring-loaded flap which will only lie flush when the switch is off.

Control Column Snatch Unit

3. The control column snatch unit operates automatically when the pilot pulls either firing handle on his ejection seat, provided that the CANOPY/SNATCH MASTER switch is ON. The unit is described in Chapter 5, para 10.

Pilot's Canopy

4. The canopy is secured to the fuselage by bolts containing detonators which are fired electrically when it is to be jettisoned. The pilot normally ejects through the canopy but if at any time it becomes necessary to jettison it, the detonators are fired by switching ON the CANOPY JETTISON switch, provided that the CANOPY/SNATCH MASTER switch is ON.

Navigator's Hatch

5. A jettisonable metal roof hatch over the navigator's station affords an emergency exit. The hatch is secured to the fuselage by bolts containing detonators which are fired electrically when the hatch is to be jettisoned. The hatch may be jettisoned in conjunction with or independently of the navigator's ejection system, as follows:

a. *Independent Jettison.* To jettison the hatch independently of the ejection system, ensure that the HATCH SAFETY switch is ON and then switch ON the HATCH JETTISON switch. As the hatch jettisons it withdraws the safety pin from the restrictor on the breech time-delay unit (BTDU) in the ejection gun (see para 25); the seat can then be fired if necessary. ▶

b. *Jettisoning the Hatch in Conjunction With the Ejection System.* Provided that the HATCH SAFETY switch is ON, the hatch is automatically jettisoned when the navigator operates either firing handle on his ejection seat. (See para 25.)

Minimum Speed for Jettisoning the Canopy or Hatch

6. When jettisoned, the canopy or the hatch comes away cleanly at speeds down to 90 knots. However, at speeds below 150 knots either may strike the tail assembly. If, therefore, it is not intended to abandon the aircraft, keep speed above 150 knots while jettisoning the canopy or hatch.

Power Supplies to the Detonator Circuits

7. The normal power supplies for operating the detonator circuits are taken from the main busbar. If the supply to the busbar from the generators or aircraft battery fails for any reason, the circuits are automatically supplied from the emergency battery. The supply to the elevator control severance unit and canopy jettison circuits is routed through the CANOPY/SNATCH MASTER switch and the supply to the hatch jettison circuit is routed through the HATCH SAFETY switch.

8. 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.

Jettisoning the Entrance Door

9. The entrance door is 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.

EJECTION SEATS

General

10. A Type 2CA1 Mk 2 ejection seat is provided for the pilot and a Type 2CA2 Mk 4 seat for the navigator. Both types are similar.

11. The seats have a ground-level ejection capability in straight and level flight at speeds above 90 knots. Fully automatic facilities are provided to release the safety harness and leg-restraint lines after ejection, separate the occupant from the seat and open the parachute at a safe speed and altitude.

Associated Aircrew Equipment

12. The associated aircrew equipment consists of the following items:

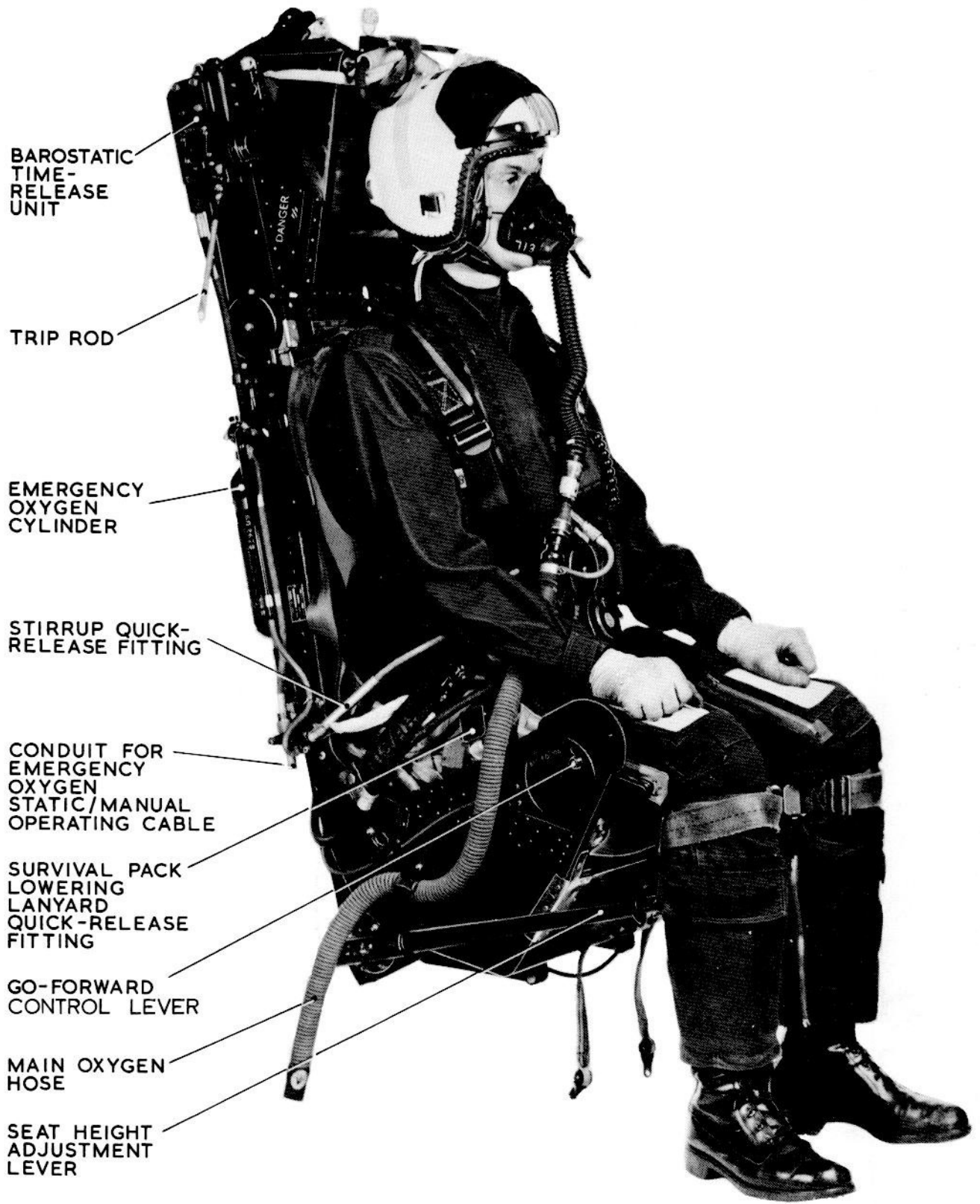
- Seat type parachute assembly with harness
- Separate safety harness with negative-g restraint strap
- Personal survival pack
- Emergency oxygen set.



- BAROSTATIC TIME-RELEASE UNIT
- TRIP ROD
- EMERGENCY OXYGEN CYLINDER
- STIRRUP QUICK-RELEASE FITTING
- CONDUIT FOR EMERGENCY OXYGEN STATIC/MANUAL OPERATING CABLE
- SURVIVAL PACK LOWERING LANYARD QUICK-RELEASE FITTING
- GO-FORWARD CONTROL LEVER
- MAIN OXYGEN HOSE
- SEAT HEIGHT ADJUSTMENT LEVER

- FACE SCREEN FIRING HANDLE SAFETY PIN
- FACE SCREEN FIRING HANDLE
- DROGUE GUN
- MIC/TEL LEAD
- MANUAL DISCONNECT HANDLE
- PARACHUTE RIPCORD HANDLE
- PARACHUTE HARNESS QUICK-RELEASE FITTING
- SAFETY HARNESS QUICK-RELEASE FITTING
- NEGATIVE-G RESTRAINT STRAP
- SEAT PAN FIRING HANDLE
- LEG-RESTRAINT LINES
- SEAT PAN FIRING HANDLE SAFETY PIN
- LEG-RESTRAINT LINE SNUBBING UNIT
- FLOOR ANCHORAGE BRACKETS WITH SHEAR RIVETS

1 - 10 Fig 1 Ejection Seat Type 2CA Series
(Terminology Updated)



BAROSTATIC
TIME-
RELEASE
UNIT

TRIP ROD

EMERGENCY
OXYGEN
CYLINDER

STIRRUP QUICK-
RELEASE FITTING

CONDUIT FOR
EMERGENCY
OXYGEN
STATIC/MANUAL
OPERATING CABLE

SURVIVAL PACK
LOWERING
LANYARD
QUICK-RELEASE
FITTING

GO-FORWARD
CONTROL LEVER

MAIN OXYGEN
HOSE

SEAT HEIGHT
ADJUSTMENT
LEVER

1 - 10 Fig 1 Ejection Seat
◀ (Terminology Up)



Ejection Seat Type 2CA Series
(Terminology Updated) ▶

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Ejection Seat and Escape System Safety Pins and Stowages

13. Safety pins with integral red labels are provided for rendering safe the seat and escape system. Stowages are provided for the pins as follows:

Pilot's Station

Face screen or gun seat	} On the canopy coaming tube above the entrance door (four pins)
Seat pan firing	
Canopy jettison*	
Time delay lever — canopy jettison*	

Navigator's Station

Face screen or gun seat	} On the port wall aft of the window (two pins)
Seat pan firing	

*Note: Although the labels on these pins bear the words 'canopy jettison', they are not associated with the canopy jettison system. They are used, during servicing, in the control column snatch firing unit seat and the time-delay trip lever respectively.

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

Controls on the Seat

15. *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.

16. *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 snubbing unit to permit the line to be slid against the snubbing 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 seat occupant and are finally looped around the shoulder strap lugs of the safety harness; the lines are released whenever the safety harness is undone.

17. *Go-Forward Control Lever.* A spring-loaded go-forward control lever on the starboard thigh-guard releases the safety harness shoulder straps permitting the seat 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 reeled in and locked in the position reached.

18. *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 and 25). 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 crew member moves into or out of the seat.

Parachute Manual Controls

19. 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.

20. 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.

Single Lever Ejection System — Pilot's Seat

21. The CANOPY/SNATCH MASTER switch must be ON before the pilot ejects.

22. A combined control column snatch and time-delay firing unit is on the rear of the seat guide rail. The snatch firing unit fires a cartridge to force gas under pressure through a small pipe to operate the control column snatch unit and elevator control tube explosive collar detonator (see Chapter 5, para 10). The time-delay mechanism delays the firing of the ejection gun for approximately one second after the operation of the snatch firing unit.

23. Both firing handles are connected by cables to the snatch firing unit seat and to the time-delay mechanism. Operation of a firing handle withdraws the seat from the snatch firing unit, thus actuating the snatch unit; at the same time the cable operates the time-delay mechanism which withdraws the ejection gun seat, after a delay of one second, and the ejection gun fires immediately.

Single Lever Ejection System — Navigator's Seat

24. The navigator's ejection sequence cannot be initiated unless the HATCH SAFETY switch is ON

or the hatch has been jettisoned independently of the ejection system (see para 5 a).

25. 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 rear 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.

26. The hatch jettisoning mechanism is inoperative until it has been mechanically cocked by means of a cocking lever, normally stowed on the aft 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.

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

NORMAL PROCEDURES

Safe for Parking, and Ejection Seat Checks

28. These are given in the FRC.

Strapping-In Procedure

29. a. Ensure that the seat is **Safe for Parking** and carry out the **Ejection Seat Checks**.

b. 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 leg-restraint lines at a later stage of the 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.

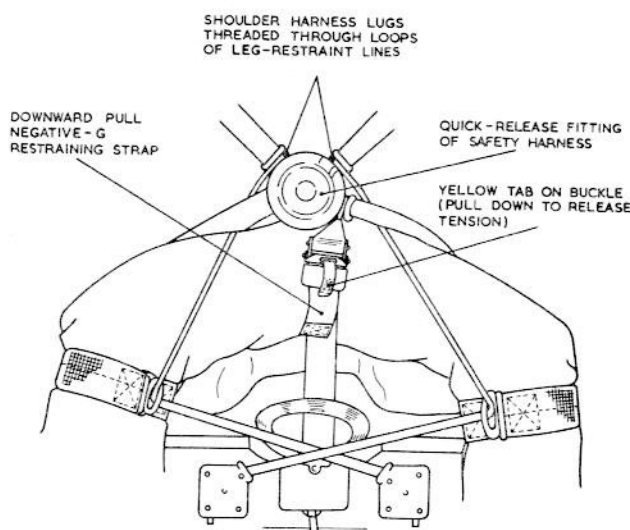
c. Connect the personal survival pack lanyard to the lifepreserver quick-release connection so that

the lanyard lies between the thigh and the thigh guard.

d. 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.

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

f. Adjust the shoulder straps so that the parachute QRF lies clear of and above the safety harness QRF when this is assembled. Tighten the parachute harness leg straps.



1-10 Fig 2 Arrangement of Negative-G Restraint Strap and Leg-Restraint Lines

(Terminology Amended)

g. 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.

h. Ensure that the loop of the right leg-restraint line is passed through the D-ring on the left garter

and threaded under the left-hand side of the safety harness lap strap. Pass the lug of the left shoulder strap of the safety harness through the loop in the end of the restraint line and insert the lug into the safety harness QRF.

i. Proceed similarly for the left leg-restraint line.

j. To adjust the working length of a 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 (it is unnecessary to press the plunger in this instance).

k. 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 re-tighten 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.

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

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

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

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

p. Connect the oxygen mask tube locating chain to the D-ring on the lifepreserver.

q. Check that the face screen handle can be reached with both hands together.

r. Ensure that the safety pins are removed and stowed before flight.

Normal Exit from the Seat

30. a. Make the seat **Safe for Parking**.

b. Disconnect the main and emergency oxygen supply pipes 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 leg-restraint lines and negative-g strap.

f. Leave the seat.

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

ESCAPE PROCEDURES

General

31. If time permits, simultaneous or near simultaneous ejections should be avoided.

Pilot's Abandoning Drill

32. The pilot ejects through the canopy. If ejection is attempted with the CANOPY/SNATCH MASTER switch off, the control column snatch unit will not operate and severe injury may result. The **Abandoning Drills** are given in the FRC.

33. 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 seat has left the aircraft.

Navigator's Abandoning Drill

34. The escape system cannot be initiated unless the HATCH SAFETY switch is ON. The hatch is automatically jettisoned when the ejection seat is operated. The ejection gun fires 0.5 second after the hatch has jettisoned. The **Abandoning Drills** are given in the FRC.

35. If the hatch does not jettison when the navigator operates his seat, proceed as follows:

a. Check that the HATCH SAFETY switch is ON, switch ON the HATCH JETTISON switch, the hatch should jettison.

b. Re-pull the seat firing handle, the seat should then fire 0.5 second later.

Note: If an aircraft is force landed after attempts by the navigator to eject have failed and the hatch is subsequently removed, the seat will not automatically fire on removal of the hatch.

36. If the hatch is jettisoned independently of the ejection system, and ejection subsequently becomes necessary, the seat fires 0.5 second after the operation of the firing handle.

Sequence on Ejection

37. After the ejection gun fires, the following sequence of events occurs for the navigator and the pilot:

RESTRICTED

- a. As the seat ascends the guide rail:
The drogue gun is armed.
The leg-restraint lines tighten, drawing the occupant's 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 1.5 seconds the safety harness is released and the scissors shackle opens, leaving the drogue to parachute attachment 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 1.5 seconds after ejecting, subject to the over-

riding 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 of a BTRU is marked on the unit.

Failure of the Automatic Systems

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

Passenger's Abandoning Drill

39. If it becomes necessary to abandon the aircraft when carrying a passenger on the occasional seat, raise the undercarriage and flaps, if possible, and reduce speed to below 160 knots, converting excess speed into height if at low level. Provided that the aircraft is not descending, 1000 feet AGL should be considered the minimum height for attempting an escape via the entrance door, although in ideal circumstances, successful escape may be possible as low as 250 feet AGL. The recommended **Passenger's Abandoning Drill** is given in the FRC.

PART 1

CHAPTER 11—RADIO AND RADAR EQUIPMENT

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RADIO

Communications Control System

1. *General.* The communication control system (ARI 18089) provides intercom facilities through an A1961 amplifier and also a means of selecting and mixing the aircraft radio communication services and audio signals from the navigational aids.

2. *Station Boxes—Type 7681.* Selection of the facilities is made at station boxes, one on the pilot's port console and another on the port wall at the navigator's station. Each box has the following controls and components on the front panel:

a. *Four LISTEN ONLY — ON/OFF Switches.* These provide a mixing service for listening only, at fixed volume, and are labelled: VOR, DME, ◀ TACAN (post-SRIM 4012), I/C. ▶

b. *Three Rotary LISTEN ONLY Volume Controls.* These provide an additional mixing service for listening only, with controllable volume, and are labelled: HF, ADF/ILS, V/UHF. The V/UHF control is also used for Standby UHF.

c. *SPEAK-LISTEN Rotary Switch.* This is a 6-position switch labelled: OFF/DME/VOR/HF/V-UHF/IC. The V/UHF position is also used for Standby UHF. The switch transfers the user's telephone, microphone (last three positions), and press-to-transmit (HF and V/UHF positions) circuits to the facility selected. (At the HF and V/UHF positions, volume is controlled by the

associated rotary LISTEN ONLY control). The positions for DME and VOR are provided so that their audio identification can be checked if the station box amplifier fails.

d. *NORMAL/OFF/DIRECT Switch.* When this switch is set to NORMAL, a DC supply is connected to an amplifier in the station box and all the selected LISTEN facilities are fed via the amplifier to the user's telephones. If this amplifier or its power supply fails, selection of DIRECT switches off the amplifier and connects the user's telephones 'direct' to only that facility that is selected on the SPEAK-LISTEN switch. The SPEAK facilities are unaffected by use of this switch.

e. *CALL Switches (Spring-Loaded to Off).* When selected to CALL, the crew members receive intercom superimposed on all other signals, even though not selected to I/C on the SPEAK-LISTEN or LISTEN ONLY switch.

f. *Fuses.* The DC supply fuse and a spare fuse are above the CALL switch.

3. *Intercommunication.*

a. *Normal Intercom.* Normal intercom facilities are provided by an A1961 amplifier; incorporated in the system is a 'constant in touch' facility which connects the microphone circuits to the amplifier at all positions of the station box SPEAK-LISTEN switches, except OFF. The DC power supply to the amplifier is controlled by the INTER-COM —

ON/OFF switch on the take-off panel; the adjacent NORMAL/EMERGENCY switch must be at NORMAL.

b. *Emergency Intercom.*

(1) *A1961 Amplifier Failure.* If the A1961 amplifier or its power supply fails, the INTERCOM—NORMAL/EMERGENCY switch must be selected to EMERGENCY. This connects the intercom microphone and telephone lines to the audio circuits of the V/UHF or Standby UHF, whichever is in use, to provide emergency intercom. The SPEAK-LISTEN switches can be at any position except OFF. Reception is controlled by either the IC or the V/UHF LISTEN ONLY control.

(2) *Station Box Failure.* If a station box fails, select the NORMAL/OFF/DIRECT switch to DIRECT and, if intercom only is required, the rotary switch to I/C. If, however, intercom and V/UHF listen are required together, then select the rotary switch to V/UHF and the INTERCOM — NORMAL/EMERGENCY switch to EMERGENCY.

4. *Microphone/Telephone Sockets.* Mic/tel sockets for the pilot and navigator are on the back of their ejection seats; these sockets are finally connected to their associated station box and provide full communication facilities. Mic/tel sockets are also provided at the folding seat position and the navigator's nose station. Their telephone lines are connected in parallel with the pilot's telephone lines and their microphone lines are connected to the intercom amplifier. ✦ An extension lead from the nose station socket is clipped to the oxygen tube from the nose-station regulator so that the navigator can remain on intercom whilst changing stations.

5. *Press to Transmit Switches.* Two P to T switches are provided, a pushbutton type on the control column handwheel for the pilot and a MUTE/off/TRANSMIT (spring-loaded to off) toggle switch type on the left-hand side of the instrument panel for the navigator. When a P to T switch is operated, the operator's microphone lines are automatically transferred from the intercom amplifier to the selected transmitter and the transmitter is also switched on. The MUTE position of the navigator's switch is used to mute the PTR 175 receiver only.

V/UHF

6. *General.* A combined V/UHF set (ARI 23143/1-PTR 175) is installed. 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 50 kHz spacing. A separate receiver in the transmitter/receiver unit allows a

preset frequency of 243.0 MHz to be superimposed on any selected channel. A combined VHF/UHF aerial is on the upper fuselage and a UHF only aerial is on the forward camera bay door. Power supplies to the V/UHF system are DC only.

7. *Miscellaneous Controls.* The following four V/UHF switches are on the miscellaneous instrument panel:

a. *AERIAL — UPPER/LOWER Switch.* This switch is used to changeover the connection of the UHF aerials to the UHF facility of the PTR 175. The VHF facility remains permanently connected to the upper aerial. If the power supply to the aerial switch units fails, both aerials are automatically disconnected from the UHF facility of the PTR 175 and the lower aerial is connected to the Standby UHF. (See para 10.)

b. *CONTROL — NAV/PILOT Switch.* This switch enables PTR 175 frequency selection to be made from either the pilot's or the navigator's control unit.

c. *TONE Switch (Spring-Loaded to Off).* This switch provides a 1 kHz tone modulation of the selected radio frequency output of the transmitter.

d. *MUTE Switch (Spring-Loaded to Off).* This switch is used to mute the PTR 175 receiver only.

8. *Pilot's V/UHF Control Unit.* A Type 1607/4 control unit is on the miscellaneous instrument panel; the unit has the following controls:

a. A 7-position function switch marked 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 the independent guard receiver is switched on in addition to the normal transmitter/receiver.

b. 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.

c. Three rotary MANUAL frequency selector switches; the frequency selected is displayed in a window above the switches.

9. *Navigator's V/UHF Control Unit.* A Type 1607/7 control unit is on the navigator's coaming panel. The unit has three rotary MANUAL frequency selector switches; the frequency selected is displayed in a window above the switches. A green

light on the unit comes on when the changeover switch (see para 7 b) is set at NAV.

Standby UHF

10. *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 of 243 MHz and on another adjacent frequency known as the alternative channel. It can also provide emergency intercom. An independent battery, with sufficient capacity to last for over 5 hours, provides for emergency operation of the set. The set is transistorised and requires no warm-up time. When the set is on, the lower UHF aerial is automatically connected to the Standby UHF set.

11. *Controls.* The set is controlled by two STANDBY UHF switches on the miscellaneous instrument panel:

a. *BATT/NORM/OFF Switch.* In the OFF position the PTR 175 is connected to the station boxes. In the NORM position the Standby UHF is switched on and connected to the station boxes and the PTR 175 is disconnected; power is obtained from the normal aircraft DC supply. If this power supply fails or both generators fail, the set can be supplied from its own battery by selecting the BATT position; should a *total* power failure occur, it will also be necessary to select DIRECT on the station boxes. Ground tests must not be made on battery power.

b. *ALT/GUARD Switch.* This should normally be selected to GUARD. The ALT position is normally used for ground testing purposes.

HF (SSB)

12. *General.* The 618T-3 HF (SSB) equipment provides voice communication facilities on any one of 28,000 frequency channels over the range of 2 to 30 MHz; channels are spaced at intervals of 1 kHz. The transmitter/receiver is in the cabin on the starboard side. The wire aerial is rigged between a mast on the upper starboard side of the front fuselage and the fin.

13. *Control Unit.* The control unit is on the pilot's miscellaneous instrument panel; it has the following controls:

a. *Frequency Selectors.* Four control knobs are used to select the required frequency; the frequency is indicated by digits in the associated window.

b. *Mode Selector Switch.* This is a 6-position switch marked: OFF, USB, LSB, AM, DATA, CW. The DATA and CW positions are not in use.

c. *RF Sensitivity Control.* The RF SENS control is used to select the required ratio of signal strength to background noise. The HF LISTEN-ONLY control on the station box is then used as a volume control.

14. *Indicator Lights.* An amber light labelled TUNE and a green light labelled OPERATE are above the HF control unit. The TUNE light should only be on during tuning; the OPERATE light is normally on and indicates that the aerial is tuned and the equipment is fully operational.

15. *Aerial Tuning.* Tuning of the aerial is automatic and is initiated by a 'recycle' signal whenever there is a change of operating frequency. Final tuning is effected by briefly depressing the press-to-transmit switch (about 1 second) and takes a maximum time of five seconds. During tuning the HF OPERATE light goes out, the HF TUNE light comes on and 1 kHz tone is heard in the telephones.

16. *Tuner Malfunction.* If both lights come on, there is a fault in the tuner. Recycle the tuning controls by selecting a new frequency and then back to the original frequency; depress the press-to-transmit switch. If the fault still occurs, switch off the equipment.

17. *Power Supplies.* The HF equipment requires DC and AC supplies. The AC supply is taken from No 6 inverter or, if No 6 fails, from No 7 inverter.

Note 1: If the mode selector is moved from OFF to an operating mode with the required frequency already selected, move one of the four frequency knobs one digit off frequency and then back again. This allows a new tuning cycle to start.

Note 2: Transmit period must not exceed 5 minutes followed by a receiving time of not less than 5 minutes. Continuous reception can take place.

WARNING: The HF equipment must not be switched on or operated unless the aircraft is at least 100 yards from any other aircraft, except where the latter is known to have suitable protection for its detonator circuits.

Radio Compass (ADF)

18. *General.* The AD 7092D radio compass receiver is in the upper equipment bay. The receiver controller, the loop controller and the RADIO COMPASS—ON/OFF switch are on the port wall of the navigator's station. A relative bearing indicator is on the navigator's instrument panel and a combined DME/VOR/ADF indicator (see para 23 b) is on the pilot's flight instrument panel. Radio compass audio signals are fed to the station boxes via the ADF position of the AUDIO-ILS/ADF switch

on the miscellaneous instrument panel. The loop aerial is on the inside of the upper equipment bay hatch and the sense aerial is on the upper surface of the port inner wing.

19. *Power Supplies.* Power supplies are DC and AC. Control of the DC supply is by means of the ADF — ON/OFF switch on the navigator's switch panel. The AC supply is taken from No 1 inverter with No 2 inverter as a standby supply.

Instrument Landing System (ILS)

20. The ILS receivers are in the upper equipment bay. The ILS indicator and ILS MARKER light are on the lower right-hand side of the pilot's flight instrument panel. The ILS — ON/OFF switch and the AUDIO — ILS/ADF switch are together on the miscellaneous instrument panel. Audio signals are fed to the station boxes via the ILS position of the AUDIO switch. The channel selector is on the port wall at the navigator's station. The glideslope and localiser aeriels are in the leading edge of the starboard and port outer wings respectively and the marker aerial is in the starboard wheelwell. Power supplies are DC via a circuit breaker on the rear face of the ECP.

VHF Omni-Directional Radio Range (VOR)

21. *General.* The Decca EAS 671 VOR receiver and adaptor units are on the shelf below the navigator's table. The control unit, marked NAV, and a bearing indicator, labelled VOR REL BRG, are on the navigator's instrument panel. A combined DME/VOR/ADF indicator is on the pilot's flight instrument panel. VOR audio signals can be selected on the station boxes. The aerial is on the tail fin. Power supplies are DC and AC; the AC supply is taken from No 7 inverter.

22. *Control Unit.* The NAV control unit has a selected frequency indicator and a pair of two concentric switches, consisting of an inner and an outer switch. The left-hand outer switch is used to select the whole MHz, part of the required frequency and the right-hand outer switch selects decimal fractions of MHz. The left-hand inner switch, marked OFF/ON/TEST is used to switch on the equipment; the TEST position of the switch is inoperative. The right-hand inner switch marked VOL controls the volume of the audio signals fed to the station boxes.

23. Bearing Indicators.

a. *Navigator's Indicator.* The navigator's indicator has a fixed compass card and a pointer which displays the bearing of the VOR station relative to the heading of the aircraft (zero on the

card) when no variation is set on the Mk 4B compass master indicator. With variation set, the pointer indicates the relative bearing of the station plus (W) or minus (E) the variation.

b. *Pilot's Indicator.* The pilot's indicator has a double-bar pointer which presents VOR information and a single-bar pointer which presents ADF information (see para 18). The information can be presented simultaneously. The pointers are read against a rotating compass card which is a repeater of the Mk 4B compass master indicator. The heading of the aircraft appears opposite a fixed index at the top of the instrument. With no variation set on the Mk 4B compass master indicator, both pointers indicate radio bearings relative to the heading of the aircraft when read against the fixed index and magnetic bearings when read against the compass card. With variation set, the ADF pointer continues to indicate the correct relative bearing but it indicates the true bearing against the compass card; the VOR pointer indicates the relative bearing plus (W) or minus (E) the variation and magnetic bearing against the compass card.

RADAR

Distance Measuring Equipment (DME)

24. The RCA AVQ 75 DME is a radar interrogator operating in two frequency bands, 978 to 1083 MHz and 1094 to 1213 MHz. 100 channels are available, each containing a transmit and a receive frequency 63 MHz apart. The operating frequencies are obtained automatically by selection of the 'paired' VOR frequency on the DME control unit, in the range 108.00 to 117.90 MHz to give:

- a. Interrogation of suitable beacons (DME, Tacan, VOR/TAC).
- b. Digital indication of slant distance.
- c. Indication of groundspeed towards the beacon.
- d. Audio reception of beacon identification signals.

The interrogator unit is on the shelf below the navigator's table and the aerial is on the underside of the fuselage, between the flare doors (pre-SRIM 4012), or on the underside of the nose (post-SRIM 4012). ▶

The control unit and a distance/groundspeed indicator are on the navigator's instrument panel. A combined DME/VOR/ADF indicator is on the pilot's flight instrument panel. The power supply for operation of all the DME equipment except the pilot's distance indicator is DC. The pilot's distance indicator requires AC supplies for its operation and these are obtained from a transformer which is supplied by No 7 inverter.

25. *Control Unit.* The DME control unit has a TEST button, a selected frequency indicator and a pair of two concentric switches. The left-hand inner switch is used to select the whole MHz part of the required frequency and the right-hand inner switch to select decimal fractions of MHz. The left-hand outer switch, marked OFF/DME, controls the DC power supply to the equipment and the right-hand outer switch, marked VOL, controls the volume of the audio signals fed to the station boxes.

26. *Indicators.*

a. *Navigator's Indicator.* The navigator's indicator shows the slant distance to the beacon (up to 196 NM) on a 3-digit counter and the ground-speed towards the beacon by a pointer against the inner scale of the dial. When tracking towards the beacon, a knob at the bottom right of the instrument can be used to set the distance to the beacon on a scale at the bottom of the dial, minutes to the station can then be read on the outer scale of the dial against the pointer. A red bar covers the distance counter when the distance displayed is invalid.

b. *Pilot's Indicator.* The 3-digit counter in the dial of the pilot's combined DME/VOR/ADF indicator is a synchro driven repeater of the navigator's DME distance indicator. A white OFF flag, which is connected in series with the red bar of the navigator's indicator, covers the counter when the distance displayed is invalid. However, failure of the AC supply only, causes the counter to freeze but the OFF flag will not appear unless the navigator's indicator also shows a failure.

27. *Operation.*

a. *Switching On.* At the control unit, set the OFF/DME switch to DME, select the required VOR frequency and turn the VOL control fully clockwise. Select DME listen on the station box. Allow one minute for warm up. If a usable signal is being received from the selected beacon, the DME goes into the search mode during which the indicator counter wheels rotate. When the DME locks onto the signal, the wheels stop rotating, the red bar withdraws and the distance from the beacon is indicated. The DME then continues in the track mode. Adjust the audio volume and identify the beacon by its code.

b. *Standby Mode.* An automatic standby facility prevents the DME searching for reply signals when the aircraft is out of range of a selected beacon. The counter wheels are steady and are covered by the red bar when in the standby mode.

c. *Memory Mode.* If the beacon signal is lost during the track mode, the DME continues to display the most recently-derived distance for about

10 seconds before going into the standby mode. If the signal is regained within 10 seconds, the distance is corrected and the DME continues tracking.

d. *System Test.* With the equipment switched ON, on the ground or in the air, a self-test cycle begins when the TEST button on the control unit is held pressed. The DME first switches to the memory mode for 10 seconds, then the indicator red bar appears and the equipment momentarily goes to the search mode; if the test is satisfactory, the red bar clears and a distance of 196 NM is displayed. Releasing the button allows resumption of operation in whatever mode was interrupted.

◀ **Tacan (Post-SRIM 4012)**

28. *General.* Tacan is a navigation system operating over the frequency band 962 to 1213 MHz in 126 channels. It functions only with complementary surface transponder beacons. The equipment provides:

- a. Continuous meter indications of the magnetic bearing of the aircraft from the beacon.
- b. Continuous meter indications of the distance of the beacon.
- c. Aural indication of the identity of the beacon to which the equipment is channelled, via the TACAN listen controls on the station boxes.
- d. A flag alarm circuit which actuates in the absence of correct distance signals.

29. *Equipment.* The Tacan installation comprises the following main units:

- a. A 'shark fin' type aerial on the undersurface of the fuselage, between the flare doors.
- b. A transmitter/receiver in the rear fuselage equipment bay.
- c. A coupling unit adjacent to the transmitter/receiver.
- d. A control unit on the pilot's miscellaneous instrument panel.
- e. Two indicators, one on the pilot's flight instrument panel and the other on the navigator's instrument panel.

30. *Control Unit.* The control unit (Type 7750) has the following switches:

- a. *Power OFF-REC-T/R Switch.* A 3-position vertically-operated switch. The top position switches on the whole equipment so that both distance and bearing information are indicated. The central position (REC) switches on the equipment so that bearing information only is indicated. ▶

b. *Channel Selectors.* Channel selection is made by two rotary switches. The number of the channel selected is displayed behind a window in the centre of the unit face-plate.

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

31. *Indicators.* 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 2-digit counter. When the transmitter/receiver 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 wheels also rotate but they are partially obscured by a flag. When the transmitter/receiver '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 at distances greater than 195 NM.

32. *Power Supplies.* Power supplies are DC and AC; the AC is provided by No 8 inverter (see Chapter 1, para 16).

Doppler and GPI

33. *Doppler.*

a. *General.* Decca doppler 72 (ARI 5972/2) is installed. The equipment is a radar navigational aid which gives continuous indication of drift angle, groundspeed and, if required, distance gone. It functions at heights from 15 to 60,000 feet. Outputs of drift angle and distance gone are available for use by the GPI Mk 4A.

b. *Equipment.* The transmitter/receiver and aerial assembly (TRA) is in the undersurface of the port inner wing. The control indicator is on the starboard side of the cabin at the navigator's rear station and a remote drift angle and ground-speed indicator (DA/GSI) is on the starboard side of the navigator's nose station. The integral lighting of the DA/GSI is controlled by its own dimmer switch which is just forward of the indicator.

c. *Power Supplies.* The doppler TRA assembly requires an AC power supply and this is taken from No 7 inverter, via a control relay. The relay is energised by a DC supply when the DOPPLER — ON/off switch, on the rear face of the ECP, is set to ON. In addition, the doppler control indicator receives an AC supply direct from No 1 inverter.

34. *GPI.* A GPI Mk 4A is on the starboard side of the cabin immediately aft of the doppler control indicator. It receives drift angle and distance gone information from the doppler and heading information from the Mk 4B compass master indicator. This information is used within the GPI to provide continuous indication of ground position. Power supplies are DC and AC; the AC supply is taken from No 1 inverter.

Radar Altimeter

35. *General.* The radar altimeter (ARI 23219/4) provides a continuous indication of aircraft height AGL/ASL up to 5000 feet. The equipment comprises a transmitter/receiver in the rear fuselage, two aeriels on the rear fuselage undersurface, a height indicator on the pilot's flight instrument panel and a low warning light on the pilot's coaming panel.

36. *Height Indicator.* The height indicator contains:

a. *Pointer and Dial.* A pointer displays height against a 0 to 5000 feet dial with three different linear scale sectors. If the aircraft is above 5000 feet with the altimeter on or if the equipment stops tracking, the pointer tip disappears behind the NO TRACK mask.

b. *Control Knob.* A control knob at the bottom left functions as an equipment power ON/off switch, low level index SET control and PUSH TO TEST switch. Clockwise movement from the OFF position switches on the equipment and further rotation sets an index arrow on the dial circumference against a required height. With the system operating satisfactorily, the pointer indicates 100 ± 15 feet when the control knob is pressed.

c. *Failure Flag.* A black/yellow striped flag appears in a cut-out in the dial to indicate power off, equipment failure or equipment not tracking.

d. *Warning Light.* An amber LOW warning light at the bottom right comes on when indicated height is below that to which the index is set. When the INST PANEL dimmer switch on the pilot's coaming is on (at any setting), the intensity of the warning light is controlled by the RADAR ALT LOW LEVEL WARN LIGHT dimmer switch also on the coaming panel; the dimmer cannot extinguish the light.

e. *Integral Lighting.* The indicator has integral lighting which is controlled by the INST PANEL dimmer switch on the coaming panel.

37. *Remote Low Warning Light.* A RADAR ALT LOW LEVEL WARNING amber light is on the left side of the pilot's coaming panel. This light is wired

in parallel with the indicator low warning light, and its intensity is controlled by the same dimmer switch.

38. *Power Supplies.* Power supplies are DC and AC; the AC supply is taken from No 6 inverter or, if No 6 fails, from No 7 inverter.

39. *Operational Check.* Ensure that DC and AC power supplies are available. Rotate the control knob clockwise from the OFF position and set the low-level index to 50 feet. The pointer moves to behind the NO TRACK mask during warm-up. After about 3 minutes the NO TRACK flag disappears and the pointer returns to zero. The amber LOW lights come on to indicate that the aircraft is below the low-level limit. Press and hold the control knob to actuate the PUSH TO TEST condition. Check that the pointer indicates 100 ± 15 feet and the amber LOW lights go out. Release the control knob and check that the pointer returns to zero and the LOW lights come on. To switch off, rotate the control knob anti-clockwise to OFF.

Note: To prevent the possibility of double height indication, the altimeter should be left switched on. If this is not operationally acceptable, the PUSH TO TEST switch should be operated every time the equipment is switched on.

IFF/SSR

40. The IFF/SSR system (ARI 23134) provides identification and information for military purposes (IFF) and civilian secondary surveillance radar (SSR).

41. The transponder, aerial switch unit and aerial test switch are in the rear fuselage. The control unit is on the pilot's port console (pre-SRIM 4012) or on the pilot's miscellaneous instrument panel (post-SRIM 4012) and the IFF FAIL light is on the pilot's flight instrument panel. Two 'shark fin' aerals are fitted, one above and one below the rear fuselage.

42. The amber IFF FAIL light has a dimmer and press-to-test facility for checking its own filament and that of the self-TEST light on the control unit. The integral lighting of the control unit is controlled by the CONSOLE LIGHTS dimmer switch (pre-SRIM 4012) or by the MISC INST dimmer switch (post-SRIM 4012).

43. Power supplies are DC and AC; the AC supply is taken from No 6 inverter or, if No 6 fails, from No 7 inverter.

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PART 1

CHAPTER 12 — OPERATIONAL EQUIPMENT
AND CONTROLS

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Camera Locations

1. There are three camera bays in the lower part of the fuselage, a forward, a centre and a rear bay. The forward bay is just aft of the lower equipment bays, the centre bay is just aft of the flare bay and the rear bay is just aft of the rear hatch. In addition a forward facing F95 camera can be fitted in the nose.

2. A variety of oblique and vertical cameras for day and night roles can be fitted. For details see the RAF Reconnaissance Data Manual, AP 112P-0003-1.

Camera Operation

3. The pilot operates the F95 low-level cameras by means of a toggle switch or push switch on the left-hand grip of the control column handwheel, in conjunction with a master ON/off switch on the F95 cameras control unit on the starboard coaming. All other cameras are controlled by the navigator, usually from his nose station but provision is also made for operating the F49 and F97 cameras from his rear station.

4. A camera distribution panel is on the starboard wall of the navigator's rear station and a camera control panel is on the port side of his nose station.

Camera Doors

5. Each camera bay incorporates hydraulically-operated sliding camera doors. The hydraulic selector valve is electrically-actuated and controlled by a

CAMERA DOORS — SHUT/OPEN switch on the pilot's port console. An adjacent MI shows white when the doors are fully open and black when they are fully closed or at any intermediate position. This MI is duplicated on the camera control panel and on the camera distribution panel.

6. Two camera windows are built into each side of the aft position of the forward camera bay, the lower pair is normally used with the F97 night cameras. Only one camera door is fitted on each side so that one pair of windows is always uncovered. With the F97 circuit breaker on the front face of the ECP tripped and the camera doors selector at SHUT, the lower windows are uncovered and external plates are fitted to protect them.

7. For the night role, the power supply to the camera doors valve actuator is changed over to reverse the operation of all the camera doors when the F97 circuit breaker is made and the adjacent F52/F49 circuit breaker is tripped. External plates are fitted over all the camera windows except the two lower windows used with the F97 cameras; the camera doors MI show white when the doors of these two windows are fully open. The F52/F97 heating changeover valve in the forward camera bay must be selected to F97.

Flare Bay Doors

8. *Flare Bay Doors Control and Indicators.* The flare bay doors are hydraulically operated. The hydraulic selector valve is electrically actuated and controlled by the PHOTOFLASH DOORS—SHUT/OPEN switch on the pilot's port console. An ad-

jacent MI shows white when the doors are fully open and black when they are fully closed or at any intermediate position. This MI is duplicated on the camera control panel and on the camera distribution panel. To prevent inadvertent closing on the ground, a locking pin is inserted in the control switch guard with the switch in the OPEN position. When not in use this pin is stowed in a bag on the entrance door.

9. Flare Bay Doors Emergency Operation

- a. If the flare bay doors selector valve fails to operate electrically, it can be moved mechanically to the 'open' position by pulling down the gated FLARE DOOR EMERGENCY CONTROL lever on the cockpit port wall. However, if the flare doors are opened in this way, they cannot be closed again until serviced.
- b. If a hydraulic failure occurs, the flare bay doors can be opened and closed by means of the handpump and normal selection on the control switch. However, this procedure should be avoided as subsequent undercarriage lowering and wheel braking may be prejudiced due to lack of hydraulic fluid.

Armament Safety Switch

10. A photoflash isolating relay in the low-level photoflash circuit provides protection against inadvertent release of the photoflashes by the normal circuits. It is controlled by an ARMAMENT SAFETY—LIVE/SAFE guarded switch on the pilot's port console. The guard holds the switch in the aft, SAFE, position and an adjacent amber light

comes on when the switch is in the LIVE position with all circuits live. The light has a dimmer and a press-to-test facility.

Firing the Photoflashes

11. The firing of the 1.75 inch photoflashes is controlled by the F97 camera control unit. Pulses are fed from the F97 master camera to the photoflash crate distributor, which in turn electrically fires the photoflash charge from the cartridge. The cameras will run if the CAMERA MASTER switch on the control unit is ON and the CAMERA DOORS are OPEN. To fire photoflashes the following conditions must be satisfied:

- CAMERA DOORS OPEN
- FLARE DOORS OPEN
- ARMAMENT SAFETY switch ... LIVE
- PHOTOFLASH MASTER switch ... ON
- *MASTER CAMERA Running

*Note: One of the two F97 cameras is selected on the ground as the master camera.

Firing the Flares Illuminating

12. Provision is made for carrying a number of 1.75 inch Flares Illuminating in the photoflash crate. Flares can be fired individually after opening the FLARE DOORS and selecting the PHOTOFLASH MASTER switch, on the F97 camera control unit, to ON and the ARMAMENT SAFETY switch to LIVE. A flare will be fired on each press of the remote push switch on the camera firing control box.

PART 2

LIMITATIONS

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PART 2

CHAPTER 1 — ENGINE LIMITATIONS

Contents

Engine Limitations — Avon Mk 109	Para
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							3

The limitations given in this Part are taken from the Release to Service Document to AL 2 standard. The Release to Service Document must be consulted to ascertain the latest release standard.

Engine Limitations — Avon Mk 109

1.

<i>Power Rating</i>	<i>Time Limit Per Flight</i>	<i>Max RPM</i>	<i>Max JPT° C</i>
Take-off and operational necessity	10 minutes (combined total)	*7950 ± 50	680
Max intermediate	30 minutes	7750	620
Max continuous	Unrestricted	7500	575
Idling on ground	Unrestricted	2750 ± 100	530

*The engine is governed at 7950 RPM at which speed maximum thrust is obtained. At low air temperatures the engines may underspeed to as low as 7800 at full throttle but they will still maintain maximum thrust. During climb, the governed speed may be permitted to rise to 8100 RPM.

Oil Pressure Limitations

2. Minimum at 7500 RPM and above	...	15 PSI
Normal at 7500 RPM	...	20 PSI
Idling RPM	...	Check oil pressure is indicated

Fuel and Oil Specifications

3. *Fuel Specifications.*

<i>UK Specification (DERD)</i>	<i>UK Inter-Service Designation</i>	<i>NATO CODE (Note 2)</i>
<i>Approved Fuels:</i>		
2453	Avtur/FSII	F34
2454	Avtag/FSII	F40
<i>Alternative Fuels:</i>		
2494 (Note 3)	Avtur	F35
2452 (Note 4)	Avcat/FSII	F44
2498 (Note 3)	Avcat	F43

Note 1: If a change of fuel is made and the SG of the fuel is different from that for which the engines are set, the engines may require adjustment.

Note 2: Equivalent fuels to the same NATO Code number also exist and are approved but fuel supplied in France, including F34 and F40, may be subject to Note 3 below.

Note 3: These fuels do not contain an approved lubricity additive to DERD Specification 2461 nor

◀ fuel system icing inhibitor (FSII) so that the following constraints apply:

- a. The HP fuel pumps are limited to 50 hours on this fuel to prevent pump seizure.
- b. Operation is limited to 14 days, to limit fungus growth, after which an equal number of days on an approved fuel is to follow.
- c. The risk of ice forming in the fuel is acceptable to the operational commander.

Note 4: This fuel does not contain an approved lubricity additive, the HP pumps are consequently limited to 50 hours on this fuel to prevent seizure. ▶

4. *Oil Specifications.*

<i>Specification</i>	<i>Inter-Service Designation</i>	<i>NATO Code</i>
DERD 2487	OX 38	O-149
DERD 2493	OX 38 (reclaimed)	O-149

PART 2

CHAPTER 2 — AIRFRAME AND MISCELLANEOUS
LIMITATIONS

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Introduction

◀ 1. Canberra PR Mk 7 aircraft are cleared for service use by day and by night in temperate and tropical climates. ▶

Speed and Mach Number Limitations

2.

<i>Condition</i>	<i>Max IAS (knots)</i>	<i>Max IMN</i>
Clean aircraft	450	0.75 below 15,000 feet 0.79 15,000 to 25,000 feet Above 25,000 feet limited by compressibility effects. The speed at which a strong nose-up change of trim occurs, ie about 0.84, must not be exceeded
With wing-tip tanks	365	0.79 below 25,000 feet 0.80 above 25,000 feet
<i>For the operation of:</i>		
◀ Flare doors	350	▶
Airbrakes MID	As for clean aircraft	
Airbrakes OUT	400	0.75 12,500 to 25,000 feet 0.79 above 25,000 feet
Undercarriage	190	
Flaps	160	

Note: The speed for the operation of a service also applies for flight with the service in the extended position.

Maximum Altitude

3. The aircraft is limited to a maximum altitude of 45,000 feet.

Maximum Weights

- 4. a. For take-off and all permitted forms of flying 55,000 lb
- b. Normal maximum for landing ... 40,000 lb
- c. In emergency the aircraft may be landed at weights up to 55,000 lb but greater care will be required particularly when braking.

CG Limits (Feet Aft of Datum)

- 5. a. *Forward Limit.* With or without wing-tip tanks 1.235 at weights up to 29,000 lb; then varying linearly aft to 2.20 at 48,000 lb, remaining constant thereafter at 2.20 up to maximum take-off weight.
- b. *Aft Limit.*
 - (1) *Without Wing-Tip Tanks.* 3.058 up to an altitude of 25,000 feet; it then moves linearly forward to 2.66 at 45,000 feet.
 - (2) *With Wing-Tip Tanks.* 2.808 up to an altitude of 37,000 feet; it then moves linearly forward to 2.66 at 45,000 feet.
- c. When taxiing over uneven surfaces the aft limit should not exceed 2.885.

Manoeuvre Limitations

- 6. Intentional spinning and aerobatics are prohibited.
- 7. The normal acceleration limitations are as follows:

Condition	With Negligible Aileron		With Aileron	
	Integral Tanks More Than 3/4 Full	Integral Tanks Less Than 3/4 Full	Integral Tanks More Than 3/4 Full	Integral Tanks Less Than 3/4 Full
Up to 48,000 lb no tip tanks	4.0g	3.5g	2.0g	1.5g
Above 48,000 lb or with tip tanks	3.0g	3.0g	1.5g	1.5g

Note 1: In all manoeuvres involving the application of g loading, the ailerons should be used with care.

At weights in excess of 48,000 lb, or when wing-tip tanks are fitted, combined application of aileron and g loading is to be avoided.

Note 2: The application of negative-g loading is to be avoided.

Maximum Crosswind Component

8. The maximum recommended crosswind component for take-off is 25 knots. The maximum permitted crosswind component for landing is 25 knots.

Jettisoning of Wing-Tip Tanks

9. The wing-tip tanks may be jettisoned (any fuel state), at any speed within the limitations imposed when carrying wing-tip tanks.

Aircraft Approach Limitations

10. The aircraft approach limitations are:

	Raw ILS feet	Rate ILS feet	PAR feet
In-line localiser	250	200	200
Off-set localiser	270	250	

Engine Out Allowance

11. The engine out allowance (EOA) is 450 feet.

Visual Committal Height

12. The visual committal height (VCH) is 600 feet.

Aircraft Arresting Barrier Engagement

13. The aircraft is cleared for engagement with the Mk 5, Mk 6, Mk 12 and Mk 12A arresting barriers; in the case of the Mk 12 and Mk 12A barriers at the 'Light Aircraft' setting only. A table giving the recommended maximum entry ground speed for aircraft weight is in the FRC. An aircraft engaging a barrier at speed/weight combinations higher than those shown runs the net out to its maximum length; the cables then come off the brake units and the aircraft continues forward at some residual velocity. An aircraft entering a barrier at a ground speed in excess of 120 knots may exceed the impact strength of the net and burst through.

14. *Aircraft Arresting Gear Trampling.* The aircraft is cleared to trample the supported and tensioned cable of RHAG, SPRAG, PUAG, CHAG and Bliss types of arresting gear without restriction.

Pilot Limitation

15. Pilots having a thigh length in flying clothing of more than 26.5 inches must not fly the aircraft. This restriction is imposed because pilots with a greater thigh length are liable to injury due to their knees fouling the coaming if the ejection seat is used.

Ejection Seats

16. The best speed for ejection is 200 knots, in straight and level flight. Ejection may be initiated, in straight and level flight, at any height from ground level upwards. However, runway ejections should only be made when the speed of the aircraft is above 90 knots or the circumstances of the emergency dictate that ejection is the only reasonable solution. If, at any time, the aircraft is nose-down or descending, the minimum safe height is increased and depends on the angle of dive and aircraft speed.

Camera Installations

17. The following cameras can be installed:

Role	Nose	Fwd Bay	Centre Bay	Aft Bay
Day	—	4-F52 24 or 36 inch	2-F52 24 or 36 inch	1-F49 6 or 12 inch
Alternative Day	—	2-F52 48 inch	2-F52 48 inch	1-F49 6 or 12 inch
Low Level Oblique Day	1-F95 4 or 12 inch	2-F95 4 or 12 inch	—	—
Low level night	—	2-F97 5 inch twin	—	—

Radio and Radar Installations

18. The following radio and radar installations are cleared for use in true outside air temperatures up to plus 40°C, subject to the limitations stated in the notes below:

- ARI 18089 Communications Control System
- ARI 23143/1 V/UHF (PTR 175) (See Note 7)

- ARI 23159 Standby UHF (D403) (See Note 1)
- ARI 23090/9 HF (SSB)
- ARI 23023 Radio Compass (AD 7092D) (See Note 7)
- ARI 18011 Military ILS (See Note 7)
- ARI 23247/2 VOR (EAS 671) (See Note 2)
- ARI 23238/5 DME (AVQ 75) (See Note 3)
- ARI 5972/2 Decca Doppler 72 (See Note 4)
- ARI 23219/4 Radar Altimeter (APN 171) (See Note 5)
- ARI 23134 IFF/SSR (See Note 6)
- ARI 18107/4 Tacan (See Note 8)

Note 1: Possibility of slight interference (buzz) when Radar Altimeter is in operation.

Note 2: Possibility of interference when transmitting on HF and V/UHF.

Note 3: Possibility of interference on indications when transmitting on V/UHF using the lower aerial.

Note 4: Possibility of interference during HF tuning cycle and subsequent HF transmissions between 15 and 22 MHz.

Note 5: Possibility of indicated error of up to ±50 feet when transmitting on HF between 19 and 24 MHz.

Note 6: Possibility of interference causing loss or reduction of interrogation replies when transmitting on:

- HF — Between 20.4 and 24.4 MHz
- UHF — Between 255.5 and 259.5 MHz
Between 341.5 and 345.5 MHz

Note 7: In outside temperatures above 30°C, operating periods should be kept to a minimum and should not exceed 10 minutes in temperatures of +35°C to +40°C.

Note 8: Tacan lock may be lost when UHF transmissions are made on harmonically related frequencies. If possible, the upper UHF aerial should be selected when Tacan is in use to minimise this hazard.

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PART 3

HANDLING

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PART 3

CHAPTER 1 — PREPARATION FOR FLIGHT

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Preliminary Checks

1. Carry out the **Safe for Parking** checks on arrival at the aircraft and then continue with the **Initial Checks** and **External Checks** given in the FRC. Systematically check the outside of the aircraft for signs of damage and security of panels, filler caps, doors and hatches. The engine air intakes must be free from obstruction, the starter fairings secure and the jet pipes free from distortion.

2. In winds above 25 knots, leave the external rudder lock in for taxiing; in winds above 35 knots, the aileron and elevator locks must also be fitted. If aileron locks are left in for taxiing, the flaps must be fully up before the locks are fitted and the flap selector must be locked in the up position by its locking pin until the **Pre-Take-Off Checks**.

WARNING: The flaps will be damaged if the flap selector is operated while the aileron locks are in. The rudder trim must not be operated while the rudder lock is in.

Internal Checks

3. Carry out the **Ejection Seat Checks** and the **Internal Checks** given in the FRC.

Starting the Engines

4. Carry out the **Starting Checks** given in the FRC.

Failure to Start

5. If an engine fails to accelerate to idling RPM, close the HP cock and switch OFF the master starting switch immediately. If it is necessary to reload the starter, switch OFF the ignition switch also and

wait until the engine has stopped rotating. If three cartridges were loaded, a further start may be attempted immediately the starter resets and the engine has stopped rotating. The starter button resets when the master starting switch is selected OFF. If during a start an engine fails to reach 1100 RPM, have it checked for freedom of rotation before attempting a further start.

6. If a cartridge fails to fire, carry out the same procedure as in para 5 except that a minimum time of one minute must elapse before reloading or firing a second cartridge. If a second cartridge fails to fire have the electrical circuit checked.

7. After a failure to start, if the HP cock is closed without delay there should be no necessity to 'Blow Through' the engine. If in doubt, excess fuel may be removed by firing another cartridge as follows:

Master starting switch ...	ON
Ignition switch	OFF
HP cock	Closed
Starter button	Press

If an internal fire is suspected, the LP cocks and pumps for that engine must also be selected off.

Checks Before Taxying

8. Carry out the **After Start Checks** and **Taxi Checks** given in the FRC. If control locks are to be left in for taxiing, delay the checks of the flaps and trims until the locks have been removed at the take-off point.

9. When checking the aileron, rudder and tailplane trims, ensure that no overrun occurs when the trims

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are stopped at the neutral position from each direction. The aircraft must not be flown if a live circuit exists or if the trim operation is faulty. Check the trims as follows:

- a. *Aileron Trim.* Operate the trim over the full range and return to neutral.
- b. *Rudder Trim.* Test for a live circuit by ensuring that no movement occurs when either switch is operated independently. Operate the trim over the full range and return to neutral.
- c. *Tailplane Actuator.* Test for a live circuit by ensuring that the tailplane does not move when either the cut-in or trim switch is operated independently. Operate the tailplane trim over the full range and return to neutral.

Taxying

10. Check the operation of the brakes, which are powerful, as soon as possible. Reduce speed when turning or manoeuvring and do not turn with one wheel locked.

◀ **WARNING:** Heavy braking will markedly reduce brake effectiveness as the heat absorption limit of the brakes is approached; even moderate braking at low AUW and slow speed can have the same effect if prolonged, eg lengthy taxiing using brakes against power. After any such case of heavy or prolonged

braking, allow sufficient time for the brakes to cool before continuing with taxiing or taking-off. ▶

11. Check the serviceability of flight instruments during turns.

12. Rudder pedal and control column loads can be high when taxiing in strong winds. If the rudder lock has been left in for taxiing, apply only sufficient pressure at the rudder pedals to obtain differential braking.

13. At aft CG avoid high-speed taxiing, because of the tendency for the nose to lift.

◀ 14. In strong crosswind conditions the engines may stall during acceleration if the throttles are opened too quickly. ▶

15. If it is necessary at any time to stand tail-into-wind, run the engines at sufficient RPM to maintain JPT within the limits.

16. Fuel consumption while taxiing is 30 to 40 lb per minute.

Checks Before Take-Off

17. Carry out the **Pre-Take-Off Checks** given in the FRC.

PART 3

CHAPTER 2—HANDLING IN FLIGHT

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Take-Off

1. Extract the take-off information from the ODM. Provided that runway and temperature conditions are suitable, at weights up to 47,000 lb, the time gap between achieving unstick speed and safety speed is reduced by keeping the aircraft on the ground until a speed of 130 knots is reached. In this case, calculate the take-off distance assuming a weight of 47,000 lb.

2. When taking-off at high AUW from a high-elevation airfield in high ambient temperature conditions, it may be necessary to use the short-run unstick speed in order to avoid exceeding the tyre limiting speed of 147 knots groundspeed.

3. *Unstick Speeds.*

<i>Take-Off Weight (lb)</i>	<i>Normal Unstick Speed (knots)</i>	<i>Short-Run Unstick Speed (knots)</i>
35,000	109	101
40,000	117	108
45,000	125	115
50,000	133	121
55,000	140	127

4. Align the aircraft on the runway and apply the brakes. Increase RPM to 7400 and check the align-

ment of the throttles and compare the JPT. Poor throttle alignment and a difference in JPT are an indication of inlet guide vanes malfunction. If an engine is suspect, increase power; the difference in JPT and throttle alignment will increase and the suspect engine will show a tendency to overspeed. If these symptoms are present do not take-off; have the fault investigated. If the above check is satisfactory, release the brakes and open the throttles fully.

5. During the take-off run, check the **tendency** for the nose to rise early. At 10 knots below unstick speed move the control column steadily backwards and fly the aircraft off the ground at the correct speed. If the nose is raised too early, the take-off run will be prolonged. When taking off from high-elevation airfields where acceleration will be poor, the nose of the aircraft should be raised approximately 5 knots below unstick speed.

6. When safely airborne, apply the wheelbrakes and retract the undercarriage. There is little change of trim but care must be taken not to exceed 175 knots before the wheels are locked up (all undercarriage lights out), particularly at low weights when acceleration is rapid. If 190 knots is reached before the doors are closed, it is possible that they may not close at all. There is no visual indication that the main doors are open but buffeting may be felt.

Should this happen, reduce speed to about 175 knots to allow the doors to close.

7. The aircraft accelerates rapidly with an increasing nose-up change of trim.

8. If a sustained climb is intended, set 7750 RPM and climb at 330 knots. For circuit practice it is recommended that the speed be kept below 180 knots. For the climb to circuit height 7000 RPM is ample.

9. *Crosswind Take-Off.*

a. The maximum recommended crosswind component for take-off is 25 knots.

b. If a normal take-off is attempted in a strong crosswind, there is a risk that the downwind engine may surge as the RPM is increased against the brakes. If a surge occurs, close both throttles. Provided that the JPT limit has not been exceeded a further attempt to take-off may be made using the following technique. Line up on the downwind side of the runway angled-off approximately 30° into wind and increase RPM to 7400 against the brakes. If the engine checks are normal release the brakes, align the aircraft with the runway centre line by careful use of differential brake and then increase RPM as the aircraft gains speed. If a surge is experienced using this technique, the engine must be considered to be unserviceable.

c. When a take-off is attempted with the crosswind component close to the recommended maximum, the crosswind take-off technique should be used without a prior attempt at a normal take-off.

Aborted Take-Off

10. *Below Stop Speed.* If a take-off is aborted below the stop speed, the aircraft can be stopped in the remaining distance available using the following technique:

Close both throttles

Select flaps DOWN

Apply maximum continuous wheel braking

Close HP cock of malfunctioning engine (if applicable)

When flaps have travelled, close HP cock of remaining engine(s)

Do not apply the brakes above EMBS since this is the maximum speed at which continuous braking may be initiated without risk of the brakes overheating and failing before the aircraft is brought to rest.

11. *Above Stop Speed.* If a take-off is aborted above the stop speed, the abort technique will be

influenced by such factors as the speed and weight of the aircraft, weather conditions, runway length and availability of an arresting barrier. The following considerations are relevant:

a. Whenever possible plan for a barrier engagement (see FRC), keep the nosewheel on the ground and delay wheel braking until EMBS to guard against brake failure. It is preferable to engage the barrier centrally with the brakes intact than to engage it off centre or to run off the side of the runway, albeit at a lower speed, because the brakes have failed. Ensure that the nosewheel is firmly on the ground before engaging the barrier.

b. In certain circumstances, particularly on a short runway, an abort at high speed and high AUW could result in either the barrier maximum entry speed being exceeded or, in the absence of a barrier, the aircraft leaving the end of the runway before the speed has reduced to EMBS. In these circumstances use wheel braking above EMBS.

c. In the last resort the undercarriage may be retracted when operating from an airfield with a hazardous overshoot area and no arresting barrier. It may be advisable to eject from the aircraft, but this should be done as early as possible and at a speed above 90 knots; adequate time must be allowed for the seat firing delays.

Engine Failure After Take-Off

12. The safety speed at all weights in all configurations is 175 knots.

13. If an engine fails during take-off, priority must be given to controlling the aircraft before dealing with the engine emergency. The aircraft responds to an engine failure by yawing and rolling towards the dead engine. The rates of yaw and roll increase rapidly if recovery action is delayed.

14. The factors affecting recovery are:

a. *Aircraft Speed.* Aircraft response to engine failure is more marked at low speeds, particularly below safety speed. The rudder is less effective at low speeds and recovery technique becomes more critical.

b. *Wing Stores.* Increased yawing and rolling inertia due to wing stores (wing-tip tanks) help to slow down the initial aircraft response to engine failure. However, the increased inertia will also make it more difficult to stop the yaw and roll if it is allowed to develop. The extra thrust required to accelerate the aircraft because of the drag of the wing stores increases the critical speed. There-

fore, the minimum speed from which a recovery can be made is also increased.

c. *AUW and CG Position.* AUW affects the speed from which recovery is possible by its effect on aircraft acceleration; at low AUW the improved acceleration assists recovery. At aft CG positions the rudder is less effective because of its reduced moment arm.

d. *Altitude and Temperature.* Increases in altitude and/or temperature cause reduced engine thrust and, therefore, lower critical speeds. This alleviates asymmetric handling difficulties but reduces aircraft acceleration and climb performance.

15. *Recovery Actions.*

a. *Undercarriage Down.* If practicable, control the yaw with rudder, close both throttles and land back on the runway. Aim for a barrier engagement. If a landing is not practicable take recovery action as for undercarriage up or eject.

b. *Undercarriage Selected UP.*

(1) Apply full rudder to oppose the yaw. Up to 10° of bank may then be applied towards the live engine; this not only reduces the minimum control speed but may also improve aircraft performance by reducing drag. If the yaw still continues, then *power on the live engine must be reduced until the yaw is stopped.*

(2) Lower the nose to improve acceleration and confirm that the undercarriage and flaps are retracted.

(3) Below safety speed, recovery is assisted considerably by jettisoning wing stores and this should be carried out as soon as possible after the initial rudder, aileron and throttle actions.

(4) Climb away when the speed has increased to 175 knots. If power has been reduced, restore slowly as speed increases further, trim as necessary and then carry out the appropriate engine failure drill. If a safe climb cannot be achieved, the decision to eject or crash land must be made.

Note 1: Application of aileron before rudder adversely affects recovery.

Note 2: Before releasing the controls to operate the ejection seat, consider throttling back the live engine to prevent further roll developing before the seat has left the aircraft.

c. At and above safety speed, it should be possible to regain and maintain control without reducing power on the live engine, provided that recovery action is taken immediately an engine failure is recognised. Below safety speed, it will always be necessary to reduce power on the live

engine. If correct action is taken quickly, it is possible, for example, to recover and climb away from an engine failure at 155 knots at AUW less than 40,000 lb.

Climbing

16. The optimum climbing speed is 330 knots until 0-72M is reached at about 20,000 feet. Thereafter, maintain 0-72M until the desired altitude is reached.

17. RPM tend to increase with altitude and must be restrained by careful throttling. At high altitudes the precise setting of desired RPM is not easy. JPT remain approximately constant up to about 30,000 feet, above which they may increase slightly at constant RPM.

18. The canopy internal demister must not be on during a climb.

19. In heavy rain, particularly if the aircraft has been standing on the ground tail-into-wind, water may collect in the region of the aileron beaks and icing could restrict aileron movement during any subsequent rapid climb in temperatures below 0°C. In these circumstances, avoid prolonged periods with the controls static and exercise the ailerons gently during the climb.

20. *Climbing Checks.* Carry out the **Climbing Checks** given in the FRC.

Engine Handling in Flight

21. *Low Level.*

a. Operate the throttles smoothly at all times and avoid slam accelerations and rapid decelerations.

b. At sea level, acceleration to full power from 4500 RPM can be obtained within 5 seconds; accelerations from lower RPM take considerably longer and care must be taken when opening the throttles, otherwise it is possible to stall the compressor, particularly when the speed is low and the aircraft is sinking. On the approach maintain a minimum of 4500 RPM until committed to a landing.

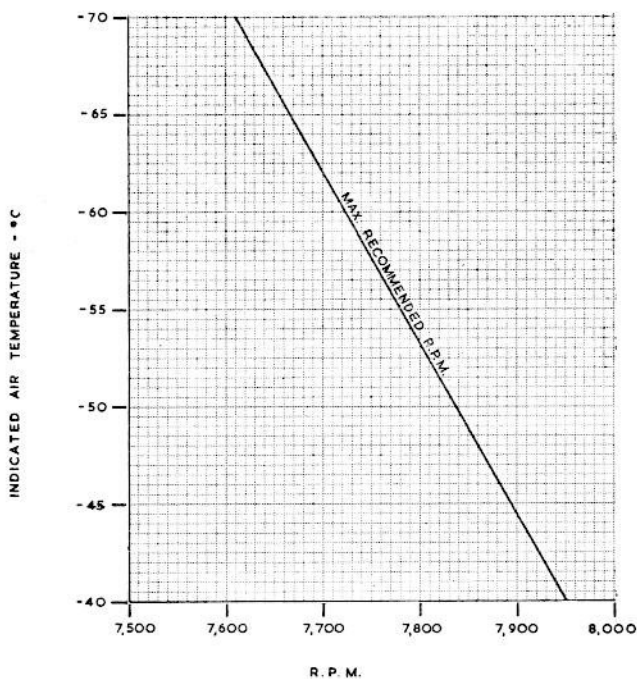
22. *High Level.*

a. Although the ACU is designed to operate at all altitudes its action, and therefore engine acceleration, deteriorates progressively with altitude. Greater care in engine handling is required at high altitudes, especially for the early stages of throttle opening at low IAS. Rapid throttle movement, either opening or closing, may cause compressor stall and engine surge which may lead to severe

overheating or flame-out, particularly at altitudes above 40,000 feet at speeds below 200 knots IAS.

b. In extremely cold temperature conditions, generally associated with high altitude flight in tropical areas, there is a risk of surge followed by flame-out when using high RPM at low IAS. This risk can be obviated by restricting maximum RPM according to variations in indicated air temperature as shown on the graph in Fig 1.

c. Any factor which disturbs the airflow through the engine, such as turbulence, turns at high angles of attack or changes of power setting, can also induce a surge. When operating close to the surge line, more delicate engine handling is essential and if steep turns are necessary or if turbulence is encountered, RPM should be limited to a maximum of 200 below that recommended in Fig 1, to reduce the risk of surge.



3 — 2 Fig 1 Low Temperature Engine Surge

d. If an engine surge occurs, the throttle must be closed immediately and the RPM and JPT allowed to stabilise before attempting to increase RPM again. An increase in speed or a slower throttle movement may be required to obtain a satisfactory engine acceleration. If an engine compressor is stalled at very high altitude and low IAS, it may remain stalled when the throttle is closed and a considerable increase in speed may be necessary to enable the engine to recover to a normal flight idling condition. If unable to obtain flight idling indications or if flame-out occurs following a surge, shut down the engine and attempt a normal

relight at or below the recommended maximum relight altitude.

General Flying

23. *Controls.* The controls are well harmonised and smooth in operation at all altitudes.

a. *Rudder.* The rudder is light and effective at small deflections; it should be used with care at high IAS. Forces increase rapidly as deflection is increased and at all speeds a marked roll occurs when rudder is applied.

b. *Ailerons.* The ailerons are light and effective at low speed and high altitude but they become heavier as speed is increased; they still give good response up to 0.83M but above this mach number their effectiveness decreases. However, at speeds below about 200 knots it is important to use co-ordinating rudder to minimise any difficulty in removing bank arising from rolling moment induced by high yaw forces in the direction of turn.

c. *Elevator.* The elevator is powerful and forces are light, becoming heavier at high speeds. Effectiveness is reduced above 0.84M. (See Part 2, Chapter 2, para 2.)

24. *Trims.* Tailplane incidence control is powerful at all speeds and becomes very sensitive at high speeds. The rudder trim is powerful and quick in operation; it requires care in its use. The aileron trim is the least powerful of the trims.

25. *Tailplane Operation.*

a. *Operation in Flight.* Tailplane runaway can only occur if there is a double failure. If the cut-in switch is held on, in anticipation of trimming, the safety factor provided by the double circuit is removed. If the tailplane moves when the trim switch alone is operated, the flight may be completed and the trim still used, but it should be remembered that the safety of the double circuit will no longer exist and the possibility of a 'runaway' is increased. For this reason speed must then be restricted to a maximum of 250 knots. If the tailplane moves when the cut-in switch alone is operated, the switch must be released immediately; no further attempt may be made to trim in either direction, the aircraft must be restricted to 250 knots, and landed as soon as possible. If any other malfunction of the tailplane trim is experienced, the aircraft should again be landed as soon as possible. With the tailplane stuck at or near the limit of travel in either direction, attempts may be made to return it towards the neutral position. If the trim fails with the tailplane at or near the neutral position, no further attempts to trim should be made.

b. *Limited Tailplane Travel.* The tailplane travel is limited and the aircraft trim adjusted to ensure that longitudinal control can be maintained under any flight conditions within the normal limitations should the tailplane actuator have 'runaway' to the maximum nose-down position, ie the actuator on its mechanical stop. With the tailplane trimmed to the full nose-down position, the aircraft is in trim longitudinally at about 450 knots with flaps up and 125 knots with flaps down. When landing at high AUV in the latter condition, the elevator authority is reduced and care must be taken to make an approach which allows a gentle round-out. ▶

26. *Airbrakes.* At high IAS the airbrakes are effective, even when in the MID position, but below about 300 knots their effectiveness decreases until at approach speed their effect is negligible; at high mach numbers their use causes increased buffeting. The use of (full) airbrakes causes noticeable buffeting, and a nose-down trim change over most of the speed range, becoming more marked near the limiting speed for its use.

27. *Change of Trim.*

Undercarriage down	Slight nose-up
Undercarriage up	Little change
Flaps down	... Strong nose-up
Flaps up	... Strong nose-down
Airbrakes out	... Little change except for nose-down at high mach numbers
Airbrakes in	... Little change
Flare bay doors open or closed	... No change

28. *Buffeting.*

- a. When lowering flaps, slight buffeting occurs which decreases as speed is reduced.
- b. When the flare bay doors are open at high airspeeds and mach numbers some buffeting occurs. Buffeting is correspondingly less with lower airspeeds and mach numbers.

Handling at Aft CG

29. With correct loading and standard fuel management, the CG will remain within limits throughout flight. If, however, the CG moves outside the aft limit due, for example, to incorrect loading or fuel mismanagement/failure, the elevator control forces will be reduced and pitch control will become more sensitive, leading to a possibility of inadvertently exceeding the aircraft's normal acceleration limits. If mismanagement of the fuel or fuel pump failure causes an aft movement of the CG, restrict handling, above 25,000 feet for aircraft without wing-tip tanks

or 37,000 feet with wing-tip tanks, to gentle manoeuvres only until the fuel balance has been restored.

Flying at Reduced Airspeed

30. Reduce speed to approximately 170 knots and keep the flaps up.

Flight in Turbulence

31. *High Altitude.* There is a risk of flame-out at high altitude due to turbulence. The risk is greatest when the variable inlet guide vanes are at the minimum swirl position and forward speed is low. The best protection is obtained by setting the engines at 7000 RPM and maintaining 270 knots/0.72M. At low weights, surplus speed may be used for a gentle climb out of the turbulent area but under no circumstances should normal climbing RPM be set. At high weights, if the recommended speed cannot be maintained at 7000 RPM a gradual reduction of altitude should, if practicable, be accepted.

32. *Low Altitude.* Below 25,000 feet there is little danger of engine surge and flame-out due to turbulence. However, the following speed ranges should be adhered to in moderate to severe turbulence:

Below 10,000 feet	... 250 to 300 knots
10,000 to 25,000 feet	... 270 to 300 knots

Operating in Icing Conditions

33. *General.*

- a. Anti-icing equipment is provided for the engines only and flight in icing conditions should be avoided whenever possible. Ice is particularly likely to form on the airbrakes when they are extended fully, and on the flare bay doors if these are opened. The rate of ice accretion increases rapidly at true airspeeds above 250 knots.
- b. Engine icing may occur both on the ground and in the air when the visible moisture content reduces visibility to 1000 metres or less, and the ambient air temperature is below +5°C with a relative humidity of 90% or more.

c. With engine anti-icing in operation, all throttle movements must be made smoothly and at least 10 seconds allowed to elapse after switching OFF the anti-icing before making any throttle adjustments. There is loss of thrust and economy and usually, a rise of about 20°C in the JPT. At full throttle, eg on take-off, this rise in JPT may necessitate a reduction in RPM to maintain JPT within the limitations. Ground acceleration will be slower than normal and there is slightly less margin from surge.

34. *Engine Starting and Taxying.* If icing conditions exist (see para 33 b), switch ON the anti-icing after starting the engines, and leave ON for taxying.

35. *Take-Off.* When icing conditions prevail, if the runway length is sufficient, take-off with the anti-icing ON. With the anti-icing ON the take-off distance may be increased (refer to ODM). If this precludes the use of anti-icing on take-off, run the engine with the anti-icing ON at 7250 RPM for one minute immediately before take-off and switch OFF the anti-icing before starting the take-off run. As soon as practicable after take-off switch ON the anti-icing and leave it on until clear of icing conditions.

36. *Climb.* Climb at 250 knots until coincident with 0.72M, thereafter maintain 0.72M until the desired altitude is reached. If an alteration in RPM is essential move the throttles smoothly.

37. *In Flight.*

a. The protection given by the anti-icing system is not adequate for continuous flight in icing conditions. When icing conditions are met, switch ON the anti-icing immediately and clear the icing region as quickly as possible. Wait 2 minutes after leaving the icing conditions before switching the anti-icing OFF.

b. Whenever the anti-icing is switched ON, RPM must be maintained at 7250 or above, or in the lower range between 5800 and 6600. However, for maximum protection in the lower range 6100 RPM is the best setting. If conditions necessitate changing the RPM from the lower to the higher range, or vice versa, the throttles should be moved smoothly and without hesitation through the intermediate range.

c. If the recommended RPM figures are not maintained and icing is moderate to severe, surge or possibly flame-out may result. If an engine surges, close the throttle, allow the RPM and JPT to stabilise and if possible descend to below the freezing level before opening the throttle again. If flame-out occurs as a result of surge, carry out the **Normal Relight** drill. If flame-out occurs with no symptoms of surge or mechanical failure, an **Immediate Relight** may be attempted.

38. *Descent and Landing.* Switch on the anti-icing before descending into icing conditions and maintain a minimum of 5800 RPM to ensure adequate heating. Descend through the icing layer as quickly as possible, bearing in mind the airframe icing considerations given in para 33a. If icing conditions exist down to circuit height or below, maintain 6100 RPM throughout the approach procedure; lower the

undercarriage when approaching the glidepath but do not lower flaps or reduce RPM below 5800 until committed to a landing.

39. *Asymmetric Approach in Icing.* At the maximum landing weight of 40,000 lb, approximately 6700 RPM is required when making an instrument approach on one engine. In these circumstances, when icing conditions prevail at the pattern and final approach heights, it is recommended that fuel be burnt off in order to reduce the AUV to below 35,000 lb before descending into the icing region. This procedure will permit a more satisfactory engine RPM setting, not exceeding 6600, to be used during the later stages of an instrument approach. If it becomes necessary to overshoot, care must be taken to open the throttle smoothly and without hesitation through the range of 6600 to 7250 RPM. If circumstances dictate that a landing has to be carried out at weights requiring a power setting between 6600 and 7250 RPM, great care must be taken to operate the throttle smoothly and without hesitation.

Stalling

40. The approximate stalling speeds in knots are:

AUV (lb)	Flaps and Undercarriage	
	Up	Down
30,000	81	71
40,000	98	88
50,000	113	102

41. Warning of the approach to the stall is given by slight buffeting which starts some 10 to 15 knots above the stall and becomes moderate as the stall is reached; as the stall occurs, the nose and either wing drop gently together. Use of aileron as the stall occurs aggravates the wing drop. Recovery from the stall is straightforward on releasing backward pressure on the control column with ailerons neutral, although in the initial stage of the ensuing dive slight buffeting may again be encountered and care is required to avoid inducing a further stall through too harsh a recovery to normal flight. If corrective action is taken at any time up to the stall, little or no height is lost; if it is taken after the stall has occurred, recovery can be effected in about 1000 feet.

42. When wing-tip tanks are fitted, the stall warning characteristics are generally similar but occur about 5 knots earlier. In addition the buffeting is more marked and is accompanied by slight aileron snatch; the snatching becomes marked if aileron is used to raise a dropping wing. With vortex generators fitted the aileron snatching is less marked: no benefit will be gained, however, unless both the wing-tip tanks and the wing tips are modified.

43. At any time when *g* loading is applied, ample warning of the approach to a stall is given by buffeting which increases down to the stall proper, at which there is a tendency for either wing to drop. Recovery is immediate upon releasing the pull force on the control column.

44. Because of the great care necessary in engine handling at high altitude, practice stalling at altitudes above 25,000 feet is not recommended.

High Speed Flight

Note 1: The limitations are laid down for structural reasons and must not be exceeded.

Note 2: The high mach-number characteristics may vary slightly from aircraft to aircraft; they also depend, particularly at high altitude, on the angle of dive (rate of increase of airspeed), on *g* loading and on the condition of the aircraft.

Note 3: With wing-tip tanks fitted the compressibility effects described below occur at slightly lower mach numbers, and even lower if they are badly fitted. If complete loss of control occurs recovery may be more difficult.

45. *Below 15,000 feet.* The speed limitation clean is 450 knots or 0.75M whichever is the lower. The speed limitation with wing-tip tanks is 365 knots. The aircraft is easily capable of exceeding its airspeed limitations, even in level flight. As speed increases there will be a slight change of longitudinal trim and, at the maximum speed or mach number, slight intermittent buffeting may occur. If a rapid longitudinal oscillation develops at or near the IAS or mach number limitation, reduce speed as soon as possible until the oscillation ceases. If speed is inadvertently increased above 450 knots, a marked vibration may develop. If this occurs, speed must be reduced immediately. The airbrakes are effective at high IAS but their use is accompanied by noticeable buffeting, especially when OUT is used.

46. *Between 15,000 and 25,000 feet.* The speed limitation clean is 0.79M. The speed limitation with wing-tip tanks is 365 knots or 0.79M. As speed is increased buffeting commences at about 0.77M and increases in strength as speed rises. If the limitation of 0.79M is exceeded, there is a tendency for lateral unsteadiness to develop.

47. *Above 25,000 feet.* The speed limitation clean is the speed at which a strong nose-up change of trim occurs, ie about 0.84M. The speed limitation with wing-tip tanks is 0.80M.

a. Up to about 35,000 feet warning of the approach of severe compressibility effects is given by a strong nose-up change of trim which occurs at

about 0.84M. Below this speed the first symptoms are given by slight buffeting which commences at about 0.78M to 0.80M. At about 0.81M the buffeting increases in intensity and at 0.83M a slight nose-down change of trim occurs followed by a strong nose-up change at about 0.84M. The lateral trim becomes sensitive at these speeds and lateral unsteadiness may be encountered.

b. Above 35,000 feet warning of the approach of severe compressibility effects is given by lateral unsteadiness and the tendency for one wing, generally the port, to drop slowly at about 0.84M. This tendency occurs at slightly lower speeds, between 0.82M and 0.83M at about 45,000 feet. Below these speeds the symptoms are much the same as in sub-para a.

c. Above 35,000 feet if the aircraft is accelerated past the speed at which there is a wing drop, aileron snatching and a loss of aileron effectiveness usually occurs, making it difficult to restore lateral level. At the same time elevator effectiveness falls off markedly and severe buffeting sets in. Should control be lost, great care must be taken to avoid overstressing the aircraft during subsequent recovery at the lower altitudes, when the airspeed may be high. Avoid the use of the tail trim during recovery if possible but if it has to be used extreme care must be taken.

d. The behaviour under compressibility will vary between aircraft and is also likely to vary on individual aircraft, depending on the CG position and the external condition of the aircraft. Although the wing-drop case above is given as being the most critical from the point of view of possible temporary loss of control, other effects such as strong nose-up or nose-down changes of trim, heavy buffeting, lateral rocking and directional instability may be apparent and are equally critical. As soon as compressibility effects become marked, particularly at the highest altitudes, speed must be reduced as the consequences of increasing the speed still further are unpredictable and may be serious. The remarks in this paragraph refer to the clean aircraft and when wing-tip tanks are fitted.

e. Recovery from mild compressibility conditions is best made by throttling back and easing the aircraft out of the dive, care being taken to avoid high *g* loading which will aggravate matters.

f. If loss of control is experienced, the engines must be throttled right back and the airbrakes extended to the MID position; the OUT position must not be used because of the resulting nose-down change of trim. About 10,000 feet may be lost before the mach number has fallen to a figure at which control can be regained. During recovery, *g* loads must be kept low. Avoid the use of

the tail trim during recovery if possible, but if it has to be used extreme care must be taken.

g. At all altitudes if the engine power is high, only a shallow dive is needed to reach limiting speeds.

Descent

48. *Emergency Descent.* The recommended technique for making an emergency descent following cabin pressurisation failure is to close the throttles, extend the airbrakes fully, open the flare bay doors and descend at 0.79M to 40,000 feet and 0.75M/350 knots to below 25,000 feet.

49. *Rapid Descent.* For a rapid descent, close the throttles, extend the airbrakes fully and descend at

0.79M above 40,000 feet and 0.75M/350 knots below.

50. *Normal Descent.* For a normal descent, close the throttles, extend the airbrakes to the MID position and descend at 0.75M until a coincident speed of 250 knots is reached, maintaining that speed thereafter.

51. *Descent in Icing Conditions.* See para 38.

52. *Use of Canopy Internal Demister.* To obtain maximum efficiency from the internal demisting system, start demisting 10 minutes before the descent. To avoid overheating the canopy the internal demister should not be on at any other time than that required for the descent.

PART 3

CHAPTER 3—CIRCUIT AND LANDING PROCEDURES

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Approach and Landing

1. Carry out the **Pre-Descent/Recovery Checks** and **Pre-Landing Checks** given in the FRC. Threshold speeds are shown in Fig 1. These speeds may be increased by 5 to 10 knots when there is a strong surface wind or in gusty or turbulent approach conditions.

2. *Normal Landing.*

a. Ascertain the threshold speed corresponding to the aircraft weight. The initial approach should be made at a minimum of threshold speed plus 30 knots. This speed should be attained by the time the aircraft is lined up with the runway, flaps being lowered as required at any time after the start of the final turn. At speeds above approximately 125 knots full nose-down trim is required when flaps are fully down.

b. When the aircraft is lined up with the runway with flaps down, reduce speed gradually, aiming to cross the runway threshold at threshold speed with power on. Do not allow the speed to fall below the minimum approach speed, ie threshold speed plus 10 knots, or reduce power below 4500 RPM until the decision to land has been made. Close the throttles just before touchdown.

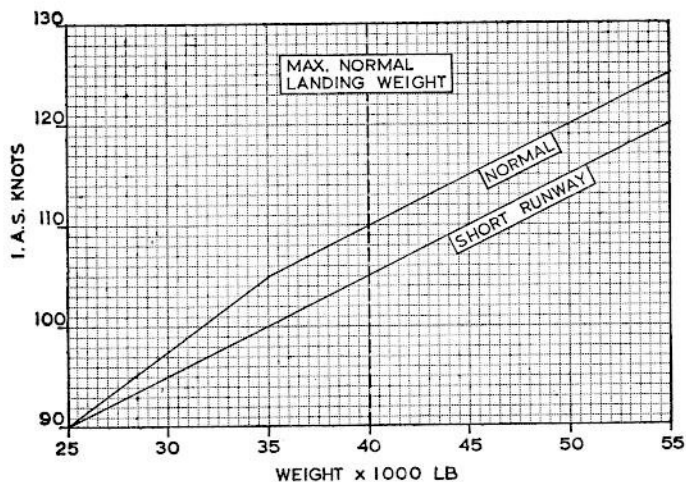
c. When the mainwheels are firmly on the runway, lower the nosewheel and when below maxi-

mum braking speed, apply the brakes (see para 13). Aerodynamic braking is not recommended for a normal landing.

d. When landing at high AUW, it is important to trim out the nose-down change of trim which occurs as speed is reduced in the final stages of the approach; this is to ensure that adequate elevator control is available for the round-out.

3. *Short Runway Landing.* When the landing run available is limited or the runway is wet or icy, use the following technique. Make the approach using the normal approach speeds. When the decision to land has been made, reduce speed gradually to cross the threshold at the short runway threshold speed, power being maintained until just before touchdown. There is a marked tendency to sink if the throttles are closed prematurely or too quickly.

4. *Landing With a Forward CG.* If landing with a forward CG, increase the threshold speed by 5 knots above the normal speed for the weight. A forward CG should only occur if the fuel drill is not followed or if the fuel system has not functioned correctly. In cases of doubt, ascertain the extent of control in the landing configuration at a safe height and adjust the approach and threshold speeds accordingly.



3 — 3 Fig 1 Threshold Speeds

5. *Approximate All-Up Weights (lb) (With Wing-Tip Tanks)*

Crew only	25,250
Crew plus full fuselage and integral tanks	47,400
Crew plus full fuselage, integral and wing-tip tanks	51,300

Note: No role equipment is included in the above AUW.

Flapless Landing

6. Before making a flapless landing, reduce the weight as much as practicable, using the normal fuel drill.

7. The initial approach should be made at the normal threshold speed plus 30 knots. When lined up with the runway, reduce speed further to not less than 20 knots above the normal threshold speed. The approach should be longer and slightly flatter than normal.

8. Throttle back early, aiming to cross the threshold 10 knots faster than the normal threshold speed at the same weight.

9. After touchdown lower the nosewheel onto the runway and when below maximum braking speed apply the brakes (see para 13). Aerodynamic braking has little effect in the flapless configuration and is not recommended unless a brake pressure failure has occurred prior to landing. If aerodynamic braking is used, careful elevator control is necessary to avoid striking the tail skid on the runway during the landing run.

10. A flapless landing may be carried out safely on a 6000 feet runway at maximum normal landing

weight (40,000 lb). At weights above 35,000 lb if the runway is wet, a 9000 feet runway should be used if available.

Crosswind Landing

11. A crosswind landing presents no special difficulty; the 'crab' technique is recommended. The maximum permitted crosswind component for landing is 25 knots.

◀ **Landing with One Wing-Tip Tank or Integral Tank Full** ▶

12. Determine, at a safe height, the lowest speed for *adequate* control, ie the speed at which rolling manoeuvres up to a maximum of 30° angle of bank can be executed safely in both directions with the undercarriage and flaps down. The threshold speed should not be allowed to fall below the speed for *adequate* control plus 5 knots.

Braking

13. Braking efficiency will be improved, especially on wet runways and/or at low weights, if the control column is moved rearwards as braking commences, thus transferring weight onto the mainwheels. When the nosewheel has lowered on to the runway and the speed is below NMBS (EMBS in emergency), the brakes can be used, dependent on runway conditions, as follows:

a. *Dry Runway.* On dry surfaces the maxaret units will normally prevent the wheels from locking when excessive brake pressure is applied but, unless the shortest possible run is required, more gentle use of the brakes is recommended. The aircraft must be firmly on the ground before the brakes are applied as the maxaret units do not operate unless the wheels are rotating. As a safeguard against locking of the wheels during a bounce the maxaret units remain operative for several seconds. If a skid is felt or if difficulty is experienced in keeping straight, release the brakes momentarily. In normal circumstances it should not be necessary to apply the brakes at ground speeds above 90 knots.

b. *Wet Runway.* Retardation may be considerably reduced, depending upon the degree of wetness and the type of runway surface. Maximum braking efficiency will be obtained by making a firm touchdown, then applying light intermittent braking as soon as the aircraft is firmly on the ground and the wheels have had time to spin up. Once positive braking action has been established, continuous braking should be used as necessary to bring the aircraft to rest using the full length of the runway. Although the maxaret units are designed to prevent skidding, under the worst conditions even light braking may cause the wheels to

spin down and eventually lock. If this is suspected the brakes must be released and the wheels given time to spin up before they are re-applied gradually.

c. *Flooded Surfaces.* With an appreciable depth of water on the runway (ie about 0.2 inch or more), friction between the tyres and the surface is drastically reduced and aquaplaning may occur. In these circumstances braking action is virtually nil and, even though the brakes are not applied, the wheels may spin down to a stop. The speed at which total aquaplaning occurs is dependent upon the type of runway surface and the tyre tread pattern but, given the right conditions, the tyres may aquaplane at ground speeds above approximately 95 knots. At lower speeds partial aquaplaning may still be present but braking action will improve as speed is reduced further. Because of this drastic loss of braking effect, flooded runways should be avoided whenever possible; if, however, a landing must be made, the recommendations in sub-para b above still apply but aerodynamic braking should be used for as long as possible, depending upon runway length. If the brakes have been applied they should be released before the aircraft enters a pool and if the control column is being held back to transfer weight onto the mainwheels, it must be moved forward to prevent the nose from rising.

d. *Icy Runways.* Whenever possible these conditions should be avoided due to the certainty of the drastic reduction in braking effectiveness on icy surfaces. However, if a landing has to be made, extreme caution is required. The brakes must be used most carefully, as continuous application of excessive pressure can lead to wheel locking and subsequent tyre damage. Aerodynamic braking may be used for as long as possible, depending upon runway length.

14. *Brakes Overheating.* Avoid overheating the brakes by using them judiciously according to the length of runway. If heavy braking is used, subsequent taxiing should be reduced to a minimum; if possible, the aircraft should be parked for 30 minutes with the wheels chocked and the parking brake off, to allow the brakes to cool before taxiing. Alternatively, it may be advisable to shutdown the engines and be towed from the end of the runway.

15. *Normal Maximum Braking Speed (NMBS).* NMBS is the highest speed, for given conditions, at which maximum continuous braking may be applied and the aircraft brought to rest without loss of braking efficiency and without damage to the brakes. NMBS is obtained from the ODM. The brakes should never be applied at speeds above NMBS except in emergency.

16. *Emergency Maximum Braking Speed (EMBS).* EMBS is the highest speed, for given conditions, at which maximum continuous braking may be applied and the aircraft brought to rest but with liability of damage to the brakes. If maximum continuous braking is applied at higher speeds, the brakes will overheat and fail before the aircraft is brought to rest. The brakes should never be applied at speeds above EMBS except in the circumstances given in Chapter 2, para 11. EMBS is obtained from the ODM and applies in emergency only.

17. *Brake Fire.* If, after landing, the brakes are observed to be smoking or on fire, the HP cocks should not be closed until fire appliances are available because dumped fuel may ignite beneath the aircraft. If fire appliances are not readily available, the engines should be stopped by switching off all LP cocks and pumps, leaving the HP cocks open. Stopping the engines by this method must be reported, so that the fuel system can be primed before the next start.

Instrument Approach

18. *Two Engines.*

a. Reduce speed to below 190 knots and carry out the **Pre-Landing Checks**. Calculate the threshold speed from the graph in the FRC. (See also Fig 1 above.)

b. When the undercarriage is down, set the required RPM (approximately 6300 RPM at 30,000 lb — 6600 RPM at 40,000 lb AUW) to maintain threshold speed plus 40 knots. Only small power adjustments should be necessary until the threshold is reached.

c. Lower the flaps when the glidepath is intercepted and reduce the speed to threshold speed plus 30 knots. To achieve the desired rate of descent and at the same time counteract the nose-up change of trim as the flaps travel down, a steady push forward on the control column is required until the flaps are fully down and the aircraft is trimmed into the descent. With full nose-down trim applied, a residual push force will remain until the speed is below approximately 125 knots.

d. Maintain threshold speed plus 30 knots until about 500 feet AGL, then reduce speed gradually, aiming to cross the runway threshold at threshold speed. Do not allow the speed to fall below threshold speed plus 10 knots or reduce power below 4500 RPM until committed to a landing.

19. *Asymmetric Approach and Engine Failure on the Approach.* See Chapter 4, para 8 to 10.

20. *Instrument Approach in Icing Conditions.* See Chapter 2, para 33 to 38.

Overshooting

◀ 21. An overshoot followed by an instrument approach and landing requires about 1250 lb of fuel. ▶

22. Open the throttles smoothly to 7400 RPM, checking that symmetrical power is being obtained before selecting undercarriage and flaps up (both systems travel together taking a total time of approximately 16 seconds to retract, the undercarriage retracts in about 10 seconds). At high AUV a higher power setting may be necessary to accelerate to the recommended climbing speed of 175 knots. There is a strong nose-down change of trim during the last half of flap travel; anticipate this by progressive application of nose-up trim as the flaps retract. The aircraft accelerates rapidly and any tendency to sink is easily held.

23. If an engine malfunction occurs when power is being applied for an overshoot, raise the flaps immediately (above 200 feet AGL) and increase power on the serviceable engine only within the limit of directional control. If the malfunction occurs below 600 feet AGL the aircraft must be landed, if possible on the runway and preferably with the undercarriage down. The overshoot may only be continued if by 600 feet AGL the flaps are fully retracted and the speed is above the asymmetric initial approach speed.

24. Overshooting below 200 feet AGL is not recommended because of the possibility of an engine malfunction occurring during acceleration from low RPM, causing high asymmetric thrust and consequent directional control problems at low level with low airspeed.

Roller Landing

25. Extreme care is necessary when carrying out a roller landing because of the danger of compressor stall and engine surge occurring while the engines are being accelerated from idling, especially in cross-wind conditions. If it becomes necessary to go round again from the runway or if a roller landing is carried out for instructional purposes, careful throttle handling and engine monitoring is essential,

and the following precautions must be observed:

- a. After touchdown lower the nosewheel onto the runway.
- b. Keeping the throttles together increase power, slowly initially to allow the engines to accelerate at the same rate. This is particularly critical up to 6000 RPM.
- c. At 7000 RPM, with the throttles aligned, compare JPT and check that symmetrical thrust is being obtained before opening the throttles further.
- d. Keep the nosewheel on the runway until the engines are at the required take-off RPM (minimum 7400) and unstick at not below the threshold speed for the AUV and flaps position.
- e. If at any time prior to unstick an engine malfunction is suspected or there is any indication of asymmetric thrust, the throttles must be closed immediately and the take-off aborted.

Checks After Landing

26. Carry out the **After Landing Checks** given in the FRC. ▶◀

27. If the surface wind is above 25 knots, the rudder lock should be fitted for taxiing, if practicable before the aircraft is turned out of wind. In wind speeds above 35 knots, the aileron and elevator locks should also be fitted.

28. After parking for an 'engines-running crew change', the aircraft must be made **Safe for Parking** before crew changeover. The relieving crew must carry out the **Crew Changeover Checks** given in the FRC before taxiing.

Shutdown Procedure

29. Before stopping the engines, trim the tailplane to fully nose-down and then give one 'blip' up on the tail-trim switch to ease tension on the tailplane microswitch spring. This will prevent ingress of moisture to the actuator jack.

30. Carry out the **Shutdown Checks** given in the FRC.

PART 3

CHAPTER 4—ASYMMETRIC FLYING

Contents

	Para
Stopping an Engine in Flight	1
Flying on One Engine	2
Relighting an Engine in Flight	4
Relighting in Icing Conditions	7
Asymmetric Approach, Landing and Overshoot	8
Engine Failure on the Approach	10
Double Flame-Out	11

Stopping an Engine in Flight

1. If an emergency or malfunction necessitates shutting down an engine in flight or when practising emergency procedures, close the HP cock and carry out the appropriate **Engine Fire** or **Failure** drill given in the FRC. When shutting down an engine in flight in circumstances which do not require immediate closure of the HP cock, use the following sequence:

- a. Carry out the electrical load shedding drill given in the FRC.
- b. Switch off the generator.
- c. Check DC voltage and confirm that the other generator warning light is out.
- d. Close the throttle and shut the HP cock.
- e. Switch off the appropriate LP pumps and engine air switch.

Flying on One Engine

2. The aircraft has a good single-engine performance and the rudder trim is powerful enough to trim out all foot loads at normal cruising speeds.

3. When only one generator is operating, use the tailplane trim as little as possible as the initial power load imposed is high.

Relighting an Engine in Flight

4. *Immediate Relight.* If an engine flames out and there are no indications of mechanical failure, an immediate relight may be attempted by pressing the relight button for 5 seconds and then releasing it, leaving the throttle and HP cock at their set positions. A successful relight will be indicated when the RPM stabilises and then begins to rise. It will probably be necessary, particularly at high altitude, to close the throttle after the RPM has stabilised in

order to stop the JPT rising beyond the limits. If JPT increases without a corresponding increase in RPM, close the throttle and then open it again slowly.

5. *Flame-Out.* If an immediate relight fails or is impracticable, carry out the **Flame-Out** drill given in the FRC and then try a **Normal Relight**.

6. *Normal Relighting.* Normal relighting is practicable at altitudes up to 35,000 feet but if range is of paramount importance, one attempt may be made at higher altitude. Relighting becomes progressively more certain with reduction of altitude and airspeed; therefore, attempting to relight above 35,000 feet is not recommended. Above 25,000 feet speed must be reduced to below 200 knots; below 25,000 feet relighting may be attempted at any speed. The **Normal Relight** drill is given in the FRC.

Relighting in Icing Conditions

7. See Chapter 2, para 37. c.

Asymmetric Approach, Landing and Overshoot

8. *Approach and Landing.*

a. Carry out the **Pre-Landing Checks** (but see sub-para c) but instead of calculating the threshold speed, use the asymmetric initial and final approach speeds for the AUW as follows:

Minimum Asymmetric Approach Speeds:

	<i>Below 45,000 lb</i>	<i>Above 45,000 lb</i>
Initial approach speed to 600 feet AGL (VCH) ...	150	160
Final approach speed from 600 feet AGL until certain of landing	135	145

b. A straight-in instrument approach is recommended. If a visual circuit is flown, extend the downwind leg to give a longer approach path. Start the finals turn so as to roll out between 650 and 750 feet on the extended centreline and on the normal glidepath to allow sufficient time to stabilise the approach before reaching VCH.

c. To avoid using high asymmetric power on an instrument approach, the undercarriage should not be lowered until the start of the glidepath descent. Approximately 6300 RPM will be required at an AUV of 30,000 lb. When carrying out a visual circuit at high AUV, lowering of the undercarriage may be delayed until near the end of the downwind leg. Whenever limited **Pre-Landing Checks**, excluding undercarriage lowering, have been carried out, they must be completed when the undercarriage is selected down by confirming 'three greens' and checking the brakes.

d. For asymmetric approaches, it is recommended that the rudder trim be set to the neutral position immediately before commencing final descent.

e. The approach should be made using a 3° glidepath. Do not reduce speed below the recommended initial approach speed, nor height below 600 feet AGL (VCH) until the final decision to land is made. When committed to a landing, reduce speed progressively by use of the throttle (minimum 4500 RPM) to not below the recommended final approach speed. Maintain this speed until absolutely certain of crossing the threshold, then close the throttle. Flaps may then be lowered to reduce the landing run but must never be selected down above 100 feet AGL. At speeds below 125 knots, the nose-up change of trim as the flaps move fully down is negligible. However, the change of trim becomes progressively more marked at the increased speeds associated with higher AUV.

f. The calculation of threshold speed for asymmetric landing is considered unnecessary, since if the technique is correctly used the speed over the threshold will always be above the flapless threshold speed.

9. *Overshoot.*

a. An overshoot can be made safely provided the wings are level, the flaps are up, the speed is at least 150 knots, (160 knots at 45,000 lb and above) and that height is 600 feet AGL (VCH) at the start of the overshoot.

b. As soon as the decision to overshoot is made, maintain the speed at not less than the initial approach speed (para 8 a), by diving if necessary, ensure that the wings are level and then increase

power on the live engine within the limits of directional control to about 7400 RPM, maintain the slip ball central by progressive application of rudder. Retract the undercarriage and check that the flaps are up. Climb away at 175 knots. If necessary, power may be further increased after the speed has increased from the initial approach speed, provided directional control can be maintained (slip ball held central) by use of rudder.

c. The initial overshoot power setting of about 7400 RPM is normally sufficient for a climb back to circuit height. Should 7400 RPM not produce a satisfactory climb performance for any reason, speed should be allowed to increase so that additional power can be used safely or, if height is critical, up to 10° of bank should be applied towards the live engine.

Engine Failure on the Approach

10. If an engine failure occurs during a normal two-engine approach, proceed as follows:

a. *If Above 600 feet AGL.* Decide whether to continue the approach or to overshoot. If possible, continue the approach; however, an overshoot may be made provided that the flaps can be fully retracted and the initial asymmetric approach speed can be achieved with wings level by 600 feet AGL. To overshoot, use the procedure recommended in para 9 b, selecting undercarriage and flaps up together. To continue the approach to land, increase power on the live engine within the limits of directional control, raise the flaps immediately and recover to the normal glidepath at the appropriate asymmetric approach speed. Adjust power thereafter as required.

b. *If Below 600 feet AGL.* The aircraft must be landed, if possible on the runway and preferably with the undercarriage down. Increase power on the live engine within the limits of directional control to counteract any increase in the rate of descent, then:

(1) *If Above 200 feet AGL.* Raise the flaps immediately. As the flaps retract and the speed increases, adjust power to achieve and maintain the asymmetric final approach speed.

(2) *If Below 200 feet AGL.* At this height little advantage is gained by raising the flaps. However, at the normal minimum approach speed with flaps down it should be possible to apply sufficient power within the limits of directional control to make a safe landing.

Double Flame-Out

11. If a double flame-out occurs, a relight on one engine may be attempted immediately, while the RPM is decreasing, by pressing the relight button for

5 seconds and then releasing it leaving the throttle at its set position. A successful relight will be indicated by the RPM stabilising and then starting to rise. Ensure, by throttling back, if necessary, that the maximum JPT (680°C) is not exceeded.

12. If double flame-out occurs below the recommended maximum altitude for relighting, first ◀switch ON the LP pump of another tank before▶ attempting an immediate relight.

13. If an attempt to relight an engine as above is unsuccessful, carry out on each engine in turn the **Flame-Out** drill given in the FRC and reduce electrical loads to an absolute minimum. If above the recommended maximum relight altitude, descend to it as rapidly as possible, commensurate with the need to avoid trimming, and carry out on one engine only the **Normal Relight** drill given in the FRC. When that engine has relit, switch its generator on and relight the other engine.

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PART 4

EMERGENCIES

List of Chapters

	Chapter
INDEX TO MALFUNCTIONING AND EMERGENCY PROCEDURES	1

PART 4

CHAPTER 1 — INDEX TO MALFUNCTIONING AND EMERGENCY PROCEDURES

The following table lists the location of all malfunctioning and emergency procedures covered in the text of the Manual and in the Flight Reference Cards.

<i>Malfunction or Emergency</i>	<i>Location in Manual</i>			<i>Location in FRC</i>
	<i>Part</i>	<i>Chapter</i>	<i>Para</i>	<i>Card Tab Index</i>
Abandoning (Pilot)	1	10	32	} Abandoning
Abandoning (Navigator)	1	10	34 to 36	
Abandoning (Passenger)	1	10	39	
Abandoning via Entrance Door	1	10	9 & 39	
Barrier Engagement	3	2	10 & 11	} Barrier Ditching
Ditching	—	—	—	
Electrical System:				
Load Shedding	1	1	26	} Electrical
Single Generator Failure	1	1	24	
Failure of Both Generators	1	1	25	
Overvolting	1	1	27	
Low Voltage	1	1	24d	
No 1 and No 2 Inverter Failure	1	1	28 & 29	
No 6 Inverter Failure	1	1	30	—
No 7 Inverter Failure	1	1	31	—
No 8 Inverter Failure	1	1	32	—
Emergency Batteries	1	1	18	—
Emergency Evacuation on the Ground	—	—	—	Emergency Evacuation
Engine Systems:				
Mechanical Failure	—	—	—	} Engine Failure and Relighting
Flame-Out	3	4	4	
Double Flame-Out	3	4	11	
Immediate Relight	3	4	4	
Normal Relight	3	4	6	
Failure to Relight	—	—	—	} Engine Surge
Engine Surge at Altitude	3	2	22	
Failure after Take-Off	3	2	12	
Operating in Icing Conditions	3	2	33 to 39	
Handling in Service Turbulence	3	2	31 & 32	
Fire:				
Fires on the Ground	—	—	—	} Fire
Wheelbrake Fire	3	3	17	
Engine Fire	1	7	1 to 4	
Cabin Fire	1	7	7	
Fuselage Fire	1	7	5	—

<i>Malfunction or Emergency</i>	<i>Location in Manual</i>			<i>Location in FRC Card Tab Index</i>	
	<i>Part</i>	<i>Chapter</i>	<i>Para</i>		
Fuel:					
LP Pump Failure ...	1	2	25 to 28	} Fuel	
Gravity/Suction Feed ...	1	2	28		
Jettisoning Procedures:					
Wing-tip Tanks ...	1	2	3b	} Jettisoning	
Pilot's Canopy ...	1	10	4 & 6		
Navigator's Hatch ...	1	10	5 & 6		
Entrance Door ...	1	10	9		
Landing:					
Flapless ...	3	3	6 to 10	} Pre-Landing	
Asymmetric ...	3	4	8		
After Undercarriage Malfunction ...	—	—	—	} Hazardous Landings	
Forced Landing ...	—	—	—		
◀ With One Wing-Tip Tank or Integral Tank Full ... ▶	3	3	12		
Oxygen:					
MI Failure ...	—	—	—	} Oxygen	
Emergency Oxygen ...	1	9	7 to 9		
Partial System Failure ...	1	9	17		
◀ Smoke or Fumes ... ▶	—	—	—	Smoke or Fumes ▶	
Pressurisation:					
Pressurisation Failure ...	1	8	13 & 14	Pressurisation	
Hydraulic System Malfunctions ...	1	3	13 to 15	} UC and Hydraulic Failures	
Undercarriage:					
Failure to Retract ...	—	—	—		
Failure to Lower ...	1	5	19		
Emergency UP selection ...	1	5	18 & 25		
Wheelbrakes:					
Hydraulic Failure ...	1	5	24 & 25		
Flare Bay Doors:					
Failure to Open ...	1	12	9		

PART 5
ILLUSTRATIONS

PART 5**CHAPTER 1—ILLUSTRATIONS****List of Illustrations**

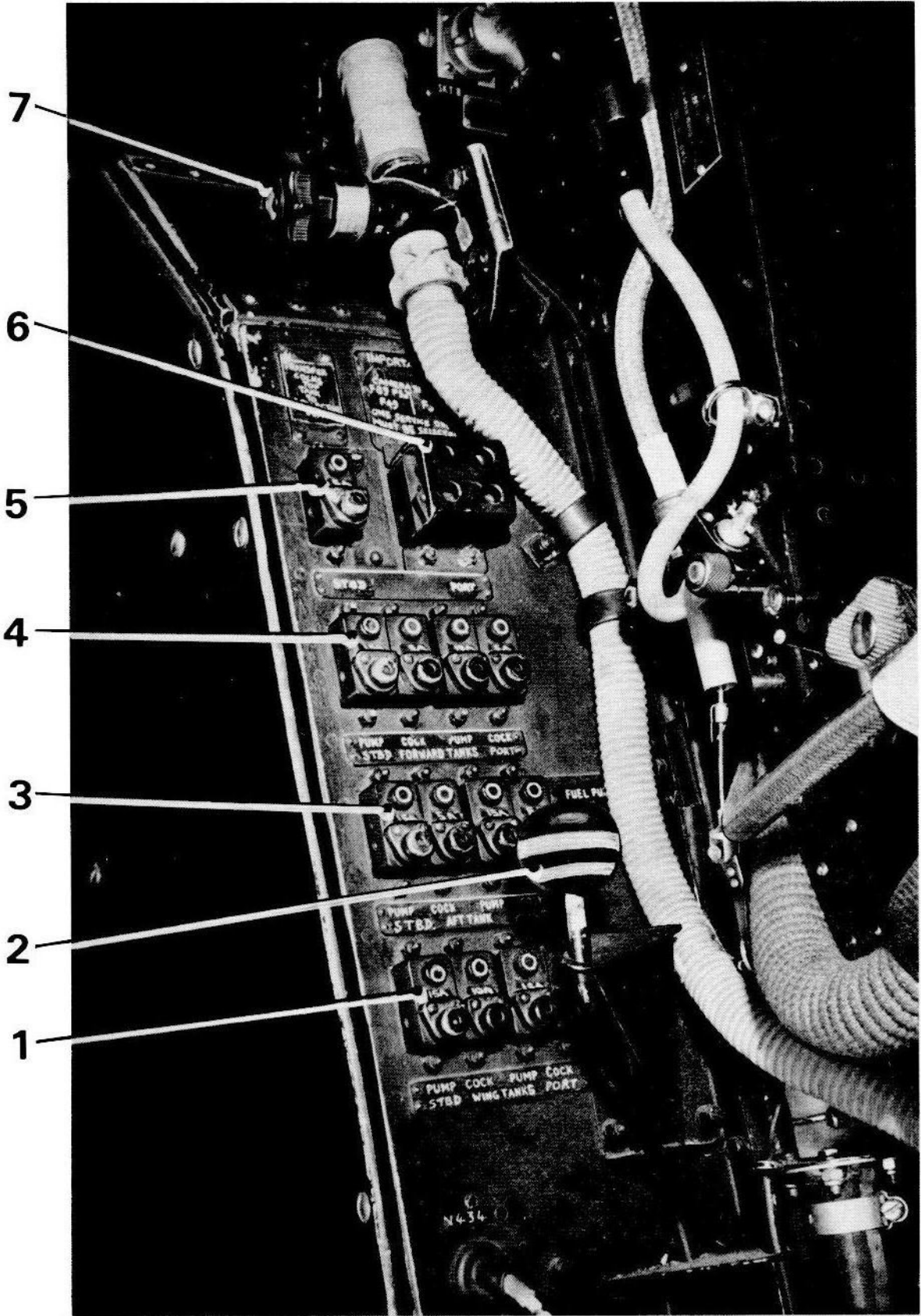
	Fig
Electrical Control Panel, Front Face	1
Electrical Control Panel, Rear Face	2
Cockpit, Port Side	3
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Cockpit, Flight and Engine Instrument Panels	5
Cockpit, Coaming and Miscellaneous Instrument Panels	6
Cabin Port Wall	7
Cabin Forward View	8
Cabin Starboard Wall	9

**Key to Fig 1 — Electrical Control Panel,
Front Face**

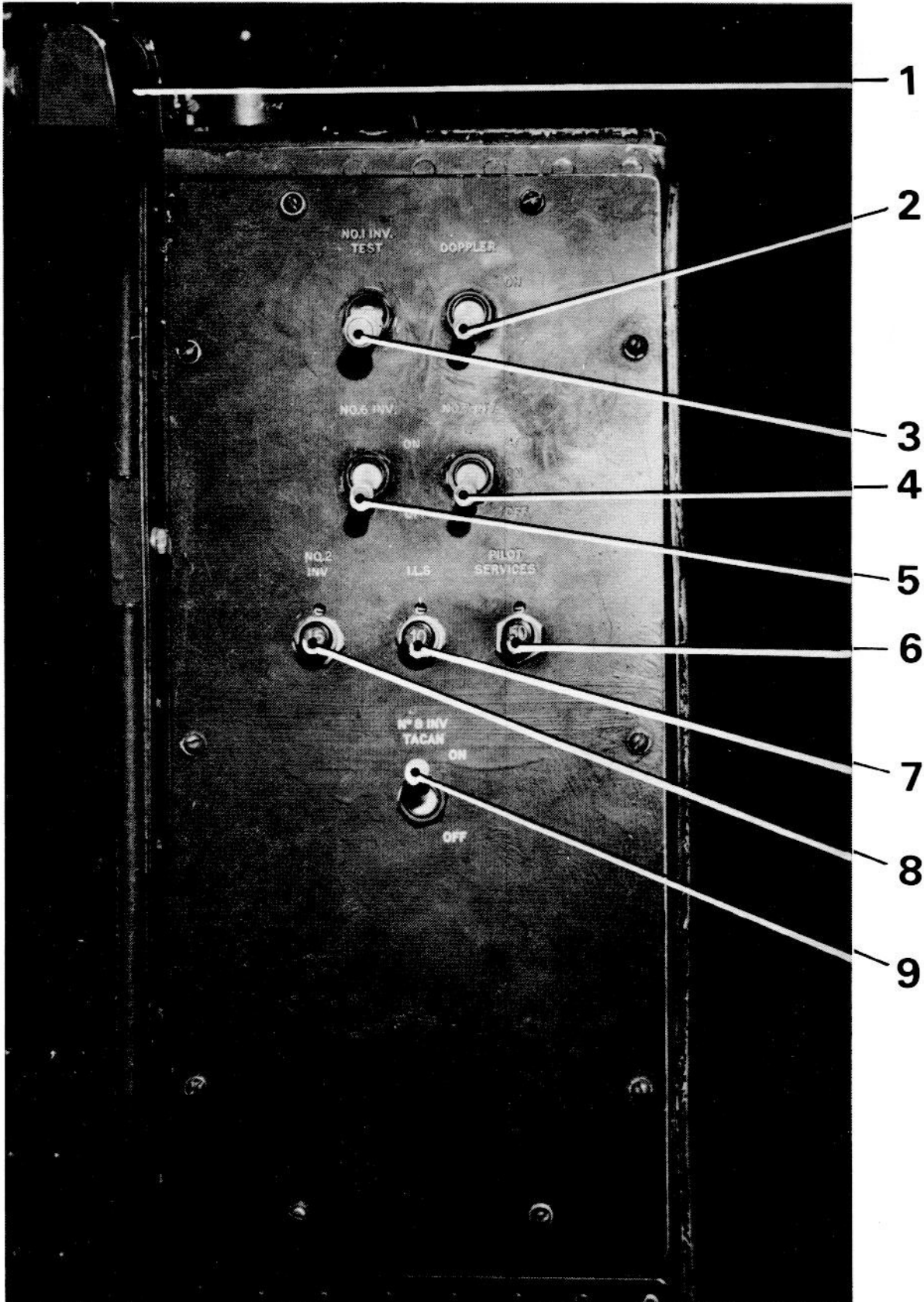
- 1 Wing integral tanks pumps and cocks circuit breakers
- 2 Pilot's emergency oxygen control knob
- 3 Rear tank cocks and pumps circuit breakers
- 4 Belly tank cocks and pumps circuit breakers
- 5 Top tanks transfer cock circuit breaker
- 6 F52/49 and F97 cameras circuit breakers
- ◀ 7 Ventilated suit control valve ▶

**Key to Fig 2—Electrical Control Panel,
Rear Face**

- 1 Red floodlamp
- 2 Doppler switch
- 3 No 1 inverter test switch
- 4 No 7 inverter and 6/7 changeover switch
- 5 No 6 inverter switch
- 6 Pilot's services circuit breaker
- 7 ILS circuit breaker
- 8 No 2 inverter circuit breaker
- 9 No 8 inverter Tacan switch



5 - 1 Fig 1 Electrical Control Panel, Front Face



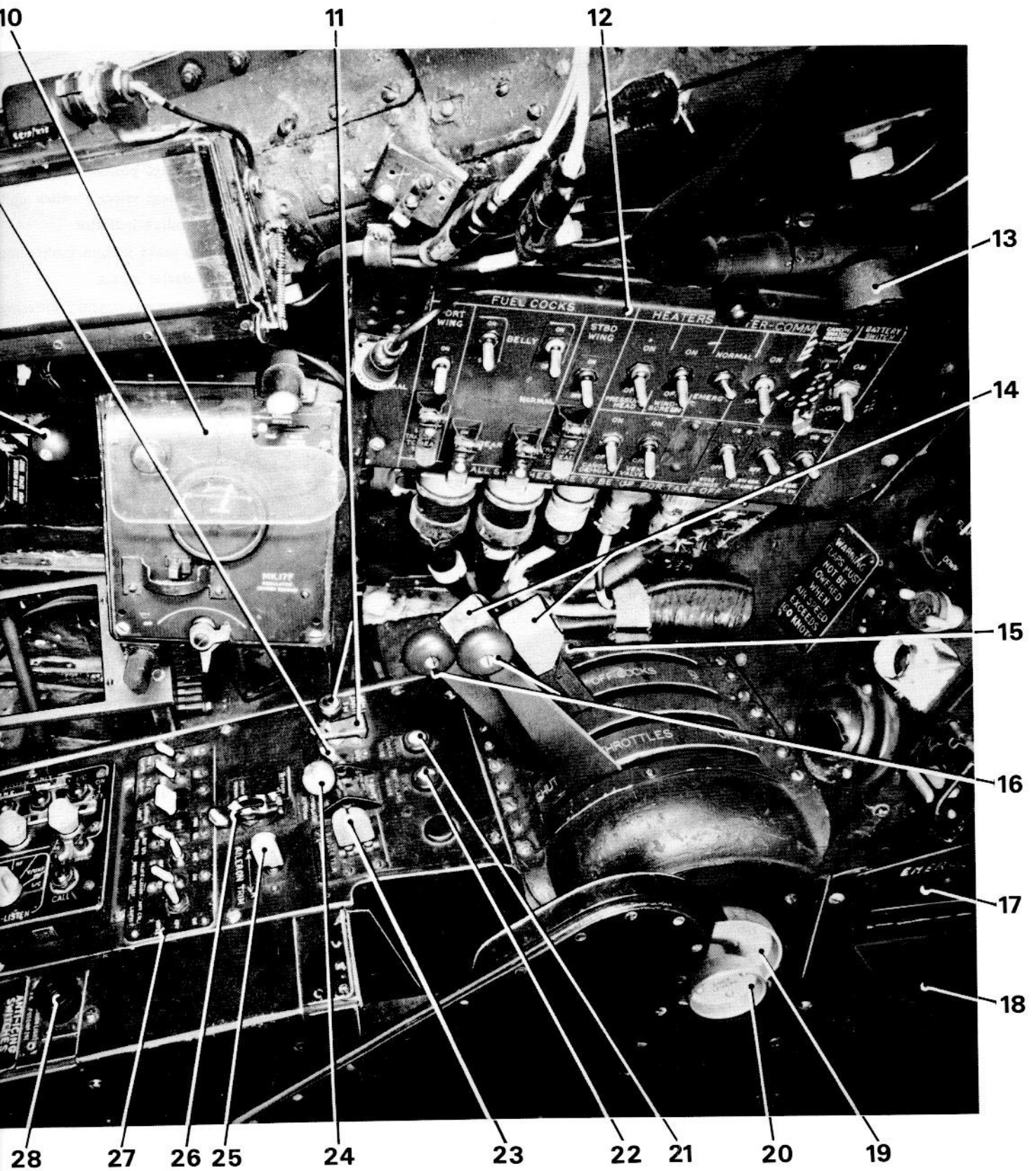
5 - 1 Fig 2 Electrical Control Panel, Rear Face
◀ (Post - SRIM 4012) ▶

Key to Fig 3 — Cockpit, Port Side

- | | |
|---|---|
| 1 Station box | 13 Canopy internal demister control |
| 2 Fuse panel | 14 HP cock levers and engine relight switches |
| 3 Panel lamps dimmer switch | 15 Canopy jettison switch |
| 4 Console lamps dimmer switch | 16 Throttle control levers |
| 5 Frequency card holder lamps switch | 17 Hinged access panel to emergency battery terminals |
| 6 Ventilation louvre | 18 Maps stowage |
| 7 Flare doors emergency control | 19 Friction damper, throttle levers |
| 8 Illuminated radio frequency card holder | 20 Friction damper, HP cock levers |
| 9 Camera doors control switch | 21 Camera doors magnetic indicator |
| 10 Oxygen regulator | 22 Flare doors magnetic indicator |
| 11 Armament safety switch and indicator light | 23 Rudder trim switches |
| 12 Take-off panel, comprising: | 24 Flare doors selector |
| FUEL COCKS switches: | 25 Aileron trim switch |
| Port wing integral tank | 26 Photoflash jettison switch (inoperative) |
| Wing transfer to rear tank (port) | 27 Lighting switches, left to right: |
| Belly tank port and starboard | Navigation lights |
| Rear tank port and starboard | Taxying lamps |
| Starboard wing integral tank | Landing lamp |
| Wing transfer to rear tank (stbd) | External lights master |
| HEATERS switches: | Identification light (morse) |
| Pressure head | Identification light (steady) |
| Windscreen (DV panel) | Anti-collision lights |
| Canopy demist | 28 Anti-collision lights fuse |
| Vent valves | 29 Port engine anti-icing magnetic indicator |
| Nose demist | 30 Port engine anti-icing switch |
| INTER-COMM switches: | 31 Starboard engine anti-icing magnetic indicator |
| Normal/emergency intercom | 32 Starboard engine anti-icing switch |
| Intercom master switch | |
| CANOPY/SNATCH MASTER switch | |
| BATTERY SWITCH | |
| GEN OFF LINE switches (port and starboard) | |



5 - 1 Fig 3 Cockpit, Port Side
◀ (Post - SRIM 4012) ▶



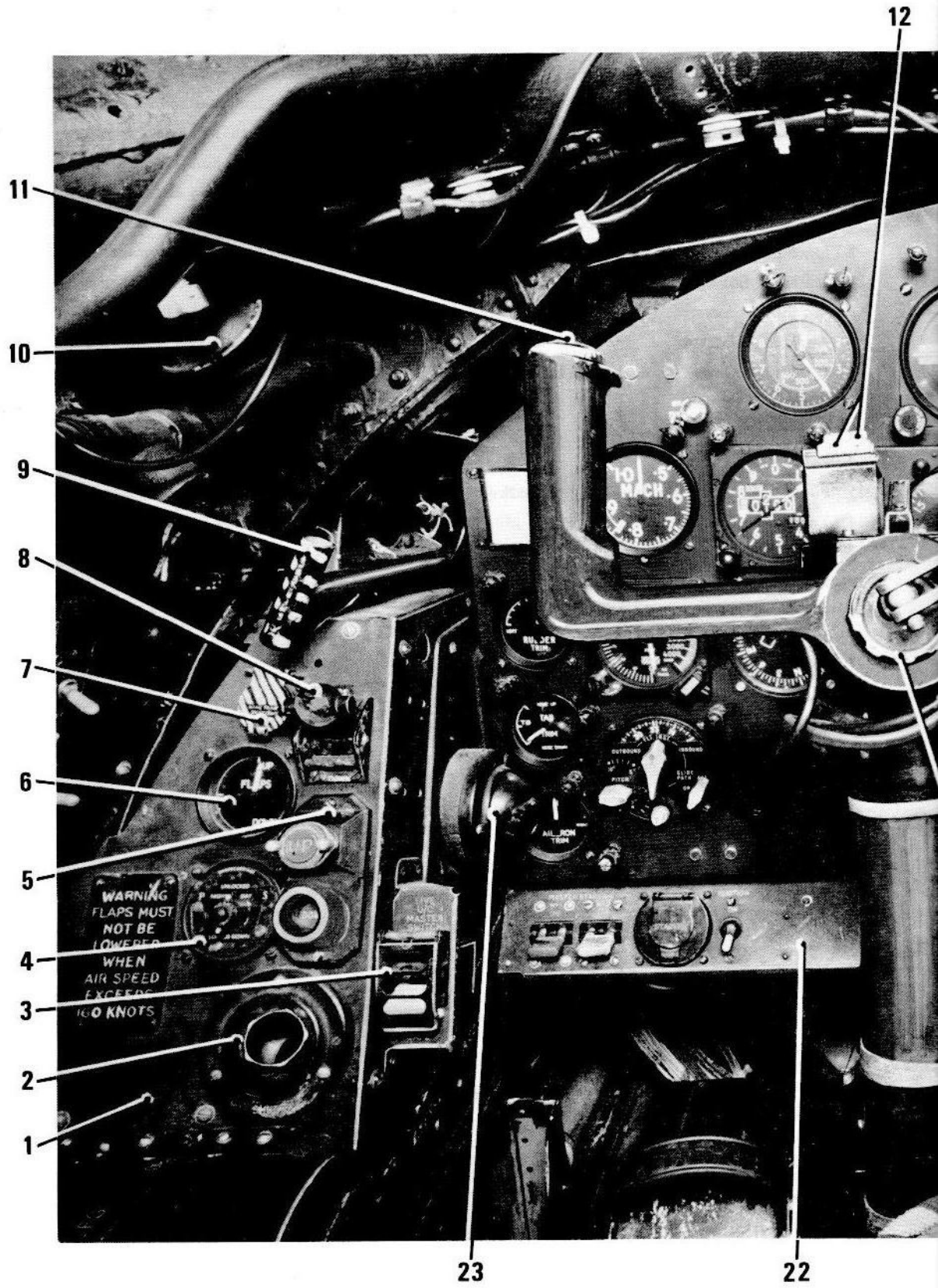
5 - 1 Fig 3 Cockpit, Port Side
◀ (Post - SRIM 4012) ▶

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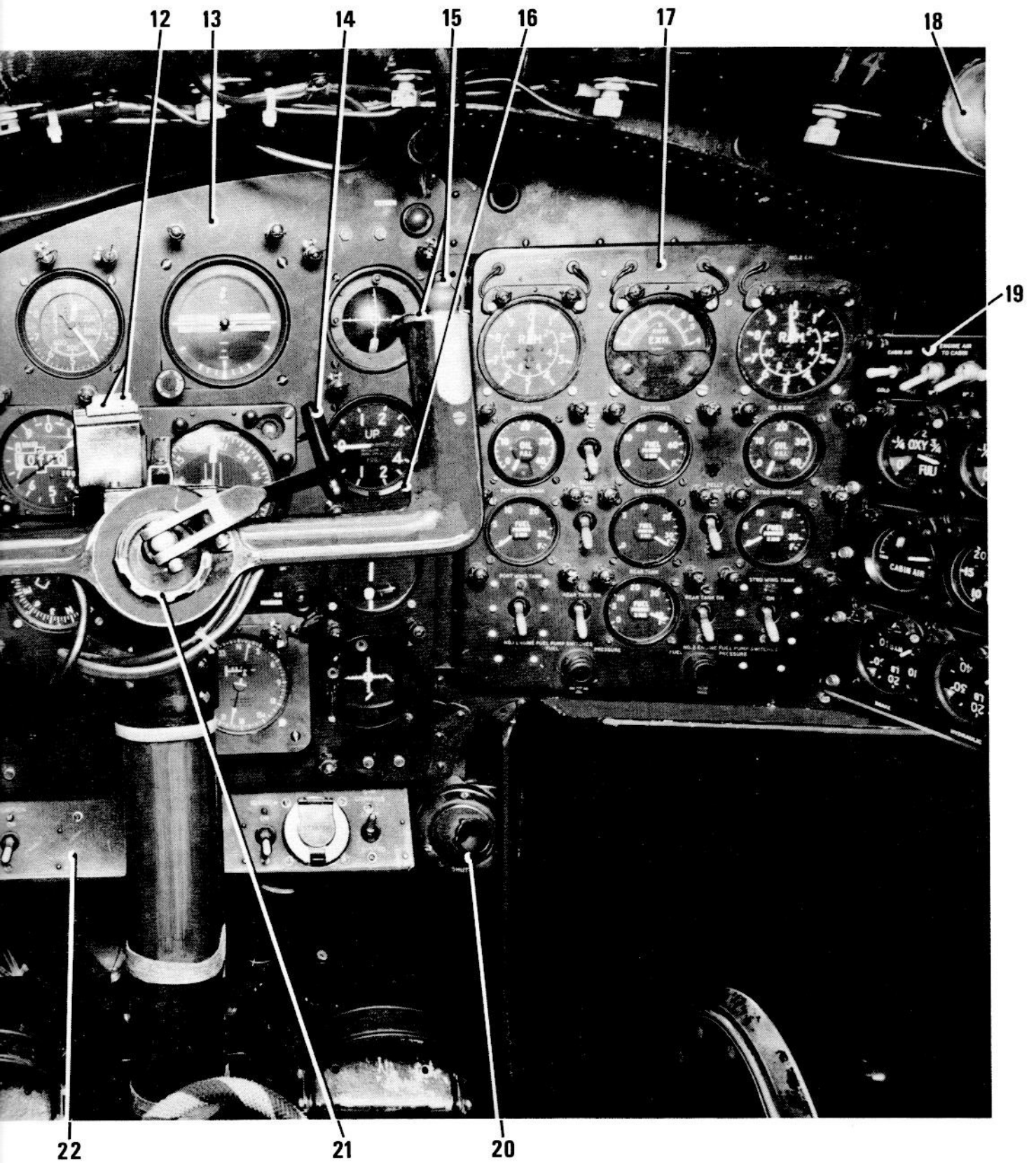
Key to Fig 4 — Cockpit, Forward View

- 1 Port front panel
- 2 Ventilation louvre
- 3 Undercarriage master switch
- 4 Undercarriage position indicator
- 5 Undercarriage selector switch unit
- 6 Flaps position indicator
- 7 Wing-tip tanks jettison pushbutton
- 8 Flaps selector switch
- 9 Undercarriage emergency lowering handle
- 10 Anti-dazzle lamp
- 11 F95 camera switch
- 12 Airbrakes control switch and stop
- 13 Flight instrument panel
- 14 Wheelbrakes control lever
- 15 Tailplane trim control and cut-in switches
- 16 Press-to-transmit switch
- 17 Engine instrument panel
- 18 Anti-dazzle lamp
- 19 Miscellaneous instrument panel
- 20 Ventilation louvre
- 21 Wheelbrakes lever parking catch
- 22 Starter panel
- 23 Ventilation louvre (cold air)

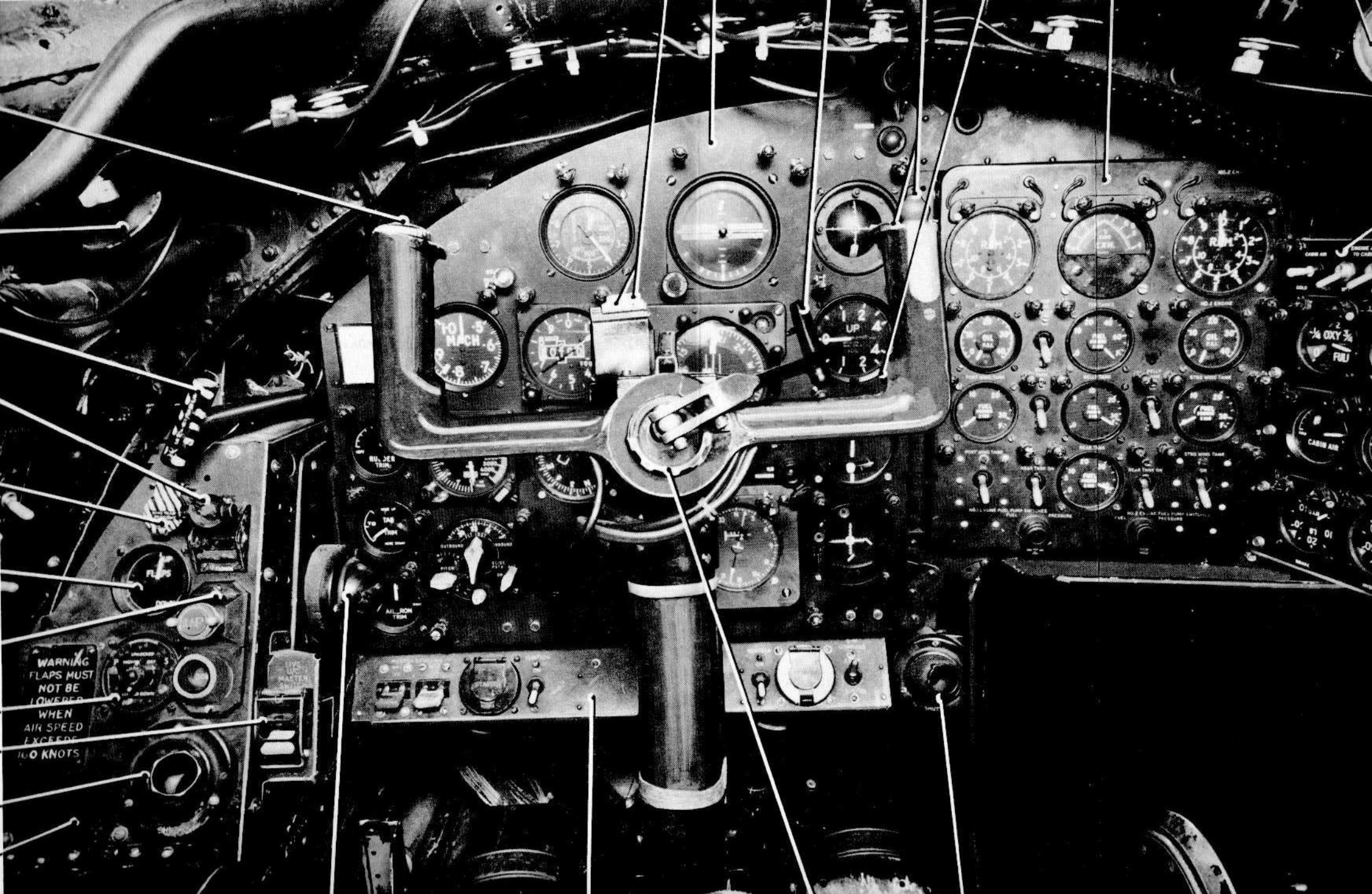
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5 - 1 Fig 4 Co
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5 - 1 Fig 4 Cockpit, Forward View
◀ (Post - SRIM 4012) ▶



WARNING
FLAPS MUST
NOT BE
LOWERED
WHEN
AIR SPEED
EXCEEDS
160 KNOTS

101-5
MACH

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

UP
1 2 3 4

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0 1 2 3 4 5 6 7 8 9

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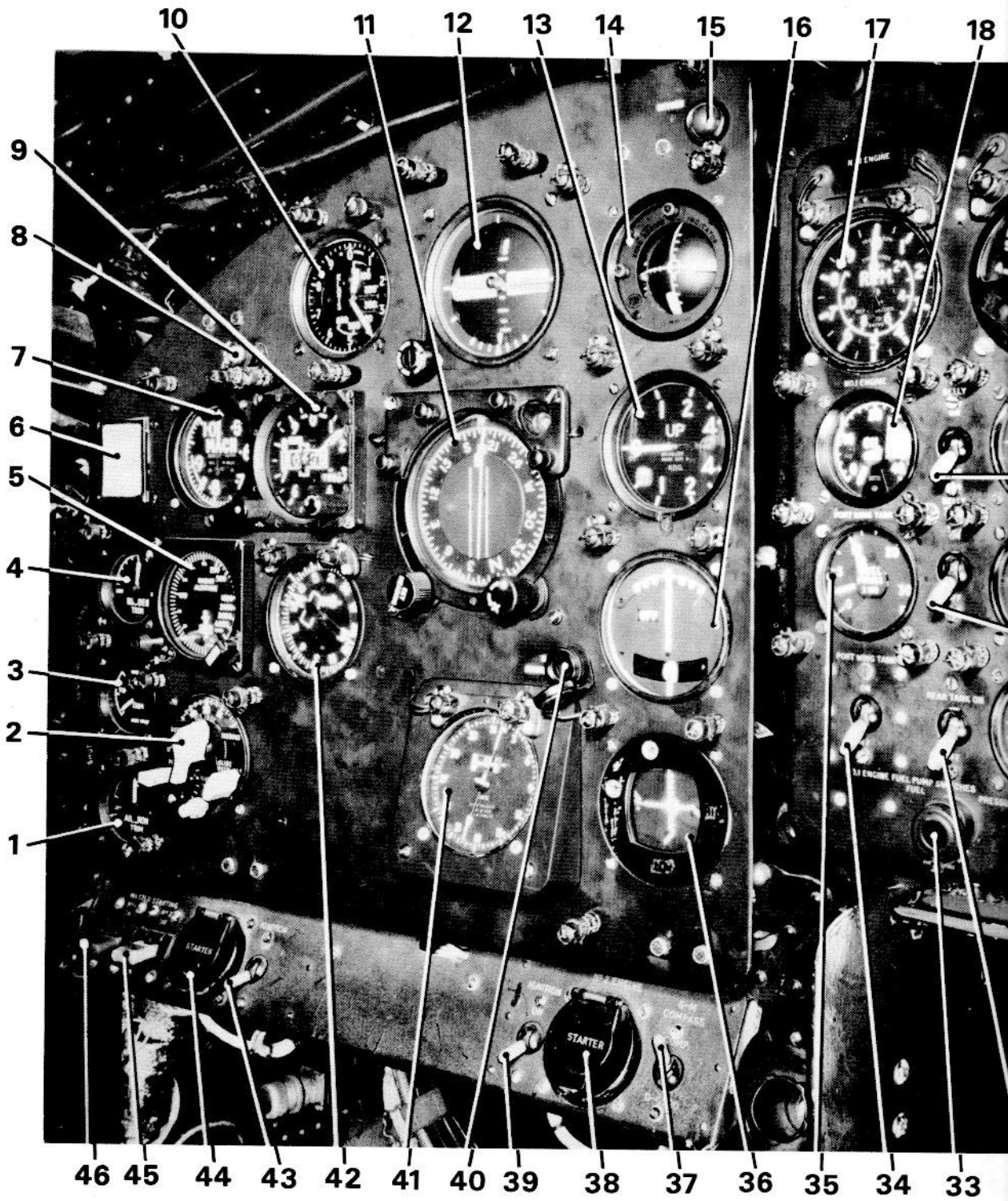
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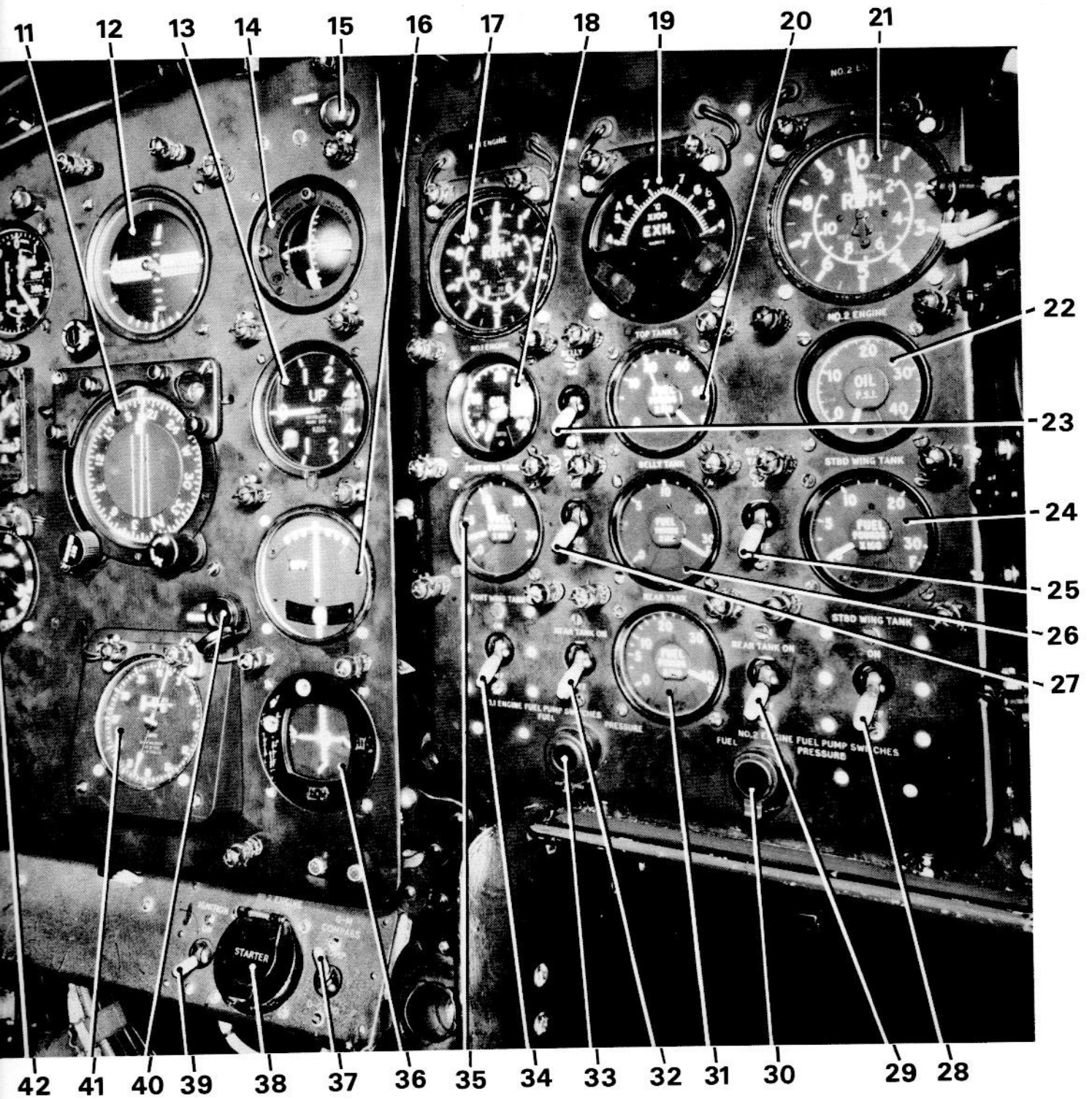
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Key to Fig 5 — Cockpit, Flight and Engine Instrument Panels

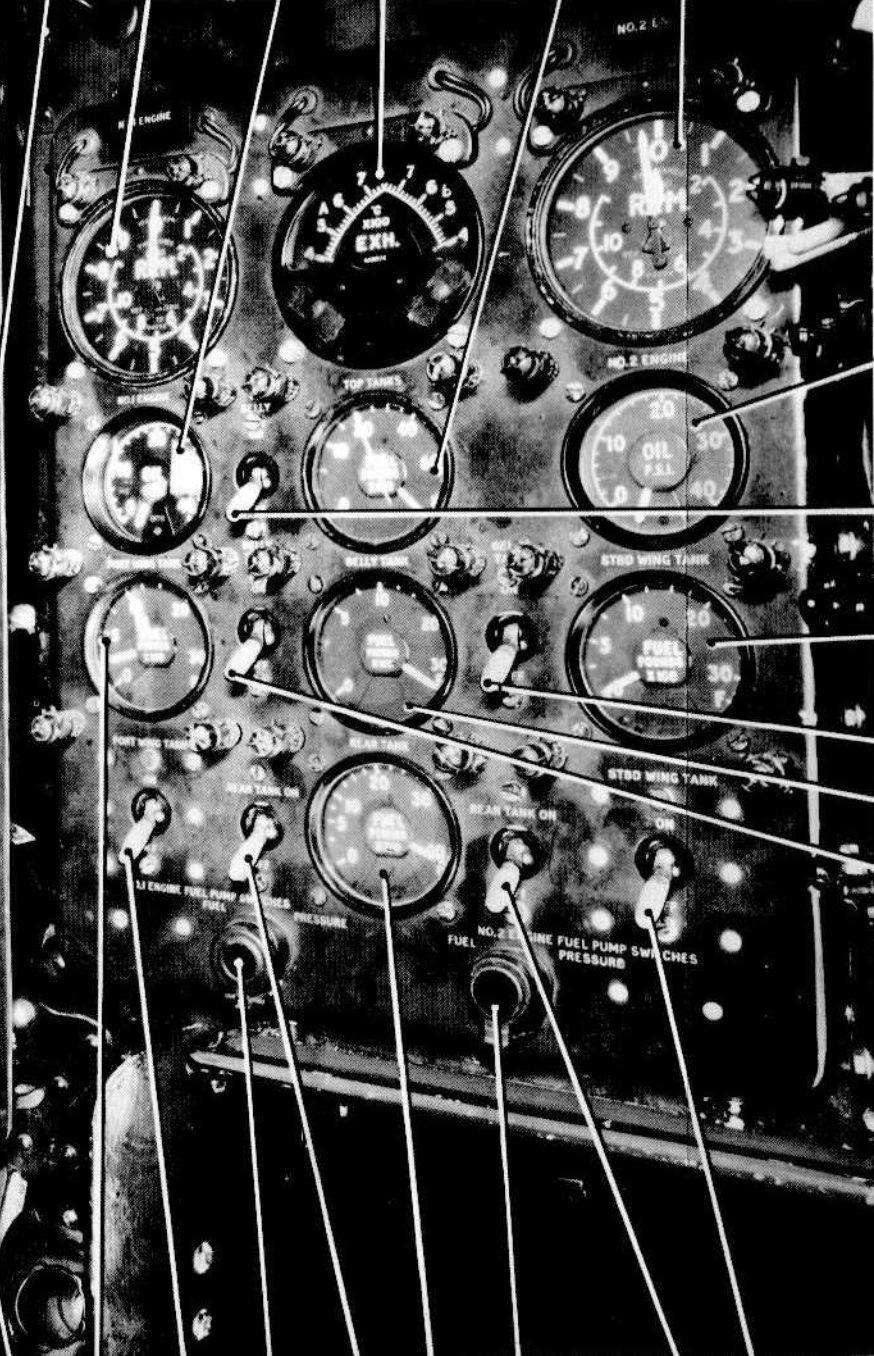
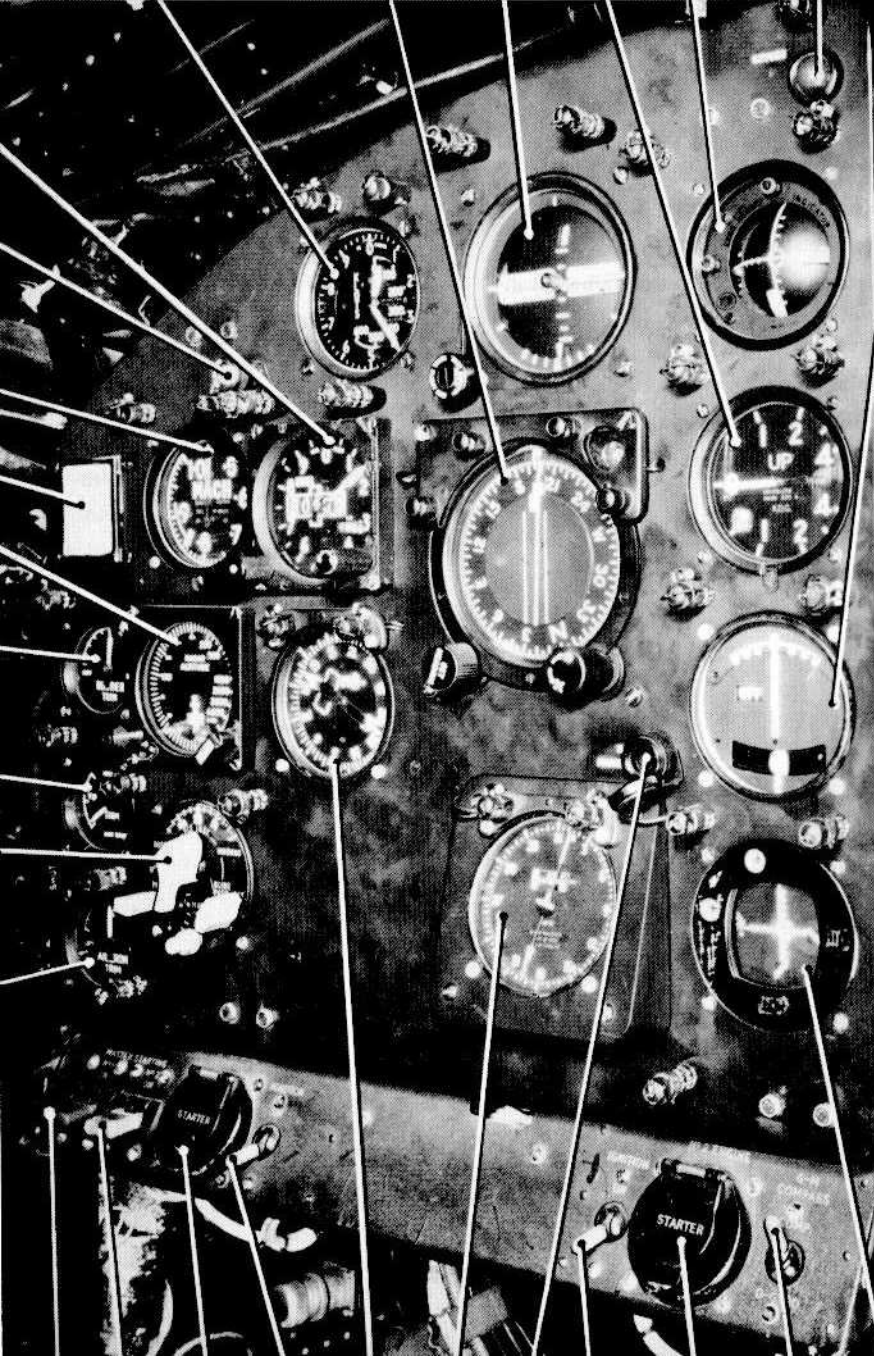
- | | | | |
|----|--|----|--|
| 1 | Aileron trim indicator | 24 | Starboard wing integral tank fuel contents gauge |
| 2 | Zero reader combined heading selector and control unit | 25 | Belly tank starboard LP pump switch |
| 3 | Tailplane trim indicator | 26 | Belly tank fuel contents gauge |
| 4 | Rudder trim indicator | 27 | Belly tank port LP pump switch |
| 5 | Radar altimeter | 28 | Starboard wing integral tank LP pump switch |
| 6 | ASI correction card holder | 29 | Rear tank starboard LP pump switch |
| 7 | Machmeter | 30 | No 2 engine fuel pressure warning light |
| 8 | IFF/SSR fail light | 31 | Rear tank fuel contents gauge |
| 9 | Mk 29B altimeter | 32 | Rear tank port LP pump switch |
| 10 | Airspeed indicator | 33 | No 1 engine fuel pressure warning light |
| 11 | Gyro-magnetic Mk 4B compass indicator | 34 | Port wing integral tank LP pump switch |
| 12 | Horizon gyro unit | 35 | Port wing integral tank fuel contents gauge |
| 13 | Vertical speed indicator | 36 | ILS indicator |
| 14 | Zero reader indicator | 37 | Compass/directional gyro switch |
| 15 | Pilot's remote oxygen flow magnetic indicator | 38 | No 2 engine starter pushbutton |
| 16 | Turn and slip indicator | 39 | No 2 engine ignition switch |
| 17 | No 1 engine RPM indicator | 40 | ILS marker light |
| 18 | No 1 engine oil pressure gauge | 41 | Tacan indicator |
| 19 | No 1 and No 2 engine jet-pipe temperature indicator | 42 | DME/VOR/ADF indicator |
| 20 | Top tanks fuel contents gauge | 43 | No 1 engine ignition switch |
| 21 | No 2 engine RPM indicator | 44 | No 1 engine starter pushbutton |
| 22 | No 2 engine oil pressure gauge | 45 | No 2 engine master starting switch |
| 23 | Top to belly tank transfer cock switch | 46 | No 1 engine master starting switch |



5 - 1 Fig 5 Cockpit Flight and Engine Instrument Panels
◀(Post - SRIM 4012)▶



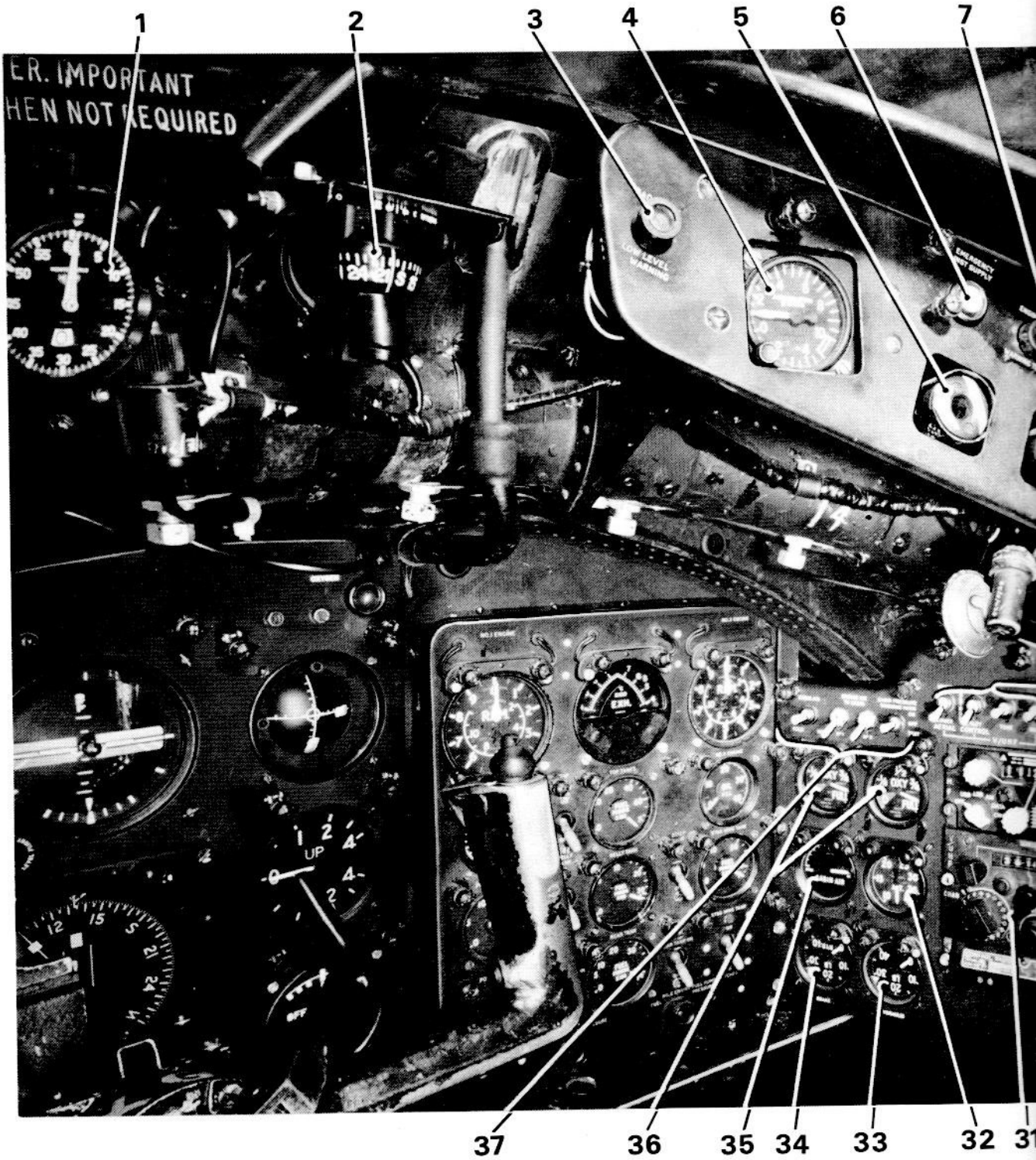
5 - 1 Fig 5 Cockpit Flight and Engine Instrument Panels
◀(Post - SRIM 4012)▶



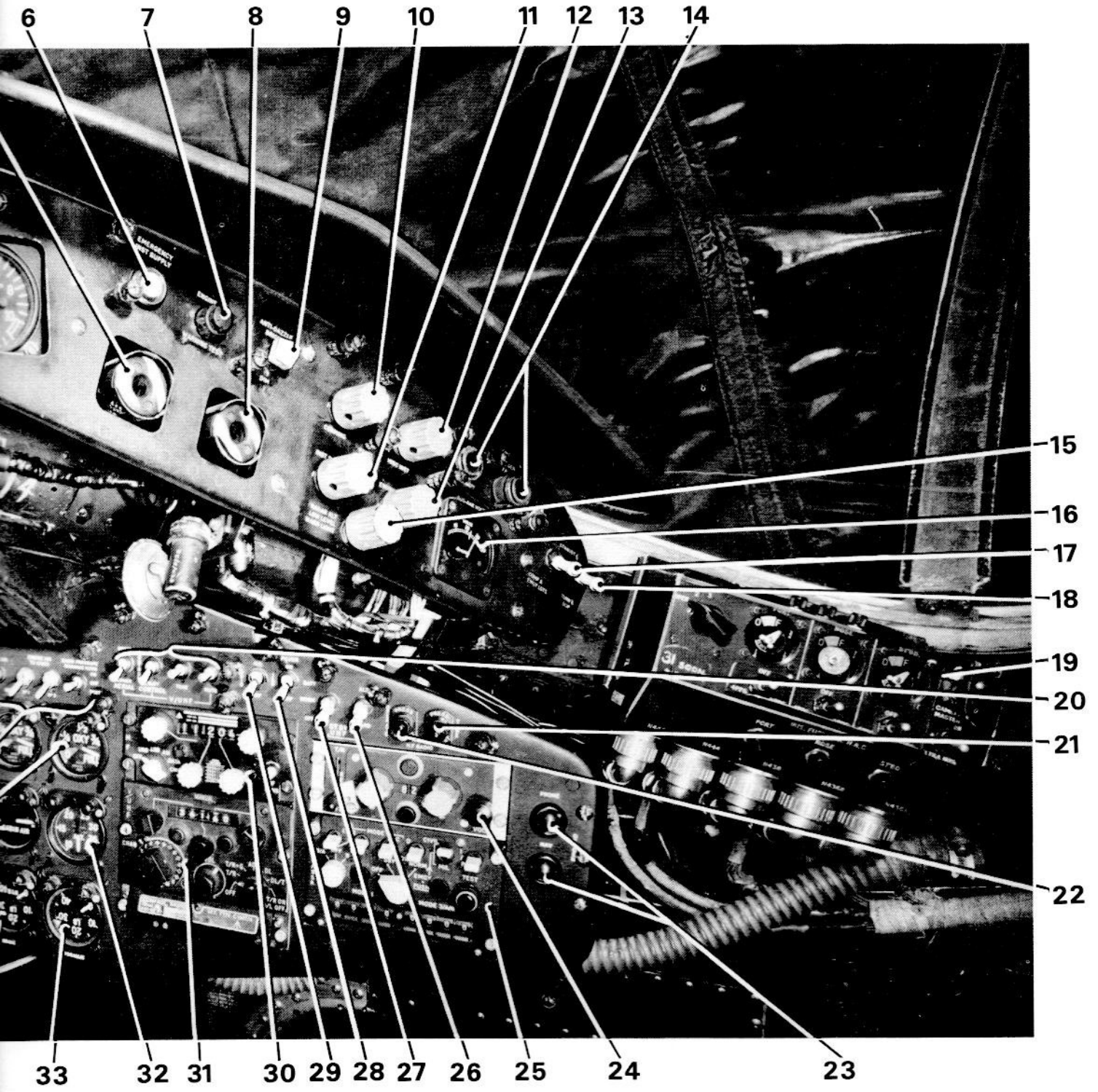
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Key to Fig 6 — Cockpit, Coaming and Miscellaneous Instrument Panels

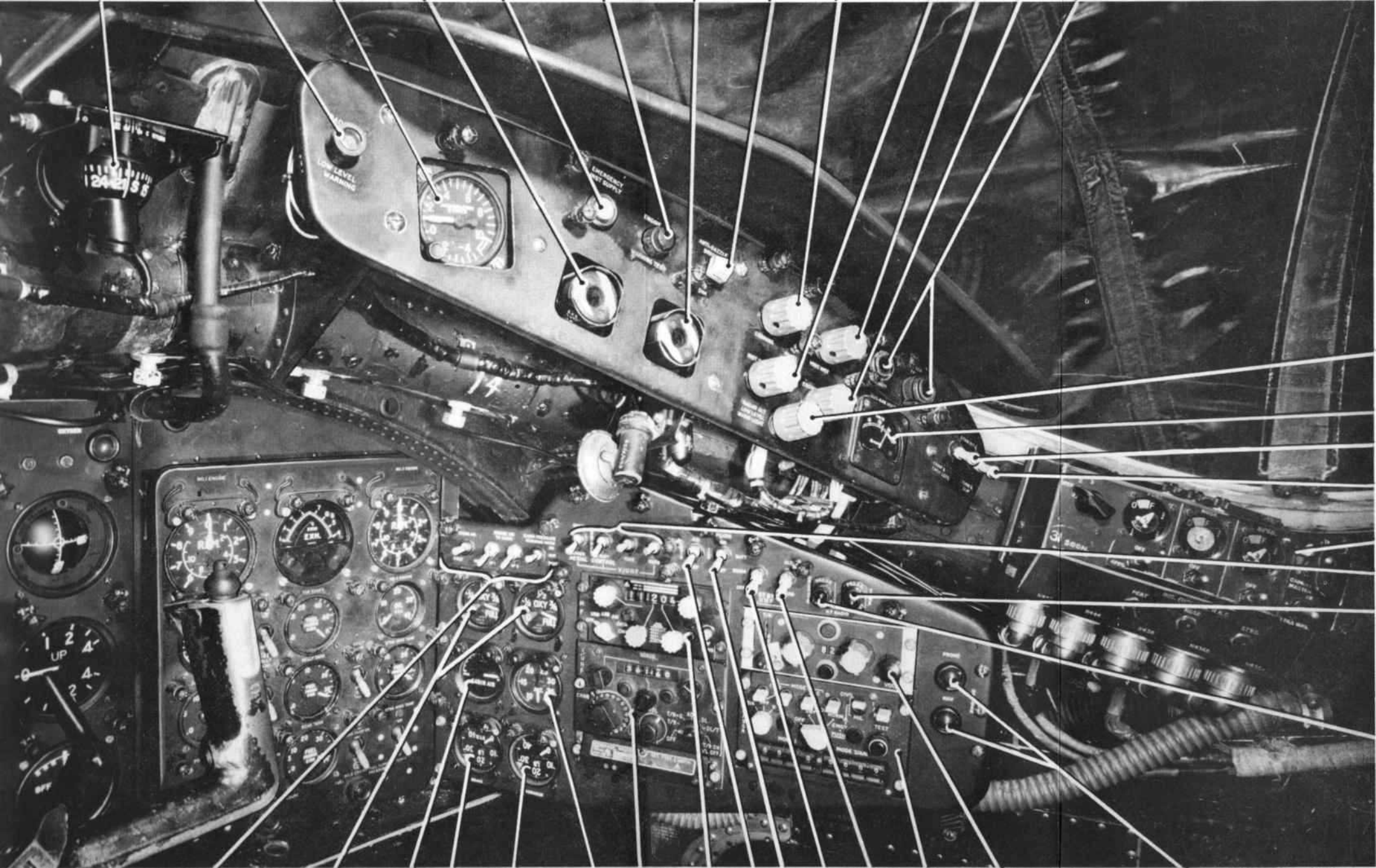
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|----|--|----|---|
| 1 | Stopwatch | 21 | HF tune light |
| 2 | E2B standby compass | 22 | HF operate light |
| 3 | Radar altimeter low level warning light | 23 | Prone and navigator remote oxygen flow magnetic indicators |
| 4 | Accelerometer | 24 | Tacan control unit |
| 5 | No 1 engine fire warning light and extinguisher pushbutton | 25 | IFF/SSR control unit |
| 6 | Emergency instrument supply magnetic indicator | 26 | Standby UHF channel selector switch |
| 7 | Engine fire warning lights test pushbutton | 27 | Standby UHF BATT/NORM/OFF switch |
| 8 | No 2 engine fire warning light and extinguisher pushbutton | 28 | ILS on/off switch |
| 9 | Anti-dazzle lamps selector switch | 29 | ILS/ADF audio selector switch |
| 10 | Coaming panel lighting dimmer switch | 30 | HF control unit |
| 11 | Flight instrument panel lighting dimmer switch | 31 | V/UHF control unit |
| 12 | Miscellaneous instrument panel lighting dimmer switch | 32 | Cabin altimeter |
| 13 | Engine instrument panel lighting dimmer switch | 33 | Main hydraulic pressure gauge |
| 14 | No 1 and No 2 engine generator failure warning lights | 34 | Wheelbrakes hydraulic pressure gauge |
| 15 | Radar altimeter low level light dimmer switch | 35 | Cabin air mixing valve position indicator |
| 16 | DC voltmeter | 36 | Oxygen contents gauges |
| 17 | E2B compass and instrument panel emergency lighting switch | 37 | Switches, left to right:
Cabin air mixing valve position selector
No 1 engine air to cabin
No 2 engine air to cabin
Cabin pressure warning horn |
| 18 | Turn and slip indicator emergency supply switch | | |
| 19 | F95 cameras control unit | | |
| 20 | V/UHF switches, left to right:
Aerial changeover
Control unit changeover
Tone
Mute | | |



5 - 1 Fig 6 Cockpit, Coaming and Miss
◀ (Post - SRIM 4012 and



Cockpit, Coaming and Miscellaneous Instrument Panels
◀(Post - SRIM 4012 and SEM/059/STC)▶

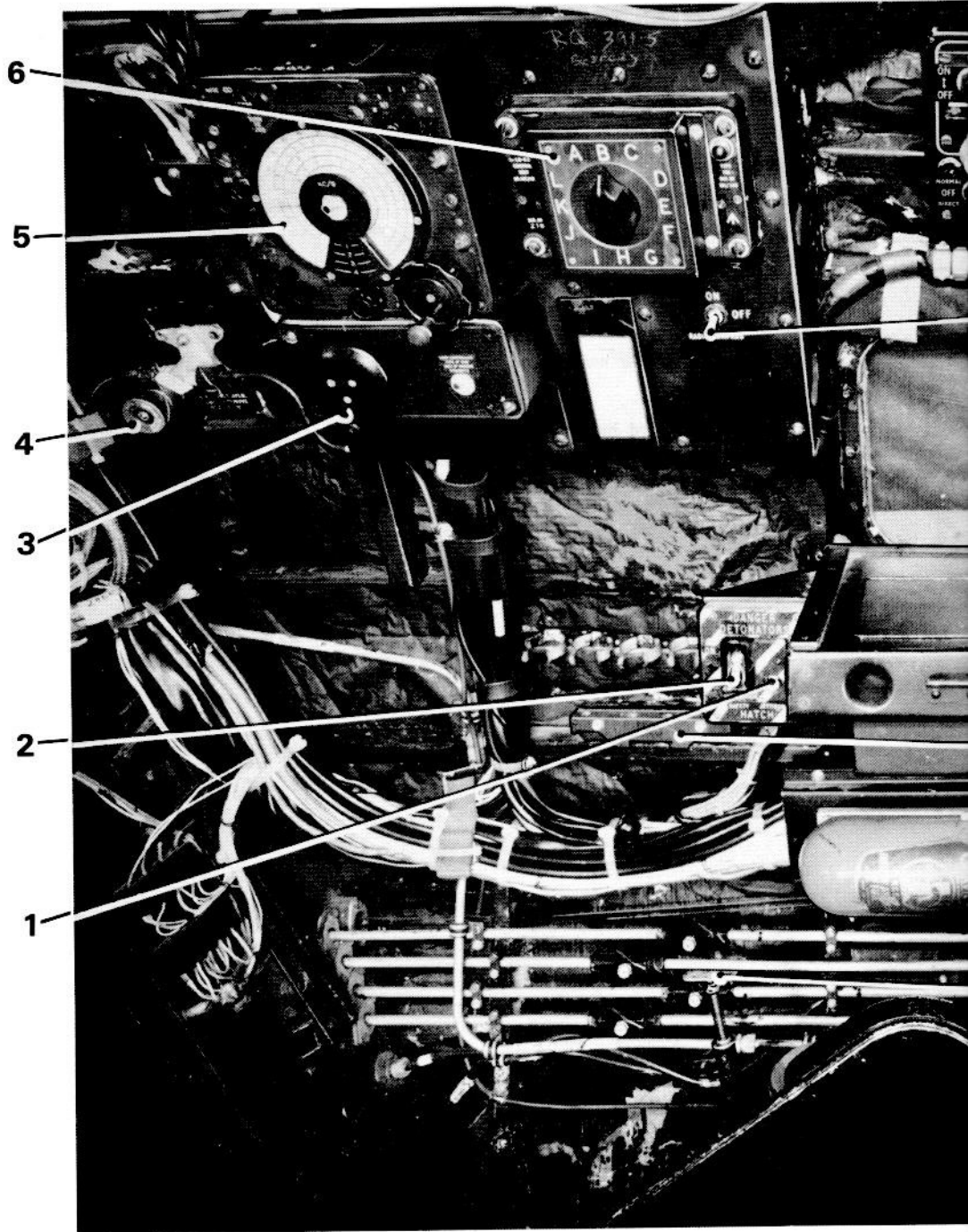


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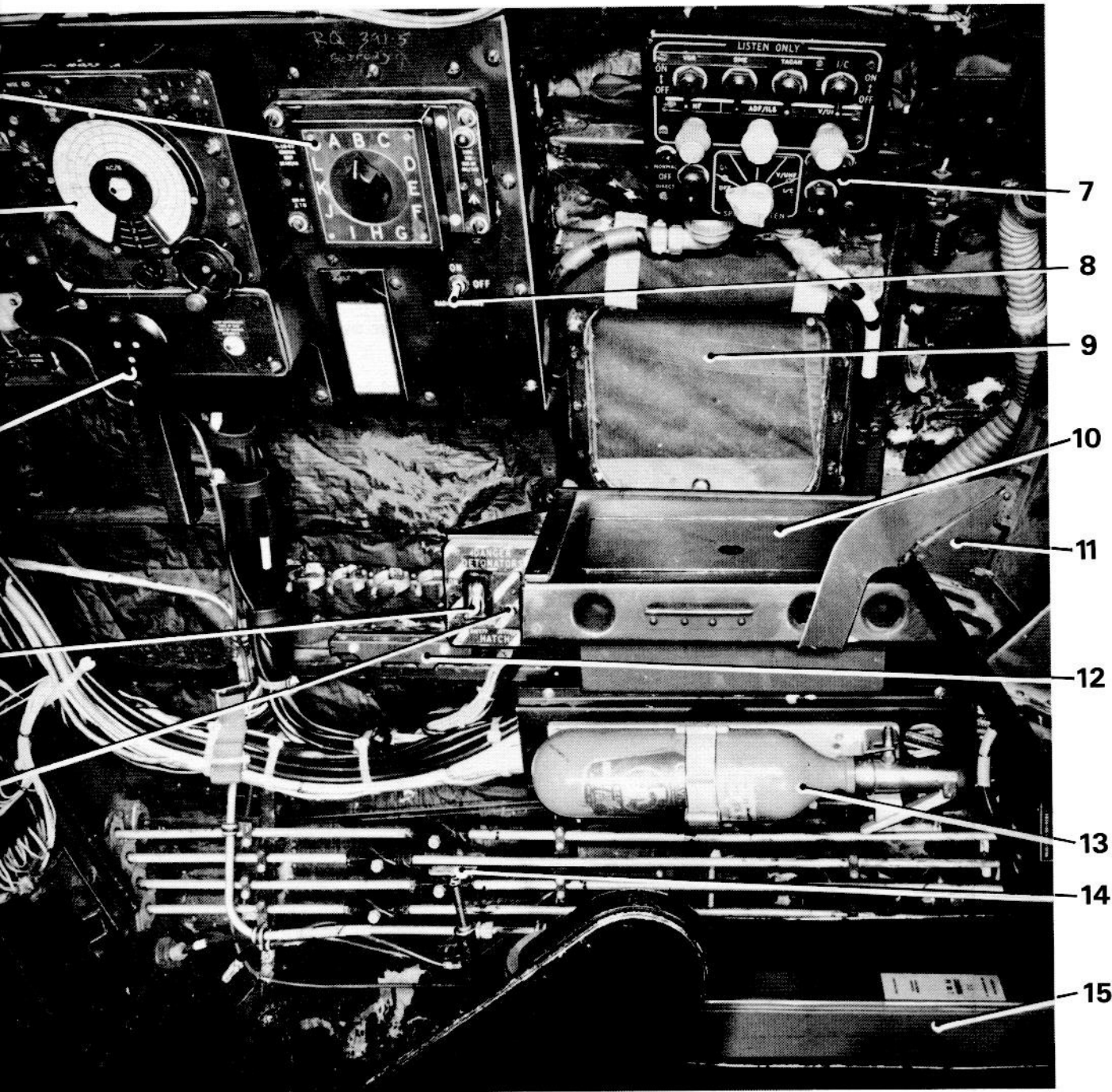
Key to Fig 7 — Cabin Port Wall

- 1 Hatch jettison switch
- 2 Hatch safety switch
- 3 Radio compass loop controller
- 4 Oxygen stop valve
- 5 Radio compass receiver controller
- 6 ILS channel selector
- 7 Station box
- 8 Radio compass on/off switch
- 9 Window blind
- 10 Table top stowage
- 11 Folding table
- 12 Ejection seat safety pin stowage
- 13 Fire extinguisher
- 14 Periscope stowage
- 15 Navigator's equipment stowage

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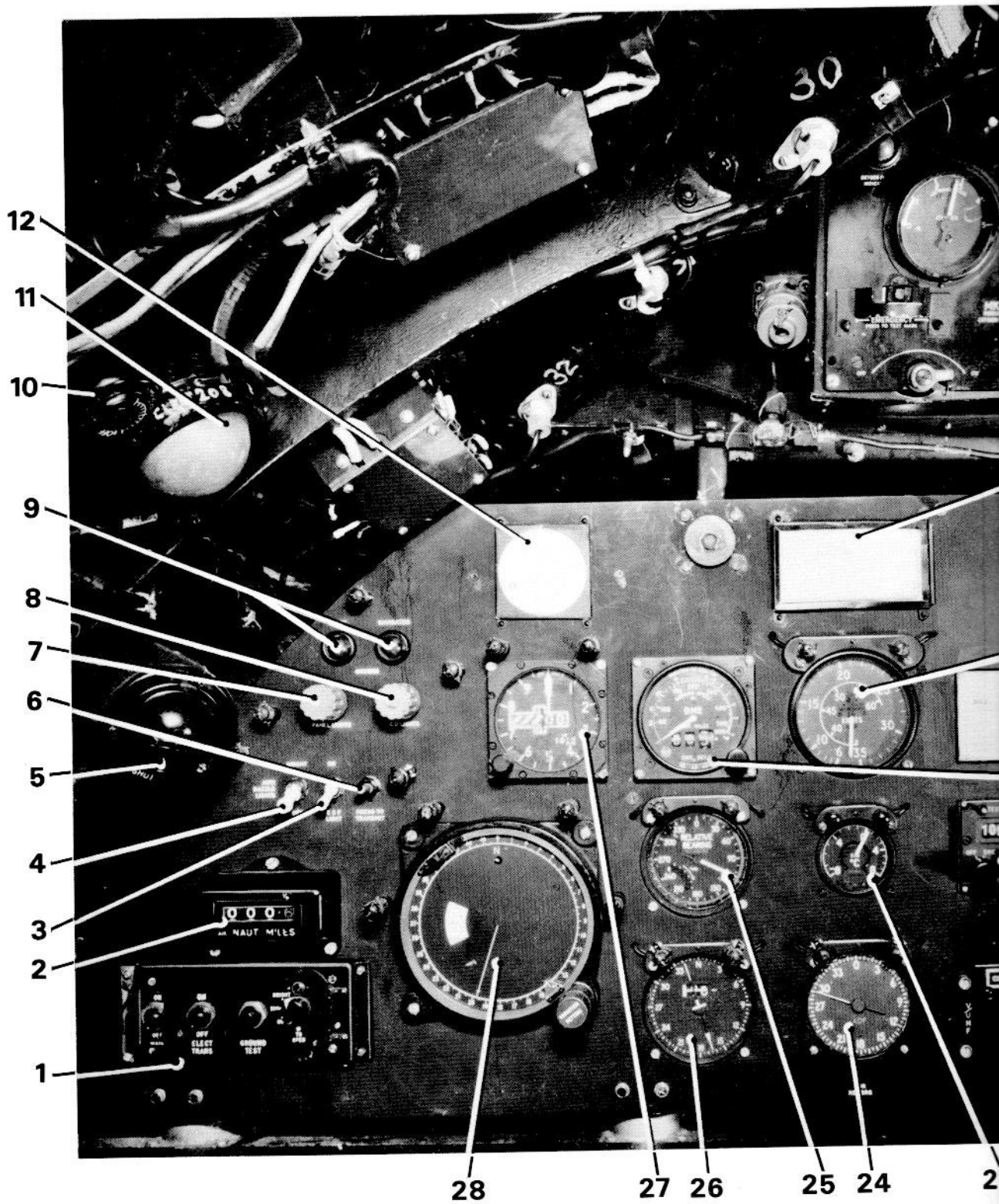
5 - 1 Fig 7 Cabin Port Wall
◀ (Post - SRIM 4012) ▶



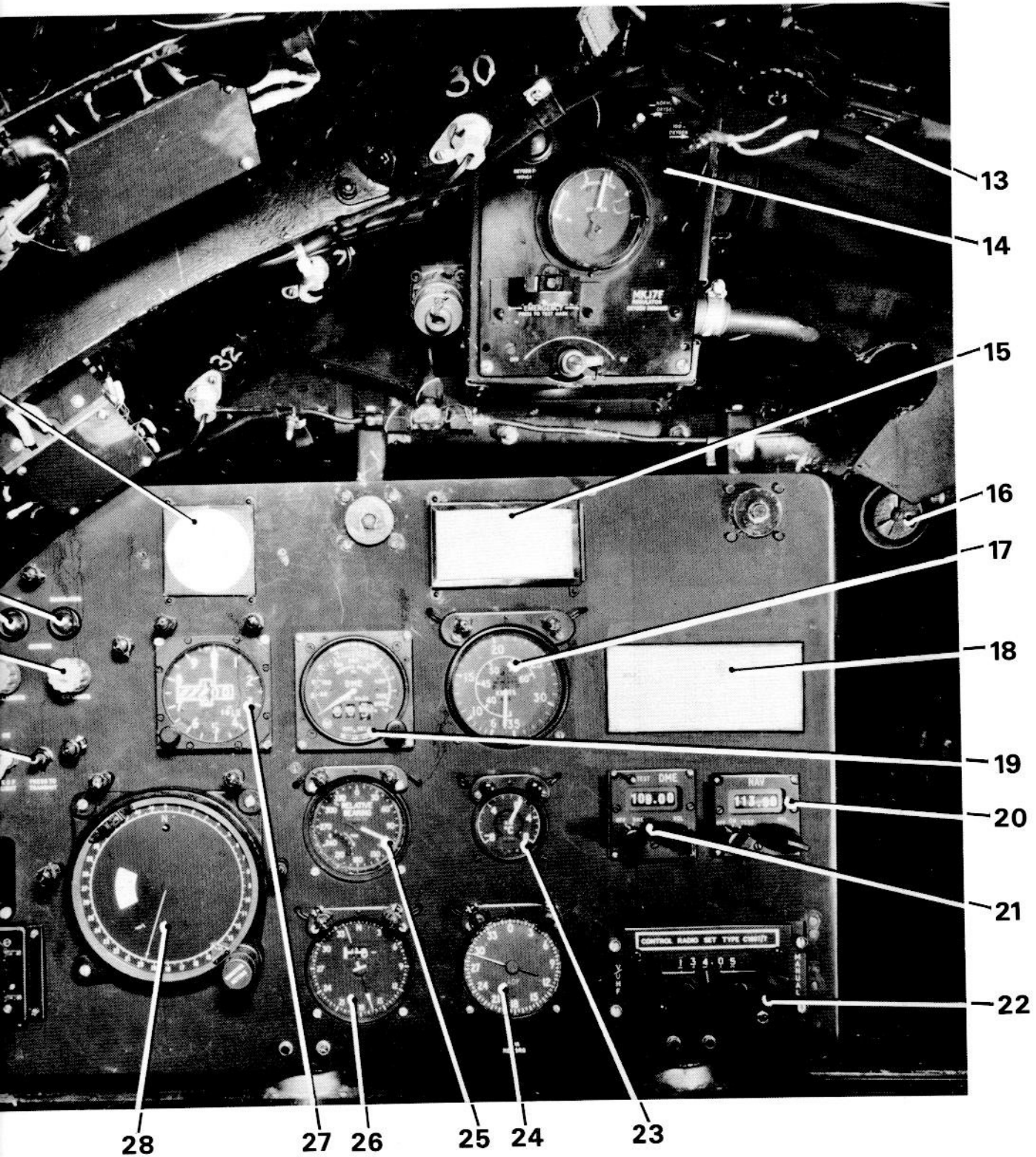
5 - 1 Fig 7 Cabin Port Wall
◀ (Post - SRIM 4012) ▶

Key to Fig 8 — Cabin Forward View

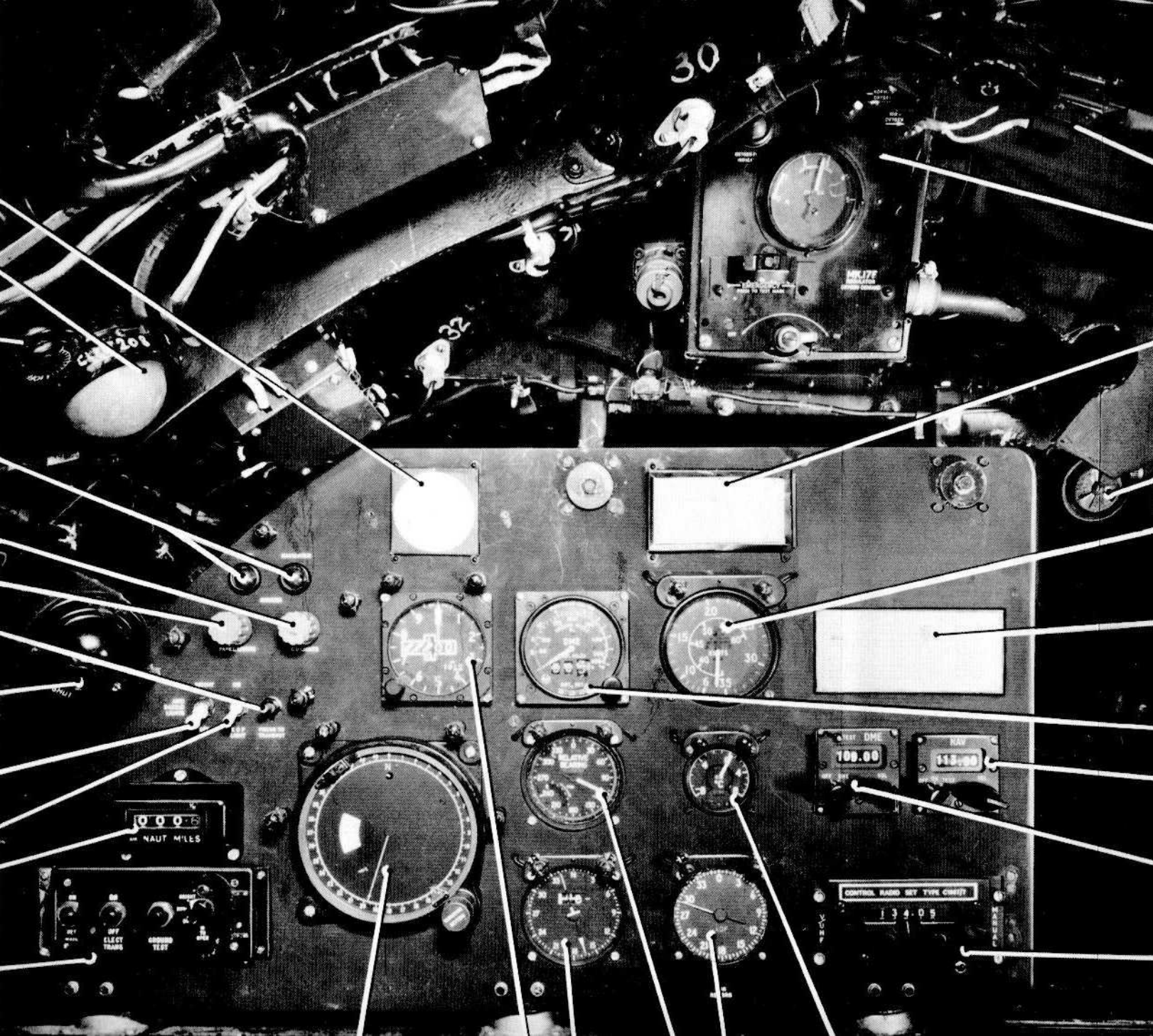
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|--|---|
| 1 Air mileage unit control panel | 15 ASI correction card holder |
| 2 Air mileage indicator | 16 Ventilation louvre |
| 3 ECP lighting switch | 17 Airspeed indicator |
| 4 Anti-dazzle lamps switch | 18 Radio frequency card holder |
| 5 Ventilation louvre | 19 DME distance/groundspeed indicator |
| 6 Press-to-transmit/mute switch | 20 VOR control unit |
| 7 Instrument panel lighting dimmer switch | 21 DME control unit |
| 8 Control units lighting dimmer switch | 22 V/UHF frequency control unit |
| 9 Pilot and navigator remote oxygen flow magnetic indicators | 23 Outside air temperature gauge |
| 10 Anglepoise lamp dimmer switch | 24 VOR relative bearing indicator |
| 11 Dome lamp | 25 Radio compass relative bearing indicator |
| 12 Compass deviation card holder | 26 Tacan indicator |
| 13 Anglepoise lamp | 27 Mk 30B height encoding altimeter |
| 14 Oxygen regulator | 28 Mk 4B compass master indicator |



5 - 1 Fig 8 Cabin Forward View
◀(Post - SRIM 4012) ▶



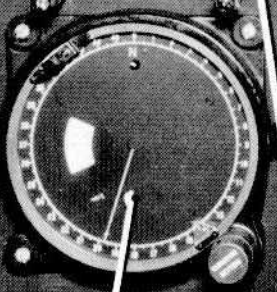
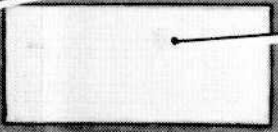
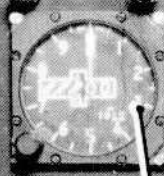
5 - 1 Fig 8 Cabin Forward View
◀ (Post - SRIM 4012) ▶



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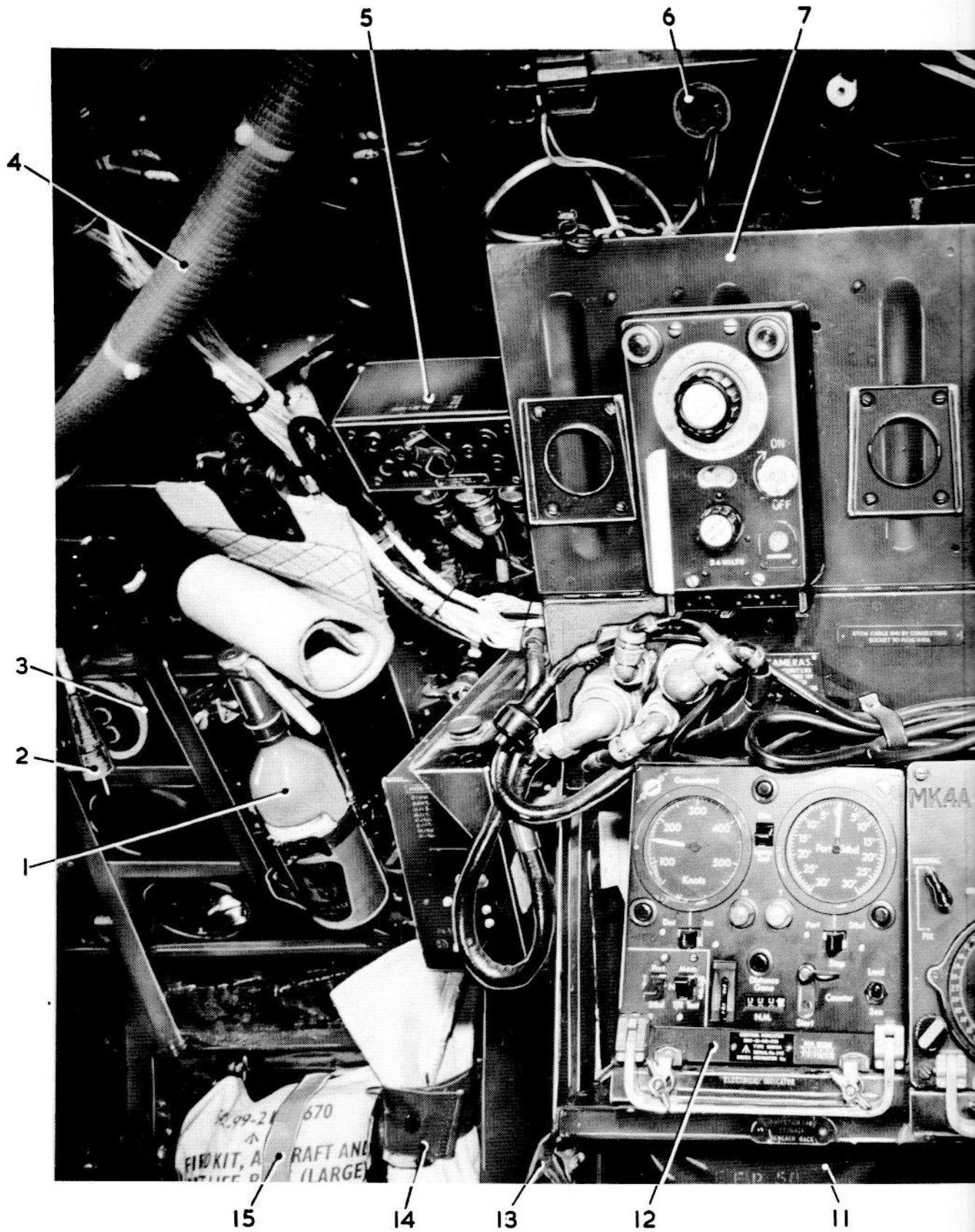


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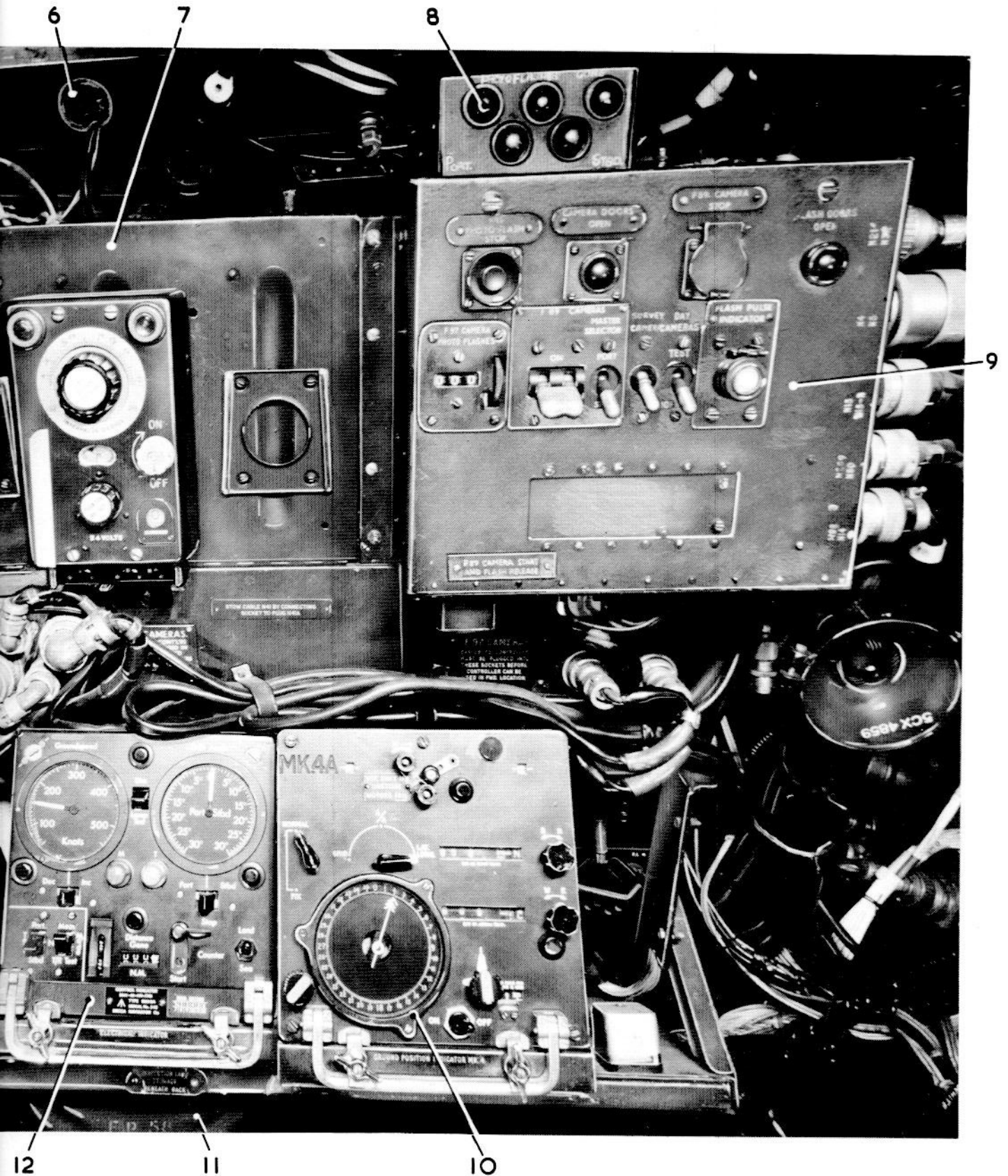
Key to Fig 9 — Cabin Starboard Wall

- 1 Fire extinguisher
- 2 Intercom extension lead from nose station socket
- 3 Folding seat
- 4 Oxygen extension lead from nose station regulator
- 5 Mk 4B compass control panel
- 6 Anglepoise lamp dimmer switch
- 7 Camera control unit wedge plates
- 8 Flashes gone magnetic indicators (unused)
- 9 Camera distribution panel
- 10 Ground position indicator Mk 4A
- 11 Inspection lamp stowage
- 12 Decca doppler indicator
- 13 Axe
- 14 Asbestos gloves
- 15 First-aid kit

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5 - 1 Fig 9 Cabin Starboard Wall



5 - 1 Fig 9 Cabin Starboard Wall

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LIGHTNING MK. 1
COVER PITOT HEAD
EB2-88-511

A close-up photograph of a red aircraft fuselage. A grey fabric cover is draped over a section, with the text "LIGHTNING MK. 1", "COVER PITOT HEAD", and "EB2-88-511" printed on it. To the right, a rectangular metal plate is mounted on the red surface. The background shows the curved structure of the aircraft with several rivets.