

Restricted

5th Edition

A.P. 4326 B-P.N.

PILOT'S NOTES
CANBERRA B. Mk. 2

Restricted

CANBERRA B Mk 2 PILOT'S NOTES

BY COMMAND OF THE DEFENCE COUNCIL

Alvie Whitmore.

Prepared by Royal Air Force Handling Squadron

NOTES TO USERS

1 This book 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Part 5 (Withdrawn)

Part 6 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—4 Page 3 is Page 3 of Part 1, Chapter 4.

2 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.

3 This book 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 Pilot's Notes 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 2 above.

4 Amendment Lists will be issued as necessary and each amendment list instruction sheet will state the main purpose of the amendment and will include a list of modifications covered in the text. New or amended matter of importance will be indicated by symbols in the text thus: ◀... ▶ or thus ◆...◆ to show the extent of the amended text and thus ▶▶ or thus ◆◆ to show where text has been deleted. The number of the amendment list by which a sheet was initially issued, or re-issued, will appear at the bottom of the odd-numbered pages and any amendment marks on either page forming a sheet will relate to that amendment. However, when a new chapter is issued with an amendment list or an existing chapter is completely revised, the fact will be

indicated within the heading of the chapter and the amendment marks will not appear on the pages.

5 The following conventions are observed throughout this Book:

(a) The actual marking 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 printed 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.

6 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 these preliminary pages, with a cross reference to the location in the text of the modification details.

7 This book is complementary to the Flight Reference Cards (AP 101B-0402-14) and the Operating Data Manual (AP 101B- $\left. \begin{matrix} 0402 \\ 0404 \end{matrix} \right\}$ -16 for the aircraft).

IMPORTANT

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

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LIST OF ASSOCIATED AIR PUBLICATIONS

Canberra B Mk 2 General and Technical Information	(AP 101B-0402-1A (AP 101B-0402-1B
Canberra B Mk 2 Flight Reference Cards	...	...	AP 101B-0402-14
Canberra B Mk 2 and T Mk 4 Operating Data Manual	...	...	AP 101B-0402/04-16

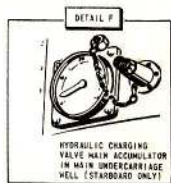
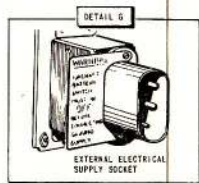
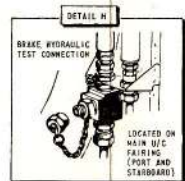
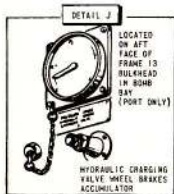
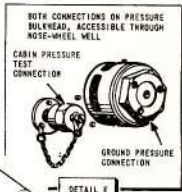
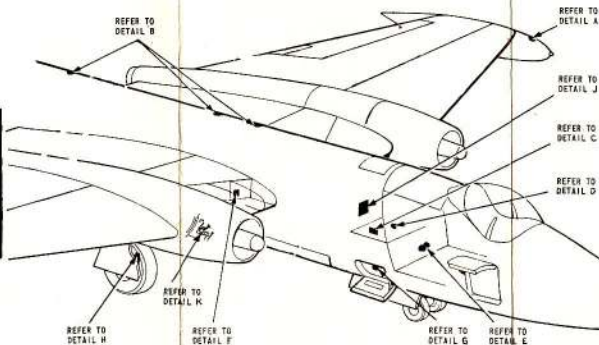
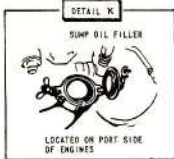
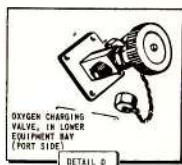
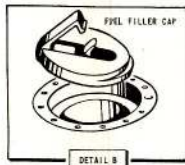
LIST OF ABBREVIATIONS USED IN THE TEXT

AC	Alternating current	FRC	Flight Reference Cards
ACU	Acceleration control unit	FSII	Fuel system icing inhibitor
AGL	Above ground level	GPI	Ground position indicator
AHE	Altimeter height encoding	HP	High pressure
API	Air position indicator	HT	High tension
ARI	Airborne radio installation	Hz	Hertz (cycles per second)
AUW	All up weight	IAS	Indicated airspeed
BCF	Bromochlorodifluoromethane	IFF	Identification friend or foe
BPC	Barometric pressure control	ILS	Instrument landing system
BTDU	Breech time delay unit	IMN	Indicated mach number
BTRU	Barometric time release unit	JPT	Jet pipe temperature
C	Celsius	kHz	Kilohertz
CG	Centre of gravity	kW	Kilowatt
CHAG	Chain arresting gear	lb	Pound
DC	Direct current	LP	Low pressure
DV	Direct vision		
ECP	Electrical control panel		
EMBS	Emergency maximum braking speed		
EOA	Engine out allowance		

(continued)

List of Abbreviations - *continued*

M	Mach number	RMI	Radio magnetic indicator
MEP	Main electrical panel	RPM	Revolutions per minute
MHz	Megahertz	SEM	Service engineered modification
MI	Magnetic indicator	SG	Specific gravity
Mod	Modification	SLE	Single lever ejection
NM	Nautical mile	SRIM	Service radio installation modification
NMBS	Normal maximum braking speed	SSR	Secondary surveillance radar
OBS	Omni bearing selector	UHF	Ultra high frequency
ODM	Operating Data Manual	VCH	Visual committal height
PE	Pressure error	VHF	Very high frequency
PSI	Pounds per square inch	VOR	VHF omni-directional radio range
PUAG	Purpose use arresting gear	VSC	Variation setting control
QRF	Quick release fitting		
RHAG	Rotary hydraulic arresting gear		



Servicing points

INTRODUCTION

1 General

(a) The Canberra B Mk 2 is employed in the Training, Silent Target and Banner Target Towing roles. It is powered by two Avon Mk 1 engines each giving 6500 lb static thrust at sea level.

- ◆ (b) The radio and radar installations in all aircraft, except the OCU aircraft WJ 731, have been brought to a common standard. WJ 731 was brought to a similar standard but with Mod 4868 introducing VOR/ILS in place of radio compass and military ILS, and Green Satin in place of the air position indicator. ◆

2 Crew Accommodation

The crew cabin is pressurized and extends from the nose fairing to an aft sloping bulkhead which seals off the compartment from the rest of the fuselage. Accommodation is provided for a crew of three seated in ejection seats; throughout these Notes the crew are individually referred to as pilot, navigator (or 1st navigator) and 2nd navigator. A folding seat is provided on the right side of the cockpit for occasional use. There is a prone position in the nose which may be used for observation and map reading.

3 Entrance Door and Emergency Exits

All crew enter through the entrance door on the right in line with the pilot's seat. The canopy above the pilot and the hatch above the rear crew are jettisonable and provide emergency exits.

4 Equipment Compartments

Three bays for various items of aircraft equipment are aft of the cabin rear pressure bulkhead. The upper equipment bay is above the nose undercarriage well; access is by a hinged hatch on top

of the fuselage. The left and right equipment bays are on either side of the nose undercarriage well, with access doors in the fuselage wall. A battery compartment is immediately aft of the lower equipment bays; a hinged access door is on the left side.

5 Flying Controls

The ailerons, elevators and rudder are all manually operated. The variable-incidence tailplane, aileron trim and rudder trim are all electrically operated.

6 Layout of Controls and Instruments

(a) *Pilot's Station.* The location of the flying controls is conventional, other controls and instruments are grouped as follows:

(i) To the left of the pilot on the cockpit left wall, on the left console and on the engine controls quadrant.

(ii) In front of the pilot on the sloping left front panel, on the main instrument panel, on the coaming 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: the flight instrument panel, the engine instrument panel and the miscellaneous instrument panel.

(b) *1st Navigator's Station.* The 1st navigator's controls and instruments are grouped around him on the cabin left wall, on the forward instrument panels, on a shelf beneath the table and on the electrical control panel (ECP) between the cockpit and cabin.

(c) *2nd Navigator's Station.* The 2nd navigator's controls are on the cabin right wall.

(d) *Control and Instrument Location.* Throughout this book the location of all controls and instruments is given relative to the above positions.

LEADING PARTICULARS

Principal Dimensions

				<i>Feet</i>	<i>Inches</i>
Span without wing-tip tanks	...	...	...	64	0
Span with wing-tip tanks	...	...	...	65	6
Length overall	...	...	...	65	6
Height to top of fin	...	...	...	15	7
Height to top of canopy (unladen aircraft)	...	...	...	8	8

Undercarriage

Mainwheel Units (two)

Type	...	...	...	Single wheel, inwards retracting
Shock absorber	...	...	...	Oleo pneumatic
◆ Nitrogen pressure	...	...	...	Refer to AP 101B-0400 -5A2 0400A
Fluid	...	...	...	OM-15 (NATO H-515)
Capacity	...	...	...	12 pints
Tyre pressure	...	...	...	Refer to AP 101B-0400 -5A2 0400A

Brakes

Pressure at reducing valve inlet	2500	+0	PSI
Pressure at brakes	1500	+150 -0	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	...	...	...	1.5 pints
Tyre pressure	...	...	...	Refer to AP 101B-0400 -5A2 0400A

Hydraulic System

Fluid	...	...	...	OM-15 (NATO H-515)
Capacity of system	...	...	...	31 pints (approximately)
Capacity of tank	...	...	...	2 gallons
Pumps (two)	...	...	...	Lockheed Mk 7 or Mk 9
◆ Accumulator charging gas	...	...	...	Nitrogen
Thermal relief valve setting	...	...	...	3450 ±100 PSI (Sec Part 1, Chap 3)

(continued)

Leading Particulars - *continued*

Accumulator inflation pressure (main and wheelbrakes) ...	1300) 1350) 1400)	+50 -0 +0	PSI	at +5°C at +15°C at +25°C
Cut-out valve setting ...	2500	-100	PSI	
Cut-in valve setting ...	2000		PSI (minimum)	
Flaps relief valve setting ...	2850		±50 PSI	
Header tank relief valve setting	12 to 17		PSI	

Power Units

Engines (two)

Name	Avon Mk 1
Type	Straight flow turbojet
Fuel)	Refer to Part 2, Chap 1
Oil)	
Complete system capacity ...	19 pints (each engine)
Sump capacity	16 pints (each engine)

Starting System

Type	Rolls-Royce turbo, type SBS 720 Mk 5
Cartridge.... ..	No 9 Mk 2 (720 grammes)

Accessories Gearbox

Oil	OEP 71
Oil sump capacity	3.125 pints (each gearbox)

Electrical System

Voltage	28 volts
Generators (two)	6 kW, Type P3
Aircraft battery	(Pre-SEM 175) 4 x 12-volt, 40 ampere- hour (lead-acid), connected in series parallel (Post-SEM 175) 2 x 12-volt sealed lead-acid, connected in series
Emergency battery	2 x 12-volt, 4 ampere-hour (lead-acid), connected in series
Standby UHF emergency battery	1 x 24-volt, 7 ampere-hour (alkaline)

Fuel System

Types of fuel	See Part 2, Chap 1
Fuel tank capacities	See Part 1, Chap 2

PART 1**DESCRIPTION AND MANAGEMENT
OF SYSTEMS****LIST OF CHAPTERS**

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PART 1

CHAPTER 1 - ELECTRICAL SYSTEM

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DESCRIPTION

1 General

(a) Power for the electrical services and aircraft main battery charging is provided by two Type P3, 6 kW DC generators operating in parallel. Each generator is in the inboard leading edge of the mainplane and coupled to a 2-speed gearbox which, in turn, is coupled to the accessories gearbox of its respective engine. The maximum load for continuous operation of a single generator is 175 amperes.

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

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

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

2 AC Supplies - Inverters

- ◆ DC supplies are converted to AC by No 2, No 3 and No 4 (post-Mod 4868) rotary inverters and No 6 and 7 (No 5 and 6 post-Mod 4868) static inverters. The distribution of supplies is as follows:◆

(a) *No 2 Inverter (Type 100)*. This is the main flight instrument inverter; it supplies 115-volt, 400 Hz, 3-phase or single-phase AC to the following:

Mk 4B compass
Artificial horizon
Radio compass (if fitted)
DV window heater control unit
Oil pressure gauges

(b) No 3 Inverter. No 3 inverter (Type RC8A or Type 100 post-Mod 4868) serves as a standby to No 2 inverter.

(c) No 4 Inverter. Post-Mod 4868, a Type F45-10 inverter is fitted to supply 115-volt, 400 Hz, 3-phase AC to the Green Satin.

(d) No 6 Inverter (No 5 Post-Mod 4868)(Type 208). No 6 inverter (No 5 post-Mod 4868) supplies 115-volt, 400 Hz, single-phase AC normally to the Tacan, but by use of the changeover facility all the equipment normally supplied by No 7 (No 6 post-Mod 4868) inverter can be supplied instead.

(e) No 7 Inverter (No 6 Post-Mod 4868)(Type 208). No 7 inverter (No 6 post-Mod 4868) supplies 115-volt, 400 Hz, single-phase AC normally to the IFF/SSR, Automatic Height Encoding (AHE) and ILS/VOR (post-Mod 4868) but, by use of the changeover facility, Tacan can be supplied instead.

3 Aircraft Battery

- ◆ Pre-SEM 175 four 12-volt, 40 ampere-hour batteries, connected in series parallel, are in the battery compartment; post-SEM 175 two 12-volt sealed lead-acid batteries, connected in series, replace the four batteries; access is through a hinged hatch on the left side of the fuselage. ◆

4 External Supply

The external supply plug is on the MEP. It is connected directly to the busbar and all services connected to the busbar can be

operated from the external supply. As no flash-back protection is provided, it is important that the aircraft battery switch is set to OFF before an external supply is connected.

5 Emergency Batteries

(a) Two 12-volt, 4 ampere-hour batteries, connected in series, completely independent of the main electrical system, are under the forward end of the pilot's left console. They are for emergency operation of the turn-and-slip indicator, the elevator control tube severance detonator circuits, canopy jettison and hatch jettison, if the supply from the main system fails. They also supply the pilot's instrument panel emergency lighting.

(b) A 24-volt battery, in the left equipment bay, provides emergency power for the standby UHF if the main power fails.

6 Circuit Breakers and Fuses

(a) Information on circuit breakers protecting services other than pilot's services is given in the appropriate paragraphs. The circuit breaker labelled PILOTS SERVICES, on the rear face of the electrical control panel (ECP), protects the supply to:

- External lights and landing lamp
- DV panel heater
- Pressure head heater.

(b) Fuses for individual services are behind the side panel of the ECP and behind the panel marked FUSES to the rear of the left console. A list of these fuses is on the back of each panel.

7 Inertia Crash Switches

Two inertia crash switches are in the fire circuits; one is in each lower equipment bay. If both switches trip during a crash landing, all engine and fuselage fire extinguishers are discharged and the aircraft battery is isolated from the main busbar. The

following emergency circuits, supplied directly from the aircraft battery, are unaffected:

Inertia crash switch circuits	
Fire extinguisher circuits (via the inertia crash switches only)	
Canopy jettison)
Elevator control tube severance	) Detonator circuits
Hatch jettison)

CONTROLS AND INDICATORS

8 Generator Controls

(a) Each generator has a GENERATOR - ON/off switch, a GENERATOR FIELD circuit breaker and a CHARGE FAILURE warning light; they are on the rear face of the ECP. The switches are of the pull-to-unlock type and are gated to lock their dollies at both selective positions. Duplicate failure lights are on the engine instrument panel. The lights come on when the generators are off-line or to indicate generator failure.

(b) A DC voltmeter on the navigator's instrument panel indicates the voltage of the supply connected to the busbar as follows:

Generator(s) charging	...	...	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

9 AC Supplies - Inverter Controls

(a) *No 2 and No 3 Inverters*

(i) No 3 and No 2 inverters are initially controlled by No 1 (left) and No 2 (right) MASTER STARTING - ON/off switches

respectively; the switches are on the engine starter panel.

(ii) When No 1 MASTER STARTING switch is selected to ON, No 3 inverter starts up to supply the items listed in para 2(a). At the same time the EMERGENCY INST SUPPLY magnetic indicator (MI), on the flight instrument panel, changes from black to white.

(iii) Subsequently, when No 2 MASTER STARTING switch is selected to ON, No 2 inverter starts up and takes over from No 3 inverter, the EMERGENCY INST SUPPLY MI then changes to black.

(iv) Thereafter, No 3 inverter continues to run but remains off-line (automatically shuts down post-Mod 4868). If No 2 inverter fails, No 3 automatically takes over the supply (starts up and takes over the supply post-Mod 4868) from No 2 and the EMERGENCY INST SUPPLY MI then changes to white.

(v) The inverters are protected by two circuit breakers, on the rear face of the ECP, labelled No 2 INV and No 3 INV.

(b) *No 4 Inverter (Post-Mod 4868)*. No 4 inverter is controlled by an OFF/NORM/START switch on the ECP; the switch is spring-loaded to NORM from START. The inverter cannot be started until both generators are on-line. If a single generator fails, the inverter is automatically shut down. The START position is selected either to start the inverter or to reclaim it after shutdown when a failed generator comes back on-line. The Green Satin is supplied from the inverter via fuses and a relay. To cut off the supply to the Green Satin it is necessary to switch OFF the inverter.

◆ (c) *Static Inverters*

(i) *Pre-Mod 4868*. No 6 and No 7 inverters are controlled by a single 3-position switch, on the ECP, labelled TACAN/◆

◆ IFF - OFF/NORM/CO. When NORM is selected, No 6 inverter supplies the Tacan and No 7 supplies the IFF/SSR and AHE. To provide flexibility in operation with one inverter failed, the circuit is arranged so that when CO (changeover) is selected No 6 is switched to IFF/SSR and AHE and No 7 to Tacan.

(ii) *Post-Mod 4868*. No 5 inverter is controlled by an ON/off switch on the ECP. No 6 inverter is controlled by a 3-position OFF/NORM/CO switch also on the ECP. With No 5 at ON and No 6 at NORM, Tacan is supplied by No 5, and IFF/SSR, AHE and ILS/VOR are supplied by No 6. With the No 6 switch at the CO (changeover) position, No 5 is switched to IFF/SSR, AHE and ILS/VOR, and No 6 is switched to Tacan. ◆

10 Aircraft Battery Control

The aircraft battery is controlled by a BATTERY ISOLATION - ON/OFF switch on the rear face of the ECP or (post-Mod 4868) on the front face of the ECP. The switch is of the pull-to-unlock type and is gated to lock its dolly at the ON (up) position. 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 those listed in para 7.

11 Emergency Batteries Controls

(a) *24-Volt Emergency Battery*. The emergency supply to the turn and slip indicator is controlled by a guarded TURN & SLIP EMERGENCY SUPPLY switch on the flight instrument panel, adjacent to the indicator. The supply to the emergency lighting is controlled by an EMERG LIGHTS - ON/off switch on the coaming panel.

(c) *24-Volt Standby UHF Battery*. See Chap 6.

NORMAL OPERATION

12 Before Starting the Engines

The **Internal Checks** may be carried out using either the aircraft battery or an external power supply. Only use the aircraft battery 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, plug in an external power supply until ready to start the engines. If the aircraft battery voltage is less than 22 volts under load the aircraft must be considered unserviceable. The battery switch must be ON if the checks are carried out using the aircraft battery and OFF during the period an external power supply is connected.

13 Starting the Engines

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

14 Before Flight

If the EMERGENCY INST SUPPLY MI shows white before take-off, increase engine RPM until the DC voltmeter shows 28 volts. Check No 2 inverter circuit breaker. Switch off the No 2 master starting switch for one second and then switch it on again; this should restart No 2 inverter.

15 During Flight

Make frequent checks in flight to ensure that both generators are on-line and maintaining 28 volts, and that the EMERGENCY INST SUPPLY MI remains black.

16 After Flight

After landing, switch off all the inverter switches on the ECP. No 2 and No 3 inverters are controlled by the engine master starting switches which are switched off during the **Shutdown Checks**.

MALFUNCTIONS

17 Generator Failure

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

(b) Failure of Both Generators

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

(ii) If both generators fail at high altitude, reduce altitude because the LP pumps only function as long as power is available from the aircraft battery. If the battery fails there is imminent danger of flame out without the ability to relight. Reduce altitude to below 15,000 feet, if possible, so that the engines may continue to obtain fuel by gravity/suction feed if the LP pumps cease to operate. However, if it is necessary to

fly at greater altitude in order to reach the nearest suitable airfield, restrict RPM to 7200 (maximum) and altitude to 35,000 feet ♦♦ (see also Chap 2).

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

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

- (i) Switch OFF the generator which has its warning light out.
- (ii) Shed non-essential loads.
- (iii) Attempt to reset the generator which had its warning light on originally.

(d) *Overvolting.* Faulty regulation may result in overvolting which in turn, if prolonged, overcharges and damages the aircraft battery. If overvolting occurs, take the following action:

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

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

Over 30 Volts. Shut down the engines immediately and report the defect.

(ii) *In Flight*

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

29 to 30 Volts. Land as soon as practicable.

Over 30 Volts:

1 Reduce electrical load.

2 Switch OFF each generator in turn and check voltage. If one generator gives less than 30 volts isolate the other and land as soon as practicable.

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

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

18 Inverter Failure

(a) *No 2 Inverter.* If No 2 inverter fails, the EMERGENCY INST SUPPLY MI shows white. When this occurs, No 3 inverter

automatically takes over from No 2 (starts up and takes over from No 2 post-Mod 4868). One attempt to restart No 2 may be made by re-setting its circuit breaker, if this has tripped, and switching the No 2 MASTER STARTING switch off for one second.

(b) *No 3 Inverter*. If, after a No 2 inverter failure, No 3 inverter fails (indicated by the artificial horizon OFF flag and zero readings on the oil pressure gauges), an attempt to restart it may be made by re-setting its circuit breaker, if this has tripped.

(c) *No 4 Inverter (Post-Mod 4868)*. If Green Satin fails, check that both generators are on-line and that the voltmeter reads 28 volts. Attempt to restart the inverter; if unsuccessful switch it OFF.

◆(d) *No 5 and 6 Inverters (Post-Mod 4868)*

(i) If only Tacan fails, check that No 5 inverter switch is ON. If ON, select No 6 inverter switch to CO. If Tacan now operates, No 5 inverter has failed; if Tacan does not operate, check the Tacan DC supply fuse in the ECP.

(ii) If IFF/SSR, AHE and VOR/ILS all fail, check that No 6 inverter switch is at NORM. If at NORM, select it to CO. If IFF/SSR, AHE and VOR/ILS now operate, No 6 inverter has failed.

(e) *Tacan/IFF Inverters (Pre-Mod 4868)*

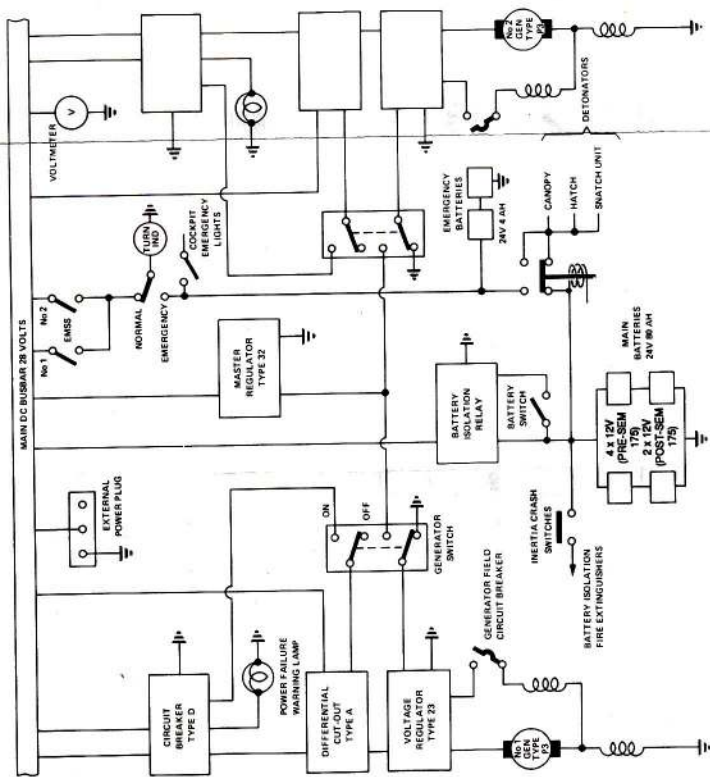
(i) If only Tacan fails, check that the TACAN/IFF inverter switch is at NORM. If at NORM, select it to CO. If Tacan now operates, No 6 inverter has failed; if Tacan does not operate, check the Tacan DC supply fuse in the ECP.

(ii) If IFF/SSR and AHE fail, check that the TACAN/IFF inverter switch is at NORM. If at NORM, select it to CO. If IFF/SSR and AHE now operate, then No 7 inverter has failed.◆

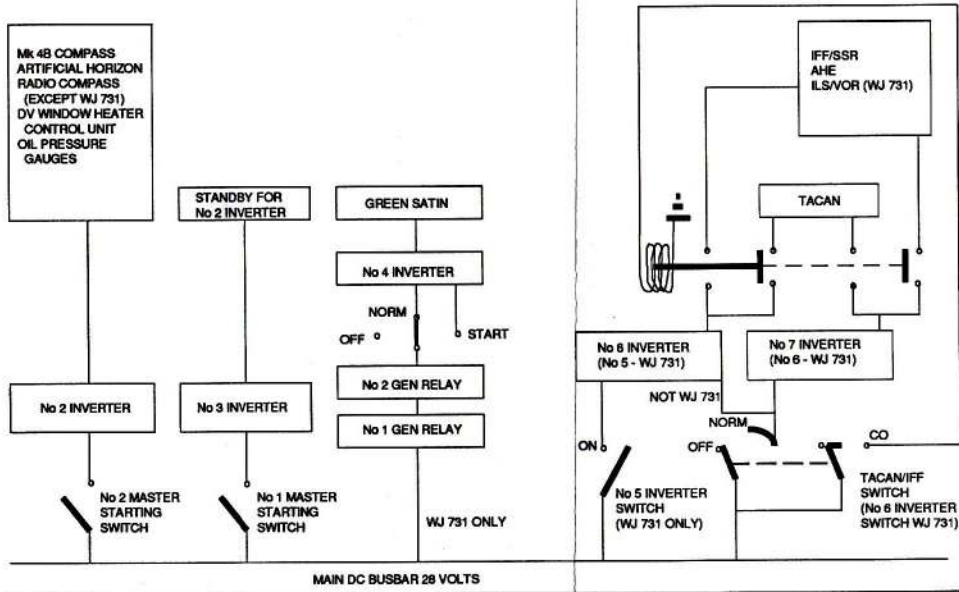
- ◆ (f) *Static Inverters.* If all the equipments supplied from the static inverters fail, check fuse No 161 in the ECP; the DC supply to the static inverters' start switch(es) is via this fuse. ◆

19 Electrical Loads

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



1 - 1 Fig 1 DC Power Supply System (Simplified)
◆ (SEM 175 added) ◆



1 - 1 Fig 2 AC Electrical System (Simplified)

PART 1

CHAPTER 2 - FUEL SYSTEM

Contents

DESCRIPTION	Para
Fuel Tanks	1
Fuel Tank Capacities	2
Fuel Feed to the Engines	3
CONTROLS AND INDICATORS	
LP Cock and Pump Controls	4
Fuel Pressure Warning Lights	5
Fuel Contents Gauges	6
NORMAL OPERATION	
Checks of LP Cocks and Pumps	7
Fuel Management	8
Use of Different Fuels	9
MALFUNCTION	
Fuel LP Pump Failure	10
Illustration	Fig
Fuel System Simplified	1

DESCRIPTION

1 Fuel Tanks

(a) *Fuselage Tanks.* Three fuel tanks are fitted in the fuselage above the bomb bay. They are numbered 1, 2 and 3 from front to rear. No 1 and No 2 tanks are rigid self-sealing structures and No 3 tank is a crash-proof collapsible fuel bag. The tanks are vented to atmosphere through a common pipe terminating at an outlet on the right of the fuselage under the tailplane. Flush-fitting filler caps, one for each tank, are on the left upper surface of the fuselage.

(b) Wing-Tip Tanks

(i) Jettisonable wing-tip tanks may be fitted. No fuel cocks or pumps are provided. The tanks feed automatically (and together), under air pressure from the engine compressors, into No 3 tank via a float valve. A flush-fitting, inward-venting filler cap is on the outboard upper surface of each tank.

(ii) The wing-tip tanks can be jettisoned by pressing in the guarded FUEL TANK JETTISON button on the sloping left front panel.

(c) *Bomb Bay Tank.* Post-Mod 1490, an overload tank of 300 gallons nominal capacity (actual capacity 293 gallons) can be fitted in the bomb bay. From this tank fuel is fed into No 3 tank by two LP pumps through two LP cocks. Fuel enters No 3 tank through a float valve but, because of LP pump pressure, do not rely on the float valve to prevent flooding.

2 Fuel Tank Capacities

The approximate effective fuel capacities are given in Table 1.

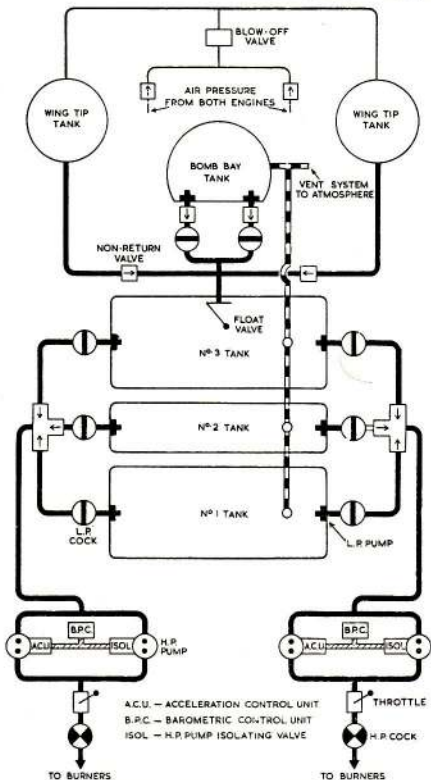
3 Fuel Feed to the Engines

Two electrically-driven LP pumps are fitted in each fuselage tank. The pumps on the left side of the fuselage

Table 1 - Fuel Tank Capacities

	Gallons ◆◆	lb Avtur (0.8 SG)	lb Avcat (0.82 SG)
No 1 tank	520	4160	4264
No 2 tank	317	2536	2600
No 3 tank	540	4320	4428
<i>Total internal fuel</i>	1377	11,016	11,292
<i>Wing-tip tanks (2 at 244 gallons)</i>	488	3904	4002
<i>Total internal and wing-tip tank fuel</i>	1865	14,920	15,294
<i>Bomb bay tank</i>	293	2344	2402
<i>Total with bomb bay tank</i>	2158	17,264	17,696

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



1—2 Fig 1 Fuel System Simplified

tanks feed fuel through their associated LP cocks and a common collector box to the port engine HP pumps; similarly the pumps on the starboard side of the tanks feed the starboard engine HP pumps.

CONTROLS AND INDICATORS

4 LP Cock and Pump Controls

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

					<u>COCK</u>	<u>PUMP</u>
Up	...	...	...	...	OPEN	ON
Middle	...	...	...	...	OPEN	OFF
Down	...	...	...	...	CLOSED	OFF

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

(b) If a bomb-bay tank is fitted, two ON/OFF switches on the engine instrument panel control its pumps and cocks. Each switch jointly controls the operation of its respective pump and associated cock.

(c) Each fuselage tank cock and pump circuit is protected by a circuit breaker on the ECP. The bomb bay tank pumps and cocks are protected by fuses in the ECP.

5 Fuel Pressure Warning Lights

Two fuel pressure warning lights, one for each engine, are on the engine instrument panel. They come on if fuel delivery pressure from the LP pumps drops below 6 PSI due to pump failure, negative-g or shortage of fuel in the tank(s) in use.

6 Fuel Contents Gauges

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

NORMAL USE OF THE FUEL SYSTEM

7 Checks of LP Cocks and Pumps

First ensure that all fuel cock and pump circuit breakers are made. Check the operation of each pump both aurally and against the appropriate fuel pressure warning light. The bomb bay tank pumps should be checked aurally and then switched OFF.

8 Fuel Management

(a) General

(i) The CG limits may easily be exceeded if the correct fuel drill is not followed. This applies particularly when making repeated circuits and landings with all pumps ON.

(ii) When using No 3 tank while the fuel from the wing-tip tanks is transferring, the fuel gauge may read full but under certain conditions of flight the level may fall to 3500 lb before transfer has been completed. When the level in No 3 tank falls steadily below 3500 lb, it indicates that the transfer of fuel has ceased. The rate of transfer from each wing-tip tank may vary, giving rise to temporary lateral trim changes.

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

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

(v) Should a pump of the fuel tank in use become uncovered by fuel and no other tank pump is supplying fuel to the engine, air may pass to the engine through the uncovered pump inlet as well as fuel under gravity or suction feed from other tanks. However, if more than one pump is supplying an engine and one of these pumps is uncovered, air should not be passed to the engine as long as the remaining pump remains adequately covered.

(b) Fuel Surge

In a steep climb or when rapid accelerations or manoeuvres are being made, there is a risk at low fuel levels of fuel surge uncovering the pumps in No 1 and No 3 tanks. When using the normal fuel drill this fuel surge will not be dangerous, as with the levels in No 1 and No 3 tanks so low, No 2 tank pumps will be ON as well. The running of both engines from one tank containing a small amount of fuel should be avoided, particularly at low altitude. Equally, running of each engine from separate tanks where each tank contains less than 500 lb should be avoided. When exercises involve periods of rapid manoeuvring or concentration on visual flying, consideration should be given to selecting all pumps ON for the period. The application of negative-g loading is to be avoided. Any sustained application of negative g is likely to cause engine fuel starvation and flame out. Subsequent relighting may not be possible because of air in the fuel system which can only be bled out on the ground.

(c) Use of Bomb Bay Tank Fuel

When the bomb bay tank is full, it is important, in case of bomb bay tank cock or pump failure, to use this fuel as early as possible. During the cruise after the wing-tip tanks are empty, use No 3 tank until it is down to 2500 lb and then switch ON the bomb bay tank pumps. When the No 3 tank contents gauge reads 3500 lb, switch OFF the bomb bay tank pumps. Repeat this procedure until the bomb bay tank is empty. As there is no cockpit contents gauge for the bomb bay tank, the only indication that it is empty will be when the No 3 tank contents gauge shows a steady decrease when the bomb bay tank pumps are ON. Therefore, when transferring fuel make a frequent check of No 3 tank contents gauge, and when this shows a steady decrease, switch OFF the bomb bay tank pumps and continue the fuel drill in the normal manner.

(d) Reserve Fuel

An overshoot followed by an instrument approach and landing requires about 1250 lb fuel which should, preferably, be retained in No 2 tank. The fuel surge in No 2 tank does not become dangerous until the contents have fallen to about 400 lb, but all the fuel can be used provided that manoeuvres or attitudes which might lead to fuel surge are avoided.

(e) Fuel Drill

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

<i>Condition</i>		<i>Tank</i>			
		<i>No 1 Pumps</i>	<i>No 2 Pumps</i>	<i>No 3 Pumps</i>	<i>Bomb Bay Pumps</i>
1	Start up and taxi	OFF	OFF	ON	OFF
2	Take-off to 2000 ft	ON	ON	ON	OFF
3	Cruise. (Bomb bay tank full)	OFF	OFF	ON	OFF
	When No 3 tank reads 2500 lb	OFF	OFF	ON	ON
	When No 3 tank reads 3500 lb	OFF	OFF	ON	OFF
Repeat the above procedure until the bomb bay tank is empty					
3A	Cruise. (Bomb bay tank empty or not fitted)	Maintain balanced amounts in No 1 and No 3 tanks			
		As reqd	OFF	As reqd	OFF
4	When No 1 and No 3 tanks read 500 lb	ON	ON	ON	OFF
5	Landing (see Note)	ON	ON	ON	OFF

Note: When carrying out circuit practice, condition 5 may be modified to read 'minimum of two pumps per engine ON, as long as No 1 and No 3 tanks read above 500 lb each'.

9 Use of Different Fuels

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

MALFUNCTION

10 Fuel LP Pump Failure

(a) If two or three LP pumps on one side are ON, no immediate indication will be given if one pump fails; but if all pumps fail, or if only one pump is ON and it fails, the warning light for that side will come on. (See para 5.)

(b) The HP pumps are designed to operate with a positive inlet pressure. LP pump failure will cause the HP pumps to obtain fuel by gravity feed and suction only, which may result in 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 inlet guide vane movement. If the fuel pressure at the HP pumps inlet is sufficiently low, cavitation of the HP pumps will occur causing further loss of thrust and reduction in RPM. In an extreme case, engine surge will be experienced as low as 15,000 feet and flame extinction could occur between 20,000 and 30,000 feet.

(c) Following a reduction in fuel pressure each HP pump servo piston moves the pump camplate to the full stroke position in an attempt to produce the normal working pressure; restoration of low pressure fuel in these circumstances may lead to over-fuelling. Therefore, if an LP pump fails, throttle the affected engine to 'idling' immediately, wait for the RPM and JPT to stabilise and then switch ON another LP pump on the same side. Accelerate the engine carefully; satisfactory operation and freedom from compressor stall will be shown by the RPM and JPT rising together. If, however, the JPT and RPM do not stabilise normally, shut down the engine, and relight using the drills given in the FRC. Fuel from the tank with the failed pump is available for use by the other engine.

(d) If both LP pumps in one tank fail, or if the distribution of fuel makes necessary the use of fuel by suction and gravity feed, altitude should be reduced to 15,000 feet

if possible. Throttle to idling the engine which is to be fed by gravity/suction, switch the related cock/pump of the affected tank to cock OPEN pump OFF and switch the remaining cocks/pumps on that side to cocks CLOSED pumps OFF. Accelerate the engine carefully; cruising RPM should be obtained below 15,000 feet. *Erratic running, which leads 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, ♦♦ but altitude and RPM must be kept as low as possible. Climb using fuel from tanks with serviceable pumps; this applies equally when landing, to avoid the possibility of having to overshoot using gravity/suction feed, which is undesirable. Any use of *gravity/suction feed must be reported.*

PART 1

CHAPTER 3 - HYDRAULIC SYSTEM

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Hydraulic System Simplified...	Fig 1

DESCRIPTION

1 General

A hydraulic pump on each engine draws fluid from a reservoir (capacity 2 gallons) at the right of the upper equipment bay. A handpump is to the right of the pilot's seat. A stack pipe in the reservoir ensures a reserve of fluid for use with the handpump. A BRAKE pressure gauge and a main HYDRAULIC pressure gauge are on the miscellaneous instrument panel.

2 Pumps and Services

(a) The engine-driven pumps deliver fluid for operating under-carriage, flaps, airbrakes, bomb doors and wheelbrakes.

(b) The handpump works in conjunction with a hydraulic GROUND/FLIGHT cock situated near the front of the bomb bay roof on the right. When the cock is at FLIGHT, the handpump can be used to operate only the undercarriage and the bomb doors and to charge the wheelbrakes accumulator. With the cock at GROUND the handpump can be used to operate all services. The cock is normally wire-locked in the FLIGHT position. The handpump handle can be stowed in clips aft of and above the entrance door; it must be in position on the pump at all times during flight, except when the folding seat is occupied when it should be in position for taxiing, take-off and landing only.

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

3 Accumulators

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

(b) A cut-out valve, in the pressure line, connects to the return line, providing an idling circuit; it is set to cut-out when the accumulator pressure reaches 2500 +0 minus 100 PSI and cut-in at a minimum of 2000 PSI. Thermal relief valves in all circuits, except the wheelbrakes, open when pressure in the line to a

PART 1

CHAPTER 3 - HYDRAULIC SYSTEM

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DESCRIPTION

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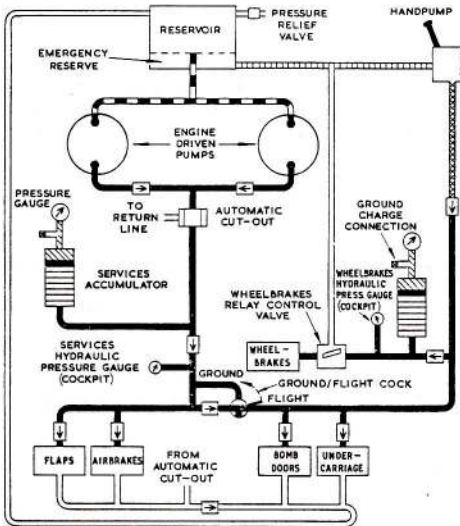
(c) A second manually-operated selector cock is on the forward face of the rear bulkhead on the left of the battery bay. It has two positions, UP and FLIGHT, and is normally wire-locked in the FLIGHT position. When in the UP position it enables the nose undercarriage unit to be retracted by the handpump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

3 Accumulators

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

(b) A cut-out valve, in the pressure line, connects to the return line, providing an idling circuit; it is set to cut-out when the accumulator pressure reaches 2500 +0 minus 100 PSI and cut-in at a minimum of 2000 PSI. Thermal relief valves in all circuits, except the wheelbrakes, open when pressure in the line to a

NOTE:- THERMAL RELIEF VALVES AND FILTERS ARE NOT SHOWN



KEY

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

1 - 3 Fig 1 Hydraulic System Simplified
◆ (Minor amendment) ◆

service increases, for any reason, to 3450 ±100 PSI; these valves reseal when pressure falls to 3100 PSI (minimum). An additional valve relieving at 3100 PSI is between the sequence valve and transfer valve in each main undercarriage circuit; to ensure satisfactory operation of these valves, a valve relieving at 3500 ±100 PSI is in the brake differential control valve.

4 Controls

The electrically-actuated selector valves for all the services except the wheelbrakes, which are mechanically selected, are controlled by switches in the cockpit. If electrical failure occurs, provision is made for mechanical selection of undercarriage lowering and bomb doors opening; details are given in Chap 5.

NORMAL MANAGEMENT

5 External Checks

Check the accumulator pressure gauges in the bomb bay and right wheelwell for minimum pressure (see para 3(a)). Ensure the hydraulic cock in the bomb bay is wire-locked at FLIGHT.

6 Before Starting the Engines

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

7 Checks During Starting

WARNING: Do not operate flaps when aileron locks are in.

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

8 After Starting the Engines

When both engines have started, check the operation of the airbrakes and flaps and note on completion of each

check that the hydraulic pressure builds up again to 2400 to 2500 PSI.

9 Checks During Shutdown

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

MALFUNCTION

10 Hydraulic Failure

(a) A failure may be assumed if the reading on the main pressure gauge is below 2000 PSI and fails to build up. If hydraulic failure occurs, the flaps and airbrakes will be inoperative. By using the hydraulic handpump, after making the appropriate selection, the undercarriage can be lowered and bomb doors opened; wheelbrakes pressure can also be obtained, provided that hydraulic fluid is available. Detailed emergency drills are given in the FRC.

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

(c) *Spurious Indication of Hydraulic Failure*

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

PART 1

CHAPTER 4—ENGINE SYSTEMS AND CONTROLS

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1 Avon Mk 1

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

2 Engine fuel system

(a) High pressure (HP) fuel pumps

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

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

- 1 The throttle, to meter fuel to the burners.
- 2 A barometric pressure control (BPC), to vary the pump output in relation to engine intake pressure.
- 3 An acceleration control unit (ACU), to prevent excess supply of fuel to the engine during periods of rapid engine acceleration between idling RPM and 5000 RPM up to 5000 ft.

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

(b) HP fuel pumps isolating valve

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

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

3 Variable inlet guide vanes and air bleed valves

(a) The first row of stator blades in the engine compressor consists of variable incidence inlet guide vanes which assist in imparting swirl to the incoming air. At low RPM the first stages of the compressor deliver more air than is acceptable to the later stages. To prevent instability of flow, ie surge, the surplus air is bled off through the air bleed valves and the guide vanes are at the closed ($+40^\circ$) position to give an angle of flow acceptable to the first stage blades at low RPM. As the normal flight range of RPM is reached, the air bleed valves close and the guide vanes move progressively to the open (0°) position and produce a minimum of swirl.

(b) No noticeable change in RPM or thrust occurs when the bleed valves change over, nor do the guide vanes have any noticeable effect on engine operation. However, the compressor is not operating at maximum efficiency and best specific fuel consumption is not obtained until the guide vanes are fully open.

(c) The guide vanes leave the 0° (open) position at 7250 ± 50 RPM ◆◆ on deceleration and leave the $+40^\circ$ (closed) position at 5850 ± 100 RPM ◆◆ on acceleration.

(d) The air bleed valves are set to open and close at 6300 ± 50 RPM ◆◆.

4 Throttle controls

The two throttle levers are on the engine controls quadrant. Friction is adjusted by turning the larger of the two knurled knobs (clockwise to increase friction) on the side of the quadrant.

5 High pressure (HP) cock controls

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 controls quadrant. In the OFF position the fuel supply to the burners is cut off. Each lever incorporates a relight pushbutton.

6 Engine starting, relighting and stopping controls

(a) General

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

(b) Starter loading

- (i) Check that the MASTER STARTING switches are off. Then unscrew the breech cap after releasing the locking ratchet by pressing on the spring-loaded stud in the cap. Remove the cartridge case from the cap by depressing the two buttons in the base. Fit a new cartridge so that the extractor claws grip the base. Insert the cartridge into the barrel and screw the cap home finger-tight only; if screwed in too tight it may be difficult to unscrew subsequently and the starter may be damaged.
- (ii) On no account may work be carried out on the starter while the engine is turning.

(c) 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.

(d) Ground starting

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

(e) Relighting in flight

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

(f) Stopping an engine

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

7 Oil system

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

8 Engine instruments

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 2 or No 3 inverter.

9 Engine fire extinguishers and inertia crash switches

See 1—7 paras 1 and 3.

10 Engine handling procedures

Detailed information to cover particular aspects of engine handling on the ground and in flight is given in the relevant chapters in Part 3 and in the FRC's.

PART 1**CHAPTER 5 - AIRCRAFT CONTROLS****Contents**

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1 Flying Controls - General

Flying controls are conventional in operation; control runs consist of push-pull tubes and levers. Rudder, left elevator and both ailerons are fitted with spring tab mechanisms. Rudder pedal reach is adjusted by a central star wheel. Wheelbrakes lever, parking catch and airbrakes control switch are on the control column. Tailplane trim and cut-in switches and a press-to-transmit switch are on the right-hand grip. Rudder and aileron trim control switches are on the pilot's left console; flaps and undercarriage selectors are on the sloping left front panel.

2 Variable-Incidence Tailplane and Indicator

(a) An electrical actuator, controlled by two switches (spring-loaded off) on the control column right-hand grip, changes tailplane incidence. The actuator cannot be operated by the trim switch without operating the cut-in switch 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 back to give a nose-up trim change. The normal limits of the tailplane travel are controlled by electrical limit switches.

(b) 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 full nose-down trim even if the actuator has overrun the electrical stop and has reached the mechanical stop.

(c) The tailplane position is shown on a trim indicator on the left of the flight instrument panel.

(d) Whenever an aircraft component which affects longitudinal trim is renewed or adjusted, the flight trim check specified in AP 101B-0402-1, Sect 3, Chap 4, App 1 is to be carried out.

3 Aileron Trim Control and Indicator

◆ (a) Pilot adjustable 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 left console.

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

4 Rudder Trim Control and Indicator

(a) The rudder spring tab also serves as a trim tab. An electrical actuator, controlled by two switches labelled RUDDER TRIM - L/off/R (spring-loaded to off) on the left console, alters the position of the spring tab relative to the rudder. Both switches must be operated together to obtain rudder trim movement.

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

5 Control Column Snatch Unit

(a) 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 (see Chap 10) must be ON to make the system live.

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

6 Flying Controls External Locks and Picketing Points

(a) *External Locks.* All control surfaces are locked by external clamps with red flags attached. When not in use the clamps are stowed ♦♦ in a metal box on the inside of the battery compartment hatch.

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

7 Undercarriage

(a) *General.* Undercarriage raising and lowering is effected by hydraulic jacks and an electrically-operated hydraulic selector valve. Sequence valves in the hydraulic circuits ensure that the undercarriage doors operate in their correct sequence. Provision is made for emergency lowering of the undercarriage in the event of main hydraulic failure or electrical failure of the selector valve (see para 8).

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

(c) *Safety Devices.* The safety devices, incorporated to prevent inadvertent undercarriage retraction on the ground, are:

(i) *Undercarriage Master Switch.* A 2-position switch marked U/C MASTER - LIVE/SAFE is adjacent to the selector switch unit. This switch is gated to lock in either selected position. At SAFE the power supply for operation of the selector valve up selection 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. The power supply is routed direct to the undercarriage DOWN selector; the MASTER switch only controls the power supply to the UP selector.

(ii) *Solenoid Lock.* A solenoid-operated mechanical lock in the selector switch unit prevents the UP button from being

operated while the main undercarriage legs are compressed. When the legs extend on the aircraft becoming airborne or on being jacked up, a microswitch on the right leg closes and the solenoid is energized; this releases the mechanical lock to allow UP to be selected. This safety device should not be relied upon when the weight of the aircraft is low. The lock can be overridden by operation of the UP button override (see para 8).

(iii) *Undercarriage Safety Clip*

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

(iv) *Undercarriage Ground Locks*

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

(d) *Undercarriage Position Indicator*

(i) A type D or D1 indicator on the left front panel is operated by microswitches in the main and nose undercarriage bays. The indications are:

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

(ii) Note 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.

(iii) If failure of a green light is suspected, reserve green lights can be brought into operation by

turning the changeover switch at the centre of the dial. For night flying, the intensity of the lights can be reduced by turning the larger winged knob at the centre of the dial. A fuse for the indicator is in the ECP (No 68).

8 Undercarriage Malfunctions

(a) Emergency UP Selection

When the aircraft is on the ground the undercarriage can be selected UP in emergency, provided that the master switch is at LIVE, by rotating the override collar on the UP button clockwise until it reaches a stop and then pressing the UP button. The override collar moves through 60° or 90° according to the type fitted. The override should not normally be operated in the air because, if the undercarriage has been damaged, subsequent lowering may be prejudiced.

(b) Emergency Lowering of the Undercarriage

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

(i) Hydraulic Failure

If hydraulic failure occurs (indicated by the main pressure gauge reading below 2000 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 (about 130 strokes); however, this largely depends on the nature of the failure and exceptionally up to 30 minutes and considerable physical effort may be required.

(ii) Electrical Failure

1 If no red indicator lights are showing, try to re-select undercarriage UP again. If the UP button will not depress, the solenoid of the UP button mechanical lock is not energized; this is an indication of failure of the control circuit fuse (67) in the ECP. When the fuse is replaced **◆◆** the undercarriage lowers immediately.

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.

(iii) Mechanical Failure

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

(c) Emergency Drills

Full emergency drills for undercarriage malfunction are given in the FRC.

9 Flaps Control and Indicator

(a) 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 operating the flaps in flight after electrical or hydraulic failure. At 6000 RPM the flaps should normally retract in about 16 seconds and lower fully in about 13 seconds.

(b) To prevent inadvertent operation of the flaps, when external locks are fitted, a locking pin is inserted in the

switch lever guard. When not in use this pin is stowed in a bag on the lower front face of the ECP.

10 Airbrakes Control

The electrically-operated hydraulic selector valve for the airbrakes is controlled by a switch on top of the control column. It has two positions, IN/OUT. ♦♦ No provision is made for operating the airbrakes in flight after electrical or hydraulic failure.

11 Wheelbrakes Control

(a) 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.

(b) The pressure in the brakes accumulator is shown on a gauge on the miscellaneous instrument panel; normal pressure is 2000 to 2500 PSI. If the hydraulic system has failed, pressure falls to 1350 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 using the hydraulic handpump if fluid is available.

(c) If a leak occurs in the wheelbrakes system while taxiing (indicated by a loss of pressure on the brake and main 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.

12 Bomb Doors Controls and Indicator

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

(b) To prevent inadvertent closing of the bomb doors on the ground, a locking pin is inserted in the control switch

guard with the switch in the OPEN position. When not in use this pin is stowed in a bag on the lower front face of the ECP.

(c) *Emergency Operation of Bomb Doors*

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

(ii) If the failure is hydraulic and provided that fluid is available, the bomb doors can be opened and closed by means of the handpump and normal selection on the control switch. It should be noted, however, that such action by using the emergency reserve fluid may prejudice subsequent lowering of the undercarriage, and wheelbraking.

PART 1

CHAPTER 6 - FLIGHT INSTRUMENTS, RADIO AND RADAR

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FLIGHT INSTRUMENTS

1 Compasses

(a) *Mk 4B Compass.* The Mk 4B compass is operative whenever AC is supplied by either No 2 or No 3 inverter. The master indicator is on the navigator's instrument panel and the compass control panel is on the cabin right wall. The gyro unit is on the pilot's flight instrument panel; it can also be used as a directional gyro by setting the COMPASS/D GYRO switch on the engine starter panel, to D GYRO.

(b) *Magnetic Standby Compass.* An E2B standby compass is fitted centrally below the canopy coaming. The integral lamp is controlled by the adjacent starboard RED dimmer switch.

2 Pitot and Static Pressure Systems

(a) An electrically-heated pressure head, controlled by the PRESS HEAD - ON/OFF switch on the left console, on the nose of the aircraft, and two static vents, one on each side of the nose (the forward hole of each two-vent plate), supply pitot and static pressure respectively to the following:

- Machmeter (P and S)
- Airspeed indicators (P and S)
- Vertical speed indicator (S)
- Mk 29B altimeter (S)
- Air mileage unit (P and S)
- Pressure error corrector unit (P).

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

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

3 Artificial Horizon

A Mk 3C or 3D artificial horizon is on the flight instrument panel. The instrument is operative whenever AC is supplied by either No 2 or No 3 inverter. Failure of the power supply to the instrument is indicated by the appearance of an OFF flag in the face of the instrument. A fast erection button is at the bottom left of the instrument.

4 Turn-and-Slip Indicator

A turn-and-slip indicator, on the flight instrument panel, is operated from duplicated DC supplies having automatic change-over. Each supply is primarily controlled by its associated engine master starting switch. If both normal supplies fail, indicated by the OFF flag appearing in the face of the indicator, the indicator can be connected to the emergency battery by selecting the TURN & SLIP EMERGENCY SUPPLY - normal/EMERGENCY switch beside the indicator to EMERGENCY. This is a pull-to-unlock type of switch, gated to lock in either selected position. When checked on the ground, the OFF flag disappears within five seconds. If the time exceeds 10 seconds, the emergency batteries may require recharging; replace them and carry out a further check.

5 Outside Air Temperature Gauge

An outside air temperature gauge is on the top left side of the navigator's instrument panel. The resistance bulb for the instrument is in the leading edge of the mainplane between the fuselage and the left engine.

6 Altimeters

(a) Mk 30A Altimeter

(i) A Mk 30A altimeter is on the navigator's instrument panel. The altimeter is the master instrument of the automatic height encoding (AHE) system. It operates in conjunction with a pressure error corrector unit and provides an electrical output to operate the pilot's Mk 29B altimeter when that instrument is in the servo mode and an encoded altitude output to the IFF/SSR transponder for altitude reporting on Mode C.

- ◆ Power supplies are DC and AC; the AC is supplied by No 7 inverter (No 6 post-Mod 4868) with supply changeover being available from No 6 inverter (No 5 post-Mod 4868)(see◆ Chap 1).

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

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

(iv) A reference datum pressure of 1013.2 mb is used for the

outputs to the pilot's Mk 29B altimeter and the IFF/SSR transponder; this is not affected by changes to the millibar counter setting.

(b) Mk 29B Altimeter

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

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

(iii) A standby/reset knob marked S \longleftrightarrow 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 three seconds, with system power supplies available, the altimeter resets to servo operation, the flag clears and the vibrator stops working.

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

1 *Pre-Take-Off.* Select the altimeter to 'S' and check that the flag shows STBY.

2 *After Take-Off.* When passing transition altitude in the climb, select the altimeter to 'R' and check that the flag clears.

3 *At Top of Climb, After Changing Flight Level and Periodically (15 minutes) During Cruise.* Select the altimeter to 'S', check the flag shows STBY and compare readings with the Mk 30A altimeter; reselect 'R' and check that the flag clears.

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

7 Air Mileage Unit

- ◆ The air mileage unit is in the left wheelwell. Post-Mod 4868, the control panel and air mileage indicator are on the lower left of the navigator's instrument panel. Pre-Mod 4868 the control panel is on the cabin left wall and the indicator is on the top right of the navigator's instrument panel.

8 Air Position Indicator

The air position indicator (API) is fitted into the navigator's instrument panel. Post-Mod 4868 the API is removed. ◆

9 Accelerometer

An accelerometer designed to operate over the range minus 5g to plus 10g is on top of the pilot's coaming panel.

RADIO AND RADAR

10 Communications Control System (ARI 18089)

(a) *Station Box - Type 768IA.* A station box is provided on the pilot's left console and another on the first navigator's instrument panel. Each box incorporates an anti-cross talk network and a telephone amplifier and has the following controls:

(i) *Seven Rotary LISTEN ONLY Volume Controls.* These allow the user to control the volume of the signals from the intercom A1961 amplifier (see sub-para (b) below) and one or more of the receivers without one adversely affecting the other. Pre-Mod 4868 the controls are labelled ADF, TACAN, spare position, I/C, ILS, spare position and V/UHF. Post-Mod 4868 the controls are labelled MKR, TACAN, spare position, I/C, ILS/VOR, VOR 2 and V/UHF. The V/UHF control is also used for standby UHF.

(ii) *SPEAK-LISTEN Rotary Switch.* This is a 6-position switch labelled (pre-Mod 4868) OFF/TACAN/ADF/ILS/V-UHF/I.C.; post-Mod 4868 it is labelled OFF/TACAN/MKR/ILS-VOR1/V-UHF/I.C. The V/UHF position is also used for standby UHF. The switch transfers the user's microphone, telephone and press-to-transmit lines to the facility selected, (volume is controlled by the associated LISTEN ONLY control). However, when the switch is set at V/UHF, the microphone lines are connected to the intercom amplifier and are only transferred to the V/UHF or standby UHF transmitter when the associated press-to-transmit switch is operated. This

permits independent control of intercom volume when at V/UHF (see sub-para (b) below). The TACAN/ADF/ILS or TACAN/MKR/ILS-VOR 1 positions are provided so that their audio identification signals can be monitored if the station box amplifier fails.

(iii) *NORMAL/OFF/DIRECT Switch.* When this switch is set at NORMAL, a DC power supply is connected to the station box amplifier and all incoming signals are fed via the volume controls, a cross talk network and the amplifier to the user's telephones. The DIRECT position is for use if the power supply or the amplifier fails. When set at DIRECT, the DC supply is disconnected from the amplifier and the user's telephones are connected via the associated volume control direct to only that facility that is selected on the SPEAK-LISTEN switch.

(iv) *CALL Switch.* The SPEAK-LISTEN switch must be selected to I/C or V/UHF before using the CALL switch which is spring-loaded to OFF. When CALL is selected all crew members receive the alerting transmission which is superimposed upon all other signals.

(v) *Fuses.* The supply fuse and a spare fuse are above the CALL switch.

(b) *Normal Intercom.* Normal crew intercom is provided by selecting I/C or V/UHF on the SPEAK/LISTEN switches and feeding the signals through a Type A1961 amplifier; intercom volume is controlled, for either selection, by the I/C volume control.

(c) *Emergency Intercom*

(i) *A1961 Amplifier Failure.* Emergency crew intercom is available in the event of A1961 amplifier failure by transferring the intercom lines to the audio circuits of the main radio or standby UHF, whichever is in use. This is achieved by

selecting the INTERCOM - OFF/NORM/EMERG switch on the pilot's left wall switch panel to EMERG. Volume is controlled initially by the volume control on the main radio control unit, if in use, and finally by either the V/UHF or I/C volume controls.

(ii) *Total Electrical Failure.* After total electrical failure, emergency crew intercom is available by using the audio circuits of standby UHF when powered by its independent battery (see para 13). DIRECT and V/UHF must be selected on both station boxes; volume is controlled by the V/UHF volume controls.

(d) *Mic/Tel Sockets*

(i) An intercom socket is fitted on the left of each ejection seat. An additional socket is fitted adjacent to the folding seat and another is at the prone position in the nose.

(ii) The nose, folding seat and 2nd navigator's mic/tel sockets are paralleled off the pilot's intercom with a mic-isolation circuit operative through the pilot's press-to-transmit switch. These crew positions hear what the pilot hears but they can only communicate with the pilot or other crew members if the pilot's SPEAK-LISTEN switch is at I/C or V/UHF.

11 Not Used ♦♦

12 U/VHF - PTR 1751/AD 120

(a) *General.* The U/VHF installation (ARI 23300/8) comprises a PTR 1751 UHF transceiver and an AD 120 VHF transceiver. These together with associated adapter and interface units are in the rear fuselage. Two U/VHF control units are provided: a Type 1754W on the pilot's miscellaneous instrument panel, and a Type 1753L on the right hand side of the navigator's

instrument panel. The power supply to the system is DC. The equipments provide 2-way communication in the VHF band from 118 MHz to 135.975 MHz, and in the UHF band from 225 MHz to 399.975 MHz at 0.025 MHz channel spacing in both bands. ♦♦ A separate guard receiver in the UHF transceiver allows a fixed frequency of 243 MHz to be superimposed on any selected VHF or UHF channel. The interface unit incorporates an amplifier to provide emergency intercom.

♦(b) *Pilot's Control Unit.* The pilot's control unit, Type 1754W♦ (Fig 1) provides the controls and facilities shown in Table 1.

(c) *Navigators Control Unit.* The navigator's control unit (Type PV 1753L) carries the same controls and display as the pilot's unit, except that the mode switch, channel selector switch and set channel button are omitted. The unit provides for (M) manual mode only. A green light, at the bottom of the panel, comes on when the CU changeover switch is set to NAV-CU.

(d) *Miscellaneous Controls*

(i) The pilot's press-to-transmit switch is in the crook of the right-hand grip of the control column and the navigator's is on the lower left-hand side of the instrument panel.

(ii) A foot-operated switch to allow the navigator to mute the main U/VHF is beneath his table.

(iii) The following three switches are on the miscellaneous instrument panel:

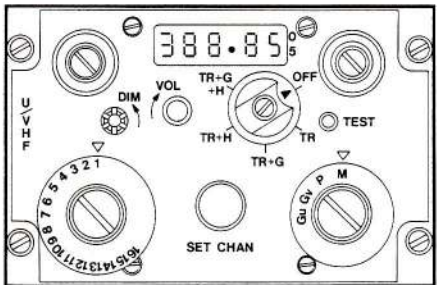
1 *MUTING SWITCH.* Used for muting the main U/VHF.

2 *CU-PILOT/CU-NAV Switch.* Used for transferring frequency selection from the pilot to the navigator.

3 *AE-UPPER/AE-LOWER Switch.* Used for connecting the main U/VHF to the upper or the lower UHF aerial. The lower is considered to be the primary aerial. A VHF whip aerial, on the left bomb door, is automatically selected when the main U/VHF is operated in the VHF mode.

(e) *Interference.* Transmissions on VHF and UHF may interfere with the ILS localiser and glidepath.

(continued on Page 15)



1 - 6 Fig 1 Pilot's U/VHF Control Unit
◆ (Controller changed) ◆

Table 1 - Pilot's Control Unit

<i>Control/Facility</i>	<i>Effect/Function</i>
Frequency selectors (A and B)	
Left outer	1st and 2nd digits (hundreds and tens of MHz)
Left inner	3rd digit (units of MHz)
Right outer	1st decimal digit (tenths of MHz)
Right inner	2nd decimal digit (0.025 MHz) Add 0 or 5 to give 3rd decimal digit
Frequency display	An incandescent filament lamp display of the first five digits of the selected frequency
DIMmer control (C)	Varies the brightness of frequency display
VOLume control (D)	Varies audio input to station boxes
Function selector (E)	
OFF	Switches T/R off
TR	Switches T/R on
TR + G	Switches T/R and guard receiver on
TR + H	Not used
TR + G + H	Not used

(continued)

Table 1 - continued

<i>Control/Facility</i>	<i>Effect/Function</i>
Channel selector (F) 1 to 16	Selects desired channel
SET CHANNEL control (G) (Rotate clockwise and press)	Enables pre-setting of 16 channels by first setting frequency and channel selectors and operating the control
Mode switch (H)	
Gu	Switches T/R to UHF guard fre- quency. Display still indicates manually dialled frequency
Gv	Switches T/R to VHF guard fre- quency. Display still indicates manually dialled frequency
P	Enables selection of pre-set channels on channel selector. Display still indicates manually dialled frequency
M	Enables frequencies to be dialled manually and displayed. Also enables frequency to be dialled when pre-setting channels
TEST button (I) Pressed (on receive)	
UHF	Steady tone if receiver serviceable

(continued)

Table 1 - continued

<i>Control/Facility</i>	<i>Effect/Function</i>
VHF	Background noise if receiver serviceable
Gu	Display indicates 243.00 MHz
Gv	Display indicates 121.50 MHz
P	Display indicates frequency of channel selected
M	Display indicates 888.88 as display serviceability check
Panel lighting	Control unit is lit by integral lamps controlled by pilot's miscellaneous instrument panel dimmer

Note: In normal operation, the digital display only indicates the frequency in use when the mode selector is set to M (Manual). With Gu, Gv, or P set, the digital display still indicates the frequency dialled on the selectors, even though this frequency is not in operation. Only when the TEST button is pressed (with Gu, Gv, or P set) does the frequency display indicate the frequency in operation.

13 Standby UHF

(a) *General.* A standby UHF set (ARI 23159 - D403M) is installed for use if the V/UHF or its power supply fails. The set provides transmit and receive facilities on the guard frequency (243 MHz) and on an adjacent frequency known as Channel A. It can also provide emergency intercom. The set is transistorized

and requires no warm-up time. An independent battery in the left equipment bay provides for emergency operation for up to five hours. When the set is on, the lower UHF aerial is automatically connected to the standby UHF set.

(b) *Controls.* The press-to-transmit switches used with the V/UHF are also used with the standby UHF. The set is controlled by two switches on the pilot's left wall switch panel:

(i) *STANDBY UHF - OFF/NORM/BATT Switch.* In the OFF position the V/UHF is connected to the station boxes. In the NORM position the standby UHF is switched on and connected to the station boxes and the V/UHF 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 when the switch is in the NORM position, the set is automatically transferred to its own battery, but it is necessary to select DIRECT on the station boxes. Ground tests must not be made on battery power.

(ii) *GUARDIA Switch.* This should normally be selected to GUARD. The channel-A position is normally used for ground testing purposes.

14 Radio Compass

- ◆ A radio compass (AD-7092D) is in all pre-Mod 4868 aircraft.◆ The RADIO COMPASS - ON/OFF switch, receiver controller and loop controller are on an auxiliary panel on the navigator's left wall. A relative bearing indicator is on the navigator's instrument panel and another is on the pilot's flight instrument panel. Audio signals are fed into the communications control system. Power supplies are DC and AC, the AC is supplied from No 2 inverter with No 3 as a standby.

15 Military ILS

- ◆ Military ILS (ARI 18011) is installed in all pre-Mod 4868 aircraft. The ILS - ON/OFF switch and the control unit are on the left wall at the navigator's station. The indicator unit and marker light are on the top right of the pilot's flight instrument panel. The glidepath and localiser aerials are in the leading edge of the right and left outer wings respectively, and the marker aerial is in the right wheel well. Localiser identification signals are fed into the communications control system. The power supply is DC and is fed via a circuit breaker on the rear face of the ECP.

16 ILS/VOR

- ◆ (a) *General.* Post-Mod 4868, single ILS/twin VOR (ARI 23118 - AD 260) is installed. The equipment provides for the reception and display of VOR navigation, ILS guidance and marker beacon signals and the reception of VHF communication signals. The audio outputs in all modes of operation are fed into the communications control system.

(b) *Installation.* The location of equipment items is given in Table 2.

Table 2 - ILS/VOR Equipment

<i>Item</i>	<i>Location</i>
No 1 VHF receiver) ILS/ No 1 Navigation unit) VOR 1 Glidepath receiver)	On the left of the navigator's seat
No 2 VHF receiver) No 2 Navigation unit) VOR 2	On the navigator's lower shelf
Marker receiver	On the left of the navigator's seat

(continued)

Table 2 - continued

<i>Item</i>	<i>Location</i>
Control units (2) ILS/VOR 1 and VOR 2	On the top right of the navigator's instrument panel
Radio magnetic indicators (RMI)(2)	One on the navigator's instrument panel and one on the bottom right of the pilot's flight instrument panel
Omni bearing selector (OBS) and indicator	On the top right of the pilot's flight instrument panel
VOR/LOC aerials	One on each side of the fin
Glidepath aerial	In the leading edge of the starboard mainplane
Marker aerial	Just outboard of the starboard wheelwell
Marker lights (press-to-test)(3) MARKER SENSITIVITY - HIGH/MED/LOW switch	On the bottom right of the pilot's flight instrument panel
ILS/VOR magnetic indicator	On the top right of the pilot's flight instrument panel
ILS/VOR 1 - VOICE/RANGE switch	On the bottom right of the navigator's instrument panel

(c) System Function

- (i) Both VHF receivers operate in the frequency range 108.00 to 135.95 MHz; channels in three frequency bands are allotted as follows:

- 108.00 to 111.95 MHz ILS on frequencies ending in odd tenths of a MHz and odd tenths plus 0.05 MHz
VOR on frequencies ending in even tenths of a MHz
- 112.00 to 117.90 MHz VOR on frequencies ending in odd and even tenths of a MHz
- 118.00 to 135.95 MHz Listen only facilities

(ii) The glidepath receiver receives glidepath signals on 40 channels spaced 0.15 MHz apart in the UHF frequency range 329.15 to 335.00 MHz. Glidepath frequencies are 'paired' with localiser frequencies and are automatically selected when a localiser frequency is selected on ILS/VOR 1.

(iii) Selection of a particular frequency automatically switches the system to the corresponding mode. In the VOR and ILS modes, the navigation unit receives navigation signal outputs from the associated VHF receiver. In the VOR mode, these signals are coupled with inputs from the G4B compass and (with ILS/VOR 1 only) the OBS. From this information outputs are derived to drive the associated pointer of both RMI and (with ILS/VOR 1 only) operate the OBS TO/FROM flag, azimuth deviation indicator and warning flag.

(iv) With an ILS frequency selected on ILS/VOR 1, the associated navigation unit output is connected to the localiser deviation indicator to give right/left guidance and to actuate the warning flag. The glidepath receiver is automatically switched on and selected to the 'paired' UHF frequency. Glidepath receiver outputs are fed to the horizontal high/low pointer of the deviation indicator and to its associated warning flag.

(d) *Controls and Indicators*

(i) *Control Units.* The two control units are each labelled NAV and adjacent labels are marked ILS/VOR 1 and VOR 2. Each unit has two rotary selector switches; the left-hand switch selects whole MHz and the right-hand switch 0.05 MHz. The selected frequency is displayed in a window between the switches. A rotary VOLUME - ON/OFF switch, fitted concentrically with the right-hand switch, controls the DC power supply to the systems.

(ii) *Radio Magnetic Indicators.* The pilot's and navigator's radio magnetic indicators (RMI) are identical. Each indicator has a single-bar red pointer which is used to present VOR 1 information and a double-bar green pointer which presents VOR 2 information; the information can be presented simultaneously. The pointers are read against a rotating compass card which is a repeater of the G4B master indicator. The magnetic heading (with VSC set at zero) appears opposite a feed index at the top of the RMI and the radio bearings indicated are relative to the aircraft heading, they are also the magnetic bearing of the VOR beacon from the aircraft.

(iii) *Omni Bearing Selector and Indicator.* The OBS and indicator combine the functions of VOR radial selector and cross-pointer deviation indicator. Any desired radial can be selected by rotation of the OBS knob; the radial selected is displayed at the top of the instrument and its reciprocal at the bottom. An ambiguity TO/FROM flag indicates TO when the radial (QDM) to the VOR beacon is within 90° of the radial selected on the OBS and FROM is indicated when it is more than 90°. The vertical pointer gives right/left indication of deviation from the selected radial in the VOR mode or from the localiser beam in the ILS mode. The horizontal pointer gives high/low indications with respect to the glidepath beam in the ILS mode. Warning flags are provided for both pointers to show when indications are unreliable. A magnetic indicator

above the OBS displays either ILS or VOR, depending on the information being fed to the OBS.

(e) *Marker Receiver and Controls.* The marker receiver operates on a fixed frequency of 75 MHz. It is switched on automatically when ILS/VOR 1 is switched on. Three press-to-test marker lights, blue, amber and white and a sensitivity switch are on the pilot's flight instrument panel. When the aircraft is passing over a marker, the receiver operates the appropriate light and feeds an audio tone into the communications control system, as shown in Table 3. The sensitivity switch can be set to MED or HIGH for general flying, but for precise overhead indications and for an ILS approach it should be set to LOW.

(f) *Power Supplies.* Power supplies are DC and AC, the latter being supplied from No 7 (No 6 post-Mod 4868) inverter with No 6 (No 5 post-Mod 4868) as an alternative supply (see Chap 1).

Table 3 - Marker Indications

<i>Marker</i>	<i>Audio Tone</i>	<i>Light</i>	<i>Keying</i>
ILS outer	400 Hz	blue	2 dashes/second
ILS middle	1300 Hz	amber	alternate dot/dash
En route	3000 Hz	white	6 dots/second
(en-route markers may also have an ident signal)			

17 IFF/SSR - Description

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

(b) *Location of Controls and Equipment.* The location of the controls and equipment is given in Table 4.

(c) *Aerial Position Switch.* The AERIAL POSN - UPPER/FLIGHT/LOWER switch is for ground testing the system aerials. It is a pull-to-unlock type of switch, gated to lock at the FLIGHT position.

Table 4 - Location of ILS/VOR Equipment

<i>Item</i>	<i>Location</i>
Aerials (2)	One projecting above and one beneath the rear fuselage ('shark fin' Type 100B)
Transponder)
Aerial switching unit	) Rear fuselage left side
Aerial position switch)
Static inverters	Upper equipment bay
Inverter OFF/NORM/CO switch	ECP
Control unit)
IFF FAIL light (amber)	) Navigator's instrument panel

(d) *Control Unit.* The control unit carries the following switches:

(i) *Rotary Function Switch.* This is marked OFF/SBY/LOW/NORM/EMGY-PUSH. The switch must be pushed in before it can be turned to the EMGY position.

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

(iii) *Rotary Code Selection Switches.* These are for use with Modes 1 and 3A/B.

(iv) *CIVIL/MIL Toggle Switch.* This is used in conjunction with the EMGY position.

(v) *I/P Toggle Switch.*

(vi) *Self-TEST Push-switch and Light (Green).*

18 IFF/SSR - Testing

(a) *Self-TEST Facility*

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

(ii) Because of reduced receiver sensitivity when the function switch is at LOW, the green light does not come on during self-TEST but the IFF FAIL light comes on steady; to cancel the fail light, select NORM and press the self-TEST switch

again. When the function switch is at SBY, the green light does not come on during self-TEST but the IFF FAIL light flashes.

(b) IFF FAIL Light

(i) The IFF FAIL light comes on automatically under the following conditions:

- 1 When the function switch is set to OFF.
- 2 When the function switch is set to SBY and the transponder is being interrogated but unable to reply (flashing light).
- 3 Transponder unserviceable when under interrogation.
- 4 Self-TEST check not satisfactory.

(ii) The IFF FAIL light has an iris dimmer, and press-to-test facility for checking the filaments of both the failure light and the self-TEST light.

19 IFF/SSR - Operation

◆(a) Select the static inverters switch to NORM or CO. ◆

(b) Use of the Rotary Function Switch

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

(ii) At SBY, the transponder accepts interrogations but replies are inhibited. After a 50-second warm-up delay, the transponder is ready for full operation when selected.

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

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

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

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

(c) *Use of MODE switches*

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

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

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

(iv) When Mode C is selected, the transponder accepts Mode C interrogations and transmits altitude information received from the automatic height encoding facility in the navigator's Mk 30A altimeter.

(d) Code Switches

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

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

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

20 Tacan

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

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

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

(iii) Aural indication of the identity of the beacon to which the equipment is channelled (see para 10 (a)).

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

- (b) The Tacan installation comprises the following main units:
- (i) *Aerial*. A 'shark fin' Type 100B aerial is fitted beneath the nose of the aircraft.
 - (ii) *Transmitter/Receiver*. The T/R is on the right side of the upper equipment bay.
 - (iii) *Coupling Unit*. The coupling unit is electrically coupled to the T/R and operates two indicators. The unit is beneath the table and the verniers are readily visible to the navigator.
 - (iv) *Control Unit (Type 9273)*. The control unit is on the right-hand side of the navigator's instrument panel and has the following switches:
 - 1 *Power ON/OFF Switch*. This controls the power supplies to the T/R.
 - 2 *BRG/DIST BRG Switch*. When BRG is selected the equipment is switched on so that bearing information only is indicated. When DIST BRG is selected the whole equipment is switched on so that bearing and distance information are indicated.
 - 3 *Channel Selectors*. Four buttons, arranged vertically in pairs to increase and decrease the 'tens' (left pair) and 'units' (right pair) digits of the channel number.
 - 4 *VOLUME Control*. The VOLUME control is used to adjust the level of the identity tone in the telephones.
 - (v) *Indicators*. Two indicators Type 9547 are fitted, one on the pilot's flight instrument panel, and the other on the navigator's instrument panel. Each indicator presents infor-

mation on 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 T/R unit is not 'locked-on' to the beacon to which it is tuned, the bearing pointer continuously rotates around the dial and the distance counter also rotates but it is partially obscured by a flag. When the T/R 'locks-on' and the distance is greater than 99 NM a figure 1 on the flag appears at the left-hand side of the distance counter so that the indicator is capable of showing distance up to 195 NM. Bearings can be obtained in excess of this figure.

◆ (c) *Power Supplies.* Power supplies are DC and AC. The AC is supplied by No 6 (No 5 post-Mod 4868) inverter with supply changeover being available from No 7 (No 6 post-Mod 4868) inverter (see Chap 1).

21 Green Satin and Ground Position Indicator

(a) Post-Mod 4868, Green Satin Mk 2 (ARI 5951) and Ground◆ Position Indicator (GPI) Mk 4 are installed.

(b) *Green Satin*

(i) Green Satin is a radar navigational aid. It operates on the Doppler principle and provides indication of ground speed, drift angle and ground miles flown when the aircraft is flying at heights between 400 and 60,000 feet. Drift angle and ground mileage information is also available for use by the GPI.

(ii) The equipment comprises an indicator, drift angle ground speed (DAGS) fitted into the navigator's forward instrument panel, a transmitter/receiver and a computer DAGS both in the rear equipment hatch, and an aerial system in the left main-plane.

(iii) The equipment operates from a 115-volt, 3-phase, 400 Hz AC supply from No 4 inverter. There is no separate Green Satin power on/off switch. See Chap 1 for No 4 inverter control information.

WARNING: The Green Satin HT switch must not be switched ON below 200 feet above ground level.

(c) *Ground Position Indicator.* The GPI is fitted into the navigator's forward instrument panel. It receives drift angle and ground mileage information from the Green Satin and heading information from the G4B compass. This information is used within the GPI to provide continuous indication of ground position. The GPI amplifier is under the navigator's bottom shelf on the left side. The power supply is 28 volts DC.

22 Sonar Locator Beacon

A sonar locator beacon is fitted as an aid to the location of sunken aircraft. The unit, in the left wheel well, is completely self contained, and is independent of aircraft power supplies. On submersion, the unit is automatically activated at a predetermined depth and transmits an acoustic signal which can be received by ship or airborne sonar equipment.

PART 1

CHAPTER 7 - GENERAL EQUIPMENT AND CONTROLS

Contents

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1 Engine Fire Protection

(a) *Engine Fire Detection.* Fifteen, resetting, fire-detector switches are installed in the engine bays, seven in the left and eight in the right. The switches are electrically connected to the engine fire warning lights and in the event of fire complete the circuit to operate the appropriate warning light. When the fire is extinguished the switches automatically reset themselves and extinguish the warning light.

(b) *Engine Bay Fire Extinguishers.* Two fire extinguisher bottles with dual operating heads are fitted, one in the left wheelwell serving the left engine and one in the right wheelwell serving the right engine. Each bottle is fully discharged in one operation. These extinguishers also serve the fuselage fuel tank compartment in crash landing conditions (see para 2).

(c) *Engine Fire Warning Lights and Buttons.* Two fire-extinguisher buttons with integral fire warning lights, one for each engine, are on the miscellaneous instrument panel. A separate ENGINE FIRE WARNING TEST button is above the extinguisher buttons; it is used to test the supply fuses to the fire-detector switches and the filaments of both warning lights.

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

2 Fuselage Fire Protection

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

(b) *Hand-Operated Fire Extinguishers.* Two bromochlorodifluoromethane (BCF) hand-operated fire extinguishers are provided; one is stowed on the cabin right wall, just aft of the entrance door, and the other is stowed on the floor between the rear seats. BCF is non-conducting and virtually non-toxic; it may be used on all classes of fires, including electrical fires. Indication that an extinguisher has been used is given by a discharge indicator or pin which pierces or distorts a disc in the head of the extinguisher when it is operated.

3 Inertia Crash Switches - Operation

For operation of the inertia crash switches see Chap 1.

4 Emergency Equipment

A crash axe, asbestos gloves and a first-aid kit are on the right wall just aft of the entrance door. Five pressure cabin leak-stoppers in envelopes are on the cabin roof hatch. Three survival packs may be carried in stowage crates on the roof in the rear fuselage; access is through the rear fuselage hatch or, in emergency, by chopping through the fuselage at the points indicated.

5 Entrance Door

The entrance door is on the right side of the fuselage aft of the nose fairing. When the door is correctly closed, the handle on the outside of the door lies flush in its recess and the handle on the inside lies in the 2 o'clock/8 o'clock position with about 2 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 counter-clockwise from the outside or clockwise from the inside. Do not use this inside handle to open the door in flight (see Chap 10). The door is supported in the open position by a strut which is attached to the door via a pivot and located in a socket in the door aperture framing.

6 Cabin Window

A small cabin window is on the left side of the navigator's station. A blackout curtain for the window is rolled up and stowed when not in use.

7 Folding Seat

A folding seat is secured to the right wall, just aft of the entrance door, by a hinged bracket which allows it to be folded against the wall and secured by a terry clip and a strap. The clip is provided

to retain the seat during an emergency evacuation of the aircraft without having to use the strap. A trigger under the front left corner of the seat releases it from the down position. A lap strap is provided, and on some aircraft a strap is provided to support the occupant's back.

Note: The seat is not stressed for a crash landing.

8 External Lighting

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

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

(i) *ANTI COLLISION LIGHTS - ON/off Switch.* (Pre-SEM 188).

(ii) *EXTERNAL LIGHTS MASTER - ON/off Switch.* This switch must be ON before any of the external lights function.

(iii) *IDENTIFICATION - AMBER/GREEN/RED Switch.*

(iv) *IDENTIFICATION - OFF/MORSE/STEADY Switch.*

(v) *LANDING - OFF/LOW/HIGH Switch.*

(vi) *Taxying LIGHTS - ON/off Switch.*

(vii) *NAVIGATION LIGHTS - ON/off Switch.* This switch also controls the navigation light on the nose of each wing-tip tank.

◆ (viii) *STROBE LIGHTS Switches.* Post-SEM 188 two switches, labelled UPPER - R/O/W and LOWER - R/O/W, are aft of the station box. ◆

(c) A morse button, just aft of the IDENTIFICATION switches,

works in conjunction with the identification light.

- (d) One taxiing lamp is on each wing tip. The landing lamp is in the left mainplane undersurface. The downward identification light is in the fuselage undersurface just forward of the bomb bay. Pre-SEM 188 one red rotating anti-collision light is above and one below the rear fuselage. Post-SEM 188 the anti-collision lights are replaced by high intensity strobe lights. ◆

9 Internal Lighting

(a) *Nose Prone Position.* A dome lamp, with an integral switch and 2-pin socket, and a wander lamp, with an adjacent dimmer switch, illuminate the nose prone position.

(b) *Cockpit*

(i) *Panel and Instrument Lighting.* The cockpit panels and instruments are illuminated by UV lamps, red floodlamps, red pillar lamps over the altimeter and the frequency card holder, and a bridge lamp over the radio magnetic indicator (RMI); post-Mod 4868, a pillar lamp is over the RMI. The E2B compass and the V/UHF control unit have integral lighting. Additionally, No 3 tank fuel gauge is illuminated by a lamp above it. The lamps are controlled by two UV and two RED dimmer switches. The two UV and the right side RED switches are below the canopy coaming. The left side RED switch is on the left wall, above the oxygen regulator or, post-Mod 4868, on the left wall switches panel and labelled RED LIGHTS.

(ii) *Console Lighting.* The left console is illuminated by red floodlamps controlled by a dimmer switch on the left wall switches panel and labelled CONSOLE LIGHTS or, post-Mod 4868, on the left wall, above the oxygen regulator. The switch also controls the station box integral lighting.

(iii) *Emergency Lighting.* Two amber emergency panel flood lamps (operated from the emergency batteries (see Chap 1)) are below the canopy coaming; one on each side. The pull-to-unlock EMERG LIGHTS - on/off switch (gated to lock at either selected position) is on the left wall switch panel or, post-Mod 4868, below the coaming. To assist identification in the dark, a luminous 'Betelight' strip is beside the switch.

(c) *Cabin*

(i) *General Lighting.* A dome lamp above the chart table provides general illumination of the cabin; the lamp has an integral switch and a 2-pin socket. Two anglepoise lamps, one on the right wall with an adjacent dimmer switch and the other above the navigator's instrument panel with a dimmer switch next to the dome lamp, provide further illumination.

(ii) *Instruments and Control Units.* The instruments on the navigator's panel are illuminated by bridge and pillar lamps. They are controlled by a dimmer switch labelled INST LIGHTS on the switch panel on the left wall; post-Mod 4868, the switch is on the lower left of the instrument panel. The switch also controls a red floodlamp which illuminates the rear face of the ECP. Post-Mod 4868, the ECP floodlamp is controlled by a LIGHT - on/off switch on the ECP, below the lamp. The integral lighting of the V/UHF, IFF/SSR and Tacan control units and the station box is controlled by a dimmer switch labelled CU LIGHTS on the switch panel on the left wall; post-Mod 4868, the switch is on the lower right of the instrument panel, below the control units.

(d) *Inspection Lamp.* An inspection lamp and an extension lead, which can be plugged into the 2-pin socket of either dome lamp, may be in two bags on the right wall aft of the entrance door.

10 Heated Flying Clothing, Power Supply and Controls

A socket for the connection of heated clothing is at each crew

PART 1

CHAPTER 8 — AIR CONDITIONING, PRESSURIZING AND DEMISTING SYSTEMS

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1 Air Conditioning System (Pre-Mod 5 or 2523)

(a) The cabin is heated with a controllable mixture of hot air from the engine compressors and cold air from an inlet in the left wing leading edge. A CABIN AIR — COLD/off/HOT switch (spring-loaded to off), on the miscellaneous instrument panel, controls the mixture valve setting, which is shown on an indicator below the control switch. The upper half of the indicator is divided into two coloured sectors: COLD (blue) and HOT (red).

(b) When the indicator pointer is fully over to the left in the blue sector, the mixing valve is in the fully cold position and only cold air from the duct in the wing leading edge is admitted to the cabin. When the switch is moved to HOT, the mixing valve progressively reduces the amount of cold air and increases the amount of hot air; the indicator pointer turns clockwise

on the dial. The valve is stopped in any desired position by releasing the switch. When the pointer reaches the vertical position the cold air inlet is shut off and only hot air from the engine compressors reaches the cabin, though at this setting most of the hot air is being passed through a cooler in the left wing root. As the pointer moves further into the red sector, hot air comes in at its maximum temperature.

(c) A supply of ventilating air to the pilot 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 left front panel; the supply may be controlled at the louvre. The system incorporates a simple non-return valve to prevent loss of cabin pressure.

2 Air Conditioning System (Post Mod 5 or 2523)

(a) Hot air from the engine compressors is used for cabin air conditioning. The initial supply from each compressor is through an electrically-operated gatevalve controlled by one of two ENGINE AIR TO CABIN — ON/OFF switches on the top left of the miscellaneous instrument panel.

(b) The temperature of the air entering the cabin is governed by a mixing valve controlled by a CABIN AIR — COLD/off/HOT, switch (spring-loaded to off) below the engine air switches. The setting of the mixing valve is shown on the indicator, labelled CABIN AIR, below the control switch.

(c) With the mixing valve set to fully HOT, the hot air is passed directly to the cabin. By moving the mixing valve to COLD, the hot air is passed through a primary cooler in the right wing leading edge, a cold-air unit in the left inner plane and a secondary cooler in the left wing leading edge; it then passes into the cabin. The proportion of air can be varied between the two extremes by setting the mixing valve to any desired intermediate position.

(d) From the common delivery duct into the cabin the conditioned air is delivered to louvres and diffusers in various parts of the cockpit and cabin. The louvres can be turned off but not the diffusers.

(e) Outside air can be made available as at para 1 (c) above.

3 Pressurising System

(a) At an altitude of about 10,000 feet a pressure controller and a combined valve unit (which regulates the outlet of air from the cabin according to static pressure) start to work in conjunction to allow the air-conditioning system to control cabin pressure with increasing altitude until a maximum differential pressure of 3.5 PSI is reached at about 25,000 feet; above this altitude the differential pressure is maintained constant. The cabin altitude is shown on an altimeter on the miscellaneous instrument panel.



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

Note 1: *Pre-Mod 5 or 2523.* As the cold air for ventilation is only at ram pressure, full pressurising will not be obtained while the mixing valve is admitting cold air. Therefore, the valve must be adjusted before take-off until the pointer of the indicator is in the red sector.

Note 2: *Post-Mod 5 or 2523.* No air will be supplied for either air conditioning or pressurising unless one or both engine air switches are ON.

4 Use of Air Conditioning and Pressurising Systems

(a) *Pre-Mod 5 or 2523 Aircraft*

(i) Before starting the engines, check the operation of the mixing valve over the full range against the indicator and leave at COLD.

(ii) After starting the engines, adjust the mixing valve as required. In the final checks before take-off ensure that the indicator pointer is in the red sector to eliminate

the risk of canopy misting during take-off. Maintain the pointer in the red sector at altitudes above 10,000 feet so that pressurising is obtained.

(iii) After landing, set the mixture valve to COLD and open the DV panel to relieve any residual cabin pressure before the entrance door is opened (see para 7).

(b) Post-Mod 5 or 2523 Aircraft

(i) Before starting the engines, with the engine air switches OFF, test the operation of the mixing valve over its full range against the indicator, leaving it set to HOT.

(ii) After starting the engines switch ON the engine air switches and set the mixing valve as required, but see (iii) below.

(iii) There is no restriction on the ground in the use of fully HOT; the use of any other setting while the aircraft is stationary is restricted to a maximum of 10 minutes and the engines must not exceed 5000 RPM continuously. Damage may be caused to the cold air unit if these limits are exceeded. It is permissible, however, to use the cold air unit whilst taxiing. In the air there is no restriction in the use of the mixing valve.

(iv) In flight always keep the engine air switches ON so that air-conditioning and pressurising is obtained. If a fault develops in the air supply from an engine or if an engine fails or is shut down, switch OFF its engine air switch.

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

5 Malfunctioning of the Pressurising System

(a) Loss of Cabin Pressure

A fall in cabin pressure will cause the warning horn to sound; this can be isolated by selecting the warning horn switch (see para 3(b)) to OFF. The following table gives the approximate operating ranges of the warning horn.

<i>Aircraft Altitude</i>	<i>Cabin Altitude</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 further loss of pressure does not cause the cabin altitude to exceed this figure. If range is not of paramount importance, it is recommended that subsequent to a partial pressurisation failure a descent is made to an aircraft altitude not exceeding 25,000 feet.

(b) Pressurisation Failure Above 40,000 feet

If pressurisation failure occurs above an altitude of 40,000 feet, altitude must be reduced to the lowest practicable, and in any case to below 25,000 feet to avoid the effects of decompression sickness. When below 40,000 feet the engine air switches should be 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.

6 Demisting System

(a) General

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

(b) Transparency Interspace Air-Driers

Three inter-space air-driers are fitted, one just aft of the nose fairing, one on the starboard coaming and one on the coaming aft of the pilot's seat. An indicator window in the casing of each air-drier enables the drying agent (silica-gel crystals) to be seen; when unserviceable the crystals are pink. There are static air-drier lines on all three transparencies, but in addition, dry air is circulated in the canopy by an electrically-driven fan controlled by a CANOPY DEMIST—ON/off switch on the port console; this is switched ON before take-off and left ON until after landing.

(c) Canopy Internal Demister

Hot air from the air-conditioning system is fed through a control valve and diffuser onto the forward inner surface of the canopy. The flow through the control valve can be regulated by means of a knurled DEMIST—ON knob above the port front panel. This system must be used only during descents from high altitude and should be turned off immediately demisting is complete.

(d) Nose Fairing Demister

Conditioned air is automatically fed onto the perspex nose fairing whenever the air-conditioning system is in use.

7 Direct-Vision (DV) Panel

An electrically-heated DV panel is in the canopy on the port side; the heater switch, labelled WIND SCREEN, is on the port console. When the cabin is unpressurised the DV panel can be opened by unscrewing the knurled clamping knob and hinging the frame downwards to engage in the retaining clip. The power supply to the heater element is DC; the control unit is operated by AC from No 2 or No 3 inverter.

Note: Rain entering the cabin via the DV panel has, on occasions, penetrated the bomb door selector switch subsequently causing malfunction. Opening the panel to relieve cabin pressure after landing should, therefore, be restricted to a small angle and the panel should then be closed again.

8 Use of Demisting System

(a) *Interspace Canopy Demist*

Check that the silica-gel crystals in the drier units are blue. During the **Internal Checks**, check the operation of the interspace canopy demist fan by switching it ON and listening for it running, then switch it off. There is no restriction on the use of this system.

(b) *Canopy Internal Demister*

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

9 Air Ventilated Suits

(a) On some aircraft provision is made for air ventilated suits at all three crew positions. A continuous supply of cooling air is passed from the engines, via the primary air cooler in the right wing, through the pressure bulkhead and into the cabin. An individual control valve is provided for each crew member; the valves are between the seats for the rear crew and on the right side of the pilot's seat. Quick release plugs and sockets are fitted to ensure safe ejection if necessary.

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

◆ 10 Cooling Fans

Post-SEM 0149 two cooling fans are fitted, one at the outboard edge of the pilot's miscellaneous instrument panel and the other at the right end of the navigator's coaming panel. The unlabelled on/off switches are on the pilot's miscellaneous instrument panel and on the navigator's coaming panel, respectively. Selecting a switch up switches a fan on. ◆

PART 1**CHAPTER 9—OXYGEN SYSTEM****Contents**

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DESCRIPTION**1 Oxygen Supplies and Contents Gauges**

(a) Oxygen is carried in two 2250-litre and five 750-litre bottles in the upper equipment bay. A charging valve on the forward frame in the battery compartment, accessible through the battery access door on the port side of the fuselage, enables the bottles to be charged in situ. The

bottles are arranged in two banks, each having a separate supply line; these lines, after passing through the stop valves (normally wire-locked ON), one on the port wall of the navigator's station and one on the forward face of the pressure bulkhead, are inter-connected at two points through non-return valves so that, while each bank can supply all the regulators independently, fracture of one supply line will not cause a total loss of oxygen. Two gauges on the miscellaneous instrument panel indicate the contents of each bank of cylinders.

(b) From the two inter-connecting points the supplies pass via filters to pressure reducing valves, which incorporate 450 to 500 PSI safety relief valves, and thence to the regulators. One line supplies the pilot's and nose position regulators and the other supplies the two rear crew regulators.

2 Oxygen Regulators and Supply Points

(a) 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, the navigator's is above his instrument panel and the 2nd navigator's is on the cabin starboard wall. A fourth regulator is on the starboard wall at the nose position.

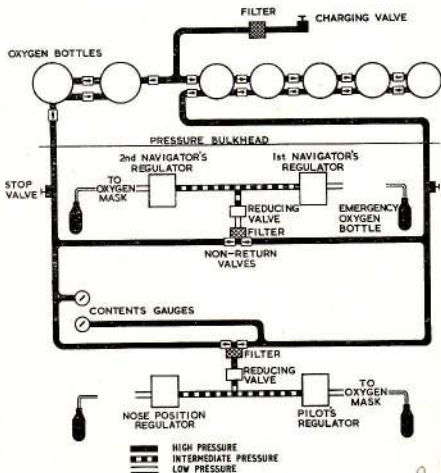
(b) Each regulator incorporates:

- (i) A regulator pressure gauge (normal pressure 200 to 400 PSI).
- (ii) An ON/OFF valve, normally wired ON.
- (iii) An oxygen flow magnetic indicator which shows a vertical white line when the user inhales.
- (iv) A NORMAL/100% OXYGEN air inlet shutter control.
- (v) An emergency toggle 3-position button. Moving the button to left or right gives a safety pressure below 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.

(c) Three remote MI are fitted; one, labelled OXYGEN, is below the forward panel at the 2nd navigator's rear position, this shows that the oxygen flow from the nose position regulator is satisfactory, one, labelled PILOTS OXYGEN, is on the pilot's flight instrument panel and

one, labelled NAVS OXYGEN, is on the top of the navigator's instrument panel. Post SRIM 3479 two additional MIs are fitted: one, labelled NAVS OXYGEN, is on the pilot's flight instrument panel and one, labelled PILOTS OXYGEN, is on the top of the navigator's instrument panel.

(d) From the regulator at the nose position a line connects to a flexible tube, terminating in a quick-release socket. The tube passes aft and is stowed in a clip on the cabin starboard wall at the 2nd navigator's position. This enables the 2nd navigator to change over supplies when preparing to move to the nose position. Alternatively the supply can be used by a 4th crew member seated in the folding seat.



1—9 Fig 1 Oxygen system simplified

3 Oxygen emergency supplies

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

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

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

4 Associated equipment

Pressure demand oxygen masks must be worn.

Normal Operation

5 Checks before flight

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

(b) On each regulator check:
ON/OFF switch ON and wired
Air inlet switch at NORMAL
Pressure 200-400 PSI
Magnetic indicator (MI) functioning correctly
(Check remote indicators also)

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

(i) Put the toggle on the mask harness to the down position and press 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 indicators should remain black. If leaks are felt or the indicators show white, the mask harness should be tightened by the adjusting screws on either side until a satisfactory seal is made.

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

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

6 During flight

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

Malfunction

7 General

Drills for oxygen failure, regulator flow indicator failure, and toxic fumes in the cockpit are given in the FRCS.

8 Loss of cabin pressure

The oxygen system automatically caters for decreased cabin pressure. It is not, therefore, necessary to change the selection on the regulator if cabin pressure is lost.

9 Partial system failure

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

NOTE: With the air inlet at NORMAL a change of altitude has little effect on the rate of oxygen consumption. However, if it becomes necessary to use 100% oxygen a smaller demand will be made on the remaining oxygen supply by flying at a cabin altitude of 25000 ft.

PART 1

CHAPTER 10—ESCAPE SYSTEMS AND EJECTION SEATS

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1 General

All three crew members have ejection seats. The pilot normally ejects through the closed canopy, the control column snatch unit being operated automatically. The rear crew's escape hatch is jettisoned automatically before either crew member ejects. Facilities are provided to jettison the hatch independently of the rear ejection seats and the pilot's canopy independently of his seat.

ESCAPE SYSTEMS

2 Controls

(a) The CANOPY/SNATCH MASTER ON/off switch is on the port wall switches panel; the switch is protected by a guard. The CANOPY JETTISON—ON/off switch is on a black/yellow diagonally striped switch unit on the port console marked DANGER DETONATORS; the switch is covered by a spring-loaded flap. The flap only lies flush when the switch is off; the dolly of the switch can then be seen through a hole in the flap.

(b) A HATCH SAFETY—ON/off switch, and a HATCH JETTISON—ON/off switch are together on a switch unit marked DANGER DETONATORS on the port wall. The SAFETY switch is protected by a guard, and the JETTISON switch is covered by a spring-loaded flap which is diagonally striped black/yellow. The flap only lies flush when the switch is off; the dolly of the switch can then be seen through a hole in the flap. A similar unit, without a HATCH SAFETY switch, is on the starboard wall.

3 Control Column Snatch Unit

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 snatch unit is described in Chapter 5.

4 Pilot's Canopy

(a) The pilot's canopy is secured to the fuselage by bolts containing detonators which are fired electrically when it is to be jettisoned.

(b) 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.

5 Navigator's Hatch

A metal roof hatch over the rear crew stations is secured to the fuselage by bolts containing detonators which are fired electrically when the hatch is jettisoned either independently of, or in conjunction with the ejection system.

(a) *Independent Jettison*

- ◆ To jettison the hatch independently of the ejection systems, a crew member must ensure that the HATCH SAFETY switch is ON and then switch ON *his* 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 on both seats (see para 15); the seats 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 either rear crew member operates either firing handle on his ejection seat. (See para 15).

6 Minimum Speed for Jettisoning the Hatch or Canopy

When jettisoned, the hatch or canopy 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 the speed above 150 knots whilst jettisoning the hatch or canopy. If jettisoned below 90 knots, it is possible for the hatch to strike the occupants of the rear seats or to remain in the emergency exit path.

7 Power Supplies to the Detonator Circuits

(a) 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, the

circuits are automatically supplied from the emergency battery.

(b) The supply to the circuits for severing the elevator control tube and for jettisoning the canopy is routed through the CANOPY/SNATCH MASTER switch. The supply to the circuit for jettisoning the hatch is routed through the HATCH SAFETY switch. ◆◆

(c) Two press-to-test lights are on the pilot's port console; one is marked CANOPY JETTISON TEST and the other HATCH JETTISON TEST. A fuse is adjacent to each light. When pressed, the lights come on to indicate that a power supply is available at the supply side of the CANOPY/SNATCH MASTER and HATCH SAFETY switches.

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

8 Jettisoning the Entrance Door

The entrance door may be jettisoned by turning clockwise the crank fitted centrally above it; this releases the hinge pins allowing the door to fall outwards. The crank may be stiff to operate and four and a half turns are required. It may be necessary to strike the door after operating the crank.

EJECTION SEATS

9 General

(a) A Type 2CA1 Mk 2 ejection seat is provided for the pilot and two similar Type 2CA2 Mk 4 seats for the rear crew.

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

(c) Fully automatic facilities release the safety harness and leg-restraint lines after ejection, separate



1-10 Fig 1 Ejection Seat Type 2CA Series

the occupant from the seat and deploy the parachute at a safe speed and altitude.

10 Associated Aircrew Equipment

The associated aircrew equipment consists of the following items:

- Seat type parachute assembly with harness
- Separate safety harness with negative-g strap
- Personal survival pack
- Emergency oxygen set (on the rear starboard side of the seat).

11 Ejection Seat and Escape System Safety Pins and Stowages

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

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

Pilot's Station

- | | | |
|-----------------------------------|---|---|
| Face screen or gun sear | } | On cockpit starboard wall above the entrance door (four pins) |
| Seat pan firing | | |
| Canopy jettison sear* | | |
| Time delay lever canopy jettison* | | |

Rear Crew Stations

- | | | |
|-------------------------|---|---|
| Face screen or gun sear | } | On the forward port and starboard corners of the hatch support structure (two pins each seat) |
| 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 sear and the time-delay trip lever respectively.

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

12 Controls on the Seat

(a) Seat-Height Adjustment

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

(b) Leg Restraint

Two leg-restraint lines are attached to brackets on the aircraft floor by lugs on the ends 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 under each snubbing unit permits 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.

(c) 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 locked in the position reached.

(d) Firing Handles

Two firing handles are provided, one at the top of the seat attached to the face screen and another on the front of the seat pan. Each handle has a safety pin. The seat is fired by pulling either handle (see para 14 and 15). Only a short upward movement of the seat-pan firing handle is necessary to fire the seat; it is important to ensure that posture is correct before operating the handle. The face screen and seat pan firing handle safety pins must be in position before the occupant moves into or out of the seat.

13 Parachute Manual Controls

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

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

14 Single Lever Ejection System — Pilot's Seat

(a) The CANOPY/SNATCH MASTER switch must be ON before the pilot ejects.

(b) 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 severance unit (see Chapter 5). The time-delay mechanism delays the firing of the ejection gun for 0.35 second after the operation of the snatch firing unit.

(c) Both firing handles are connected by cables to the snatch firing unit sear and to the time-delay mechanism. Operation of a firing handle withdraws the sear 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 sear 0.35 second later and the ejection gun fires immediately.

15 Single Lever Ejection System — Rear Crew Seats

(a) The rear crew ejection sequence cannot be initiated unless the **◆ ◆ HATCH SAFETY** switch is ON, or the hatch has already been jettisoned independently (see para 5).

(b) Firing Mechanism

◀ On each seat, the face screen firing handle and the seat pan firing handle are connected to a bifurcated cable. One arm of the cable is connected to the sear of a hatch jettisoning mechanism on the rear face of the pressure bulkhead and the other is connected to the sear of the BTDU fitted in the ejection gun. The BTDU has a restrictor mechanism which prevents the sear from being withdrawn. The safety pin of the restrictor is connected to the hatch by a cable. When either firing handle is operated, the sear is extracted from the hatch jettisoning mechanism and the hatch leaves the aircraft, extracting the safety pin from the restrictor in the BTDU on *both* seats; 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. The remaining seat may then be fired by pulling either firing handle; the 0.5 second delay between pulling the firing handle and ejection also occurs on the second seat. ▶

(c) The hatch jettison mechanisms are inoperative until they have been mechanically cocked by means of a cocking lever, normally stowed on the pressure bulkhead. Cocking of the mechanisms is a ground crew responsibility. When the mechanisms are cocked, a white line on the cocking link is aligned with another on the bulkhead above each seat.

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


NORMAL PROCEDURES**16 Safe for Parking and Ejection Seat Checks**

These are given in the FRC.

17 Strapping-In Procedure

(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 restraint lines at a later stage to the strapping-in procedure, pass the left-hand line through the right garter D-ring, and the right-hand line through the left garter D-ring, and allow them to hang loose temporarily.

(c) Connect the survival pack lanyard to the lifepreserver quick release connection so that the lanyard lies between the  thigh and the thigh guard.

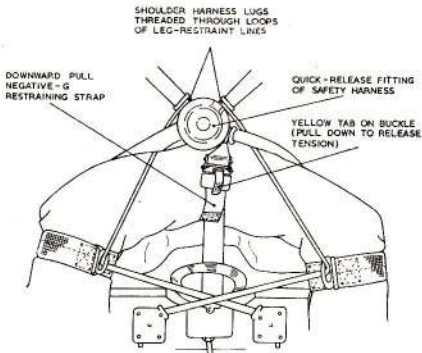
(d) Connect the parachute harness shoulder straps to the parachute QRF. The shoulder straps should lie under the lifepreserver stole. To fit a harness lug into an inertia-proof QRF it is necessary to turn the disc knob until the yellow line passes the dots on the body of the fitting, hold it in this 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 parachute 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 will lie clear of and above the safety harness QRF when this is assembled. Tighten the parachute harness leg straps.

(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 leg strap. Pass the lug of the left shoulder strap of the safety harness



1—10 Fig 2 Ejection Seat Type 2CA—Arrangement of Negative-G Restraint Strap and Leg-Restraint Lines

through the loop in the end of the leg-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 leg-restraint line, press and hold the plunger under the snubbing unit and draw the line upwards. If there is too much, draw any excess downwards through the unit.
- (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 retighten the lap straps and negative-g strap. Repeat until the straps are as tight as possible. The negative-g strap can be loosened by pulling down on the yellow tab attached to the snubber lever.
- (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 hose and adjust the hose in its clip or loop on the right lap strap of the safety harness to allow full and free movement of the head.

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

(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.

18 Normal Exit from the Seat

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

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

(c) Release the safety harness and parachute harness.

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

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

(f) Leave the seat.

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

ESCAPE PROCEDURES

19 General

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

20 Pilot's Abandoning Drill

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

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

21 Rear Crew Abandoning Drill

◆ (a) The escape system cannot be initiated unless the HATCH SAFETY switch is ON. The hatch is then automatically jettisoned when the first ejection seat is operated. The ejection gun fires 0.5 seconds after the hatch has jettisoned. The second crewman then operates either of his firing handles and his seat fires 0.5 seconds later.

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

(c) If the hatch does not jettison when a rear crewman operates his seat, proceed as follows:

(i) First crewman — check HATCH SAFETY switch. If it is off, switch it ON; the hatch should then jettison. If the HATCH SAFETY switch is ON, switch ON the HATCH JETTISON switch; the hatch should jettison.

(ii) If the hatch still does not jettison, the second crewman should repeat the drill using *his* HATCH ◆ ◆ JETTISON switch. If the hatch still does not jettison or if the seat fails to fire after the hatch has jettisoned, carry out the drill given in the FRC under **Ejection Seat Fails to Fire or Hatch Fails to Jettison**.

(iii) If the hatch does jettison, re-pull the seat firing handle to withdraw the BTDU sear; the seat should fire 0.5 second later.

22 Sequence on Ejection

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

(a) As the seat ascends the guide rail:

The drogue gun is armed.

The leg-restraint lines tighten, pulling the legs together and back until the rivets in the line fittings shear.

The barostatic time-release unit (BTRU) is tripped.

The emergency oxygen supply is turned on.

The main oxygen hose and mic-tel lead are pulled away from the aircraft connections.

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

(c) If the ejection has taken place above an altitude of 10,000 feet, a stabilized 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 scissor shackle opens, leaving the drogue line connected to the apron behind the occupant and thence via the parachute withdrawal line to the apex of the parachute. On release, the drogues pull on a lifting line which disconnects the face screen and deploys the parachute. The occupant is momentarily prevented from leaving the seat by two sticker straps clipped to the seat pan, until the pull of the parachute lifts him clear.

(d) If the ejection occurs below 10,000 feet, the same sequence ensues except that the BTRU operates 1.5 seconds after ejecting, subject to the overriding influence of the g controller which delays operation of the BTRU if the speed is too high for safe parachute deployment.

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

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

23 Failure of the Automatic Systems

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

24 Passenger's Abandoning Drill

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 2
LIMITATIONS

LIST OF CHAPTERS

	Chapter
Engine limitations	1
Airframe and miscellaneous limitations	2

PART 2

The limitations given in this Part are taken from the Release to Service (Issue 2) dated 4 June 1981 to AL 3. The Release to Service must be consulted to ascertain the latest release standard.

CHAPTER 1 - ENGINE LIMITATIONS

Contents

	Para
Operating Limitations - Avon Mk 1	1
Approved Fuels	2
Oil	3

1 Operating Limitations - Avon Mk 1

The Avon Mk 1 operating limitations are given in Table 1.

Table 1

<i>Time Limit Power Rating</i>	<i>Maximum per Flight</i>	<i>Maximum RPM</i>	<i>JPT °C</i>
Take-off and operational necessity	30 minutes (combined total)	7800 ±50	600
Maximum continuous	Unrestricted	7600	565
Idling on ground	Unrestricted	2750 ±100	500

Note 1: At low air temperature the engines may underspeed to as low as 7650 RPM at full throttle, but they still maintain maximum thrust.

Note 2: The governed RPM vary with a change of fuel density from those at which the engine settings were made. A higher density causes a drop in RPM and a lower density a rise. Every 0.01 change in density causes a corresponding difference of 50 in the governed RPM.

2 Approved Fuels

The approved fuels are shown in Table 2.

Table 2

<i>NATO Code No</i>	<i>UK Joint-Service Designation</i>	<i>UK Specification</i>	<i>US Designation/ Specification</i>
-------------------------	---	-----------------------------	--

Standard Fuel. The following fuel may be used without flight or maintenance restrictions:

F-34 (Note 1) Avtur/FSII DERD 2453 JP-8/MIL-T-83133



Alternative Fuels. The following fuels may be used only if standard fuel is not available; subject to the relevant notes:

F-35 (Note 2,3)	Avtur	DERD 2494	Jet A-1 or Jet A (Note 2,3,4)/ ASTM-D-1655
F-44 (Note 2)	Avcat/FSII	DERD 2452	JP-5/MIL-T-5624
F-43 (Note 2,3)	Avcat	DERD 2498	- Jet B (Note 2,3,5)/ ASTM-D-1655

Note 1: F-34 supplied at French and Canadian bases may be subject to Note 2 below.

Note 2: Unless blended during refuelling, these fuels do not contain a lubricity additive to specification DERD 2461; conse-

quently, early HP fuel pump failure is possible. Pump operation on these fuels is limited to a cumulative total of 50 hours. All uplifts are to be recorded in the MoD Form 700.

Note 3: Unless either AL-31 or AL-38 is blended during refuelling, these fuels do not contain Fuel System Icing Inhibitor (FSII). Therefore:

- a. Operation on these fuels is limited to 14 elapsed days to limit fungus growth and an equal number of days on a fuel containing FSII is to follow; this limit applies whether or not flying takes place. All uplifts of non-FSII fuel are to be recorded in the MoD Form 700.
- b. Operational commanders should note the possibility of LP filter blockage with ice if the fuel temperature falls below 0°C.
- c. Water drain checks are particularly important when operating on these fuels, especially if refuelling at high ambient temperatures when the maximum possible time should be allowed between refuelling and drain checks.

Note 4: This fuel is an aviation kerosene with a freezing point of minus 40°C. When using this fuel, the flight profile is to be planned to avoid low outside air temperatures; the subsequent flight must also be operated as if Jet A were being used.

Note 5: This fuel is an aviation wide-cut fuel with a freezing point of minus 50°C. When using this fuel, the flight profile is to be planned to avoid low outside air temperatures; the subsequent flight must also be operated as if Jet B were being used.

3 Oil

(a) The approved oil is to DERD specification 2490, Joint

Service Designation OM-11, NATO Code No O-135. As an emergency alternative, OM-13, NATO Code No O-134 may be used.

(b) Oil Pressure

Minimum at idling RPM	...	...	...	3 PSI
Minimum at 7400 RPM and above	...	...	...	15 PSI
Normal at 7400 RPM	...	...	...	20 PSI

PART 2

CHAPTER 2 - AIRFRAME AND MISCELLANEOUS LIMITATIONS

Contents

	Para
General	1
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	◆◆
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Maximum Weights	5
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1 General

(a) The aircraft is released for Service use in temperate climates, by day or night, in the training, target and banner towing roles.

(b) The folding seat is not to be used during take-off and landing except for operational emergencies.

2 Speed and Mach Number

See Table 1.

Table 1

<i>Condition</i>	<i>Maximum IAS (knots)</i>	<i>Maximum IMN</i>
Clean aircraft	450 (425 on WJ 731 when 4 crew members are carried)	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 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
For operation of:		
Bomb doors	350	0.75 up to 40,000 feet 0.80 above 40,000 feet
Airbrakes	As for clean aircraft	As for clean aircraft
Undercarriage	190	
Flaps	160	

Note 1: The speed for the operation of a service also applies for flight with the service in the extended position.

Note 2: There is no role requirement to open the bomb doors in flight. They are to remain closed except during emergencies, icing letdowns and as required by the flight test schedule.

3 Not Used ♦♦

4 Maximum Altitude

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

5 Maximum Weights

- (a) For take-off and all permitted forms of flying 46,000 lb
- (b) Maximum normal for landing 40,000 lb
- (c) In emergency the aircraft may be landed at higher weights but great care is required, particularly when braking.

6 Centre of Gravity

(a) *Forward Limit (With or Without Wing-Tip Tanks).* 1-235 feet aft of datum at weights up to 29,000 lb; it then moves linearly aft to 2-1 feet aft of datum at 46,000 lb.

(b) *Aft Limit*

(i) *Without Wing-Tip Tanks.* 3-058 feet aft of datum up to an altitude of 25,000 feet; it then moves linearly forward to 2-66 feet aft of datum at 45,000 feet.

(ii) *With Wing-Tip Tanks.* 2-808 feet aft of datum up to an altitude of 37,000 feet; it then moves linearly forward to 2-66 feet aft of datum at 45,000 feet.

(c) *Taxying Over Uneven Surfaces.* When taxying over uneven surfaces the aft limit is not to exceed 2-885 feet aft of datum.

7 Manoeuvre

- (a) Intentional spinning and aerobatics are prohibited.
- (b) Practice stalling is permitted above 10,000 feet but it is not recommended above 25,000 feet.
- (c) Combined application of coarse aileron and g loading is to be avoided.
- (d) The application of negative-g loading is to be avoided. This is an engine fuel supply consideration (see Part 1, Chap 2).
- (e) The normal acceleration limitations are as follows:

(i) *At Weights Up To 37,600 lb Without Wing-Tip Tanks:*

With negligible aileron applied

4g 3g

With aileron applied

2g

CSTI
CAN/15

(ii) *At Weights Above 37,600 lb or With Wing-Tip Tanks:*

With negligible aileron applied

3g

With aileron applied

1.5g

8 Jettisoning of Wing-Tip Tanks

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

9 Aircraft Category

The aircraft category for approaches is Category C.

10 Engine Out Allowance

The engine out allowance (EOA) is 450 feet.

11 Visual Committal Height

The visual committal height (VCH) is 600 feet.

12 Pilot's Eye to Mainwheel Height

The pilot's eye to mainwheel height in the landing configuration, and on a 3° glidepath, is 8.6 feet. Under these conditions, the effect of a 1° change in attitude is 0.4 feet.

13 Maximum Crosswind Component

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

14 Arresting Barrier Engagement

The aircraft is cleared for engagement with the Mk 5, Mk 6, Mk 12A, Type A and Type B arresting barriers; in the case of the Mk 12A and Type B barriers at the 'Light Aircraft' setting only. A table giving the recommended maximum entry groundspeed for aircraft weight is in the FRC. An aircraft engaging a barrier at speed/weight combinations higher than those in the table 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 groundspeed in excess of 120 knots may exceed the impact strength of the net and burst through.

15 Aircraft Arresting Gear Trampling

The aircraft is cleared to trample the supported and tensioned cable of the following types of arresting gear at speeds up to unstuck speed: RHAG; PUAG; CHAG; BAK 9; BAK 12; 500 S.

16 Pilot

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.

17 Ejection Seats

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.

18 Tyre Limiting Speed

The tyre limiting speed on the ground is 161 knots groundspeed.

19 Banner Target Towing

◆◆ An under fuselage hook is provided for banner target towing using the ground snatch take-off technique subject to the following limitations:

(a) *Type of Banner.* 6 x 30 feet

(b) *Take-Off*

- (i) *Minimum Runway Length.* 6000 feet
- (ii) *Maximum Crosswind Component.* 20 knots for runways over 150 feet wide.
15 knots for runways up to 150 feet wide
- (iii) *Maximum Tailwind Component.* 5 knots

(c) *In Flight*

<i>Condition</i>	<i>Max IAS</i>	<i>Altitude</i>	<i>Max Bank Angle</i>
Transit overland	250 knots	2000 feet AGL) (minimum)	) 45° at 300 knots and below
Over range	300 knots (maximum)	20,000 feet))	

(d) *Dropping the Target*

- (i) Approach descent 3°
- (ii) Release ... 150 knots and 350 feet aircraft AGL

(iii) If unable to release the target normally, increase speed to the maximum permitted aircraft speed in order to break the 20 cwt cable (weak link). The breaking point tension (about 2600 lb) is reached at about 350 knots in a turn. It is unlikely that the necessary tension would be achieved in straight flight.

(iv) If the banner has been released by breaking the tow line, ascertain the length of cable remaining attached to the aircraft. In this case, or if the banner cannot be detached, adjust the aircraft touchdown point to ensure that the cable end or banner

clears the runway threshold. If the runway has an arresting gear, ensure that it is derigged before landing.

20 Radio and Radar Installations

All the radio and radar installations covered in Part 1, Chap 6 are cleared for use, subject to the proviso in the following note.

- ◆ Note: (*Applicable to WJ 731*). When the IFF is used for identification by air defence weapon system interrogators, UHF transmissions in the frequency bands 254 to 260 MHz and 338 to 346.5 MHz should be prohibited.

PART 3**HANDLING****LIST OF CHAPTERS**

	Chap
Preparation for flight
Handling in flight
Circuit and landing procedures
Asymmetric flying

PART 3

CHAPTER 1 — PREPARATION FOR
FLIGHT

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Failure to Start	4
Checks Before Taxying	5
Taxying	6
Checks Before Take-Off	7

1 Preliminary Checks

(a) 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 intakes must be free from obstruction, the starter fairings secure and the jet pipes free from distortion.

(b) 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.

2 Internal Checks

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

3 Starting the Engines

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

4 Failure to Start

(a) If an engine fails to accelerate to idling RPM or a cartridge fails to fire, the HP cock must be closed immediately and the master starting and ignition switches set to OFF before any further action is taken.

(b) If, after a cartridge has fired, the pressure relief valve blows (indicated by clouds of black smoke in the engine air intake) or the starter fails to accelerate the engine to more than 1000 RPM, no further attempt may be made with that starter, which is to be removed as suspect.

(c) If a cartridge fails to fire, at least one minute must elapse before the starter breech cap is removed. If a second cartridge fails to fire, have the electrical system checked.

(d) If the engine fails to light up when the first cartridge is fired, a second may be loaded when the compressor has stopped rotating. If two cartridges have been fired the starter must be allowed to cool for a period of 10 minutes before loading a third cartridge. If the engine still fails to light up, not less than 45 minutes must elapse before loading each subsequent cartridge.

(e) 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 and provided that the engine has accelerated to more than 1000 RPM during the previous attempt, any excess fuel may be removed by firing a further cartridge as follows:

MASTER STARTING

switch	ON
IGNITION switch ...	OFF
HP cock	OFF
LP pumps	OFF
Starter button	Press

5 Checks Before Taxying

(a) Carry out the **After Start Checks** and **Taxy 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.



(b) When checking the aileron, rudder and tailplane trims, ensure that no overrun occurs when the trims 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:

(i) *Aileron Trim*

Operate the trim over the full range and return to neutral.

(ii) *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.

(iii) *Tailplane Actuator*

Test for a live circuit by ensuring that the tailplane does not move when either the cut-in switch or trim switch is operated independently. Operate the tailplane over the full range and return to neutral.

6 Taxiing

(a) 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 cases of heavy or prolonged braking, allow sufficient time for the brakes to cool before continuing with taxiing or taking-off.

(b) Check the serviceability of flight instruments during turns.

(c) 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 to the rudder pedals to obtain differential braking.

- (d) Avoid high-speed taxiing at aft CG, because of a tendency for the nose to lift.
- (e) In strong crosswind conditions the engines may stall during acceleration if the throttles are opened too quickly.
- (f) If it is necessary at any time to stand tail-into-wind, run the engines at sufficient RPM to maintain JPT within the limit.
- (g) Fuel consumption while taxiing is about 32 lb per minute.

7 Checks Before Take-Off

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

PART 3

CHAPTER 2—HANDLING IN FLIGHT

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1 Take-Off

(a) Extract the take-off information from the Operating Data Manual (ODM). If runway and temperature conditions are suitable, the time between achieving unstick speed and safety speed is reduced by keeping the aircraft on the ground until 125 knots is reached. If a short ground run is necessary, use the appropriate unstick speed given in the ODM.

(b) Align the aircraft on the runway and apply the brakes. Increase RPM to 7000, check the alignment 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 RPM; the difference in JPT and throttle alignment increases and the suspect engine shows 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.

(c) 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 off at the correct speed. If the nose is raised early, the take-off run is prolonged. When taking-off from high-elevation airfields, where acceleration is poor, the nose of the aircraft should be raised approximately 5 knots below unstick speed.

(d) When safely airborne, apply the wheelbrakes and retract the undercarriage. There is little change of trim, but take care not to exceed 170 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, they may not close at all. There is no visual indication that the main doors are open but buffeting may be felt. If this happens, reduce speed to about 170 knots to allow the doors to close.

(e) The aircraft accelerates rapidly with an increasing nose-up change of trim.

(f) If a sustained climb is intended, set the engines at 7600 RPM and climb at 330 knots. For circuit practice it is recommended that speed be kept below 180 knots. For the climb to circuit height 7000 RPM is ample.

(g) *Crosswind Take-Off*

(i) The maximum recommended crosswind component for take-off is 25 knots.

(ii) 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 7000 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.

(iii) 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.

2 Aborted Take-Off

(a) *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

Select HP cock of malfunctioning engine OFF (if applicable)

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

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. Apply the brakes carefully at EMBS to avoid locking the wheels.

(b) *Above Stop Speed*

(i) If a take-off is aborted above the stop speed, the abort technique is influenced by such factors as the speed and weight of the aircraft, weather conditions, runway length and availability of an arresting barrier. Use the following technique:

Close both throttles

Select flaps DOWN

Select HP cock of malfunctioning engine OFF (if applicable)

When flaps have travelled, select the HP cock of remaining engine(s) OFF

(ii) The following considerations are relevant:

(1) 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.

(2) 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.

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

◆ **WARNING:** Experience indicates that the undercarriage main legs may retract unevenly following an emergency UP selection on the ground; this is likely to result in a swing. If wing tip fuel tanks are fitted, these may rupture and thus greatly increase the risk of fire. ◆

3 Engine Failure After Take-Off

(a) The safety speed with or without wing-tip tanks (full or empty) is 140 knots.

(b) 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.

(c) The factors affecting recovery are:

(i) *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.

(ii) *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 also makes 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. Therefore, the minimum

speed from which a recovery can be made is also increased.

(iii) *AUW and CG Position*

AUW affects the speed from which recovery is possible by its affect on aircraft acceleration; at low AUW the improved acceleration assists recovery. At aft CG posi-

(continued on Page 5)

tions the rudder is less effective because of its reduced moment arm.

(iv) *Altitude and Temperature*

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

◀ (v) *Banner Target on Tow*

A banner target on tow gives a considerable increase in drag which reduces aircraft acceleration. If, consequently, extra thrust is required to accelerate the aircraft, the critical speed will be increased. ▶

(d) *Recovery Actions*

(i) *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.

(ii) *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 releasing a banner target and/or 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 160 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.

(iii) 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 corrective action is taken quickly, it is possible to recover and climb away from an engine failure at 125 knots.

4 Climbing

(a) The optimum climbing speed is 330 knots until 0.72M is reached at about 20,000 feet. Thereafter, maintain 0.72M until reaching the desired altitude.

(b) 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.

(c) The canopy internal demister must not be on during a climb.

(d) 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.

(e) *Climbing Checks*

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

5 Engine Handling in Flight

(a) *Low Level*

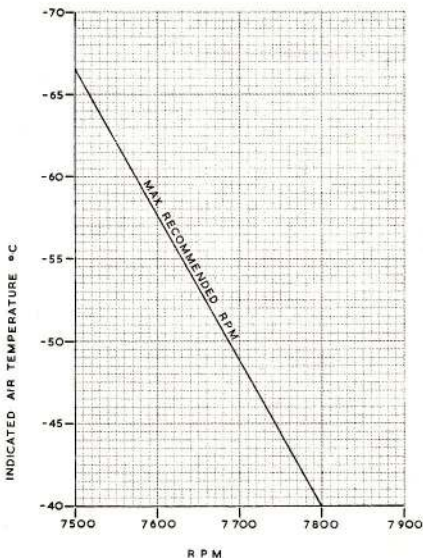
(i) Operate the throttles smoothly at all times and avoid slam accelerations and rapid decelerations.

(ii) 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.

(b) *High Level*

(i) The ACU is not altitude compensated. Its action, and therefore engine acceleration, deteriorates progressively as altitude is increased above 5000 feet. Greater care in engine handling is necessary at high altitudes, especially during the early stages of throttle opening at



3—2 Fig 1 Low Temperature Engine Surge

low IAS. Rapid throttle movement, either opening or closing, may cause compressor stall and engine surge which may lead to severe overheating or flameout, particularly at altitudes over 40,000 feet at speeds below 200 knots IAS.

(ii) In extremely cold temperature conditions, generally associated with a high altitude flight in tropical areas, there is a risk of surge followed by flameout 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 in Fig 1.

(iii) 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 the graph, to reduce the risk of surge.

(iv) 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 a flameout occurs following a surge, shut down the engine and attempt a **Normal Relight** at or below the recommended maximum relight altitude.

(c) *Use of the HP Fuel Pumps Isolating Valve*

(i) Failure of either HP pump or a fault in the servo control system causes a sudden drop in engine RPM. If a sudden drop occurs in flight, first establish that this is not due to LP pump failure or icing. If neither of these is the cause, close the throttle and select ISOL (up) on the appropriate isolating switch. If the engine then idles normally, an attempt may be made to accelerate it. If it fails to idle normally, close the HP cock and relight the engine using the **Flame-Out** and **Normal Relight** drills given in the FRC; leave the isolating switch set to ISOL. Having relit, if both HP

pumps are serviceable, maximum RPM should be obtainable, but if one HP pump has failed, only 60% engine thrust will be available at sea level, rising progressively with altitude; 100% thrust will be available at about 12,000 feet.

(ii) With the HP pump isolating switch set to ISOL, considerable care must be exercised when accelerating the engine from idling RPM. If the throttle is handled coarsely at engine speeds below 5000 RPM, the engine is prone to over-fuelling and excessively high JPT, resulting in a possible engine fire. While opening the throttle keep a check on the RPM and JPT. If the JPT rises rapidly and reaches the maximum, the RPM meanwhile remaining constant, close the throttle immediately and then open it again using a slower throttle movement. In the event of having to go round again, it should be remembered that only 60% of take-off thrust will be obtainable at low altitude if one pump has failed.

6 General Flying

(a) Controls

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

(i) 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.

(ii) Ailerons

The ailerons are light and effective at low speed and high altitude but become heavier as speed is increased; they still give good response up to 0.83M, but above this mach number 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.

(iii) Elevator

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

(b) *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 use. The aileron trim is the least powerful of the trims.

(c) *Tailplane Operation*

(i) *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 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; on no account may any further attempt be made to trim in either direction; the aircraft must be restricted to a maximum of 250 knots and landed as soon as practicable. If any other malfunction of the tailplane trim is experienced, the aircraft should again be landed as soon as practicable. 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.

(ii) *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 approximately 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.

(d) Airbrakes

At high IAS airbrakes are effective, but below about 300 knots their effectiveness decreases until at approach speeds their effect is negligible. Above about 0.6M the use of airbrakes causes noticeable buffeting and a nose-down change of trim; the buffeting increases at high mach numbers.

**(e) 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
Bomb doors open or closed	Little change

(f) Buffeting

- (i) When lowering flaps slight buffeting occurs which decreases as speed is reduced.
- (ii) When bomb doors are opened at high airspeeds or mach numbers, marked buffeting occurs. Buffeting is correspondingly less at lower airspeeds and mach numbers.

7 Handling at Aft CG

With correct loading and standard fuel management, the CG remains within limits throughout flight. If, however, the CG moves outside the aft limit due to fuel mismanagement/failure, the elevator control forces are reduced and pitch control becomes 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 above 37,000 feet with wing-tip tanks, to gentle manoeuvres only until the fuel balance has been restored.

8 Flying at Reduced Airspeed

Reduce speed to about 170 knots and keep the flaps up.

9 Flight in Turbulence

(a) 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 6900 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 6900 RPM, a gradual reduction of altitude should, if practicable, be accepted.

(b) Low Altitude

Below 25,000 feet there is little danger of engine surge and flameout due to turbulence. The speed range 250 to 300 knots should be adhered to in moderate to severe turbulence.

10 Operating in Icing Conditions

(a) General

(i) No airframe or engine anti-icing equipment is provided; therefore, flight in icing conditions must be avoided whenever possible. If icing is experienced in flight, an immediate climb or descent until clear of icing conditions should be made.

(ii) The build up of airframe ice increases rapidly above 250 knots TAS. Ice is particularly likely to form on **◆ ◆** open bomb doors and may prevent them from being closed. Therefore, the bomb doors should be opened only for short periods if required to increase the rate of descent through icing conditions or to assist with speed control on an approach in icing conditions.

(iii) Engine icing in flight may occur in the presence or absence of airframe icing. The engines are most prone to icing at low airspeeds with high RPM settings when icing may occur in cloud or precipitation at true outside air

temperatures as high as plus 5°C. At normal cruising speeds and RPM settings engine icing is unlikely to occur above 0°C.

(b) *Engine Icing on the Ground*

(i) The engines must not be started when the air temperature is between plus 1°C and minus 5°C with the relative humidity greater than 95 per cent and the visibility reduced to 600 metres or less by the visible moisture content of the air.

(ii) When the temperature is between plus 5°C and minus 5°C with the relative humidity greater than 90 per cent and the visibility reduced to less than 1000 metres by the visible moisture content of the air, avoid prolonged engine running at high RPM settings. The inlet guide vanes should be inspected frequently for ice after engine start with a final check at 7000 RPM immediately before take-off. If ice is present the engines must be shutdown.

(c) *Engine Handling in Flight*



(i) The engine is more prone to surge in the inlet guide vanes operating range with the bleed valves closed and also during acceleration from below 6000 RPM. Throttle handling should receive the utmost care, RPM between 6250 and 7250 should be avoided and on the final approach RPM should not be reduced below 6000 RPM until it is certain that the runway can be reached. ◆◆

(ii) To climb through or out of icing conditions, set 7600 RPM and climb at 250 knots. Do not move the throttles unless it is essential and then only very smoothly. If it is necessary to accelerate the engines from low RPM, move the throttles smoothly and without hesitation through the range 6250 to 7250 $\blacklozenge\blacklozenge$ RPM.

Note: Climbing at 250 knots with 7600 RPM results in a steep nose-up attitude, particularly at low AUW.

(iii) Avoid cruising in cloud or precipitation at levels where the true outside air temperature is between plus 1°C and minus 5°C.

(iv) To descend through or out of icing conditions, set 6000 $\blacklozenge\blacklozenge$ RPM and descend at 250 knots using airbrakes and bomb doors as required, subject to sub-para (a) (ii) above. Maintain descent until either clear of cloud or the OAT is above plus 1°C, then maintain 6000 $\blacklozenge\blacklozenge$ RPM for 5 minutes before exercising each engine in turn to check surge free operation. If unable to descend clear of icing conditions, maintain 6000 $\blacklozenge\blacklozenge$ RPM until finally committed to landing or climb using the technique described in sub-para (c) (ii) above.

(v) If an engine surges in icing conditions, close the throttle and, if height permits, make a rapid descent until clear of icing conditions. The engine may then be slowly accelerated to 6000 $\blacklozenge\blacklozenge$ RPM and left for 5 minutes, after which an attempt may be made to accelerate it further. If the JPT rises rapidly, throttle the engine back again to 6000 $\blacklozenge\blacklozenge$ RPM immediately and allow a further 5 minutes for de-icing.

(vi) If, following a surge, flameout occurs, the throttle and HP cock should be closed and a **Normal Relight** attempted. If the relight is successful and height permits, descend until clear of icing conditions before accelerating the engine from idling to 6000 $\blacklozenge\blacklozenge$ RPM. Great care must be taken when opening the throttle and when clear of icing conditions, RPM must be maintained at 6000 $\blacklozenge\blacklozenge$ for 5 minutes before attempting to accelerate the engine further.

(viii) If a flameout occurs in icing conditions with no symptoms of surge or mechanical failure, an **Immediate Relight** may be attempted; if this fails, carry out the **Normal Relight** drill.

11 Stalling

(a) The approximate stalling speeds in knots are:

<i>Weights (lb)</i>	<i>Flaps and UC Up</i>	<i>Flaps and UC Down</i>
25,000	70 to 75	60 to 65
30,000	80 to 85	70 to 75
35,000	90 to 95	80 to 85

(b) 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. Just before the stall either wing may drop gently and aileron is effective in raising the wing, but finally, 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.

(c) 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 obtained, however, unless both the wing-tip tanks and the wing tips are modified.

(d) 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 the wing to drop. Recovery is immediate upon releasing the pull force on the control column.

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

12 High Speed Flight

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

Note 2: The flight characteristics at high mach numbers 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 will 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.

(a) Below 15,000 Feet

The speed limitation clean is 450 knots or 0.75M whichever is the lower. The speed limitation with tip-tanks is 365 knots. The aircraft is easily capable of exceeding its airspeed limitation 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.

(b) 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 severity as speed rises. If the limitation of 0.79M is exceeded, there is a tendency for lateral unsteadiness to develop.

(c) 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.

- (i) 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.

(ii) 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 (i).

(iii) 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 over-stressing the aircraft during subsequent recovery at the lower altitudes when the airspeed may be high. Avoid the use of the tail trimmer during recovery if possible but if it has to be used, extreme care must be taken.

(iv) 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, severe 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.

(v) Recovery from mild compressibility conditions is best made by throttling back and easing the aircraft out of the dive. Care must be taken to avoid high g-loading, which will aggravate matters.

(vi) If loss of control is experienced, the engines must be throttled right back and the airbrakes extended. ♦ ♦ About 10,000 feet may be lost before the mach number has fallen to a figure at which control may be regained. During recovery g loads must be kept low. Avoid the use of the tail trim during recovery if possible, and if it has to be used extreme care must be taken.

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

13 Descent

(a) *Emergency Descent*

The recommended technique for making an emergency descent following cabin pressurization failure at high altitude is to close the throttles, extend the airbrakes, open the bomb doors and descend at 0.79M above 40,000 feet and 0.75M/350 knots below. Descend to below 25,000 feet.

(b) *Rapid Descent*

To make a rapid descent, close the throttles, extend the airbrakes and descend at 0.79M above 40,000 feet and 0.75M below, until a coincident speed of 350 knots is reached; maintain that speed thereafter.

(c) *Normal Descent*

To make a normal descent, close the throttles, extend the airbrakes and descend at 0.75M until a coincident speed of 250 knots is reached; maintain that speed thereafter.

(d) *Descent in Icing Conditions*

See para 10(c)(iv).

(e) *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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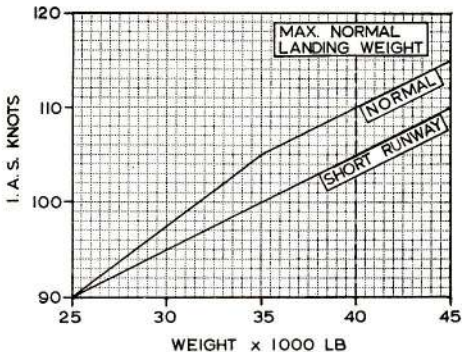
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1 Approach and Landing

(a) Carry out the **Pre-Descent/Recovery Checks and Pre-Landing Checks**. 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.

(b) *Normal Landing*

(i) Ascertain the threshold speed corresponding to the aircraft weight. Make the initial approach at a minimum of threshold speed plus 30 knots. Attain this speed by the time the aircraft is lined up with the runway, flap being lowered as required at any time after the start of the final turn. At speeds



3 - 3 Fig 1 Threshold Speeds

above about 125 knots full nose-down trim is required when flaps are fully down.

(ii) 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 RPM below 4500 until the decision to land has been made. Close the throttles just before touchdown.

(iii) When the mainwheels are firmly on the runway, lower the nosewheel and, when appropriate, apply the brakes (see para 5). Aerodynamic braking is not recommended for a normal landing.

(iv) When landing at high all up weight (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 roundout.

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

(d) *Landing with a Forward Centre of Gravity.* If landing with a forward centre of gravity (CG), increase the threshold speed by 5 knots above the normal threshold speed for the AUW. 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.

(e) *Approximate All-Up Weight*

Crew only	...	...	...	...	23,000 lb
Full fuselage tanks	...	...	...	...	34,000 lb
Full fuel including wing-tip tanks	...	...	...	...	38,000 lb
Full fuel including overload bomb bay tank	...	...	...	...	40,500 lb

2 Flapless Landing

(a) Before a flapless landing, reduce the AUW as much as practicable, using the normal fuel drill.

(b) Make the initial approach 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.

(c) Throttle back early, aiming to cross the threshold 10 knots faster than the normal threshold speed for the same AUW.

(d) After touchdown, lower the nosewheel onto the runway and when below normal maximum braking speed (NMBS) use the normal braking technique, taking care not to lock the wheels (see para 5). Aerodynamic braking has little effect in the flapless configuration and is not recommended unless a brake pressure failure has occurred before landing. If aerodynamic braking is used, careful elevator control is necessary to avoid striking the tail-skid on the runway during the landing run.

(e) A flapless landing may be carried out safely on a 6000-foot runway at maximum normal landing AUW (40,000 lb). At AUW above 35,000 lb, if the runway is wet, use a 9000-foot runway if available.

3 Crosswind Landing

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

4 Landing with One Wing-Tip Tank Full

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 be the speed for *adequate* control plus 5 knots.

5 Braking

◆ (a) Definitions

(i) *Normal Maximum Braking Speed.* NMBS is the highest IAS, for given conditions, at which maximum continuous braking may be applied and the aircraft brought to rest without damage to the brakes. (NMBS is obtained from the ODM.)

(ii) *Emergency Maximum Braking Speed.* Emergency Maximum Braking Speed (EMBS) is the highest IAS, for given conditions, at which maximum continuous braking may be applied and the aircraft brought to rest but with the liability of damage to the brakes. (EMBS is obtained from the ODM.)

(b) *General.* After the nosewheel has been lowered onto the runway, braking efficiency is improved, especially on wet runways and/or at low AUW, if the control column is moved rearward as braking commences, thus transferring weight onto the mainwheels. The use of brakes is dependent upon conditions, as explained below. Do not apply the brakes at speeds above NMBS except in emergency. Never apply the brakes at speeds above EMBS except in the circumstances of a take-off aborted above stop speed (Chap 2); if maximum continuous braking is applied at higher speeds, the brakes overheat and fail before the aircraft is brought to rest.

(i) *Normal Braking.* After the nosewheel has been lowered onto the runway, hold the control column slightly forward of centre and allow one to two seconds for the wheels to spin up. Below NMBS apply sufficient braking to slow the aircraft down using the full length of runway available. This ensures minimum wear and tear of the brakes and tyres. In normal circumstances it should not be necessary to apply the brakes at speeds above 90 knots. Above 90 knots, particularly at low ◆

◆ AUW, it is easy to lock the wheels. For flapless landings see para 2 and for asymmetric landings see Chap 4. ◆

(ii) *Maximum Braking.* After the wheels have been allowed to spin up, apply as much brake as possible *without skidding*. Move the control column progressively rearward to increase the effective weight on the mainwheels, simultaneously increasing the application of brakes to ensure the nosewheel remains in firm contact with the runway. Continue this technique throughout the landing run. If deceleration appears to decrease then the wheels have probably locked; release the brakes immediately and move the control column forward to hold the nosewheel on the runway. Allow the wheels time to spin up again before restarting braking using the 'stick back' technique.

(iii) *Wet Runway.* A longer time is needed for the wheels to spin up when the runway is slippery; allow two to four seconds before commencing gentle intermittent braking with the control column held slightly forward of central. When positive deceleration is achieved, begin continuous braking using the 'stick back' technique. The purpose of gentle intermittent braking is solely to determine whether the wheels have spun up sufficiently to allow braking without excessive spin down and wheel locking. If the wheels are felt to skid, or if a large expanse of water is about to be entered, release the brakes and move the control column forward. Allow a further period for the wheels to spin up before starting intermittent braking again while using the 'stick back' technique.

(iv) *Flooded Surfaces.* With an appreciable depth of water on the runway (ie, 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 depends upon the runway surface and the tyre tread pattern but given the right conditions the tyres may aquaplane

at groundspeeds above 80 knots. At lower speeds partial aquaplaning may still be present but braking action improves as speed is reduced further. Because of this drastic loss of braking effect, avoid flooded runways whenever possible; if, however, a landing must be made, the recommendations in (iii) above still apply. When pools of water exist, if the brakes have been applied, release them before the aircraft enters a pool and, if the control column is being held back to transfer weight on to the mainwheels, move it forward to prevent the nose rising.

(v) *Icy Runways.* Whenever possible avoid icy runways because of the certainty of a drastic reduction in braking effectiveness. However, if a landing has to be made, extreme caution is required. Use the brakes 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 on runway length.

(c) *Brakes Overheating.* Avoid overheating the brakes; use them judiciously according to the length of runway. Do not make landings involving heavy braking at less than 10-minute intervals. If heavy braking is used, reduce subsequent taxiing to a minimum. If possible, park the aircraft for 30 minutes, with the wheels chocked and the parking brake off, to allow the wheels to cool before taxiing. Alternatively, it may be advisable to shut down the engines and be towed from the end of the runway.

(d) *Brake Fire.* If, after landing, the brakes are observed to be smoking or on fire, do not close the HP cocks until fire appliances are available, because dumped fuel may ignite beneath the aircraft. If fire appliances are not readily available, stop the engines by switching off the 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.

6 Instrument Approach

(a) *Two Engines*

- (i) 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).
- (ii) When the undercarriage is down, set the required RPM (about 6200 RPM at 30,000 lb - 6600 RPM at 40,000 lb AUW) ◆ to maintain threshold speed plus 40 knots. Only small RPM ◆ adjustments should be necessary until the threshold is reached.
- (iii) 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 remains until the speed is below about 125 knots.
- (iv) Maintain threshold speed plus 30 knots until about 500 feet above ground level (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 RPM below 4500 until committed to a landing.

(b) *Asymmetric Approach and Engine Failure on the Approach.* See Chap 4.

(c) *Instrument Approach in Icing Conditions.* Avoid instrument approaches when widespread cloud together with temperatures below plus 1°C exist at or below pattern height. Divert to an airfield clear of icing conditions if possible, otherwise adopt the following recommended technique:

(i) Set and maintain 6000 RPM throughout the approach until certain of reaching the runway. Leave the undercarriage and flaps up in the pattern keeping the speed down to about 170 knots by use of the airbrakes and, if necessary, bomb doors. The bomb doors are prone to icing; only open them for short periods in icing conditions.

(ii) Lower the undercarriage when the glidepath is intercepted but do not select flaps down until certain of reaching the runway without increasing RPM. If the aircraft is below ♦ 500 feet AGL when the flaps are lowered, a higher than ♦ normal speed at the threshold may be unavoidable.

(iii) If it is necessary to overshoot, move the throttles smoothly and without hesitation through the range 6250 to 7250 RPM and climb away at 7600 RPM.

7 Overshooting

(a) An overshoot followed by an instrument approach and landing requires about 1250 lb of fuel.

(b) Open the throttles smoothly to 7400 RPM, checking that symmetrical thrust is being obtained before selecting undercarriage and flaps up (both systems travel together taking a total time of about 16 seconds to retract, the undercarriage retracts in about 10 seconds). At high AUW a higher RPM setting may be necessary to accelerate to the recommended climbing speed of 160 knots. There is a strong nose-down change of trim during the last half of flaps 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.

(c) If an engine malfunction occurs when RPM are being increased for an overshoot, raise the flaps immediately (above 200 feet AGL) and increase RPM 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.

(d) 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.

8 Roller Landing

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 crosswind 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 on to the runway.

(b) Keeping the throttles together increase RPM, 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 AUW and flaps position.

(e) *If, at any time prior to unstick, an engine malfunction is suspected or there is any indication of asymmetric thrust, close the throttles immediately and abort the take-off.*

9 Checks After Landing

(a) **Carry out the After Landing Checks.**

(b) *If the surface wind is above 25 knots, the rudder lock must be fitted for taxiing before the aircraft is turned out of wind. In windspeeds above 35 knots, the aileron and elevator locks must also be fitted.*

(c) *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** before taxiing.*

10 Shutdown Procedure

(a) *Before stopping the engines, trim the tailplane fully nose-down and then give one 'blip' up on the tail-trim switch to ease tension on the tailplane microswitch spring. This also prevents ingress of moisture to the actuator jack.*

(b) **Carry out the Shutdown Checks.**

PART 3

CHAPTER 4 - ASYMMETRIC FLYING

Contents

	Para
Stopping an Engine in Flight	1
Flying on One Engine	2
Relighting an Engine in Flight	3
Relighting in Icing Conditions	4
Asymmetric Approach, Landing and Overshoot	5
Engine Failure on the Approach	6
Double Flame Out	7

1 Stopping an Engine in Flight

If an emergency or malfunction necessitates shutting down an engine in flight or when practising emergency procedures, carry out the appropriate engine fire or failure drill. When shutting down an engine for other reasons, use the following sequence:

- (a) Carry out the electrical **Load Shedding** drill.
- (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 (if fitted).

2 Flying on One Engine

(a) 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.

(b) When flying on one engine, use the tailplane trim as little as possible, as the initial power load is high.

3 Relighting an Engine in Flight

(a) *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 in their set positions. A successful relight is indicated when the RPM stabilizes and then begins to rise. At the higher altitudes particularly, it is probably necessary to close the throttle after the RPM has stabilized, 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.

(b) *Flame Out.* If an immediate relight fails or is impracticable, carry out the **Flame Out** drill and then try a **Normal Relight**.

(c) *Normal Relighting - Recommended Conditions.* For normal relighting, the recommended maximum altitude is 25,000 feet, and there is no RPM restriction. Relighting is practicable up to about 5000 feet above the recommended altitude, but a reduction in altitude and windmilling RPM make relighting progressively more certain. If relighting is attempted above 25,000 feet reduce the windmilling RPM to 1200 or less.

4 Relighting in Icing Conditions

See Chap 2.

Table 1 - Minimum Asymmetric Approach Speeds

	<i>Below 36,000 to 36,000 lb</i>	<i>36,000 to 45,000 lb</i>
Initial approach speed to 600 feet above ground level (AGL) (VCH)	140	150
Final approach speed from 600 feet AGL until certain of landing	125	135

5 Asymmetric Approach, Landing and Overshoot

(a) Approach and Landing

(i) Carry out the **Pre-Landing Checks** (but see sub-para (iii)) but instead of calculating the threshold speed, use the asymmetric initial and final approach speeds for the all-up weight (AUW) shown in Table 1.

(ii) 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 AGL on the extended centreline and on the normal glidepath to allow sufficient time to stabilize the approach before reaching visual committal height (VCH).

(iii) To avoid using high RPM on an asymmetric instrument approach, do not lower the undercarriage until the start of the glidepath descent. About 6300 RPM are required at an AUW of 30,000 lb. When carrying out a visual circuit at high AUW, undercarriage lowering 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.

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

(v) Use a 3° glidepath for the approach. 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 AUW.

(vi) Calculation of threshold speed for asymmetric landing is considered unnecessary, since, if the technique is correctly used, the speed over the threshold is always above the flapless threshold speed.

(vii) Use the normal braking technique (see Chap 3) but take extra care to avoid locking the wheels. The flaps are likely to be travelling through the maximum lift position during the initial part of the landing run; this is liable to exacerbate the effect of the high threshold speed and makes it easier for the wheels to lock.

(b) Overshooting

(i) An overshoot can be made safely provided that the wings are level, the flaps are up, the speed is at least 140* knots and that the height is 600 feet AGL (VCH) at the start of the overshoot.

* 150 knots at 36,000 lb and above.

(ii) As soon as the decision to overshoot is made, maintain the speed at not less than the initial approach speed (sub-para (a)(i)) by diving if necessary, ensure that the wings are level and then increase RPM on the live engine within the limits of directional control to about 7400 RPM, maintaining the slip ball central by progressive application of rudder. Retract the undercarriage and check that the flaps are up. Climb away at 160 knots. If necessary, RPM 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.

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

(c) *Approach and Landing in Icing Conditions.* Whenever possible divert to an airfield that is clear of icing conditions. If compelled to carry out an asymmetric approach in icing conditions, use the normal asymmetric approach and landing technique.

6 Engine Failure on the Approach

If an engine failure occurs during a normal 2-engine approach, proceed as follows:

(a) *Above 600 Feet AGL.* 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 5(b), selecting undercarriage and flaps together. To continue the approach to land, increase RPM 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 RPM thereafter as required.

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

(i) Above 200 Feet AGL. If above 200 feet AGL, raise the flaps immediately. As the flaps retract and the speed increases, adjust RPM to achieve and maintain the asymmetric final approach speed.

(ii) Below 200 Feet AGL. If below 200 feet AGL, 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 RPM within the limits of directional control to make a safe landing.

7 Double Flame Out

(a) If a double flame out occurs, a relight on one engine may be attempted immediately, while the RPM are decreasing, by pressing the relight button for 5 seconds and then releasing it, leaving the throttle at its set position. A successful relight is indicated by the RPM stabilizing and then starting to rise. Ensure, by throttling back if necessary, that the maximum JPT (600°C) is not exceeded. 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.

(b) If an attempt to relight an engine as above is unsuccessful, carry out the **Flame Out** drill on each engine in turn 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 the **Normal Relight** drill on one engine only. When that engine has relit, switch its generator ON and relight the other engine.

PART 4**EMERGENCIES****LIST OF CHAPTERS**

	<i>Chapter</i>
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 malfunction and emergency procedures covered in the text of the Notes and in the Flight Reference Cards (FRC).

<i>Malfunction or Emergency</i>	<i>Location in Notes Part Chappara</i>			<i>Location in FRC (Tab ident)</i>
Abandoning				
Pilot	1	10	20	) Abandoning
Rear Crew	1	10	21	
Passenger	1	10	24	
Barrier Engagement	2	2	13	) Barrier
	3	2	2	
Bomb Doors				
Failure to open	1	5	12(c)	UC and Hydraulic Failures
Ditching	-	-	-	Ditching
Electrical System				
Load shedding drill ... ..	-	-	-	) Electrical
Single generator failure	1	1	17(a)	
Double generator failure	1	1	17(b)	
Overvolting	1	1	17(d)	
Inverter failure	1	1	18	

(continued)

<i>Malfunction or Emergency</i>	<i>Location in Notes</i>			<i>Location in FRC (Tab ident)</i>		
	<i>Part</i>	<i>Chappara</i>	<i>19</i>			
Electrical loads	1	1	19)		
Failure of the Type A differential cut-out	1	1	17(c))	Electrical	
Emergency Evacuation on the Ground	-	-	-	Emergency Evacuation	
Engine Systems						
Mechanical failure	-	-	-)	
Flame out	3	4	3(b))	
Double flame out	3	4	7	)	Engine
Immediate relight	3	4	3(a)	)	Failure and
Normal relight	3	4	3(c)	)	Relighting
Failure to relight	-	-	-)	-
RPM surge at altitude	3	2	5(b)		Engine Surge
Failure after take-off	3	2	3		-
Operating in icing conditions	3	2	10		-
Flight in turbulence	3	2	9		-
Fire						
Fires on the ground	-	-	-)	
◆ Wheelbrake fire	3	3	5(d)	)	Fire ◆
Engine fire	1	7	1)	
Fuselage fire	1	7	2		-
Cabin fire	1	7	2(b)		Fire
Fuel						
LP pump failure	1	2	10		Fuel

(continued)

<i>Malfunction or Emergency</i>	<i>Location in Notes Part Chappara</i>			<i>Location in FRC (Tab ident)</i>
Jettison Procedure				
Canopy	1	10	4)
Hatch	1	10	5 & 21)
Entrance door	1	10	8)
Wing-tip tanks	1	2	1(b)(ii)	) Jettison
	2	2	7)
	3	2	3(b))
Banner target	1	7	11	) External
Landing				
Flapless	3	3	2)
Asymmetric	3	4	5	) Pre-Landing
Asymmetric wing-tip fuel load	3	3	4)
After undercarriage malfunction ... ..	-	-	-	) Hazardous Landings
Forced landing	-	-	-)
Oxygen				
Smoke or fumes ... ..	-	-	-	) Smoke or Fumes
MI failure	-	-	-)
Emergency oxygen	1	9	3	) Oxygen
Partial system failure	1	9	9)
Pressurization				
Pressurization failure	1	8	5	) Press'n
Emergency descent	3	2	13(a))

(continued)

<i>Malfunction or Emergency</i>		<i>Location in Notes Part Chappara</i>			<i>Location in FRC (Tab ident)</i>
Undercarriage					
Failure to retract	...	1	5	7)
Failure to lower...	...	1	5	8)
Emergency UP selection		1	5	8(a) &)
				11(c))
		3	2	2(b))
)
Wheelbrakes					
Hydraulic failure	...	1	5	11)

PART 5

17

~~OPERATING DATA~~

Part not used

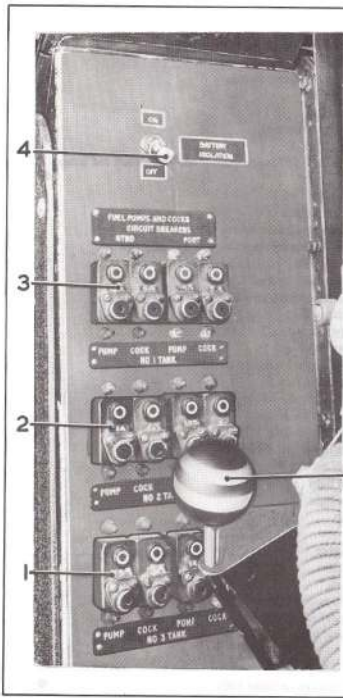
See Operating Data Manual

ALH

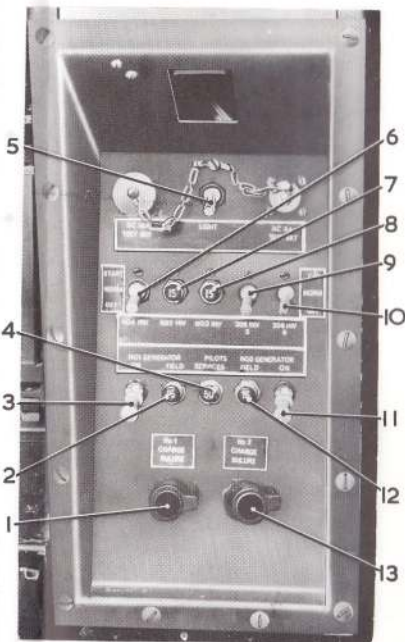
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PART 6

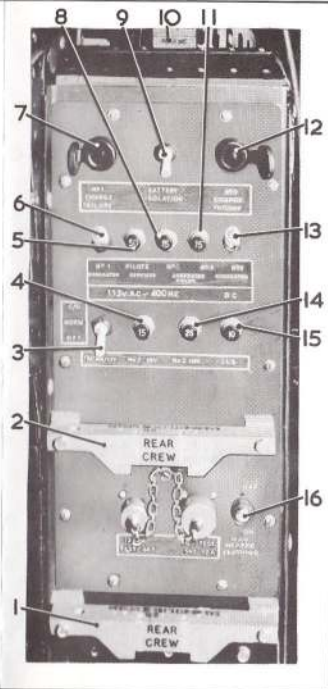
ILLUSTRATIONS



6 - 1 Fig 1 Electrical Control Panel, Front Face



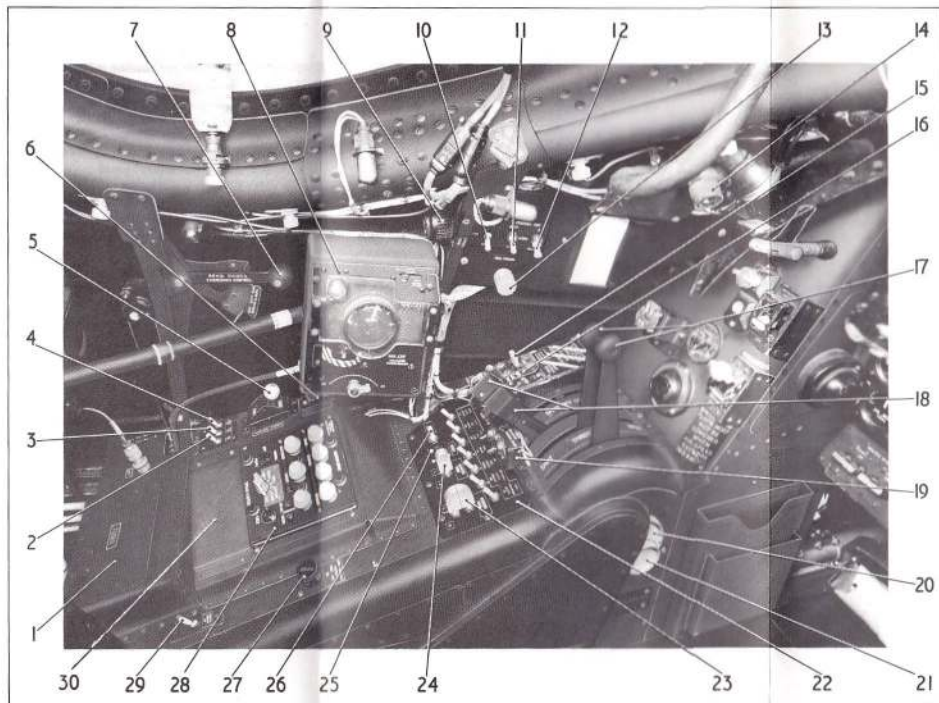
6 - 1 Fig 2 Electrical Control Panel, Rear Face
(Post-Mod 4868)



6 - 1 Fig 3 Electrical Control Panel, Rear Face
(Pre-Mod 4868)

Key to 6 - 1 Fig 4 - Cockpit Left Console

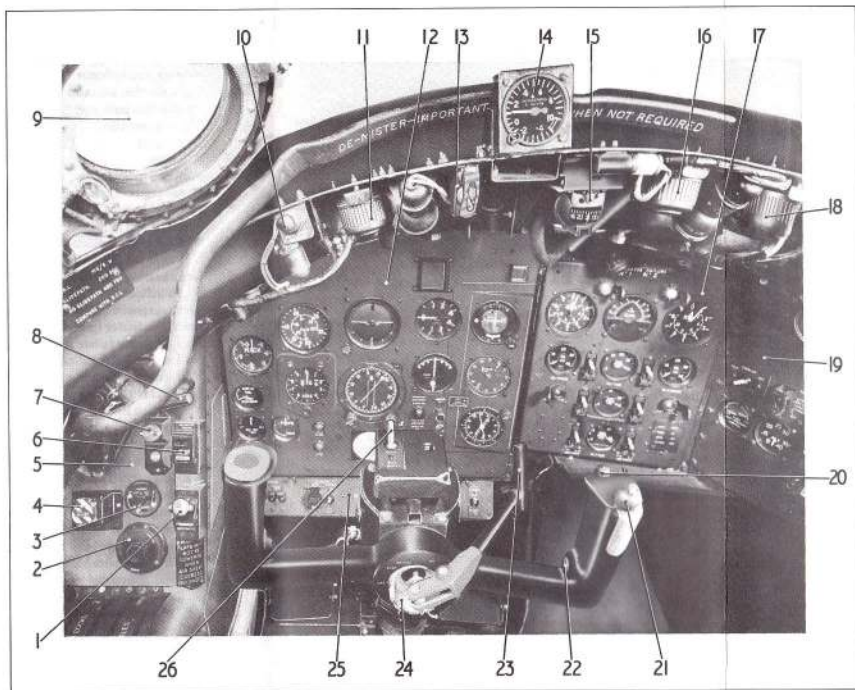
- 1 Fuse panel
- 2 Vent valve heater switch (inoperative)
- 3 Pressure head heater switch
- 4 Windscreen (DV panel) heater switch
- 5 Bomb doors selector
- 6 Bomb doors indicator
- 7 Bomb doors emergency control
- 9 Pilot's oxygen regulator
- ◆9 Dimmer switch (console red lamps post-Mod 4868 or left red lamps pre-Mod 4868) ◆
- 10 Intercom master switch
- 11 Standby UHF master switch
- 12 Standby UHF Guard/A selector switch
- ◆13 Dimmer switch (left red lamps post-Mod 4868) or (console red lamps pre-Mod 4868) ◆
- 14 Canopy internal demister control
- 15 Canopy/snatch master switch, now on the left wall switches panel forward of item 12
- 16 Canopy jettison switch
- 17 Throttle control levers
- 18 HP cock levers and engine relight switches
- 19 HP pump isolation switches
- 20 Friction damper, throttle control levers
- 21 Friction damper, HP cock levers
- 22 Lighting switches right to left:
 - Anti-collision lights (pre-SEM 188)
 - External lights master
 - Identification light (colour)
 - Identification light
 - Landing lamp
 - Taxy lamps
 - Navigation lights
- 23 Rudder trim switches
- 24 Aileron trim switch
- 25 Identification light morse button
- 26 Camera switch (post-Mod 4868)
- 27 Anti-collision lights fuse
- 28 Station box
- 29 Canopy demist switch
- ◆30 Strobe lights switches (post-SEM 188) ◆



6 - 1 Fig 4 Cockpit Left Console
◆ (SEM 188 added) ◆

Key to 6 - 1 Fig 5 - Cockpit Forward View

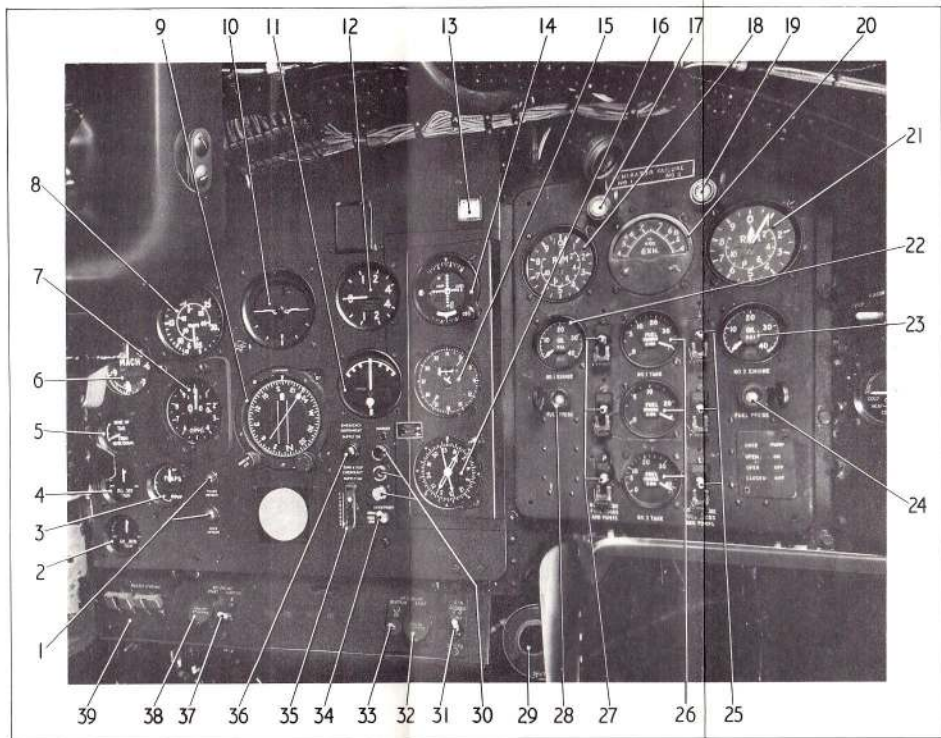
- 1 Flaps selector switch
- 2 Ventilation louvre
- 3 Undercarriage position indicator
- 4 Wing-tip tank jettison button
- 5 Left sloping front panel
- 6 Undercarriage master switch
- 7 Undercarriage selector switch unit
- 8 Undercarriage emergency lowering control
- 9 Direct vision (DV) panel
- 10 Call navigator button
- 11 Dimmer switch (left UV lamps)
- 12 Flight instrument panel
- 13 Emergency amber lamps switch
- 14 Accelerometer
- 15 Standby compass
- 16 Dimmer switch (right red lamps)
- 17 Engine instrument panel
- 18 Dimmer switch (right UV lamps)
- 19 Miscellaneous instrument panel
- 20 Tailplane trim cut-in switch
- 21 Tailplane trim control switch
- 22 Press-to-transmit button
- 23 Wheelbrakes control lever
- 24 Wheelbrakes lever parking catch
- 25 Engine starter panel
- 26 Airbrakes control switch



6 - 1 Fig 5 Cockpit Forward View

Key to 6 - 1 Fig 6 Cockpit, Flight and Engine Instrument Panels

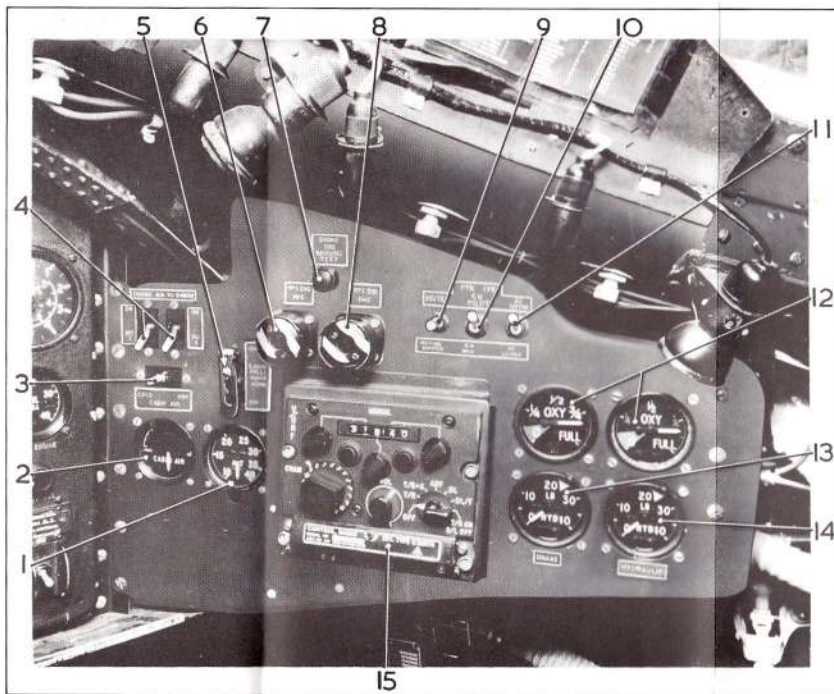
- ◆ 1 Pilot's and navigator's remote oxygen MI (post-Mod 4868) or pilot's remote oxygen MI only (pre-Mod 4868) ◆
- 2 Aileron trim indicator
- 3 Flaps position indicator
- 4 Rudder trim indicator
- 5 Tail trim indicator
- 6 Machmeter
- 7 Altimeter
- 8 Airspeed indicator
- 9 Gyro-magnetic compass indicator
- 10 Artificial horizon
- 11 Turn and slip indicator
- 12 Vertical speed indicator
- ◆ 13 ILS/VOR MI (post-Mod 4868) or marker light (pre-Mod 4868)
- 14 Omni bearing selector (post-Mod 4868) or ILS indicator (pre-Mod 4868)
- 15 Tacan indicator
- 16 Radio magnetic indicator (post-Mod 4868) or radio compass relative bearing indicator (pre-Mod 4868) ◆
- 17 No 1 generator failure warning light
- 18 No 1 engine RPM indicator
- 19 No 2 generator failure warning light
- 20 No 1 and No 2 engine jet-pipe temperature indicator
- 21 No 2 engine RPM indicator
- 22 No 1 engine oil pressure gauge
- 23 No 2 engine oil pressure gauge
- 24 No 2 engine fuel pressure warning light
- 25 No 2 engine fuel cocks and pumps switches) Top to bottom
- 26 Fuel contents gauges) No 1, No 2 and
- 27 No 1 engine fuel cocks and pumps switches) No 3 tank
- 28 No 1 engine fuel pressure warning light
- 29 Ventilation louvre
- 30 Marker lights (post-Mod 4868)
- 31 Compass directional gyro switch
- 32 No 2 engine starter button
- 33 No 2 engine ignition switch
- ◆ 34 Marker sensitivity switch (post-Mod 4868) ◆
- 35 Turn and slip indicator emergency supply switch
- 36 Emergency instrument supply MI
- 37 No 1 engine ignition switch
- 38 No 1 engine starter button
- 39 No 1 and No 2 engine master starting switches



6-1 Fig 6 Cockpit, Flight and Engine Instrument Panels

Key to 6-1 Fig 7 — Cockpit, Miscellaneous Instrument Panel

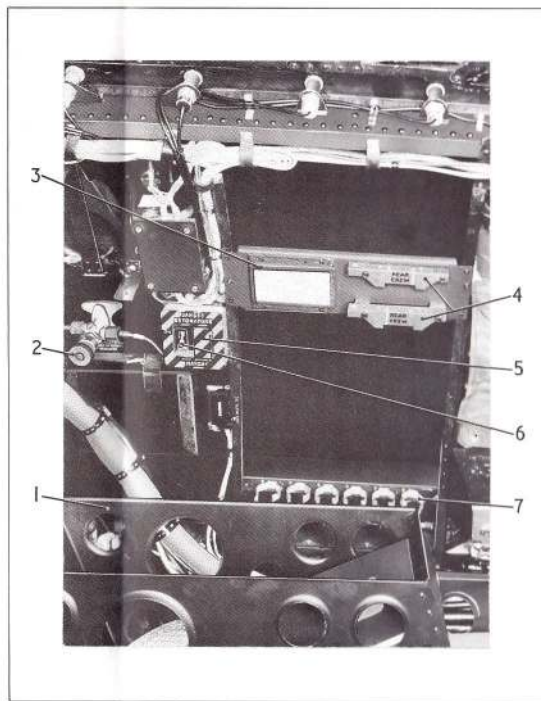
- 1 Cabin altimeter
- 2 Cabin air mixing valve position indicator
- 3 Cabin air temperature control switch
- 4 Engine air to cabin switches
- 5 Cabin pressure warning horn switch
- 6 No 1 engine combined engine fire warning light and extinguisher button
- 7 Engine fire warning test button
- 8 No 2 engine combined engine fire warning light and extinguisher button
- 9 V/UHF muting switch
- 10 V/UHF control unit changeover switch
- 11 UHF upper/lower aerial switch
- 12 Oxygen contents gauges
- 13 Wheelbrakes hydraulic pressure gauge
- 14 Main hydraulic pressure gauge
- 15 V/UHF control unit



6 - 1 Fig 7 Cockpit, Miscellaneous Instrument Panel

◆ **Key to 6 - 1 Fig 8 Cabin Left Wall (Post-Mod 4868)** ◆

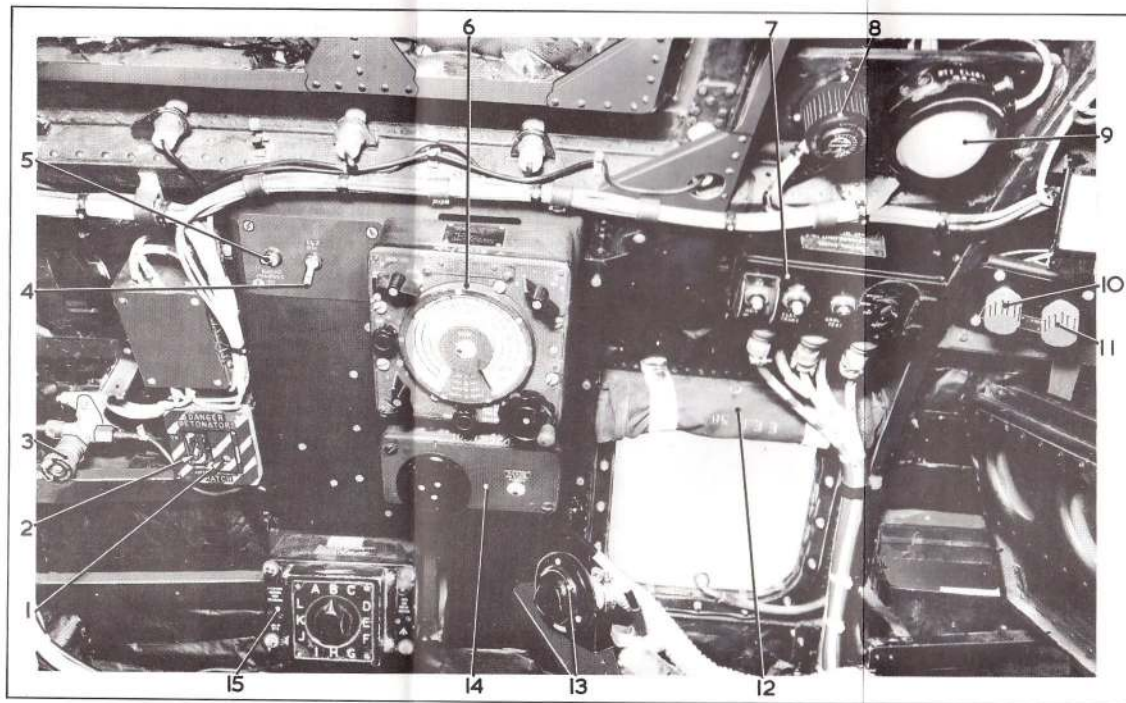
- 1 Navigator's bag stowage
- 2 Oxygen stop valve
- 3 Basic ejection drill card
- 4 Ejection seat safety pin stowages
- 5 Hatch jettison switch
- 6 Hatch safety switch
- 7 Signal cartridge stowage



6 - 1 Fig 8 Cabin Left Wall (Post-Mod 4868)

◆ Key to 6 - 1 Fig 9 - Cabin Left Wall (Pre-Mod 4868) ◆

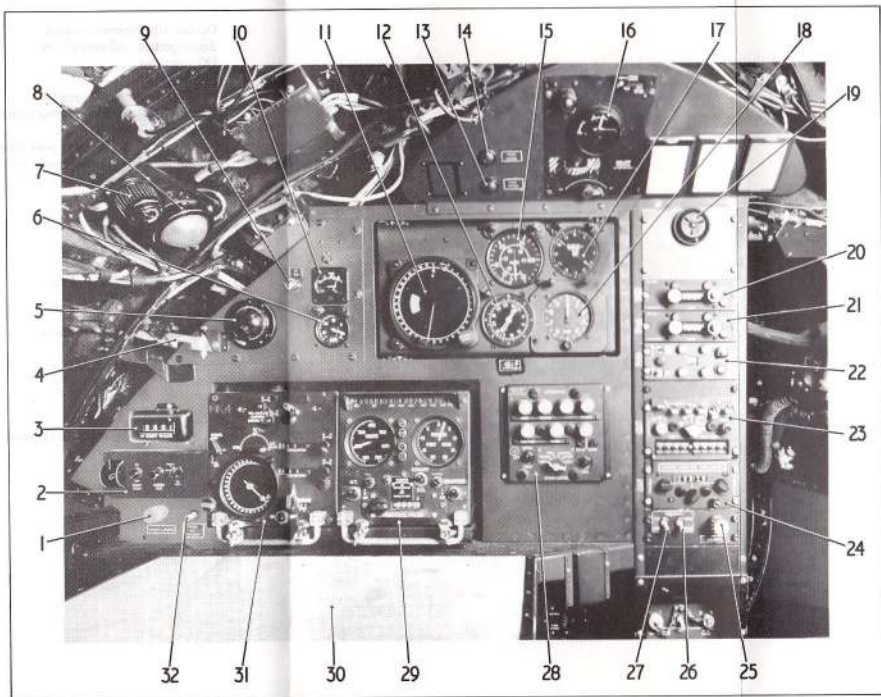
- 1 Hatch jettison switch
- 2 Hatch safety switch
- 3 Oxygen stop valve
- 4 ILS on/off switch
- 5 Radio compass on/off switch
- 6 Radio compass receiver controller
- 7 AMU control panel
- 8 Dimmer switch (anglepoise lamp)
- 9 Dome lamp
- 10 Dimmer switch (instrument and ECP lights)
- 11 Dimmer switch (control units)
- 12 Window blind
- 13 Ventilation louvre
- 14 Radio compass loop control unit
- 15 ILS control unit



6 - 1 Fig 9 Cabin Left Wall (Pre-Mod 4868)

◆ Key to 6 - 1 Fig 10 - Cabin Forward View (Post-Mod 4868) ◆

- 1 Dimmer switch (instruments)
- 2 Air mileage unit control panel
- 3 Air mileage indicator
- 4 Folding table retaining catch
- 5 Ventilation louvre
- 6 Outside air temperature gauge
- 7 Dimmer switch (anglepoise lamp)
- 8 Dome lamp
- 9 IFF fail light
- 10 DC voltmeter
- 11 G4B compass master indicator
- 12 Radio magnetic indicator
- 13 Navigator's remote oxygen MI
- 14 Pilot's remote oxygen MI
- 15 Airspeed indicator
- 16 Navigator's oxygen regulator
- 17 Tacan indicator
- 18 Altimeter
- 19 Air diffuser
- 20 ILS/VOR 1 control unit
- 21 VOR 2 control unit
- 22 Tacan control unit
- 23 IFF/SSR control unit
- 24 V/UHF frequency control unit
- 25 Dimmer switch (control units)
- 26 Voice/range filter switch
- 27 Item removed
- 28 Station box
- 29 Green Satin indicator
- 30 Folding table
- 31 Ground position indicator
- 32 Press-to-transmit switch

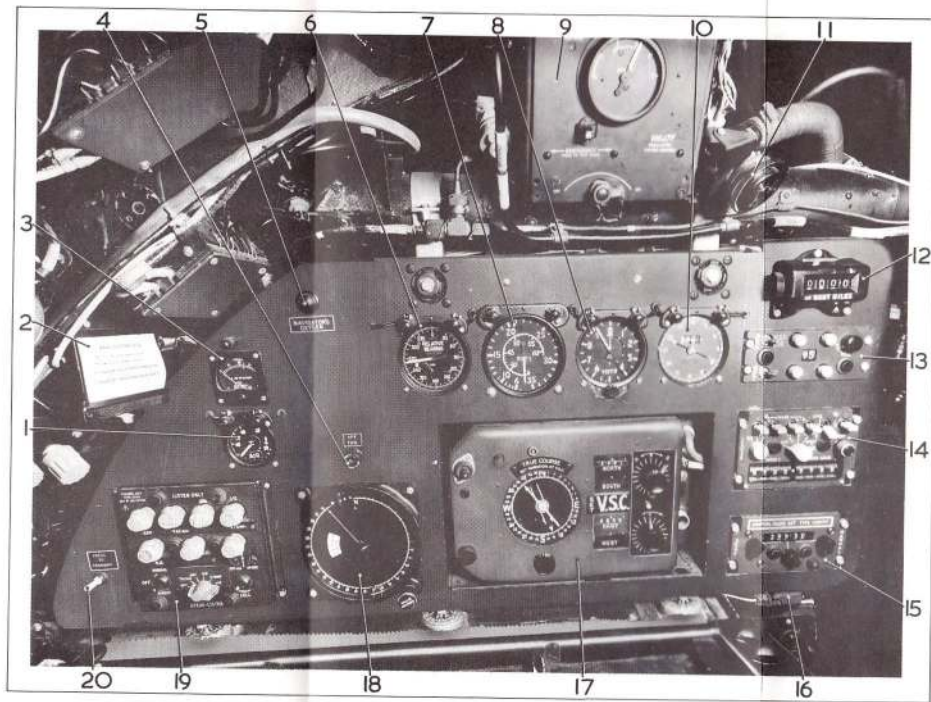


6 - 1 Fig 10 Cabin Forward View (Post-Mod 4868)

◆ Key to 6 - 1 Fig 11 - Cabin Forward View (Pre-Mod 4868) ◆

- 1 Outside air temperature gauge
- 2 Basic ejection drill card holder
- 3 DC voltmeter
- 4 IFF fail light
- 5 Navigator's remote oxygen MI
- 6 Radio compass relative bearing indicator
- 7 Airspeed indicator
- 8 Item removed and blanking plate fitted. On banner target towing aircraft a guarded banner emergency jettison switch is fitted
- 9 Navigator's oxygen regulator
- 10 Tacan indicator
- 11 Air diffuser
- 12 Air mileage indicator
- 13 Tacan control unit
- 14 IFF/SSR control unit
- 15 V/UHF frequency control unit
- 16 Red floodlamp (ECP)
- 17 Air position indicator
- 18 G4B compass master indicator
- 19 Station box
- 20 Press-to-transmit switch

Note: A Mk 30A altimeter is fitted between items 3 and 6.



6 - 1 Fig 11 Cabin Forward View (Pre-Mod 4868)

Key to 6 - 1 Fig 12 - Cabin Right Wall

- 1 First-aid kit stowage
- 2 Hand-operated fire extinguisher
- 3 Axe
- 4 G4B compass control panel
- 5 2nd navigator's oxygen regulator
- 6 Dimmer switch (anglepoise lamp)
- 7 Basic ejection drill card holder
- 8 Anglepoise lamp
- 9 Item removed
- 10 Hatch jettison switch
- 11 Periscope stowage
- 12 Oxygen stop valve
- 13 Nose position oxygen regulator remote MI

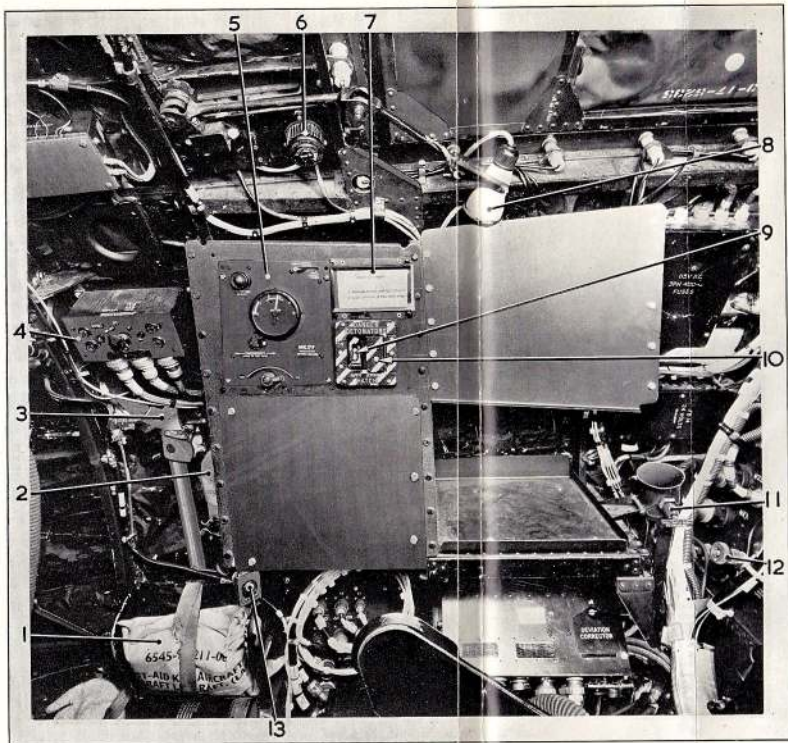


Fig 12 Cabin starboard wall

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