4th Edition A.P. 4326 D-P.N.

Restricted

72

PILOT'S NOTES

CANBERRA T.Mk 4

Restricted

3

AMENDMENTS

Amendment lists will be issued as necessary and should be in ' in the appropriate place in the Notes. New or amended ɔphs will be indicated by triangles positioned in the text ◀ .... ▶ to show the extent of the amended text, us ▶◀ to show where the text has been deleted. When a page ued or re-issued by amendment the number of the Amendment ɔpear at the bottom of the page. When a chapter is issued or sued in a completely revised form the triangles will not appear. rporation of an Amendment list must be certified by inserting date of its issue, the date of incorporation and signature below.

ıt list	Signature	Date of Incorporation	Amdt. list		Signature	Date of Incorporation
Date			No.	Date		
SEP 63 3/.66	[illegible]	31/5/66	7.			
NOV 63	[illegible]	31/5/66	8.			
APR 65	[illegible]	/66	9.			
			10.			
DEC 66	[illegible]	30/3/67	11.			
APR 67	[illegible]	15/9/67	12.			

SUPERSEDED BY AMENDMENT RECORD SHEET ISSUED WITH AL 9 16.12.68. 5 MAR 70

ments and suggestions regarding Pilot's Notes should forwarded to the Officer Commanding, Handling Squad- n, Royal Air Force, Boscombe Down, Wiltshire.

T 123

4th Edition
August 1962
(Amended by AL10)

AP101B-0404-15

CANBERRA T Mk 4
PILOT'S NOTES

BY COMMAND OF THE DEFENCE COUNCIL

Prepared by Procurement Executive,
Ministry of Defence

AMENDMENT RECORD SHEET

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

A.L. No.	AMENDED BY	DATE
1	Incorporated	
2	Incorporated	
3	Incorporated	
4	Incorporated	
5	Incorporated	
6	Incorporated	
7	Incorporated	
8	Incorporated	
9	Incorporated	
10	Crisby	29 MAY 73
11	B.J. Gladwell	3 JUN 74
12	[illegible]	21 Sep 75
13	Incorporated [illegible]	16 Mar 76
14	J. Gardener	3 Nov 77
15	S.P. Dedair	4 Feb 80
16	[illegible]	Dec 80
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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◀ Part 5 (Withdrawn) ▶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 triangles positioned in the text thus ◀......▶ to show the extent of amended text and 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 markings on controls are indicated in the text by capital letters.

(b) Unless otherwise stated all airspeeds, mach numbers, accelerations, temperatures and altitudes quoted are indicated values.

(c) **WARNINGS** are inserted only when the serious consequences of not following a certain procedure might otherwise be overlooked.

(d) Information which requires to be emphasised is 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-0404-14) 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.

ANA INCORPORATED

ANA No								

LIST OF PAGES

This list shows all the pages which should be present in this Book when AL16 is incorporated. Pages which should have manuscript amendments are marked with an asterisk.

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Procurement Executive
Ministry of Defence
November 1980

Amendment Instructions
to
AP 101B-0404-15

AMENDMENT LIST No 16
to
CANBERRA T Mk 4 PILOT'S NOTES

1. In addition to this Instruction Sheet, this Amendment List consists of 4 sheets which should be inserted in the Pilot's Notes as replacements for existing sheets.

2. This Amendment List updates or revises the Pilot's Notes as follows:

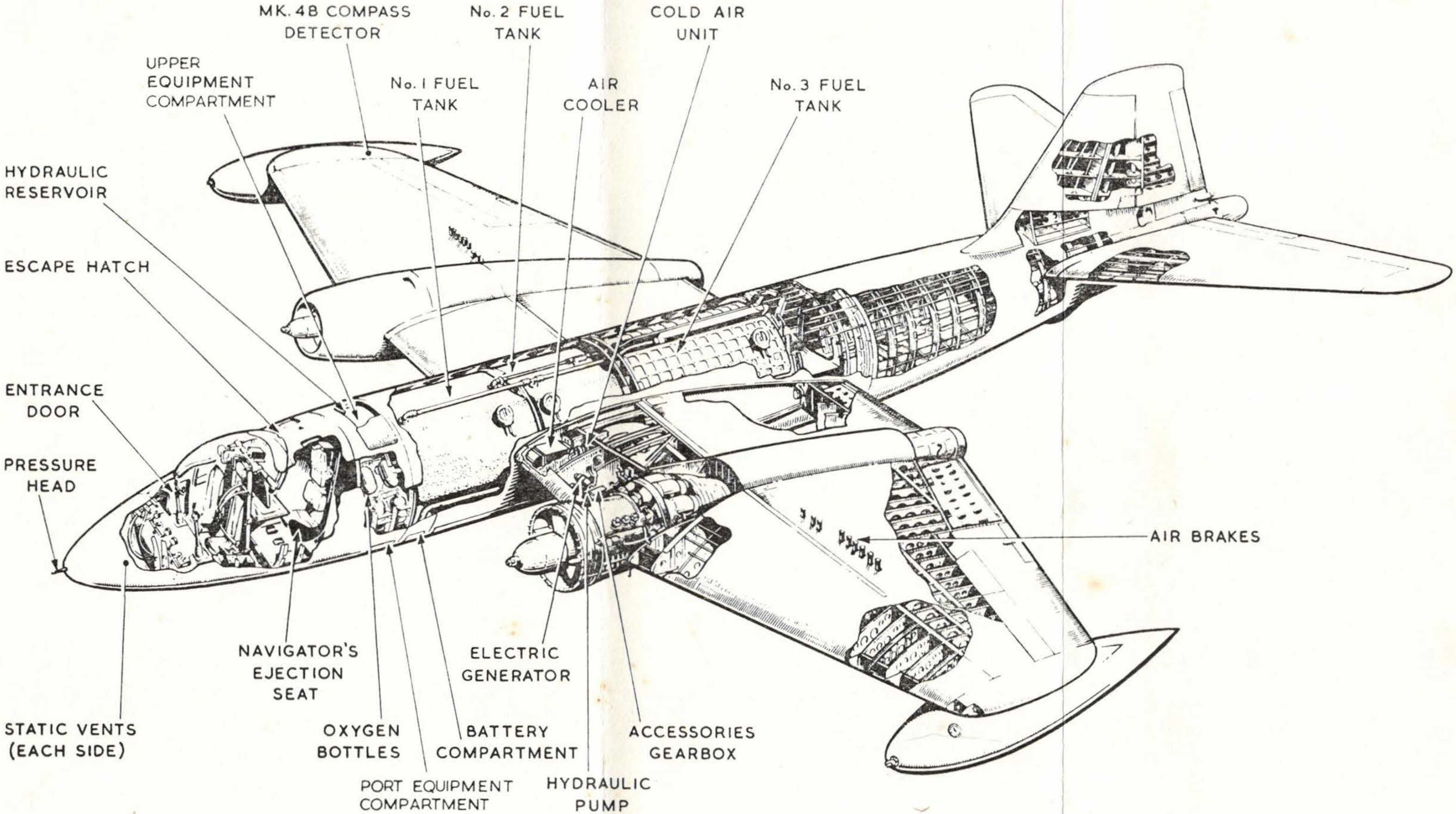
Part and Chapter	*Amendment*	*Related Authority*
1 — 5	Emergency lowering of the undercarriage — Electrical failure (para 7 (b) (ii)) revised.	RAF Handling Sqn
2 — 1	Authority for all limitations block included.	Release to Service

Manuscript Amendments

When a manuscript amendment is made, endorse the adjacent margin 'AL16'.

No	*Location*	*Amendment*
1	Part 1, Chap 3, Para 5, lines 3 and 4	*Amend sentence to read* 'Ensure that the hydraulic cock in the bomb bay is wire-locked at FLIGHT.'
2	Part 1, Chap 3, Para 7, line 4	*Amend* 'gauge' to read 'gauges'
3	Part 1, Chap 4, Para 2 (b) (ii), last line	*Amend to read* 'covered in 3 — 2 Para 5 (c)'
4	Part 1, Chap 6, Para 19 (b) (v), line 10	*Delete* 'clockwise'

When this Amendment List is fully incorporated, check that the make-up of the Pilot's Notes is in agreement with the List of Pages issued with this Amendment List; then endorse the Amendment Record Sheet and destroy this



Canberra T Mk 4

◀ *(Rebecca and VHF aerials Deleted)* ▶

Intentionally Blank

MODIFICATION NUMBERS MENTIONED IN THE TEXT

Mod No	*Title*	*Location in Text Pt Ch Para*
	CANBERRA MOD	
1178	To introduce a main hydraulic pressure gauge	1 3 1
3850	To introduce fuel recuperators ...	1 2 3
	▸◂	
◂ 5098	To introduce refurbished aircraft (Alteration R60/63. 9000 series switches)	1 1 10 1 5 6(*c*)(i) 1 6 5 1 6 12(*b*) 1 7 7(*b*) 1 10 5(*a*)(ii) ▸
	COMMAND MOD	
0561/STC	Relocation of pupil's canopy jettison switch	1 10 5(*a*)
	▸◂	
	SEM	
06/STC	Introduction of press-to-test facility in canopy and hatch detonator systems	1 10 10(*c*)

Mod No	*Title*	*Location in Text Pt Ch Para*
011/STC	To introduce an 'attention getter' Betalight marker adjacent to the emergency lamps control switch	1 7 7(*b*)
052/STC	To introduce a red floodlamp to illuminate the navigator's hatch switch unit	1 7 7(*c*)(i)
055/STC	To relocate the landing lamp control switch to position now taken by the identification light morse switch	1 7 6(*b*)
057/STC	To introduce red rotating anti-collision lights	1 7 6(*c*)
	AVON MOD	
857	Introduction of larger diameter interconnectors	3 4 3(*b*)
5278	Introduction of lower rate IGV ram piston spring. To increase engine speed at which the ram leaves max incidence position (40°) on acceleration	1 4 3(*c*) &(*d*) 3 2 6&7(*b*)
	▶◀	
	NAVAL SERVICE MOD	
NSM 3004	To introduce Projector Sonar (ARI 23240/1)	1 6 15

▶◀

INTRODUCTION

1 General

The Canberra T Mk 4 is a dual-controlled trainer powered by two Avon Mk 1 engines, each of 6500 lb static thrust. The cabin is pressurised and provides accommodation for a pupil and instructor seated side by side in the cockpit and a navigator at the rear of the cabin. Ejection seats are provided at all three stations.

2 Entrance Door and Emergency Exits

Entrance to the cabin is through a door on the starboard side. This door is jettisonable and provides an emergency exit. The cockpit canopy above the pilots' stations and the hatch above the navigator's station are both jettisonable and also provide emergency exits.

3 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 wall and access to it is by means of a hinged hatch on top of the fuselage. The port and starboard equipment bays are on either side of the nose undercarriage well, with access doors in the fuselage wall. A battery compartment is immediately aft of the lower equipment bays; a hinged access door is on the port side. There is a bomb bay in the belly of the fuselage although no provision is made to carry bombs.

4 Flying Controls

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

5 Layout of Controls and Instruments

Throughout these Notes the term 'pupil' refers to the pilot in the left-hand seat and the term 'instructor' to the pilot in the right-hand seat. Controls and instruments are grouped as follows:

(*a*) *Pilots' Stations*

(i) In front of the pupil and instructor on the main instrument panel. This panel is divided into three sections; from left to right, the flight instrument panel, the engine instrument panel, and the miscellaneous instrument panel. Various controls are on the coaming panel above the main instrument panel and on the engine starter panel below it.

(ii) To the left of the pupil on the cockpit port wall, on the port console and forward of the port console on the port front panel.

(iii) To the right of the instructor on the cockpit starboard wall.

(*b*) *Navigator's Station*

(i) On the cabin starboard wall which includes the electrical control panel (ECP).

(ii) On the navigator's forward instrument panel.

(iii) On the cabin port wall.

6 LABS Equipment

Training facilities for LABS, introduced by mods 3816 and 3817, are no longer required, but the fixed LABS equipment may still be fitted in some aircraft. Details of the equipment have been deleted from the book.

LEADING PARTICULARS

PRINCIPAL DIMENSIONS

	feet	inch
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
Air pressure	Refer to AP 101B-0404-1A
Fluid	OM-15 (NATO H515)
Capacity	12 pints
Tyre pressure	Refer to Servicing Schedules AP 101B-0404-5

Brakes

Pressure at reducing valve inlet	2500 $^{+0}_{-100}$ 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 H515)
Capacity	$1\frac{1}{2}$ pints
Tyre pressure	Refer to Servicing Schedules 101B-0404-5

HYDRAULIC SYSTEM

Fluid	OM-15 (NATO H515)
Pumps (two)	Lockheed Mk 7 or Mk 9
Accumulator, charging gas ...	Air
Thermal relief valve setting	3450±100 PSI (See Part 1, Chapter 3, para 3 (*b*))
Capacity of system	31 pints (approx)
Capacity of tank	2 gallons
Accumulator inflation pressures, main and wheel-brakes	1300 / 1350 / 1400 $^{+50}_{-0}$ PSI at +5°C / at +15°C / at +25°C

Automatic cut-out valve:

Cut-out	2500 $^{+0}_{-100}$ PSI
Cut-in	2000 PSI (min)
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 } Oil }	Refer to Part 2, Chapter 1, para 3
Oil system capacity	19 pints each engine including—
Oil 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 Gearboxes

Oil	OEP 71
Oil sump capacity	$3\frac{1}{8}$ pints

ELECTRICAL SYSTEM

Voltage	28 volts
Generators (two)	6 kW, Type P3
Aircraft battery	4 × 12 volt, 40 ampere hour (lead acid), connected in series parallel
Emergency battery	2 × 12 volt, 4 ampere hour (lead acid), connected in series
◀ Emergency lighting battery ...	1 × 2·4 volt (alkaline) ▶
Standby UHF emergency battery	1 × 24 volt, 7 ampere hour (alkaline)

FUEL SYSTEM

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

PART 1

DESCRIPTION AND MANAGEMENT OF SYSTEMS

LIST OF CHAPTERS

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Electrical system	**1**
Fuel system	**2**
Hydraulic system	**3**
Engine systems and controls	**4**
Aircraft controls	**5**
Flight instruments, radio and radar	**6**
General equipment and controls	**7**
Air conditioning, pressurising, and demisting systems	**8**
Oxygen system	**9**
Ejection seats and escape systems	**10**

PART 1

CHAPTER 1 — ELECTRICAL SYSTEM

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DESCRIPTION

1 Generators

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

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

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

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

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

2 AC Supplies — Inverters

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

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

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

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

▶◀

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

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

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

3 Aircraft Battery

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

4 External Supply

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

5 Emergency Batteries

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

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

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

6 Electrical Control Panel (ECP)

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

(i) *Forward Panel*

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

(ii) *Aft Panel*

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

▶◀

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

7 Inertia Crash Switches

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

Inertia crash switch circuits.

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

Canopy jettison
Elevator control tube severance } Detonator circuits
Hatch jettison

CONTROLS AND INDICATORS

8 Generator Controls

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

9 AC Supplies — Inverter Controls

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

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

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

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

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

(b) No 6 *Inverter*

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

(c) No 7 *Inverter*

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

10 Aircraft Battery Control

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

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

11 Emergency Batteries Controls

(a) 24 *Volt Emergency Battery*
The emergency supply to the turn and slip indicator is controlled by a TURN & SLIP EMERGENCY SUPPLY switch on the engine instrument panel.

(b) 2·4 *Volt Emergency Lighting Battery*
The supply to the emergency lighting is controlled by an EMERG LIGHTS—ON/off switch on the coaming panel.

(c) 24 *Volt Standby UHF Emergency Battery*

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

NORMAL OPERATION

12 Before Starting the Engines

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

13 Starting the Engines

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

14 During Flight

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

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

15 After Flight

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

MALFUNCTION

16 Generator Failure

(a) Single Generator Failure

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

(b) Failure of Both Generators

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

(c) If both generators fail at high altitude, altitude should be reduced because the LP fuel pumps will only function as long as power is available from the aircraft battery. If the battery fails there is imminent danger of flame-out without the ability to relight. Altitude should be reduced to below 15,000 feet, if possible, so that the engines may continue to obtain fuel by gravity/suction feed if the LP pumps cease to operate. However, if it is necessary to fly at greater altitude in order to reach the nearest suitable airfield, RPM should be restricted to 7200 ◀(maximum), and altitude to 35,000 feet (Avtur or Avcat)▶ or 25,000 feet (Avtag). (See also Chapter 2, para 11.)

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

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

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

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

(ii) Reduce electrical load.

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

(e) Overvolting

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

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

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

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

(ii) *In Flight*

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

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

Over 30 *Volts*

1. Reduce electrical load.

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

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

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

17 No 1 Inverter Failure

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

18 No 6 Inverter Failure

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

19 Electrical Loads

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

Intentionally Blank

PART 1

CHAPTER 2 — FUEL SYSTEM

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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 while No 3 tank is a crash-proof collapsible fuel bag. The tanks are vented to atmosphere through a common pipe terminating at an outlet on the fuselage starboard surface under the tailplane. Flush fitting filler caps, one for each tank, are on the port upper surface of the fuselage.

(*b*) *Wing Tip Tanks*

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

(ii) The wing tip tanks may be jettisoned by pressing in the guarded FUEL TANK JETTISON button on the port console.

2 Fuel Tank Capacities

The effective fuel capacities are approximately:

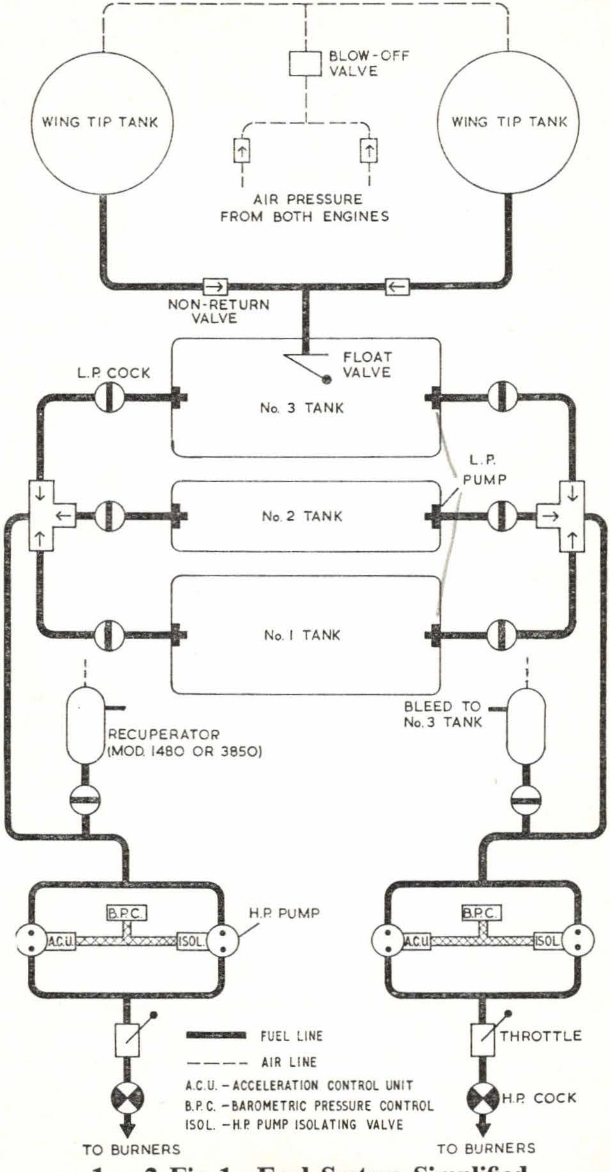
◀

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

3 Fuel Recuperators

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

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



1 — 2 Fig 1 Fuel System Simplified

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

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

4 Fuel Feed to the Engines

Two electrically-driven LP pumps are fitted in each fuselage tank. The pumps on the port side of the fuselage tanks feed fuel through their associated LP cocks and a common collector box to the port engine HP pumps; similarly the pumps on the starboard side of the tanks feed the starboard engine HP pumps.

CONTROLS AND INDICATORS

5 LP Cock and Pump Controls

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

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

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

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

6 Fuel Pressure Warning Lights

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

7 Fuel Contents Gauges

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

NORMAL USE OF THE FUEL SYSTEM

8 Checks of Fuel Pumps and Cocks

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

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

9 Fuel Management Drill

(a) General

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

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

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

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

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

(vi) *Fuel Surge*

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

(b) Fuel Drill

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

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

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

▸◂

(c) Reserve Fuel

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

10 Use of Different Fuels

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

11 Fuel LP Pump Failure

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

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

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

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

cruising RPM should be obtained below 15,000 feet. *Erratic running, which will lead to fuel system failure, must be avoided.* If maximum range is essential, level flight may be possible, using 7200 RPM maximum up to 35,000 feet with Avtur or Avcat or up to 25,000 feet with Avtag, but altitude and RPM must be kept as low as possible. Any climbing should be done using fuel from tanks with serviceable pumps; this applies equally when landing, to avoid the possibility of having to overshoot using suction feed, which is undesirable. Any use of *gravity/suction feed must be reported.*

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

PART 1

CHAPTER 3 — HYDRAULIC SYSTEM

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DESCRIPTION

1 General

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

2 Pumps and Services

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

Undercarriage
Flaps
Airbrakes
Bomb doors
Wheelbrakes

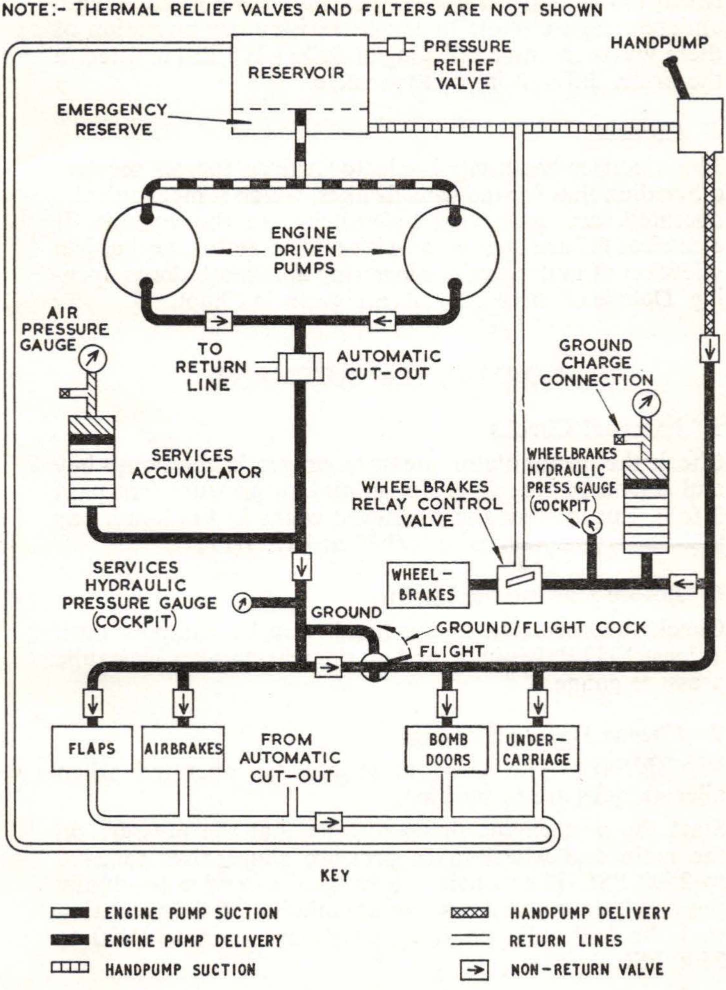
(b) The handpump works in conjunction with the hydraulic GROUND/FLIGHT cock situated near the front of the bomb bay roof on the starboard side. When the cock is at FLIGHT the handpump can be used to operate only the undercarriage and the bomb doors and to charge the wheelbrakes accumulator. With the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

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

3 Accumulators

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

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



1 — 3 Fig 1 Hydraulic System Simplified

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

4 Controls

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

NORMAL MANAGEMENT

5 External Checks

Check the accumulator pressure gauges in the bomb bay and starboard wheelwell for minimum pressure (see para 3 (*a*)). Ensure that the hydraulic cocks in the bomb bay
AL 16 ~~and battery bay are~~ is wire-locked at FLIGHT.

6 Before Starting the Engines

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

7 Checks During Starting

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

Start the port engine first and note that the pressure on the main and wheelbrakes pressure gauges rises to 2400
AL 16 to 2500 PSI. Then operate a hydraulic service (normally the bomb doors) and note on completion of the operation that the hydraulic pressure builds up again to 2400 to 2500 PSI.

8 After Starting the Engines

When both engines have started, check the operation of the airbrakes and flaps and note on completion of these checks that the hydraulic pressure builds up again to 2400 to 2500 PSI.

9 Checks During Shutdown

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

MALFUNCTION

10 Hydraulic Failure

(*a*) A failure may be assumed if the reading on the main pressure gauge (mod 1178) is below 2000 PSI and fails to build up. If hydraulic failure occurs, the flaps and airbrakes will be inoperative. By using the hydraulic handpump, after making the appropriate selection, the undercarriage can be lowered and bomb doors opened; wheelbrakes pressure can also be obtained, provided that hydraulic fluid is available. Detailed emergency drills are given in the FRC.

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

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

Cases have occurred, particularly at high altitude, where the main hydraulic pressure gauge (mod 1178) reading has dropped sufficiently to suggest that hydraulic failure has occurred; on returning to low altitude the reading may build up again. If the symptom appears and there are no other symptoms of hydraulic failure, check the operation of the handpump. If there is firm resistance to movement of the handpump, it may be assumed that the hydraulic system is serviceable and the gauge reading is inaccurate.

PART 1

Chapter 4 — ENGINE SYSTEMS AND CONTROLS

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1 Avon Mk 1

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

2 Engine fuel system

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

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

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

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

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

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

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

(ii) The HP pump isolating valve of each engine is energised by setting the appropriate switch on the port console to ISOL (up); the use of these switches is AL16 covered in 3—2 Para 5(*c*).

3 Variable inlet guide vanes and air bleed valves

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

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

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

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

4 Throttle controls

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

5 HP cock controls

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

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

6 Engine starting, relighting and stopping controls

(*a*) *General*

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

(*b*) *Starter loading*

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

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

(*c*) *Starting controls*

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

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

(*d*) *Ground starting*

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

(*e*) *Relighting in flight*

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

(*f*) *Stopping an engine*

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

7 Oil system

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

8 Engine instruments

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

9 Engine fire extinguishers and inertia crash switches

See 1—7, Paras 2 and 4.

10 Engine handling procedures

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

PART 1

CHAPTER 5 — AIRCRAFT CONTROLS

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1 Flying Controls — General

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

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

(i) *Pupil's*

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

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

Press-to-transmit pushbutton

▶◀

(ii) *Instructor's*

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

2 Variable-Incidence Tailplane and Indicator

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

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

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

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

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

3 Rudder and Aileron Trim Indicators

(a) Rudder Trim

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

(b) Aileron Trim

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

(c) Indicators

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

4 Control Columns Snatch Unit

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

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

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

5 Flying Controls External Locking Gear and Picketing Points

(a) External Locks

All control surfaces are locked by external clamps with red flags attached. When not in use the clamps are stowed in a valise in the rear fuselage accessible through the rear fuselage hatch. On some aircraft they are stowed in a metal box on the inside of the battery compartment hatch.

(b) Picketing

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

6 Undercarriage

(a) General

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

(b) Normal Controls

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

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

(c) Safety Devices

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

(i) *Undercarriage Master Switch*

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

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

(ii) *Solenoid Lock*

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

(iii) *Undercarriage Safety Clip*

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

(iv) *Undercarriage Ground Locks*

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

(*d*) *Undercarriage Position Indicators*

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

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

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

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

7 Undercarriage Malfunctions

(a) Emergency UP Selection

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

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

(b) Emergency Lowering of the Undercarriage

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

(i) *Hydraulic Failure*

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

(ii) *Electrical Failure*

An electrical failure of the selector valve is the probable cause. 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*) Full emergency drills for undercarriage malfunction are given in the FRC.

8 Flaps Controls and Indicator

(*a*) The electrically-operated hydraulic selector valve for the flaps is controlled by two switch levers, one, for the pupil, on the port front panel and the other, for the instructor, on the miscellaneous instrument panel. The pupil's switch lever has two positions, UP and DOWN, and the instructor's switch lever has three positions UP/TO PUPIL/DOWN. Until the instructor's switch lever is selected to TO PUPIL, the pupil's switch lever is inoperative. At 6000 RPM the flaps should normally retract in about 16 seconds and lower fully in about 13 seconds.

(*b*) To prevent inadvertent operation of the flaps when aileron control locks are fitted, the instructor's switch lever is selected UP and a locking pin is inserted in the switch lever guard.

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

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

9 Airbrakes Controls

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

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

10 Wheelbrakes Controls

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

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

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

11 Bomb Doors Controls and Indicator

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

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

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

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

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

PART 1

CHAPTER 6 — FLIGHT INSTRUMENTS RADIO AND RADAR

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FLIGHT INSTRUMENTS

1 Compasses

(a) Mk 4B Compass

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

(b) Magnetic Standby Compass

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

2 Pitot and Static Pressure Systems

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

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

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

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

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

3 Horizon Gyro Unit (HGU)

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

4 Altimeters

(a) Mk 30A Altimeter

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

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

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

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

(b) Mk 29B Altimeter

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

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

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

(iv) *Operating Procedure*

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

(1) *Pre-Take-Off*

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

(2) *After Take-Off*

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

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

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

(4) *Descent*

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

5 Turn-and-Slip Indicator

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

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

6 Zero Reader System

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

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

7 Accelerometer

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

8 Outside Air Temperature Gauge

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

9 Air Mileage Unit and Air Position Indicator

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

RADIO AND RADAR

10 Intercommunication

(a) Intercom Amplifier

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

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

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

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

(b) Microphone/Telephone Sockets

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

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

(b) Emergency Lowering of the Undercarriage

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

(i) *Hydraulic Failure*

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

(ii) *Electrical Failure*

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

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

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

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

(iii) *Mechanical Failure*

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

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

8 Flaps Controls and Indicator

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

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

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

9 Airbrakes Controls

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

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

10 Wheelbrakes Controls

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

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

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

11 Bomb Doors Controls and Indicator

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

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

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

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

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

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

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

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

(v) An I/P toggle switch.

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

17 IFF/SSR — Testing

(a) Self-TEST Switch and Light

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

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

(b) System Failure Light

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

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

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

(iii) Transponder unserviceable when under interrogation.

(iv) Self-TEST check not satisfactory.

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

18 IFF/SSR — Operation

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

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

(c) *Use of the Rotary Function Switch*

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

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

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

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

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

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

(d) *Use of MODE Switches*

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

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

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

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

(e) Code Switches

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

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

(f) I/P Switch

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

19 Tacan

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

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

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

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

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

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

(i) *Aerial*

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

(ii) *Transmitter/Receiver*

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

(iii) *Coupling Unit*

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

(iv) *Control Unit*

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

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

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

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

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

▸◂

(v) *Indicators*

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

AL 16

(c) ILS/Tacan Audio Switch

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

(d) Power Supplies

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

Intentionally Blank

PART 1

CHAPTER 7 — GENERAL EQUIPMENT AND CONTROLS

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▸◂

1 Entrance Door

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

2 Engine Fire Protection

(a) Engine Fire Detection

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

(b) Engine Bay Fire Extinguishers

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

(c) Engine Fire Warning Lights and Pushbuttons

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

(d) Engine Fire Extinguisher Operation

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

3 Fuselage Fire Protection

(a) Fuselage Fire Extinguishers

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

(b) Hand-Operated Fire Extinguishers

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

4 Inertia Crash Switches

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

5 Emergency Equipment

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

6 External Lighting

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

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

(i) EXTNL LIGHTS MASTER—ON/OFF switch. This must be ON before any external lights will function.
(ii) IDENTIFICATION LIGHT STEADY — ON/OFF switch.
(iii) IDENTIFICATION LIGHT MORSE—ON/OFF switch (pre-SEM/055/STC) or LANDING LIGHT — ON/OFF switch (post-SEM/055/STC).
(iv) TAXY LIGHT — ON/OFF switch.
(v) ANTI-COLLISION LIGHTS — ON/OFF switch.
(vi) STEADY NAV'N LIGHTS — ON/OFF switch.
(vii) LANDING LAMP — OFF/LOW/HIGH switch (pre-SEM/055/STC). Switch removed (post-SEM/055/STC).

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

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

7 Internal Lighting

(a) Cockpit, Normal Lighting

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

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

(b) Cockpit, Emergency Lighting

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

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

(c) Cabin Lighting

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

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

(d) Inspection Lamp

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

▶◀

PART 1

CHAPTER 8 — AIR CONDITIONING, PRESSURISING, AND DEMISTING SYSTEMS

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1 Air Conditioning System

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

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

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

(d) From the common delivery duct into the cabin the conditioned air is delivered to louvres and diffusers in various parts of the cockpit and cabin. The louvres may be turned off but, of the diffusers, only that on the inboard edge of the navigator's table has any form of control, ie the diffuser head may be rotated to give either a jet or diffused flow.

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

2 Pressurising System

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

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

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

3 Use of Air Conditioning and Pressurising Systems

(a) Pre-Starting Checks

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

(b) Checks After Starting Engines

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

(c) Use of Mixing Valve

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

(d) Use of Engine Air Switches in Flight

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

(e) Checks After Landing

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

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

4 Malfunction of the Pressurising System

(a) Loss of Cabin Pressure

A fall in cabin pressure will cause the warning horn to sound; this can be isolated by selecting the warning horn switch (see para 2 *(b)*) to OFF. The following table gives the approximate operating ranges of the warning horn.

Aircraft Altitude	*Cabin Altitude*	*Cabin Altitude (feet) at which Warning Horn Sounds*
20,000	12,000	15,300
30,000	16,500	21,800
40,000	21,500	28,000
45,000	23,500	31,000

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

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

If pressurisation failure occurs above an altitude of 40,000 feet, altitude must be reduced to the lowest practicable, and in any case to below 25,000 feet to avoid the effects of decompression sickness. When below 40,000 feet the engine air switches should be selected to OFF to lessen the risk of damage; if the failure was caused by damage to the canopy or cabin, depending on the degree of damage and fuel state, return to base or land at the nearest airfield. Except for the initial descent do not exceed a speed of 0·70M or 300 knots. The full drill for this emergency is given in the FRC.

5 Demisting System

(a) Canopy and Navigator's Window

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

(b) Direct-Vision (DV) Panels

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

(c) Canopy Internal Demister

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

6 Use of the Demisting System

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

PART 1

Chapter 9 — OXYGEN SYSTEM

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Description

1 Oxygen supplies and contents gauges

(*a*) Oxygen is carried in one 2,250 and five 750 litre bottles stowed in the upper equipment bay. A charging valve on the forward frame in the battery compartment, accessible through the battery access door on the port side of the fuselage, allows the bottles to be charged in situ. The bottles are arranged in two banks each having a separate supply line; these lines, after passing through stop valves (normally wire-locked ON), one on each side of the rear pressure bulkhead, are inter-connected at two points through non-return valves so that, while each bank can supply all the regulators independently, fracture of one supply line will not cause a total loss of oxygen. Two gauges on the flight instruments panel indicate the contents of each bank of cylinders.

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

2 Oygen regulators and supply points

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

(*b*) Each regulator incorporates

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

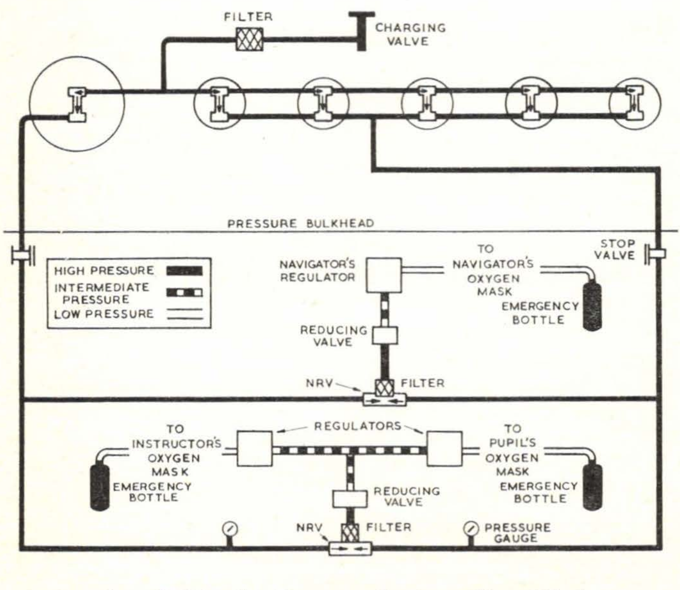
(ii) An ON/OFF valve, normally wire-locked ON.

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

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

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

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



1—9 Fig 1 Oxygen System Simplified

3 Oxygen emergency supplies

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

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

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

4 Associated equipment

Pressure demand oxygen masks must be worn.

Normal Operation

5 Checks before flight

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

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

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

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

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

(iii) All three crew position regulators must be checked as above and the navigator's remote oxygen flow indicator checked for correct operation.

6 During flight

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

Malfunction

7 General

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

8 Loss of cabin pressure

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

9 Partial system failure

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

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

PART 1

CHAPTER 10 — EJECTION SEATS AND ESCAPE SYSTEMS

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GENERAL

1 Ejection Seats

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

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

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

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

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

2 Associated Aircrew Equipment

The associated aircrew equipment consists of the following items:

Seat-type parachute assembly with harness.

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

Personal survival pack.

Emergency oxygen set.

3 Associated Escape Systems

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

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

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

4 Ejection Seats and Escape Systems Safety Pins and Stowages

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

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

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

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

5 Controls

(a) Pupil's Station

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

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

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

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

(b) Instructor's Station

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

(c) Navigator's Station

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

6 Control Column Snatch Unit

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

7 Pilots' Canopy

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

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

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

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

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

8 Navigator's Hatch

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

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

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

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

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

9 Minimum Speed for Jettisoning the Canopy or Hatch

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

10 Power Supplies to the Detonator Circuits

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

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

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

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

11 Jettisoning the Entrance Door

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

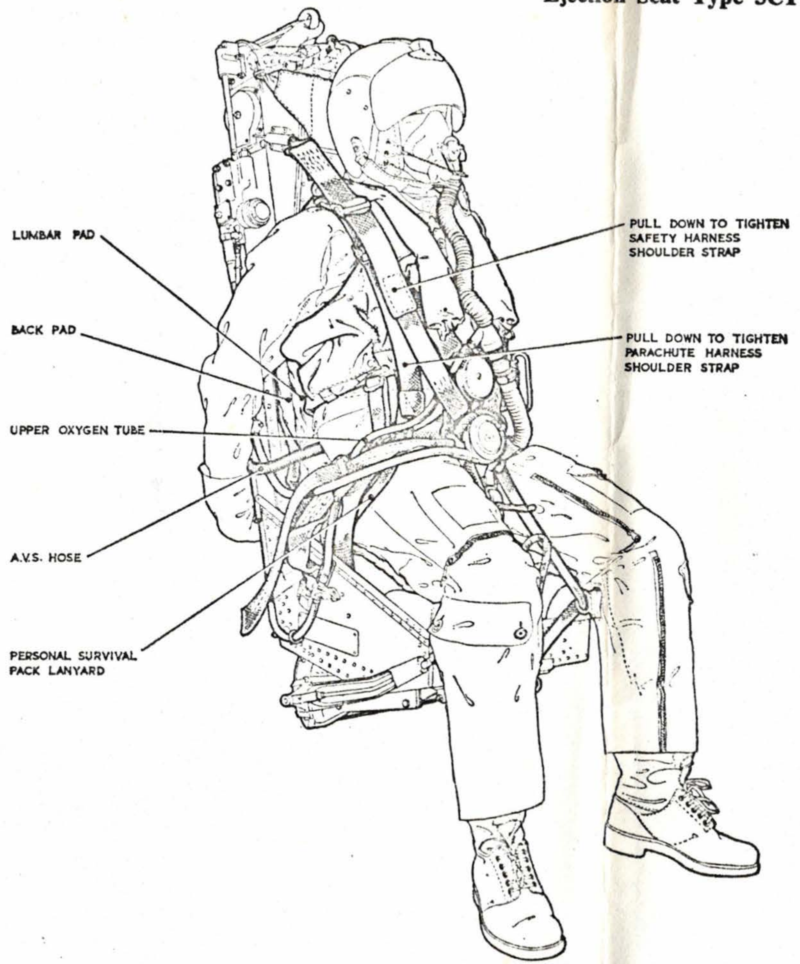
PILOTS' EJECTION SEATS (TYPE 3CT 1 & 2 Mk 3)

12 Controls on the Seat

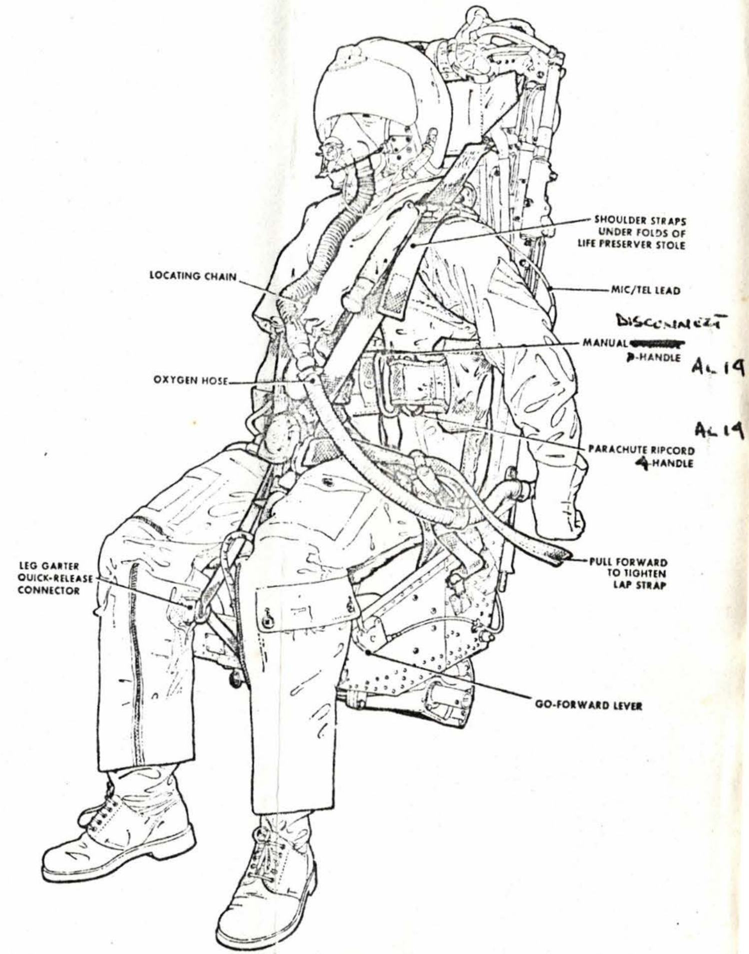
(*a*) *Seat-Height Adjustment*

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

Ejection Seat Type 3CT 1 and 2 Mk. 3



1—10 Fig. 1 Starboard Side



1—10 Fig. 2 Port Side

(*b*) *Leg Restraint*

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

(*c*) *Go-Forward Lever*

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

(*d*) *Firing Handles*

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

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

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

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

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

13 Parachute Manual Controls

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

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

14 Single Lever Ejection System (SLE)

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

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

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

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

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

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

15 Safe for Parking and Ejection Seat Checks

These are given in the FRC.

16 Strapping-In Procedure

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

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

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

(iii) Connect the parachute harness shoulder straps to the parachute QRF. The shoulder straps should lie under the lifepreserver stole. To fit a harness lug into an inertia-proof QRF it is necessary to turn the disc knob until the yellow line passes the dots on the body of the fitting, hold it in this position and insert the first lug. Repeat this procedure when inserting the remaining lugs.

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

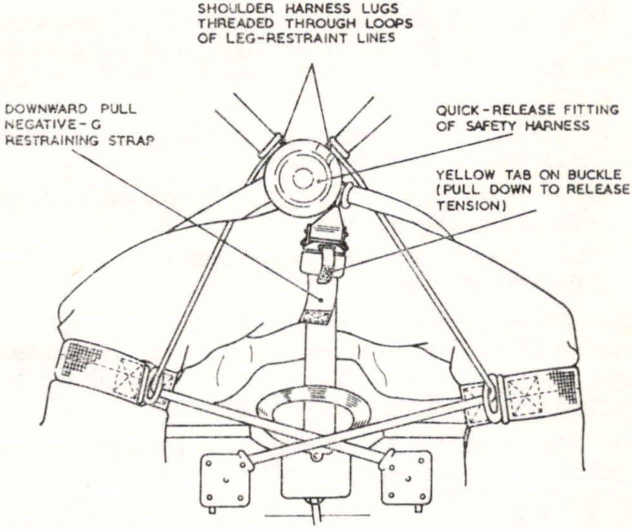
(v) Adjust the shoulder straps so that the parachute QRF will lie clear of and above the safety harness QRF when this is assembled. Tighten the parachute harness leg straps.

(vi) Draw the negative-g restraint strap up between the legs ensuring that it lies to the rear of, and not through, the seat pan firing handle. Insert the lug of the left-hand lap strap through the loop of the negative-g restraint strap. Ensure that the negative-g restraint strap end fitting is located behind the larger diameter of the QRF before fastening the harness. If correctly fitted, the negative-g restraint strap end fitting should be a loose fit over the end of the lap strap lug. Give the lap strap a jerk to ensure that it is correctly engaged in the QRF. Do not tighten the lap straps at this stage.

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

(viii) Proceed similarly for the left restraint line.

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



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

(x) Tighten the lap straps of the safety harness. Tighten the negative-g restraint strap by pulling downwards on the free end of the blue strap. Move the body about inside the harness and then retighten the lap straps and negative-g strap. Repeat until the straps are as tight as possible. The negative-g strap can be loosened by pulling down on the yellow tab attached to the snubber lever.

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

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

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

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

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

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

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

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

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

17 Normal Exit from the Seat

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

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

(c) Release the safety harness and parachute harness.

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

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

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

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

18 Pilots' Abandoning Drills

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

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

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

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

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

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

19 Sequence on Ejection

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

(a) As the seat ascends the guide rail:

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

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

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

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

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

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

20 Failure of Automatic Systems

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

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

21 Controls on the Seat

(a) Seat-Height Adjustment

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

(b) Leg Restraint

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

1—10 Fig 4 Ejection Seat Type 2CA Series

◀ *(Terminology Amended)* ▶

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

(c) Go-Forward Lever

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

(d) Firing Handles

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

22 Parachute Manual Controls

See para 13.

23 Single Lever Ejection System (SLE)

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

(b) Firing Mechanism

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

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

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

NORMAL PROCEDURES (TYPE 2CA2 Mk 4)

24 Safe for Parking and Ejection Seat Checks

These are given in the FRC.

25 Strapping-In Procedure

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

26 Normal Exit From the Seat

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

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

(c) Release the safety harness and parachute harness.

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

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

(f) Leave the seat.

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

ESCAPE PROCEDURES (TYPE 2CA2 Mk 4)

27 Navigator's Abandoning Drills

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

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

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

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

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

28 Sequence on Ejection

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

29 Failure of the Automatic Systems

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

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LIMITATIONS

PART 2

LIMITATIONS

LIST OF CHAPTERS

	Chapter
Engine limitations	**1**
Airframe and miscellaneous limitations	**2**

PART 2

CHAPTER 1 — ENGINE LIMITATIONS

Contents

Para
Engine Limitations — Avon Mk 1 1
Oil Pressure Limitations 2
Fuel and Oil Specifications 3

The limitations given in this Part are taken from the Release to Service Document to AL No 1 standard. The Release to Service Document must be consulted to ascertain the latest release standard.

1 Engine Limitations — Avon Mk 1

Power Rating	*Time Limit per Flight*	*RPM*	*Max JPT °C*
Take-off and operational necessity	30 minutes (combined total)	7800 ± 50	600
Max 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 will still maintain maximum thrust.

Note 2: The governed RPM will vary with a change in fuel density from that at which the engine settings were made. A higher density will cause a drop in RPM and a lower density a rise. Every 0·01 change in density will cause a corresponding difference of 50 in the governed RPM.

2 Oil Pressure Limitations

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

3 Fuel and Oil Specifications

(a) Fuel Specification

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

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

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

Note 3: These fuels do not contain an approved lubricity additive to DERD Specification 2461 nor fuel system icing inhibitor (FSII) so that the following constraints apply:

a. The HP fuel pumps are limited to 50 hours on this fuel to prevent pump seizure.

b. Operation is limited to 14 days, to limit fungus growth, after which an equal number of days on an approved fuel is to follow.

c. The risk of ice forming in the fuel is acceptable to the operational commander.

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

(b) Oil Specification

Oil to DERD specification 2490, UK Inter-Service designation OM-11, NATO Code O-135 is cleared for use.

PART 2

CHAPTER 2 — AIRFRAME AND MISCELLANEOUS LIMITATIONS

Contents

	Para
General	1
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Maximum Altitude	3
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1 General

Intentional spinning and aerobatics are prohibited.

2 Speed and Mach Number Limitations

Condition	*Max IAS (knots)*	*Max IMN*
Clean aircraft	450	0·75 below 15,000 feet 0·79 15,000 to 25,000 feet Above 25,000 feet limited by compressibility effects The speed at which a strong nose-up change of trim occurs, ie about 0·84 must not be exceeded
With wing-tip tanks	365	0·79 below 25,000 feet 0·80 above 25,000 feet

Service	*Max IAS (knots)*	*Max IMN*
For the 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: The speed for the operation of a service also applies for flight with the service in the extended position.

3 Maximum Altitude

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

4 Maximum Weights

(*a*) *Role*		*Take-Off AUW*	*Landing AUW*
Flying training	...	38,000 lb	31,500 lb
Support roles by experienced pilots	...	39,000 lb	32,000 lb

(*b*) In emergency the aircraft may be landed at weights up to 39,000 lb but the initial touchdown must be made on the mainwheels only, and the brakes must be used with care.

5 CG Limits (Feet Aft of Datum)

(*a*) *Forward Limit (With or Without Wing-Tip Tanks)* 1·235 at weights up to 29,000 lb; it then moves linearly aft to 1·718 at 39,000 lb.

(*b*) *Aft Limit*

(1) *Without Wing-Tip Tanks.* 3·058 up to an altitude of 25,000 feet; it then moves linearly forward to 2·660 at 45,000 feet.

(2) *With Wing-Tip Tanks.* 2·808 up to an altitude of 37,000 feet; it then moves linearly forward to 2·660 at 45,000 feet.

(*c*) *Taxying Over Uneven Surfaces*

When taxying over uneven surfaces the aft limit is not to exceed 2·885.

6 Manoeuvre Limitations

Combined application of coarse aileron and g loading should be avoided. The normal acceleration limitations are as follows:

(*a*) *At Weights Up to* 37,600 *lb Without Wing-Tip Tanks*

- (i) With negligible aileron applied ... ... 4·0g
- (ii) With aileron applied ... ... 2·0g

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

- (i) With negligible aileron applied ... ... 3·0g
- (ii) With aileron applied ... ... 1·5g

7 Jettisoning of Wing-Tip Tanks

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

8 Aircraft Approach Limitations (True Heights (feet)

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

9 Engine Out Allowance

The engine out allowance (EOA) is 450 feet.

10 Visual Committal Height

The visual committal height (VCH) is 600 feet.

11 Maximum Crosswind Component

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

12 Aircraft Arresting Barrier Engagement

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

13 Aircraft Arresting Gear Trampling

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

14 Pilot Limitation

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.

15 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.

PART 3

HANDLING

LIST OF CHAPTERS

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PART 3

CHAPTER 1 — PREPARATION FOR FLIGHT

Contents

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Preliminary Checks	1
Internal Checks	2
Starting the Engines	3
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 taxying; in winds above 35 knots, the aileron and elevator locks must also be fitted. If aileron locks are left in for taxying, the flaps must be fully up before the locks are fitted and the instructor's 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 whilst the aileron locks are in. The rudder trimmer 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. If the aircraft is to be flown with the instructor's seat unoccupied, before strapping-in adjust the throttle and HP cock friction dampers, which are on the instructor's throttle quadrant. Ensure that the instructor's seat is positively locked in the mid (flying) position.

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 inlet) 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 1 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 taxying, delay the checks of the flaps and trims until the locks have been removed at the take-off point.

(b) Where the controls are duplicated, the checks are to be made on both sets of controls; the operation of the instructor's override should also be checked.

(c) 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 trim 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 Taxying

(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 taxying using brakes against power. After any such cases of heavy or prolonged braking, allow sufficient time for the brakes to cool before continuing with taxying or taking-off. ▶

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

(c) Rudder pedal and control column loads can be high when taxying in strong winds. If the rudder lock has been

left in for taxying, apply only sufficient pressure to the rudder pedals to obtain differential braking.

(d) Avoid high speed taxying 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 taxying 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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Illustration Fig

Low Temperature Engine Surge 1

1 Take-Off

(a) Extract the take-off information from the ODM. Provided that runway and temperature conditions are suitable, the time gap between achieving unstick speed and safety speed is reduced by keeping the aircraft on the ground until a speed of 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 and 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 power; the difference in JPT and throttle alignment will increase and the suspect engine will show a tendency to overspeed. If these symptoms are present, do not take-off; have the fault investigated. If the above check is satisfactory, release the brakes and open the throttles fully.

(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 the aircraft

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

(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, it is possible that they may not close at all. There is no visual indication that the main doors are open but buffeting may be felt. Should this happen, reduce speed to about 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 are 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
Close HP cock of malfunctioning engine (if applicable)
When flaps have travelled close HP cock of remaining engine(s)

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

(b) Above Stop Speed

If a take-off is aborted above the stop speed, the abort technique will be influenced by such factors as the speed and weight of the aircraft, weather conditions, runway length and availability of an arresting barrier. The following considerations are relevant:

(i) 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.

(ii) 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.

(iii) 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 from the aircraft, but this should be done as early as possible and at a speed above 90 knots; adequate time must be allowed for the seat firing delays.

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*

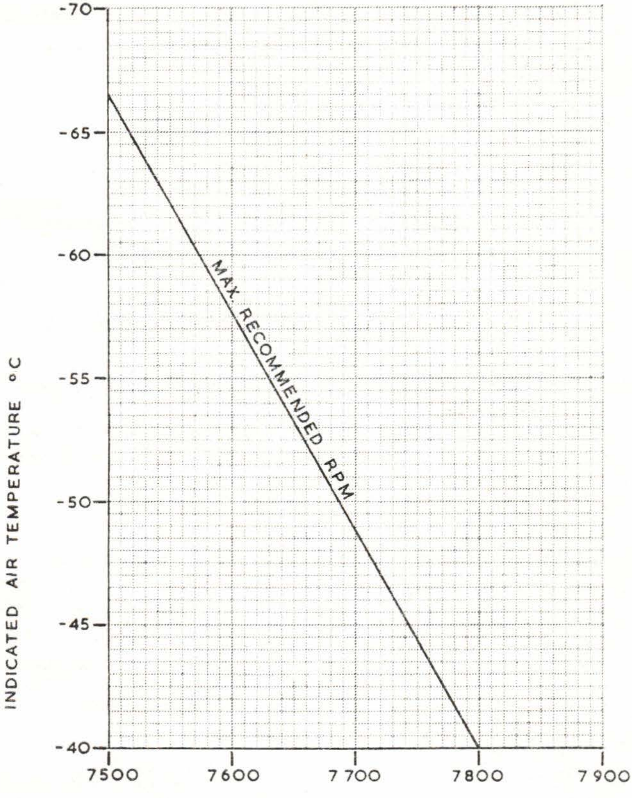
Increased yawing and rolling inertia due to wing stores (wing-tip tanks) help to slow down the initial aircraft response to engine failure. However, the increased inertia will also make it more difficult to stop the yaw and roll if it is allowed to develop. The extra thrust required to accelerate the aircraft because of the drag of the wing stores increases the critical speed. 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 effect on aircraft acceleration; at low AUW the improved acceleration assists recovery. At aft CG positions the rudder is less effective because of its reduced moment arm.

(iv) *Altitude and Temperature*

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



3—2 Fig 1 Low Temperature Engine Surge

(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 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 seats have 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 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 above 40,000 feet at speeds below 200 knots IAS.

(ii) In extremely cold temperature conditions, generally associated with 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 any attempt is made 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 altitude.

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

(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 the engine is opened up 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 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, para 2.)

(b) Trims

Tailplane incidence control is powerful at all speeds and becomes very sensitive at high speed. 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 trimmer 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 possible. If any other malfunction of the tailplane trim is experienced, the aircraft should again be landed as soon as possible. With the tailplane stuck at or near the limit of travel in either direction, attempts may be made to return it towards the neutral position. If the trim fails with the tailplane at or near the neutral position, no further attempts to trim should be made.

(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 about 450 knots with flaps up and 125 knots with flaps down. When landing at high AUW in the latter condition, the elevator authority is reduced and care must be taken to make an approach which allows a gentle roundout.

(d) Airbrakes

At high IAS the 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 trim change; 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 flameout 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 (6700)* 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 (6700)* RPM, a gradual reduction of height should, if practicable, be accepted.

*Pre-Avon mod 5278 engines.

(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

Note: The RPM figures in brackets apply to engines pre-Avon mod 5278.

(i) The engine is more prone to surge in the inlet guide vanes operating range with the bleed valves closed and

Intentionally Blank

also during acceleration from below 6000 (5800) RPM. Throttle handling should receive the utmost care, RPM between 6250 and 7250 (6000 and 7000) should be avoided and on the final approach RPM should not be reduced below 6000 (5800) RPM until it is certain that the runway can be reached. Post-Avon mod 5278, 5800 RPM may be used on the final approach if bomb doors cannot be used for speed control.

(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 (6000 to 7000) 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 (5800) RPM and descend at 250 knots using air-brakes 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 (5800) 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 (5800) 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 (5800) 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 (5800) 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 (5800) RPM. Great care must be taken when opening the throttle and when clear of icing conditions, RPM must be maintained at 6000 (5800) for 5 minutes before attempting to accelerate the engine further.

(vii) 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:

Weights (lb)	*Flaps and UC Up*	*Flaps and UC Down*
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 considerably reduced; 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 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 high mach number characteristics may vary slightly from aircraft to aircraft; they also depend, particularly at high altitude, on the angle of dive (rate of increase of airspeed), on g loading and on the condition of the aircraft.

Note 3: With wing tip tanks fitted the compressibility effects described below 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* 0·75*M 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 0·79*M. The speed limitation with wing-tip tanks is* 365 *knots or* 0·79*M.* 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 0·84*M. The speed limitation with wing-tip tanks is* 0·80*M.*

(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 falls to a figure at which control can be regained. During recovery, g loading must be kept low. Avoid the use of the tail trimmer 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 pressurisation 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. This gives a rate of descent of approximately 5000 feet/minute down to 30,000 feet, increasing to 10,000 feet/minute or more at lower altitudes.

(*c*) *Normal Descent*

To make a normal descent, close the throttles, put the airbrakes OUT and descend at 0·75M until a coincident speed of 250 knots is reached, maintaining 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. The internal demister should not be on at any other time than that required for the descent, otherwise damage may be caused to the canopy.

PART 3

CHAPTER 3 — CIRCUIT AND LANDING PROCEDURES

Contents

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1 Approach and Landing

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

(*b*) *Normal Landing*

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

(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 power below 4500 RPM 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 AUW, it is important to trim out the nose-down change of trim which occurs as speed is reduced in the final stages of the approach; this is to ensure that adequate elevator control is available for the round-out.

(*c*) *Short Runway Landing*

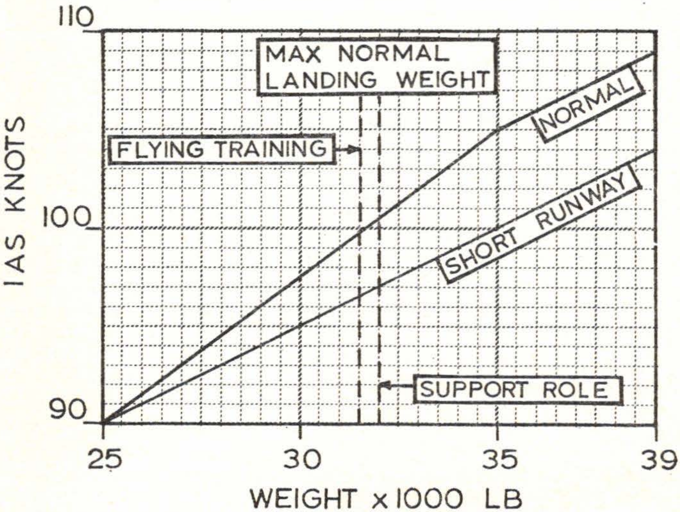
When the landing run available is limited, or the runway is wet or icy, use the following technique. Make the approach using the normal approach speeds. When the decision to land has been made reduce speed gradually to cross the threshold at the short runway threshold speed, power being maintained until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

(*d*) *Landing With a Forward CG*

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

(*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



3—3 Fig 1 Threshold Speeds

2 Flapless Landing

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

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

(*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 maximum braking speed apply the brakes, taking care not to lock the wheels (see para 5). Aerodynamic braking has less effect in the flapless configuration and it is not recommended unless a brake pressure failure has occurred prior to landing. If aerodynamic braking is used, careful elevator control is necessary to avoid striking the tail-skid on the runway during the landing run.

(*e*) A flapless landing may be carried out safely on a 6000 feet runway at maximum normal landing AUW (32,000 lb) and up to 39,000 lb in emergency. At AUW above 35,000 lb, if the runway is wet, a 9000 feet runway should be used 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*) *General*

Braking efficiency is improved, especially on wet runways and/or at low AUW, if the control column is moved rearwards as braking commences, thus transferring weight onto the mainwheels. When the nosewheel has lowered onto the runway the brakes can be used, dependent upon runway conditions, as follows:

(i) *Normal*

After the aircraft has touched down and the nosewheel has been lowered onto the runway, hold the control column slightly forward of centre and allow 1 to 2 seconds for the wheels to spin up. 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.

(ii) *Maximum*

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. This technique should be continued throughout the landing run. If deceleration appears to decrease, then the wheels will probably have locked and the brakes should be released immediately and the control column moved forward to hold the nosewheel on the runway. The wheels must be allowed 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; 2 to 4 seconds should be allowed 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. It is important to remember that the purpose of gentle intermittent braking is solely to determine whether the wheels have spun up sufficiently to allow brake function 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 again with intermittent braking 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 is dependent upon the type of runway surface and the tyre tread pattern but given the right conditions the tyres may aquaplane at ground speeds above 80 knots. At lower speeds partial aquaplaning may still be present but braking action will improve as speed is reduced further. Because of this drastic loss of braking effect, flooded runways should be avoided whenever possible; if, however, a landing must be made, the recommendations in (iii) above still apply. When pools of water exist, if the brakes have been applied they should be released before the aircraft enters a pool and if the control column is being held back to transfer weight onto the mainwheels, it must be moved forward to prevent the nose from rising.

(v) *Icy Runways*

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

(*b*) *Normal Maximum Braking Speed (NMBS)*

NMBS is the highest speed, for given conditions, at which maximum continuous braking may be applied and the aircraft brought to rest without loss of braking efficiency and without damage to the brakes. NMBS is obtained from the ODM. The brakes should not be applied at speeds above NMBS except in emergency.

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

(*d*) *Brakes Overheating*
Avoid overheating the brakes, by using 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, subsequent taxying should be reduced to a minimum. If possible, the aircraft should be parked for 30 minutes, with the wheels chocked and the parking brake off, to allow the wheels to cool before taxying. Alternatively, it may be advisable to shutdown the engines and be towed from the end of the runway.

(*e*) *Brake Fire*
If, after landing, the brakes are observed to be smoking or on fire, the HP cocks should not be closed until fire appliances are available, because dumped fuel may ignite beneath the aircraft. If fire appliances are not readily available, the engines should be stopped by switching off 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) to maintain threshold speed plus 40 knots. Only small power 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 will remain until the speed is below about 125 knots.

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

(*b*) *Asymmetric Approach and Engine Failure on the Approach*

See Chapter 4.

(*c*) *Instrument Approach in Icing Conditions*

Instrument approaches should be avoided 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* (5800 pre-Avon mod 5278 engines) RPM throughout the approach until certain of reaching the runway. Leave the undercarriage and flaps up in the pattern keeping the speed down to approximately 170 knots by use of the airbrakes and, if necessary, bomb doors. The bomb doors are prone to icing and should only be opened for short periods in icing conditions.

*5800 RPM may be used for short periods of time on post-mod 5278 engines if, for any reason, the bomb doors may not be used on the approach to assist with control of the speed.

(ii) Lower the undercarriage when the glidepath is intercepted but do not select flaps down until certain of reaching the runway without increasing power. If the aircraft is below 500 feet 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 (6000 to 7000 pre-mod 5278 engines) 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 power 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 power 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 checked.

(*c*) If an engine malfunction occurs when power is being applied for an overshoot, raise the flaps immediately (above 200 feet AGL) and increase power on the serviceable engine only within the limit of directional control. If the malfunction occurs below 600 feet AGL the aircraft must be landed, if possible on the runway and preferably with the undercarriage down. The overshoot may only be continued if by 600 feet AGL the flaps are fully retracted and the speed is above the asymmetrical 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 throttling handling and engine monitoring is essential, and the following precautions must be observed:

(*a*) After touchdown lower the nosewheel onto the runway.

(*b*) Keeping the throttles together increase power, slowly initially to allow the engines to accelerate at the same rate. This is particularly critical up to 6000 RPM.

(*c*) At 7000 RPM, with the throttles aligned, compare JPT and check that symmetrical thrust is being obtained before opening the throttles further.

(*d*) Keep the nosewheel on the runway until the engines are at the required take-off RPM (minimum 7400) and unstick at not below the threshold speed for the 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, the throttles must be closed immediately and the take-off aborted.

9 Checks After Landing

(*a*) Carry out the **After Landing Checks** given in the FRC.

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

(*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** given in the FRC before taxying.

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 will also prevent ingress of moisture to the actuator jack.

(*b*) Carry out the **Shutdown Checks** given in the FRC.

PART 3

CHAPTER 4 — ASYMMETRIC FLYING

Contents

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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 given in the FRC. When shutting down an engine for other reasons, use the following sequence:

(a) Carry out electrical load shedding.

(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.

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, the tailplane trim should be used 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 will be indicated when the RPM stabilises and then begins to rise. At the higher altitudes particularly, it will probably be necessary to close the throttle after the RPM has stabilised, in order to stop the JPT rising beyond the limits. If JPT increases without a corresponding increase in RPM, close the throttle and then open it again slowly.

(b) Flame-Out

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

(c) Normal Relighting — Recommended Conditions

For normal relighting, the following altitude and windmilling RPM are the recommended maxima, depending on the modification state of the engines.

(i) Pre-Avon mod 857 — 20,000 feet; 1200 RPM.

(ii) Post-Avon mod 857 — 25,000 feet; no RPM restriction.

Relighting is practicable up to approximately 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 (Avon mod 857), reduce the windmilling RPM to 1200 or less. The Normal Relight drill given in the FRC applies to both the pre- and post-mod 857 engines.

4 Relighting in Icing Conditions

See Chapter 2, para 10.

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 AUW as follows:

Minimum Asymmetric Approach Speeds

	Below 36,000 lb	Above 36,000 lb
Initial approach speed to 600 feet AGL (VCH)	140	150
Final approach speed from 600 feet AGL until certain of landing	125	135

◀ (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 final turn so as to roll out between 650 and 750 feet on the extended centreline and on the normal glidepath to allow sufficient time to stabilise the approach before reaching VCH. ▶

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

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

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

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

(b) Overshooting

(i) An overshoot can be made safely provided 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 power on the live engine within the limits of directional control to about 7400 RPM, maintain the slip ball central by progressive application of rudder. Retract the undercarriage and check that the flaps are up. Climb away at 160 knots. If necessary, power may be further increased after the speed has increased from the initial approach speed, provided directional control can be maintained (slip ball held central) by use of rudder.

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

(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 Approach

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

(a) If Above 600 Feet AGL

Decide whether to continue the approach or to overshoot. If possible, continue the approach; however, an overshoot may be made, provided that the flaps can be fully retracted and the initial asymmetric approach speed can be achieved with wings level by 600 feet AGL. To overshoot, use the procedure recommended in para 5 *(b)*, selecting undercarriage and flaps up together. To continue the approach to land, increase power on the live engine within the limits of directional control, raise the flaps immediately and recover to the normal glidepath at the appropriate asymmetric approach speed. Adjust power thereafter as required.

(b) If Below 600 *Feet AGL*

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

(i) *If Above* 200 *Feet AGL*

Raise the flaps immediately. As the flaps retract and the speed increases, adjust power to achieve and maintain the asymmetric final approach speed.

(ii) *If Below* 200 *Feet AGL*

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

7 Double Flameout

(a) If a double flameout 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 will be indicated by the RPM stabilising and then starting to rise. Ensure, by throttling back if necessary, that the maximum JPT (600°C) is not exceeded.

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

PART 4

EMERGENCIES

LIST OF CHAPTERS

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CHAPTER 1 — INDEX TO MALFUNCTIONING AND EMERGENCY PROCEDURES

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

Malfunction or Emergency	*Location in Notes Pt*	*Ch*	*Para*	*Location in FRC (Tab ident)*
Abandoning	1	10	—	**Abandoning**
Barrier Engagement	–	—	—	**Barrier**
Ditching	–	—	—	**Ditching**
Electrical System				
Load shedding drill	–	—	—	**Electrical**
Single generator failure	1	1	16*(a)*	**Electrical**
Double generator failure	1	1	16*(b)*&*(c)*	**Electrical**
Overvolting	1	1	16*(e)*	**Electrical**
No 1 inverter failure	1	1	17	**Electrical**
◀ No 6 inverter failure ▶	1	1	18	**Electrical**
Electrical loads	1	1	19	**Electrical**
Failure of the Type A differential cut-out	1	1	16*(d)*	**Electrical**
Emergency Evacuation on the Ground	–	—	—	**Fire**
Engine Systems				
Mechanical failure	–	—	—	**Engine Failure and Relighting**
Flameout	3	4	3*(b)*	**Engine Failure and Relighting**
Double flameout	3	4	7	**Engine Failure and Relighting**
Immediate relight	3	4	3*(a)*	**Engine Failure and Relighting**
Normal relight	3	4	3*(c)*	**Engine Failure and Relighting**
Failure to relight	–	—	—	**Engine Failure and Relighting**
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	

Malfunction or Emergency	*Location in Notes Pt Ch Para*	*Location in FRC (Tab ident)*
Fire		
Fire on the ground	— — —	**Fire**
Wheelbrake fire	3 3 5(*e*)	
Engine fire	1 7 2	
Fuselage fire	1 7 3	
Cabin fire	1 7 3(*b*)	
Fuel		
LP pump failure	1 2 11	**Fuel**
Jettison Procedures		
Canopy	1 10 7 & 9	**Jettisoning**
Hatch	1 10 8 & 9	
Entrance door	1 10 11	
Wing-tip tanks	1 2 1(*b*)(ii)	
	2 2 7	
	3 2 3(*d*)(ii)	
Landing		
Flapless	3 3 2	**Pre-Landing**
Asymmetric	3 4 5	
Asymmetric wing-tip fuel load	3 3 4	**Hazardous Landing**
After undercarriage malfunction	— — —	
Forced landing	1 10 27(*b*)(iii) Note 2	
Oxygen		
◀ Smoke or fumes	— — — ▶	**Oxygen**
MI failure	— — —	
Emergency oxygen	1 9 3	
Partial system failure	1 9 9	
Pressurisation		
Pressurisation failure	1 8 4	**Pressurisation**
Emergency descent	3 2 13(*a*)	

Malfunction or Emergency	*Location in Notes Pt*	*Ch*	*Para*	*Location in FRCs (Tab ident)*
Undercarriage				**UC and Hydraulic failures**
Failure to retract	1	5	6	
Failure to lower	1	5	7	
Emergency UP selection	1	5	7(*a*) & 10(*c*)	
Wheelbrakes				
Hydraulic failure	1	5	10	
Bomb doors				
Failure to open	1	5	11(*c*)	

PART 6

ILLUSTRATIONS

PART 6

ILLUSTRATIONS

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Navigator's Station, Starboard Wall	7

Key to Fig 1 Cockpit, Port Wall

1 Canopy demist switch
2 Vent valve heater switch (inoperative)
3 Pressure head heater switch
4 Windscreen (DV panels) heaters switch
5 Bomb doors position indicator light
6 Bomb door selector switch
7 Wing-tip tanks jettison pushbutton
8 Ejection seat safety pin stowage (pupil)
9 Bomb doors emergency opening control
10 Port console lamp and dimmer switch
11 Voltmeter
12 No 1 generator failure warning light
13 No 1 generator switch
14 No 2 generator switch
15 No 2 generator failure warning light
16 Canopy/snatch master switch
17 Battery master switch
18 V/UHF press-to-mute switch (pupil)
19 Canopy internal demister control
20 HP cock levers and relight buttons (pupil)
21 Throttle levers (pupil)
22 HP pump isolation switches
23 Lighting switches, right to left:
   External lights master switch
   Identification light steady switch
AL15   Identification light morse switch (Pre-SEM 055) Landing lamp switch (Post-SEM 055)
   Taxy lamps switch
   Anti-collision lights switch
   Navigation lights switch
AL15   Landing lamp switch (Pre-SEM 055).
24 Pilot's Notes and maps stowage
25 Canopy jettison switch
26 Hatch jettison test light
27 Canopy jettison test light
28 Rudder trim switches (pupil)
29 Aileron trim switch (pupil)
30 Fuse panel

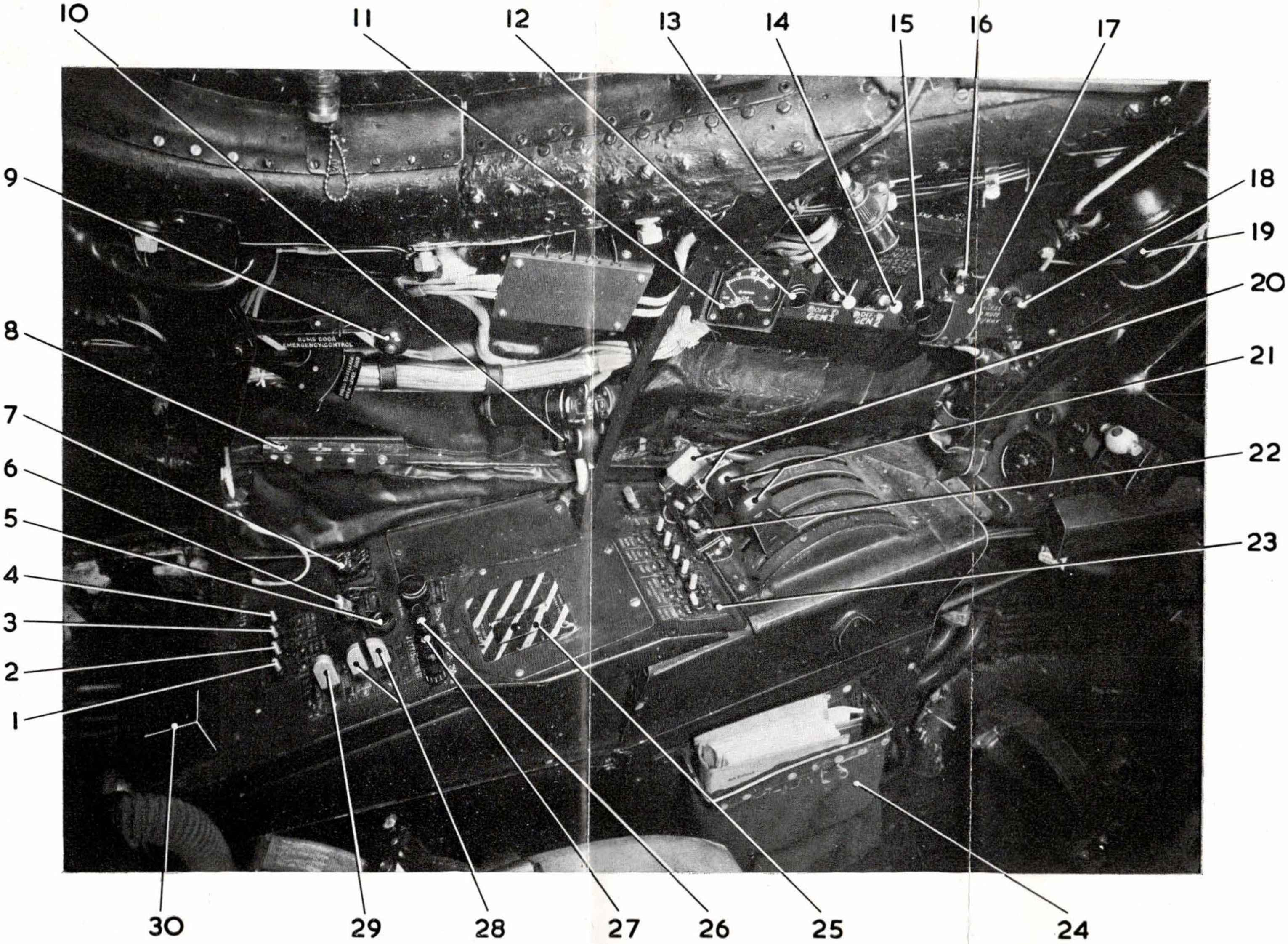

Fig 1 Cockpit, Port Wall

Key to Fig 2 Cockpit, Forward View Left-Hand Side

1 Undercarriage master switch
2 Undercarriage position indicator (pupil)
3 Undercarriage selector switch unit
4 Flaps selector switch (pupil)
5 Undercarriage emergency lowering control
6 Flaps position indicator
7 Ventilation louvre
8 Machmeter
9 Tacan indicator
10 Altimeter
11 Direct vision panel (pupil)
12 Airspeed indicator (pupil)
13 Dimmer switch (port U/V lamps)
14 Horizon gyro unit
15 Marker light (on panel behind U/V lamp)
16 Dimmer switch (port red lamps)
17 Standby compass
18 ILS indicator
19 ILS control switch
20 Zero reader indicator
21 Emergency instrument supply MI
22 Vertical speed indicator
23 Mk 4B compass
24 Turn and slip indicator
25 Oxygen contents gauges
26 No 1 and No 2 engine master starting switches
27 V/UHF control unit
28 No 2 engine ignition switch and starter pushbutton
29 No 1 engine ignition switch and starter pushbutton
30 Oxygen regulator (pupil)
31 Airbrakes control switch (pupil)
32 Rudder trim indicator
33 Tail trim indicator
34 Aileron trim indicator

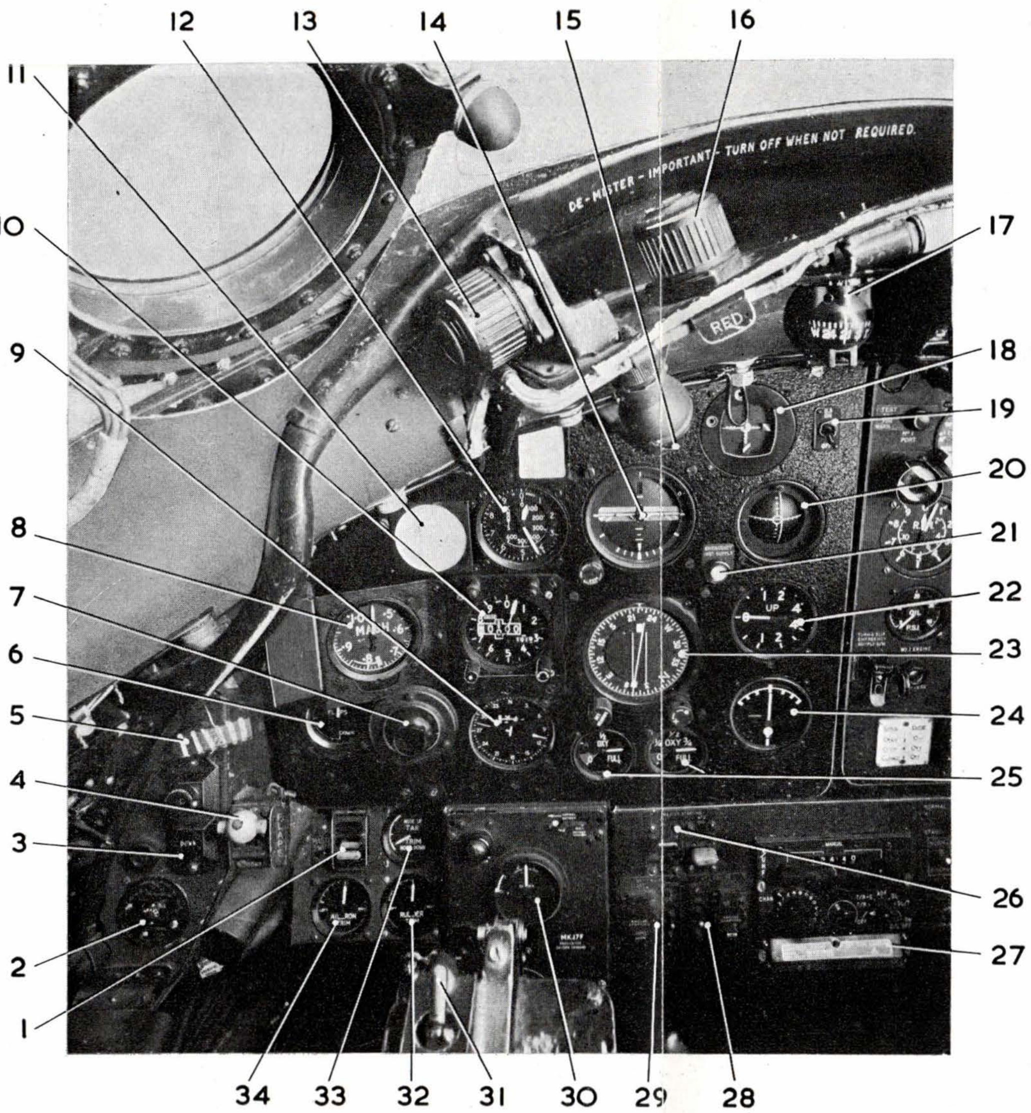

Fig 2 Cockpit, Forward View Left-Hand Side

Key to Fig 3 Cockpit, Forward View Right-Hand Side

1 Intercom master switch
2 Intercom normal/emergency switch
3 Standby UHF guard/A selector switch
4 Standby UHF normal/standby power supply switch
5 No 1 engine fuel cock and pump switches
6 Turn and slip indicator emergency supply switch
7 No 1 engine fuel pressure warning light
8 No 1 engine oil pressure gauge
9 Fuel contents gauges
10 No 1 engine fire extinguisher pushbutton and warning light
11 No 1 engine RPM indicator
12 Engine fire warning test pushbutton
AL5 13 Dimmer switch (~~starboard red lamps~~) (Centre red lamps)
14 Dimmer switch (starboard U/V lamps)
15 Zero reader control unit
16 V/UHF tone switch
17 Dimmer switch ~~(red lamps)~~ (Starboard red lamps)
18 Direct vision panel (instructor)
19 No 1 and No 2 engine JPT indicator
20 No 2 engine fire extinguisher pushbutton and warning light
21 No 2 engine RPM indicator
22 No 2 engine oil pressure gauge
23 Airspeed indicator (instructor)
24 Undercarriage position indicator (instructor)
25 V/UHF frequency card holder
26 Flaps selector switch (instructor)
27 Cabin air temperature control switch
28 Cabin pressure warning horn switch
29 Wheelbrakes hydraulic pressure gauge
30 Cabin air mixing valve position indicator
31 Engine air to cabin switches
32 Cabin altimeter
33 No 2 engine fuel pressure warning light
34 Oxygen regulator (instructor)
35 Airbrakes control switch
36 No 2 engine fuel cock and pump switches
37 Compass/directional gyro switch
38 ILS/Tacan audio selector switch
39 V-UHF/UHF standby selector switch
40 ILS volume control

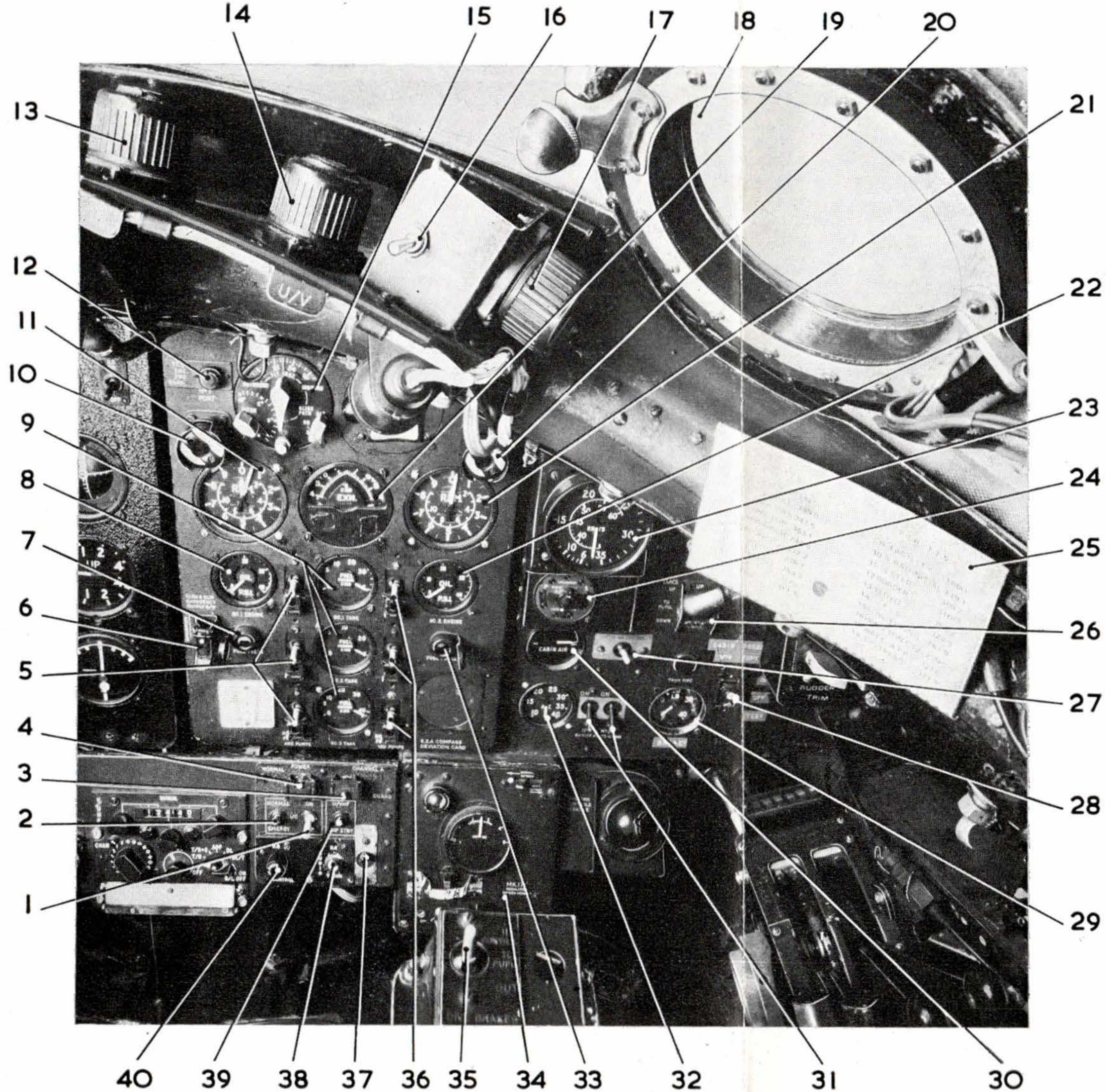

Fig 3 Cockpit, Forward View Right-Hand Side

Key to Fig 4 Cockpit, Starboard Wall

1 Rudder trim switches (instructor)
2 Tail trim switch (inoperative)
3 Canopy jettison switch (instructor)
4 Aileron trim switch (instructor)
5 V/UHF press-to-mute switch (instructor)
6 Entrance door jettison handle
7 Ejection seat safety pin stowage (instructor)
8 Throttle levers (instructor)
9 HP cock levers and relight buttons (instructor)
10 Friction damper, throttle levers
11 Friction damper, HP cock levers

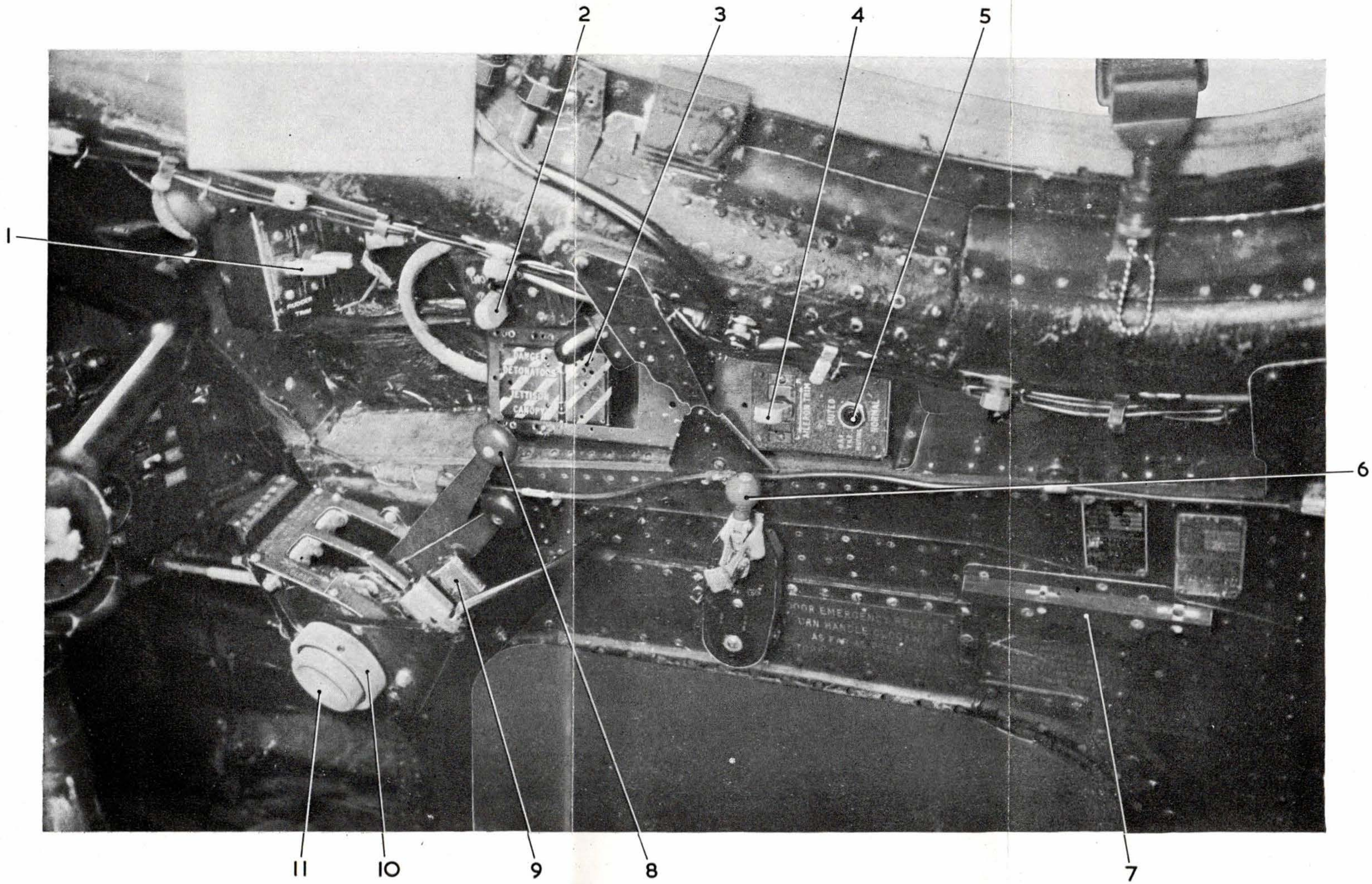

Fig 4 Cockpit, Starboard Wall

Key to Fig 5 Navigator's Station, Port Wall

1 AMU control panel
2 Hatch safety switch
3 Hatch jettison switch
4 ILS control unit
5 Anglepoise lamp dimmer switch
6 Dome lamp
7 Ventilation louvre
8 Tacan indicator
9 Tacan control unit
10 IFF/SSR control unit
11 Navigator's table (Ejection seat safety pin stowage on inboard edge)
12 IFF/SSR normal/emergency supply switch
13 IFF/SSR lamp check switch
14 IFF/SSR system failure light
15 Dimmer switch (IFF/SSR and Tacan control units)
16 Oxygen regulator
17 Window with blind

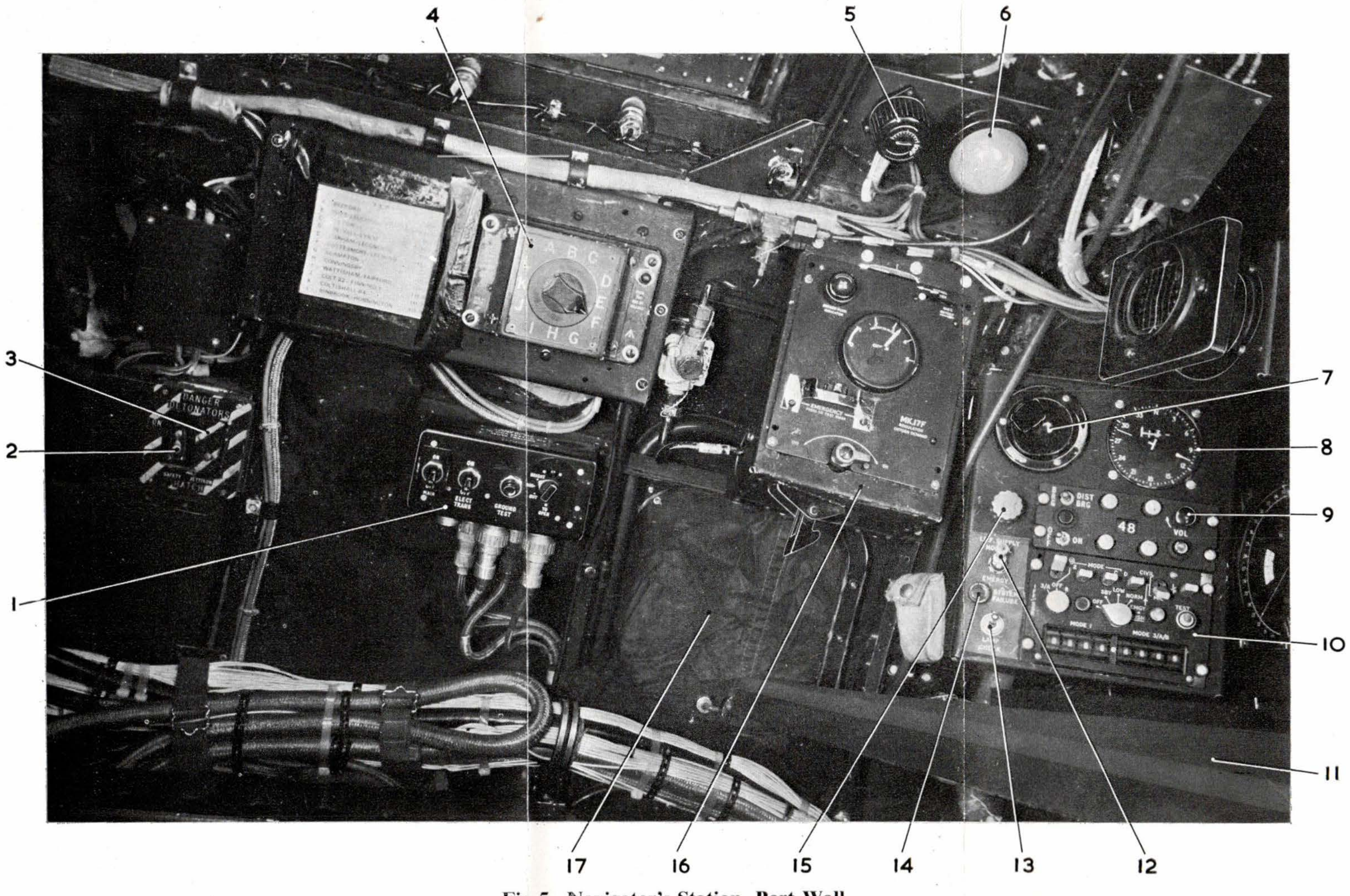

Fig 5 Navigator's Station, Port Wall

Key to Fig 6 Navigator's Station, Forward View

1 Mk 4B compass master indicator
2 Rebecca indicator
3 Airspeed indicator
4 Anglepoise lamp
5 Tacan coupling unit
6 Air position indicator
7 Compass deviation card stowage
8 Outside air temperature gauge
9 V/UHF press-to-mute switch
10 Altimeter

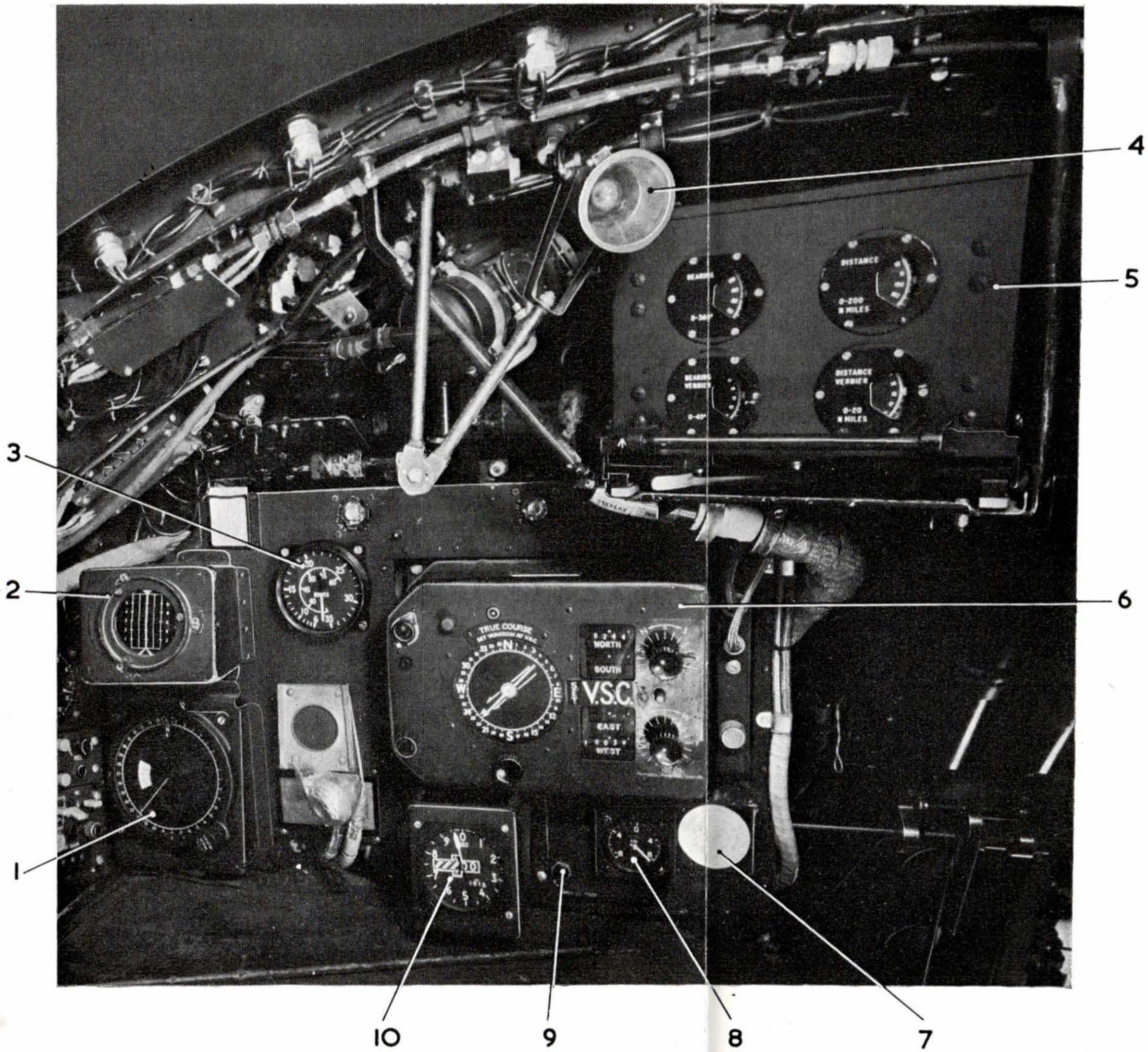

Fig 6 Navigator's Station, Forward View

Key to Fig 7 Navigator's Station, Starboard Wall

1 Hand-operated fire extinguisher
2 Axe
3 First-aid kit
4 Asbestos gloves
5 Fuel pump test switches
6 Mk 4B compass control panel
7 Anglepoise lamp dimmer switch
8 Cabin air pressure warning horn
9 Dome lamp
10 Fuel pump and cock circuit breakers
11 Anglepoise lamp
12 No 6 inverter (Type 108) ON switch
13 No 6 inverter (Type 108) OFF switch
14 IFF/SSR aerial position switch
15 No 1 and No 2 engine generator field circuit breakers
16 Circuit breakers, left to right:
   ILS
   No 1 inverter
   No 2 inverter
   No 3 inverter
   No 4 inverter
   Pilot's services
17 Hand-operated fire extinguisher
18 Rebecca control switch
19 No 3/No 4 inverter control switch
20 Generator test sockets
21 Fuel pump ammeter test socket

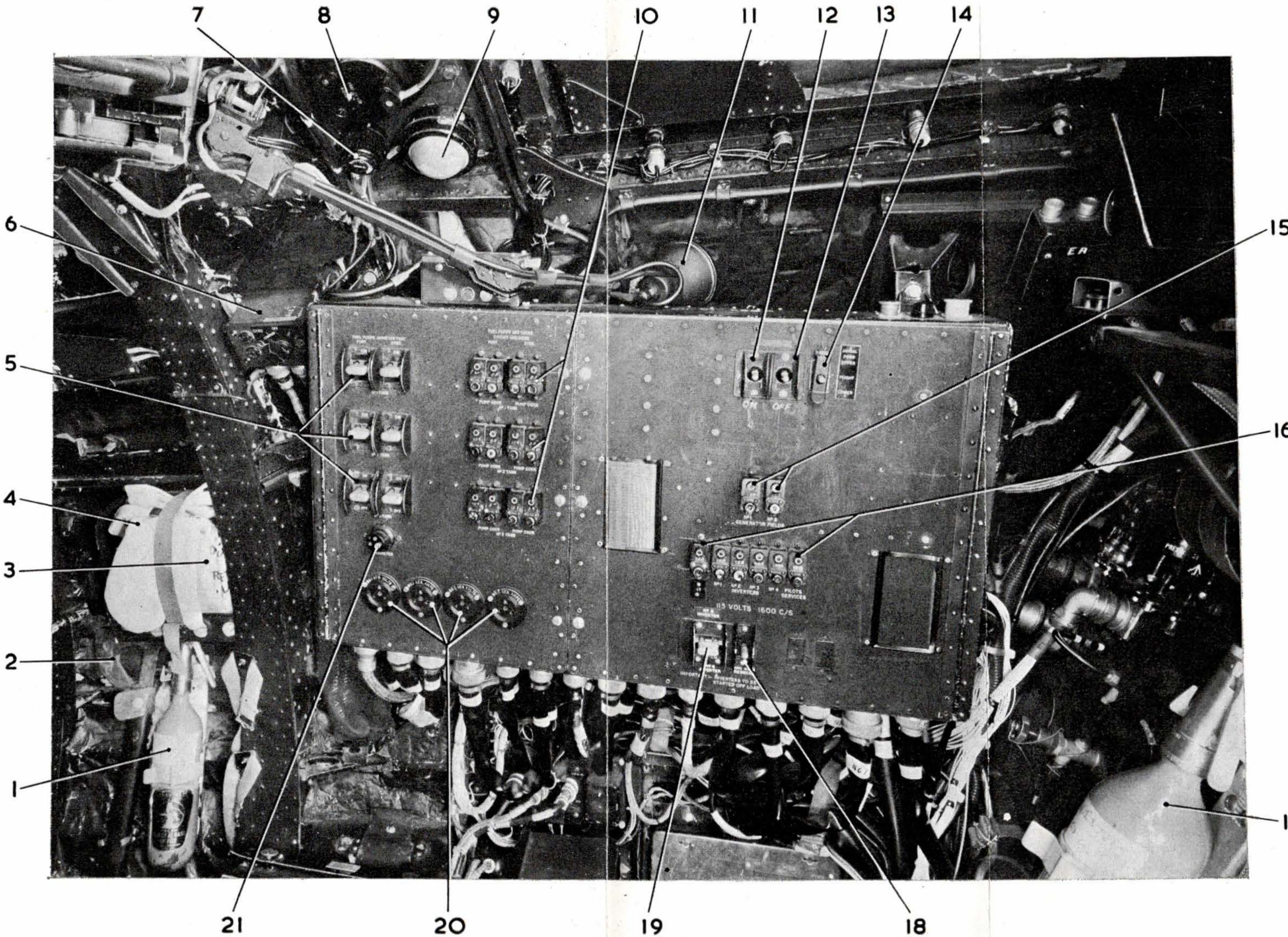

Fig 7 Navigator's Station, Starboard Wall