

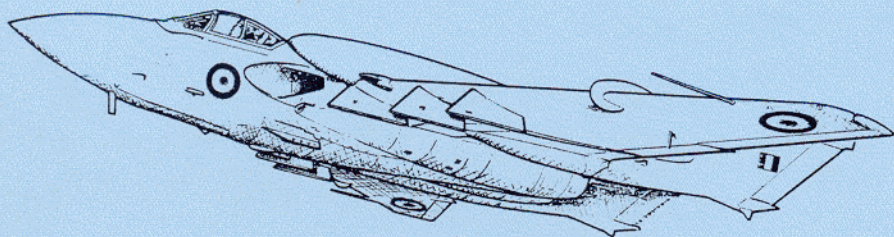
SEA VIXEN

D MK.3

AIRCRAFT XP924

FR12/84

COMPLETELY REVISED



PILOT'S NOTES

ISSUED MARCH '86



FR

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NOTE TO USERS
(Completely Revised)

1 These Notes are complementary to AP.3456 (Flying) and reference should be made to Sea Vixen Operating Data Manual (AP 101B-3002-16 formerly AP 4647B-OD).

2 A set of Flight Reference Cards (FR 11/84-1, -2 and -3) for use in the air, is issued separately from these Notes and is subject to separate amendment procedure. The cards are, however, complementary to these Notes and reference is made to them when necessary.

3 The limitations quoted in Part II of the Notes are mandatory and are not to be exceeded except in emergency. The contents of other Parts of the book are mainly advisory, but instructions containing the word "must" are also mandatory.

4 Throughout these Notes the following conventions apply:

- (a) Words in large capital letters indicate the actual markings on the controls concerned.
- (b) Unless otherwise stated all airspeeds, accelerometer readings and Mach numbers quoted are indicated values.

5 Each Amendment List instruction sheet includes a list of Special Flying Instructions, and a list of the modifications, covered by the Amendment. 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 pages and any triangles on a page will, therefore, refer to that amendment list. However, when a new chapter is issued with an amendment list, or an existing chapter is completely revised, this fact will be noted within the heading of the chapter and the triangles will not appear.

AMENDMENT RECORD SHEET

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

AL No	AMENDED BY	DATE
1	Incorporated	Feb 86
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ASSOCIATED AIR PUBLICATIONS

AP

Aircraft hydraulic equipment	...	...	1803 Series
Aircraft pressure fuelling equipment	...	...	4511
Aircraft pressurising and air conditioning equipment	...	...	4340
Aircraft wheels, tyres and brakes	...	...	2337
Aircrew equipment assemblies	...	...	1182 (Naval)
Ejection seats RN Aircraft	...	...	4288 (Naval)
Electrical manual	...	...	4343 Series
Fire prevention and fire extinguishing equipment in aircraft	...	...	957C
Flying clothing and survival equipment	...	...	1182E
Instrument manual	...	...	1275 Series
Lifting equipment and haulage accessories	...	...	2817A
Engine change units and associated equipment	...	...	4481H
Miscellaneous power cartridges	...	...	1661F
Palouste Mk 101 pressure air supply for aero-engine starting	...	...	4677A
Powered flying control units and equipment - Hobson control units Type 157, 190, 194	...	...	4604F
RAF Engineering - ground equipment	...	...	1464G
Rotol accessory gear boxes and drives	...	...	2240A
Amplifier, Type A1961 and associated i/c equipment	...	...	2876E
Auto control actuator assemblies - Twin motor actuators			
Motorised valve actuators			
Universal drone pack			
- ATISTTA Publication	...	...	FR 7/79
Flight control system	...	...	Marconi
		Avionics	250TP0580-M10
ARI 23187 SSR	...	...	114J-0102-16
A 1961 Intercomm	...	...	116N-0105-1
ARI 18012 Telebrief	...	...	116N-0301-1
ARI 18124/1 UHF installation	...	...	116D-0105-1
ARI 23057 Standby UHF installation	...	...	116D-0110-16
IR 122 Command receiver	...	...	1R 122A
WRE/TA.157B Telemetry transmitter	...	...	WRE-TA 157B
Telemetry interface	...	...	FRS 7125840
ARI 302C-4 Transponder	...	...	Vega Cantley
ARI 319X-9 Transponder	...	...	Vega Cantley
Flight Test Instrumentation	...	...	Plessey Av.151/4349

INTRODUCTION

1 The Sea Vixen D Mk 3 is a high speed aircraft designed to be flown as a:

- (a) Conventional Pilot controlled aircraft (Flight Control Computer (FCC) inoperative) - controlled by the pilot in the conventional manner.
- (b) Manned Drone aircraft (Flight Control Computer FCC operative) - controlled by:
 - (i) Commands via a Radio Link from a Ground Control Unit (GCU) located in a command cell.
 - (ii) Commands via Pilot operated pushbuttons on the Pilot Control Unit (PCU) located in the cockpit.

The Sea Vixen D Mk 3 is basically a Sea Vixen Mk 2 FAW aircraft modified for the application of a drone role auto-control system, mounted in an open fronted crate fitted to the observer's seat rail. Modification to the various conventional aircraft control system have been made where necessary.

The pilot's cockpit is enclosed by a sliding canopy and the observer's compartment is covered with a hinged flush fitting hatch. Both compartments are fully pressurised. Access to both positions is by special ladders, supplied as ground equipment, which are fitted to the appropriate sides of the aircraft.

2 The aircraft is powered by two Avon Mk 208 engines together developing 22,500 lb static thrust at sea level. A single accessory gearbox is mounted between the engines, and carries four hydraulic pumps and two generators. The gearbox is so designed that the faster running engine drives three hydraulic pumps and one generator, the slower running engine drives the other hydraulic pump and generator. If an engine has failed, or is not running, one hydraulic pump and one generator will be inoperative.

3 All flying control surfaces are power-operated by duplicated hydraulic systems, no provision is made for manual control.

4 The following table lists the panels in the pilot's cockpit under their respective code letters, which are those used throughout the text:

Code	Panel	Fig No in Part VI
AU	Upper instrument panel	C
B	Main instrument panel	C
E	Port instrument panel	C
F	Throttle control box	B
G	Port console	B
D	Starboard side panel	E
H	Starboard switch panel	E
J	Starboard console forward	F
K	Starboard warning panel	F
L	Starboard console, rear	F
-	PCU and control columns	D

5 A Centralized Warning System (CWS) is fitted to ensure that all important emergencies are immediately brought to the notice of the pilot.

6 The principal dimensions of the aircraft are:

Span (wings spread)	...	...	50' 0"
Span (wings folded)	...	...	22' 3"
Length	...	...	53' 6½"
Height (wings spread)	...	...	11' 6" (approx)
Height (wings fully folded)	...	...	14' 11½"
Height (wings vertical)	...	...	18' 7"

7 Runway LCN

35 flexible and 30 for rigid pavements at maximum take-off weight of 39,500 lb.

PART IDESCRIPTION AND MANAGEMENT OF SYSTEMS

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PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 1 - ELECTRICAL AND CENTRALIZED WARNING SYSTEM

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DESCRIPTION

1 Generators

(a) Each engine drives a 28 volt 9 Kw, Type 519A wide speed-range generator. Together the generators supply the aircraft electrical system and charge the main and the standby 24 volt 25 amp hour batteries; the standby battery receiving a trickle charge only. In the event of an engine failure or shut down, the associated generator will come off line.

(b) The output of the generators is maintained over the speed range of the engines. Each generator is controlled by a voltage regulator and control unit. Generator output is automatically connected to the busbar and the Generator failure warning lights on the CWP are extinguished when the engines are started.

(c) Each generator circuit is protected against fault conditions by reverse-current circuit-breakers. The circuit-breakers are located, one on the port and one on the starboard wing deck panel, aft of the cockpit, and are accessible through panels in the fuselage upper surface.

2 Batteries

(a) Main:

A single 24 volt 25 amp hour battery which feeds the main busbar, is charged by the generators whenever the engines are running.

(b) Standby:

WARNING ...

TO PREVENT INADVERTENT INITIATION OF THE ICO CIRCUITS ENSURE THAT THE STANDBY BATTERY IS CONNECTED AND THE POWER ON LAMP IS ILLUMINATED BEFORE THE FCC SWITCH IS SELECTED ON.

A second 24 volt 25 amp hour battery, trickle charged when the generators are on line, provides electrical power to the ICO system and standby electrical power for the following essential services:

Cockpit emergency lighting

Engine igniters

Standby UHF (via UHF standby power switch)

Horizon Gyro Unit (via St/by Artificial Horizon switch)

No 2, 3 and 4 auxiliary fuel pumps and No 3 main fuel pumps

Port pitot head heater

U/C indicator

Fire extinguisher

Flight control computer (FCC)

Main receiver and heater

HP cocks

Instinctive cut out (ICO) gas detonator circuits

Flaps 2

Undercarriage (U/C) 2

Emergency U/C 2

CWP 'attention' light

Air direction detection (ADD) indicator

Green hydraulic system triple pressure gauge

Press to transmit circuits

Windscreen rain shedding

* Fuel gauges (SUM readings only, via the FG gage
PORT/ STARBOARD switch)

* Fire detection circuits

* via the inverter DA 1

(c) Emergency:

In the event of supply failure from the main busbar,
a third 24 volt 25 amp hour, ground charged, battery
provides emergency power for the following services:

Emergency U/C 1

LP cocks

Ram air turbine

Standby receiver and heater

Note ...

The standby and emergency batteries can only be
disconnected when the aircraft is on the ground.

(d) With the exception of the main fuel pumps which are
supplied by circuit breakers, and the ICO circuits which
are supplied direct from the standby battery, the services
listed are normally fed from the main electrical supply
via a 100 amp fuse, code PEA, situated in the airbrake bay.

(e) The main battery, with all the services selected on, should last for approximately 15 minutes.

3 External power supply

CAUTION ...

Before connecting a 28V dc ground supply ensure that the master accumulator switch (Pt VI, fig F, panel J, Item 5) is OFF. If the main battery is in a discharged condition when the ground supply is connected the resultant high reverse current through the battery will damage the plates.

(a) On the lower surface of the fuselage, in the accessory bay, is a 3 pin socket to which an external 28 volt dc supply can be connected. Two of the 3 pins are connected to the aircraft services; the third pin connects a supply to the central warning system which prevents warning panel overheat and prolongs filament life by muting all warnings except fire and wing fold.

4 a.c. supplies

(a) Two type 103A inverters, (the main and the standby), supply three-phase 115 volts 400 hertz a.c. for the flight instruments, fuel gauges, flow meter, top temperature control, cabin temperature control, fire warning system and the flight control computer (FCC).

(b) A type DA1 inverter provides emergency supply for either the port or starboard fuel gauge (SUM reading only) and the firewire detector system.

5 Centralized warning system

(a) The centralized warning system ensures that all important emergencies are immediately brought to the notice of the pilot by concentrating warnings to certain areas. The main electrical system provides all warnings, and the standby battery provides fire warning and operation of the fire extinguishers if required. When an external supply is connected, only fire and wing fold warnings are available.

Note ...

To enable the fire warning system to operate, a 103A inverter must be running.

(b) The system comprises two red flashing 'attention' lights, on each side of panel AU, an audio warning unit and a centralized warning panel (CWP), which carries duplicated red indicator lamps for each emergency.

(c) The CWP carries separate windows to give, when illuminated, the following warnings:

- | | |
|--------------------------|---|
| 1. GENERator | Failure, Port and Starboard. |
| 2. CABin pressure | Failure. |
| 3. HYDraulic pressure | Failure BLUE and YELLOW systems. |
| 4. OXYgen (disconnected) | Failure. |
| 5. FUEL pressure | Failure, main fuel feed pressure, Port and Starboard. |
| 6. ASI | Max. airspeed warning, 600 knots. |
| 7. OIL pressure | Failure, Port and Starboard. |
| 8. WFOLD | Wingfold, radome or observer's hatch not locked. |
| 9. FIRE | Zone A.
Zone 1 and 2 Port.
Zone 1 and 2 Stbd. |

The panel also includes four pushbuttons:- T (test), M (mute), C (cancel) and GT (ground test). The M and C buttons illuminate, the M button on test and when the CWP panel lamps intensity is muted, and the C button, to flash on test, and when one or more of the warning lamps illuminates.

(d) When one or more of the emergencies listed above occurs, the following indication will be given:

- (i) The 'attention' lights flash
- (ii) The audio warning sounds
- (iii) The appropriate indication on the CWP illuminates
- (iv) Button C lamp flashes
- (v) If the warning is a fire warning, the appropriate fire extinguisher button, immediately behind the CWP, will also illuminate.

(e) The 'attention' lamps, the audio warning and the button C lamp will all be cancelled when button C is pressed. The appropriate emergency warning light, however, will remain illuminated for the duration of the emergency.

CONTROLS AND INDICATORS

6 Circuit-breakers and fuses

(a) Circuit-breakers for the fuel pumps, the flaps and undercarriage are situated at the top left hand corner and the centre of panel H, respectively. Circuit-breakers for other systems are located on the port and starboard wing deck panels.

(b) Fuse blocks are mounted below and aft of the observer's station side window, on the port and starboard wing deck panels, in the airbrake bay and on the forward face of the rear pressure bulkhead.

7 Generator controls

Two emergency GENERATOR ISOLATE switches, one for each generator, are located on panel J; selecting either or both of these switches to ON will isolate the respective generator.

8 Main battery control

The battery is connected to the main busbar through a heavy duty circuit breaker, controlled by master accumulator ON/OFF switch on panel J. When the switch is selected OFF, the main battery is isolated from all services except the canopy, pressure refuelling control and the fire extinguisher circuits.

9 Standby battery control

The standby battery is brought into use by selecting the rotary EMERGENCY ELECTRICAL SERVICES switch, on panel H, from MAIN ACCUMULATOR ON (normal position) to EMERGENCY ACCUMULATOR ON.

Note ...

The standby battery is directly connected to the DC POWER ON indicator and the ICO circuits. It can only be disconnected when the aircraft is on the ground.

10 Emergency battery control

The emergency battery is brought onto line automatically, when the supply from the main busbar fails, and supplies the undercarriage actuator, LP cock actuators, standby command receiver, and ram air turbine release.

Note ...

The emergency battery is connected at all times and can only be disconnected when the aircraft is on the ground.

11 Type 103A inverters - controls and indicators

(a) Standby inverter control is through the INVERTER ON/OFF switch on panel H. Before engine starting the standby inverter is started, to supply the instruments etc, by selecting the switch to ON.

(b) After an engine has started and the generator contactor has closed, a torque switch energizes, starting the main inverter, which then takes over the services supplied by the standby inverter. At the same time the INST. a.c. SUPPLY FAIL magnetic indicator on the right hand of panel B changes from striped to black and the standby inverter reverts to standby/running.

(c) In the event of main inverter failure, the magnetic indicator changes from black to striped and the standby inverter takes over the load of the failed inverter.

12 Emergency inverter - control

The type DAL inverter is started and brought into operation when the EMERGENCY ELECTRICAL SERVICES switch is selected to EMERGENCY ACCUMULATOR ON.

13 CWP controls

The Test, Mute and Ground Test pushbuttons are used as follows:

(a) The Test button when pressed, with the system unmuted, causes all indicator lamps, the visual and the audio warnings to operate.

(b) The Mute pushbutton when pulled out, renders all indicators inoperative except for fire warnings and wing-fold. The button, which illuminates when pulled, is for ground use only and must always be pushed in for flight.

(c) The Ground Test pushbutton is provided to enable a check of the CWP indications to be carried out when the external mute supply is made to the centralised warning system.

Note ...

Selection of the No 1 fuel pump PORT to ON will override the ground mute supply to the centralised warning system to provide CWP indications prior to flight.

14 Internal and external lighting

(a) Internal lighting

(i) Three dimmer switches on panel G control the following lighting:

OXYGEN REGULATOR	Controls a red lamp which illuminates panel J.
INSTRUMENT PANEL	Controls the lighting to the main instrument panel B.
PORT FLOODLIGHTS	Controls four red lamps which illuminate the Port side of the cockpit.

(ii) An additional dimmer switch on the top of panel H controls all the remaining trans-illuminated panels, the pillar lamps and the E2B compass.

(iii) A high intensity thunderstorm lamp is controlled by a DIM/OFF/BRIGHT switch on the cockpit port wall above panels F and G.

(iv) An EMERGENCY LIGHTS ON/OFF switch, located at the bottom left hand of panel B, controls the supply to the E2B compass lamp, a lamp at the pilot's RH shoulder and a lamp on panel F.

(b) External lighting

Two switches on panel H control the NAVIGATION LIGHTS, BRIGHT/DIM and STEADY/off/FLASH.

During FCC controlled flight, the navigation lights are controlled by FCC.

NORMAL MANAGEMENT OF THE SYSTEM

15 Before starting engines

(a) General

It is recommended that engine starting be carried out with an external electrical supply connected; it may be necessary for operational reasons, however, to start on the internal battery, in which case all unnecessary services should be switched off to reduce the load on the battery. Those items, such as the inverter (giving fire detection facilities) and the appropriate No 1 fuel pump, which constitute the greatest drain on the battery, should not be switched on until the last moment before pressing the starter button. Note that the engines can be started, if necessary, without fuel pumps.

(b) Checks before starting

Check:-

Master accumulator switch	...	ON
EMERGENCY ELECTRICAL SERVICES switch	...	MAIN ACCUMULATOR ON
Standby inverter	...	ON (magnetic indicator striped and instruments erecting)

16 After starting engines

The generators will come on line but may indicate GEN P or S on the CWP if the system is only lightly loaded. Selection of a further electrical service (eg UHF) should extinguish the warning. Check that the inverter magnetic indicator is black and that the instruments are functioning correctly (MRG on).

17 Before take offWARNING ...

TO PREVENT INADVERTENT OPERATION OF THE ICO CIRCUITS, THE FCC SWITCH MUST NOT BE SELECTED ON UNTIL THE STANDBY BATTERY IS CONNECTED AND THE DC POWER LAMP IS ILLUMINATED.

(a) Piloted flight - Check that the DC POWER lamp is illuminated then select:-

FCC switch ON (for ICO operation only)

Refer to the Flight Reference Cards FR 11/84-1 for switch selection in Piloted flight

(b) PCU Manned drone flight - check that the DC POWER lamp is illuminated then select:-

FCC switch ON

Refer to the Flight Reference Cards FR 11/84-2 for switch selections in PCU flight

(c) GCU Manned drone flight - check that the DC POWER lamp is illuminated then select:

FCC switch ON

Refer to the Flight Reference Cards FR 11/84-3 for switch selections in ground controlled flight.

18 Stopping the engines

(a) Switch off all non-essential loads, including the FCC switch, before stopping the engine.

(b) After closing an HP cock, isolate the appropriate generator, then switch off all electrical services.

(c) After closing the HP cock and isolating the generator of the second engine, select the master accumulator switch OFF.

19 CWS management

Test the serviceability of the CWS by pressing the Test or Ground Test button as appropriate (para 13) and check that:-

The 'attention' lights flash

The audio warning sounds

All sections of the CWP illuminate, including the 'C', 'M' and fire extinguisher pushbuttons.

Release the Test button and check that all indicator lamps, except 'C' and the 'attention' lamps, extinguish. Press the 'C' pushbutton to reset the system and check that the 'attention' lamps extinguish.

Note ...

The fire warning system is inoperative unless an inverter is on.

MALFUNCTION OF THE SYSTEM

20 Single generator failure

(a) AUTO-LOAD SHEDDING switch OUT and wing tip ISOLATION switch ARMED.

Should a single generator failure occur, isolate the generator and reduce the load below 350 amps (estimated) for 30 minutes, then further reduce the load to 300 amps (estimated) to avoid overheating the remaining generator. (Para 21).

Note ...

When flying on one engine, below a speed of approximately 270 KIAS, the failed engine will be windmilling at 18-20% rpm and the generator of that engine will be off line.

21 Circuit load table

The following table lists the major services and the current they require. Its purpose is to assist the pilot in deciding which loads can be shed if generator failure occurs.

Service	Load of 28V	
	Amps	Watts
Main fuel pumps:-		
All running	194	5432
No 1 tank fuel pumps (two) only	58	1624
Type 103A inverter	46	1288
UHF	19.6	550
All other main fuel pumps	17 each	476
Air intake de-icing	12.8	358.4
Pitot heaters	7 each	208.5
Cockpit lighting	4.5	131
Auxiliary fuel pumps	3.5 each	98
Navigation lights	2.5	69
Cabin temp control (AUTO)	2.4	67
Fuel filter de-icing	2.	56
Windscreen de-icing	1.65	46.5
MRG	1	28
* Tailplane trim	2.27	63.7
* Rudder trim	2.	56
* Aileron trim	2.	56
* Airbrake control	0.5	14

* These items are cyclic or intermittent in operation.

22 PEA fuse failure

The PEA fuse controls the current available to the 'essential services' busbar. Indications of fuse failure will depend upon the configuration at that time, the most likely indication, however, will be a loss of the ability to transmit whilst reception will remain normal.

(a) If failure is suspected, press the T button on the CWP; failure will be confirmed by the Audio warning sounding without the accompanying 'attention' lights.

(b) PEA fuse failure may also be indicated initially, or confirmed subsequently, by the GREEN system hydraulic pressure gauge showing full scale deflection left.

(c) If failure occurs, the following services will be inoperative:-

Auxiliary fuel pumps.

Main UHF transmitter with normal P to TX.

Standby UHF on normal P to TX (still available on emergency standby P to TX).

Undercarriage position indicator.

Undercarriage and flap actuator motor control.

Relight system.

Attention lights.

Port pitot heater.

ADD.

Cockpit emergency lights.

Cockpit high intensity lights.

Fuel jettison.

Oxygen demand indicator.

(d) All other electrical services will operate normally, but if it is necessary to use any of the above services select the EMERGENCY ELECTRICAL SERVICES switch to EMERGENCY ACCUMULATOR ON, then select as follows:

Standby UHF to EMERGENCY

Fuel cross-feed cocks OPEN, then switch Port and Starboard auxiliary fuel pumps as required.

The undercarriage and flaps will operate on the No 2 actuator motors.

(e) The following 'essential services' will not be lost:

Fuel gauges

Fire detection, warning and extinguisher

Horizon Gyro Unit

ICO gas detonator circuits

PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 2 - FUEL SYSTEM

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DESCRIPTION

1 Fuel tanks

(a) Fuel is carried in twelve internal tanks, three in each wing, one (pinion tank) formed by each boom forward fairing, and four in the fuselage. Two fuselage tanks on each side are interconnected and can be regarded as one tank. Each pair of fuselage tanks, one pinion tank and three wing tanks together act as a group and normally feed their associated engine, but cross-feed facilities are provided. Each No 1 fuselage tank contains a 6-gallon capacity fuel recuperator, the contents of which are used when fuel pump pressure is low, for example, during conditions of negative G, or when No 1 fuel pumps are switched off.

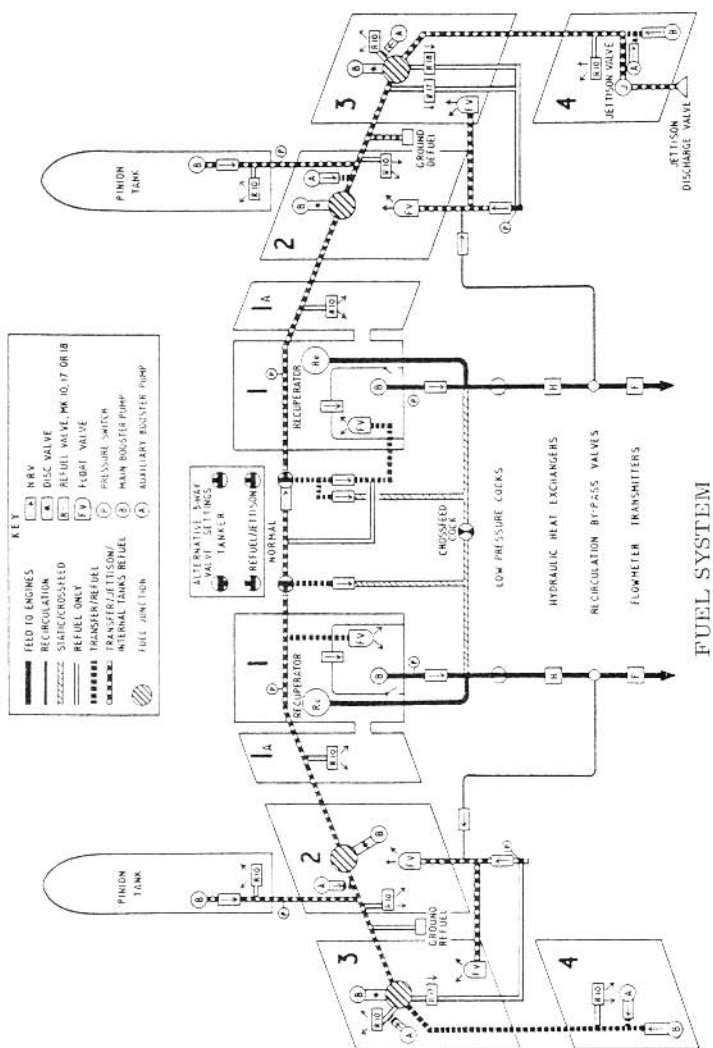
(b) The location of the tanks and their pressure refuelled capacities are:

Tank No	Location	Capacity (lb) at 8.0 lb/gall	Imp Galls
1	Fuselage	2 x 1312=2624	2 x 164
1A	Fuselage (stub wing)		
2	Inboard wing	2 x 1016=2032	2 x 127
3	Front outboard wing	2 x 848=1696	2 x 106
4	Rear outboard wing	2 x 928=1856	2 x 116
Pinion	Boom fwd. fairing	2 x 1000=2000	2 x 125
Recuperator	In tank No 1	2 x 48= 96	2 x 6
Total internal fuel		10,304	2 x 644

2 Fuel pumps

(a) Each No 1, pinion and wing tank has an electrically-operated main fuel pump (ten pumps), and each No 2, 3 and 4 tank has an auxiliary fuel pump.

(b) If an electrical failure occurs, and the electrical services switch is set to EMERGENCY ACCUMULATOR ON, the auxiliary fuel pumps can be selected either individually or all on by two rotary switches, port and starboard, and No 3 main fuel pumps can be used by selection of the normal No 3 fuel pump switches.



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3 Fuel system operation

Fuel is supplied to the engines under pressure from the fuel pumps. Should No 1 tank fuel pumps fail, the wing tanks and pinion tanks will feed until they are empty, when the No 1 tanks will feed by gravity. The wing tanks and pinion tanks also feed to the No 1 tank collector box via a float valve and should normally prevent the No 1 tank contents falling below 800 lb per side. At high fuel flows or with the wing tank fuel pumps switches off, the No 1 tank levels may reduce below that figure, as check and non-return valves in the collector box prevent fuel from re-entering the No 1 tank proper. The wing tank fuel can be used by operating the relevant auxiliary fuel pump. If an electrical failure occurs, the pinion tank fuel is unusable.

4 Fuel tank sequencing

(a) Fuel sequencing is automatic with all fuel pumps ON and operative.

(b) With the fuel pumps running and fuel flows below 135 lb/min per side, float valves in the tanks and pressure relief valve in the wing tank feed lines ensure that fuel is fed to the engines in the following order:-

Tank	Sequence	Approx. quantity used(lb)	CG move- ment
1 & 1A	Fuel used until float valve opens to permit fuel to flow from tank No 2.	400	Aft
2	Fuel transferred to No 1 tank collector box.	All	Aft
Pinion	Transfer to collector box.	All	Aft
3	When Pinion tank empties, No 3 tank transfers fuel to collector box.	All	Forward
4	When No 3 tank empties, No 4 tank transfers fuel to collector box.	All	Forward
1 & 1A	Remaining fuel now flows to engine.	900	Aft

Note ...

- 1 The CG movement shown is when both sides of the system are feeding simultaneously.
- 2 At fuel flow in excess of 135 lb/min per side, all tanks may feed together.
- 3 When the No 4 tanks are emptying, switch on all auxiliary fuel pumps to transfer 184 lb of previously unusable fuel.

(c) At high fuel temperatures, fuel will be re-circulated from the main engine fuel line back to either the No 2 or 3 wing tanks which may, therefore, refill with fuel after they have emptied. The No 2, 3 and 4 main fuel pumps should be left on even after tanks are apparently empty.

Note ...

The recirculation rate may be as much as 300 lb/min or sufficient to empty any tank in 3 minutes.

5 Fuel jettison system

A jettison pipeline is taken from the transfer/refuelling line between the starboard No 3 and No 4 tanks. Jettisoned fuel is directed aft, through No 4 tank and discharged to atmosphere aft of the trailing edge. Fuel jettisoning is from the No 2, No 3 and pinion tanks.

6 Fuel filter de-icing

- (a) (i) A heat exchanger is fitted in each engine main fuel feed line upstream of the LP filter for the dual purpose of cooling the general services hydraulic fluid and heating the fuel for filter de-icing.

(ii) A differential pressure switch is fitted to each LP fuel filter. Either switch operates a magnetic indicator to show striped when icing has caused a pressure drop.

(iii) The system is controlled manually.
- (b) (i) A methanol injection system of filter de-icing supplements the fuel heating system.

(ii) The system may be controlled manually or automatically.

(iii) When the system is under automatic control and either differential pressure switch operates, the magnetic indicator shows striped and two valves are opened, an air valve and a methanol valve. The air valve admits air, tapped from the 15th stage

compressors of the engines, into a $\frac{1}{2}$ gallon methanol container on the main spar. This forces the methanol out of the container, through the methanol valve, into the fuel lines upstream of the LP cocks. When the icing has cleared, the differential pressure switches revert to normal and the system is switched off. The magnetic indicator reverts to black.

7 Ground refuelling system

(a) Pressure refuelling

Pressure refuelling is via a refuelling unit and control panel on the undersurface of the port centre section inboard of the wing fold. The amount of fuel loaded is controlled by individual refuelling valve REFUEL-OFF switches in conjunction with the fuel gauges. A white light adjacent to each switch comes on when the switch is set to REFUEL and goes out either when the switch is set to OFF or when the tank is full. The LP cocks must be off. Two ISOLATION VALVES lamps on the refuelling panel light when the three-way valves are set to receive fuel. These lamps are duplicated on the observers' panel AN. A defuelling unit is situated on the under surface of the starboard centre section.

(b) Overwing refuelling

Nos 1, 2, 3 and 4 tanks, and the pinion tanks, are each fitted with a filler cap. No 1A tank is filled via a balance pipe from the No 1 tank. Nos 2, 3, and 4 tanks should be filled until fuel rises to the level of the orifice in the wing skin: pinion tanks should be filled until the fuel rises to the level of the tank filler orifice. The No 1 tank is filled when the fuel level rises to the bottom of the filler orifice.

CONTROLS AND INDICATORS

8 Fuel pump controls

(a) All fuel pumps are controlled by switches on Panel H. Switches for the pinion tank fuel pumps are labelled PT, the remainder are numbered to correspond to the related tank. A pivoted lever attached to a sliding plate, when pushed forward, switches on all main fuel pumps. Reverse operation of the lever switches off all main fuel pumps except those in No 1 tanks.

(b) Individual circuit breakers for the main fuel pumps are on the top forward end of panel H.

(c) Two AUXILIARY FUEL PUMP switches, marked PORT or STBD and OFF -2-3-4-ALL-OFF, control the auxiliary fuel pumps according to the selection. These fuel pumps can operate

off the main or standby battery depending upon the position of the EMERGENCY ELECTRICAL SERVICES switch. The No 3 main fuel pumps can also be run from the standby battery by normal use of their switches.

9 Fuel contents gauges and flowmeter

(a) Two fuel contents gauges, which are operated by a.c. from the 103A inverters, are on the starboard side of panel B. By means of two CONTENTS GAUGE rotary switches, on panel H, the total contents (SUM) or individual contents of tanks 1, 2, 3 and 4, can be selected for gauge reading. The contents of the pinion tanks is not gauged. When reading an individual tank contents, d.c. is fed to the relays of all the remaining tanks, isolating their capacitors. This d.c. feed is obtained only from the main electrical supply. In the SUM position there is no d.c. supply and all the relays are de-energised, thus ensuring that all tank capacitors are operating.

(b) A FUEL GAUGE TEST PORT/STBD switch, spring-loaded to off, is at the top of panel D. When selected to PORT or STBD, the needle of the associated contents gauge, if serviceable, rotates anti-clockwise. If the gauge is unserviceable, the needle may either remain at the last indication before failure or return to below zero (needle pointing vertically downwards).

(c) If electrical failure has occurred and the EMERGENCY ELECTRICAL SERVICES switch has been set to EMERGENCY ACCUMULATOR ON, an electrical supply may be obtained from the emergency inverter to either gauge by selecting the F.G. PORT/STARBOARD switch on panel H as appropriate and obtaining individual tank readings. There will be a few seconds delay in obtaining readings when changing from port to starboard or vice versa.

(d) A single flowmeter, below the contents gauges, gives the combined rate of fuel flow to both engines and fuel used in lb/min. The scale is graduated from 0 to 6 and is to be multiplied by 100 to obtain the rate of flow. A lb gone veeeder counter is provided at the bottom of the instrument; multiply the indicated figure by 10 to obtain the total amount of fuel used. Electrical supply is from the Type 103A inverters.

10 Low fuel pressure warning indicators

Six magnetic TANK FLOW indicators are installed on panel AU - one for each WING group, one for each CENTRE (No 1) tank and one for each PINION tank. These indicators show striped if fuel pressure from their associated fuel pump/group drops below normal (wing group and centre tanks) and when the tanks are empty (wing group, centre and pinion tanks). In addition, warning of main fuel feed pressure dropping below normal is given on the centralized warning panel.

11 LP fuel cocks

The LP fuel cocks, one for each tank group port and starboard, are controlled by the two three-position switches - AUTO-ON-OFF on panel G. They should be ON at all times except when fire occurs, when an engine has failed, or for ground refuelling. The AUTO position is not to be selected - the LPC fuse being removed before flight and thus inhibiting this switch position.

12 Fuel cross-feed and isolation cocks

(a) Fuel cross-feed cock

A single cock is controlled by the FUEL CROSS-FEED OPEN/SHUT lever on panel G, outboard. The cock should be shut at all times, except when using fuel from both sides, when flying on one engine, when balancing an uneven fuel state, or when on the standby battery following double generator failure.

(b) Fuel isolation cocks

An isolation cock is embodied in each wing group feed pipe; these cocks are operable on the ground only by means of screw-in fittings, one in each main wheel bay.

13 Fuel jettison controls

Fuel jettisoning is controlled by a FUEL JETTISON switch on panel E, which when selected on, opens the jettison valve in the jettison pipeline, switches off the No 4 tanks main and auxiliary fuel pumps and sets the three-way valves to receive. Fuel is jettisoned from No 2, 3 and pinion tanks if their fuel pumps are operating.

14 Fuel filter de-icing controls

(a) The heat exchanger system is controlled by an HYDRAULIC AUTO/Off/MANUAL switch, on panel AU with an adjacent indicator, which shows striped when icing occurs. Ice is cleared by selecting the switch to MANUAL (on):- the associated indicator reverting to black when ice has been cleared. The AUTO position is not to be selected.

(b) The methanol injection system is controlled by a METHANOL AUTO/Off/MANUAL switch adjacent to the HYDRAULIC switch.

NORMAL MANAGEMENT OF THE SYSTEM15 Before starting

(a) With the standby inverter on, check the fuel quantities in tanks 1, 2, 3 and 4, then check that the LP cocks are ON and the fuel pump circuit breakers are closed (Panel H). The serviceability of each fuel pump can be tested by switching each one in turn and checking that the associated magnetic indicator goes black when the fuel pump is on and returns to striped when it is switched off; check that the CWP fuel warnings are out with any fuel pump on.

(b) Start up and taxi on No 1 fuel pumps only.

(c) The CWP will 'warn' when the No 1 port fuel pump is switched on.

16 Before take-off

Switch all main fuel pumps on by pushing the fuel master lever forward. Then check that the internal tanks flow magnetic indicators are black, that the CWP fuel warnings are out and that the fuel cross-feed cock (panel G) is SHUT.

17 In flight

(a) At frequent intervals check, the correct sequencing of the fuel tanks by use of the fuel gauge rotary switches. Correct sequencing of the pinion tanks will be indicated by the fuel level in No 3 tanks being maintained after No 2's are empty. Failure of any tank to empty in sequence normally indicates fuel pump failure. Switch port and starboard auxiliary fuel pumps to ALL when the No 4 tanks are emptying.

(b) Fuel gauge selection

At low fuel states, the fuel gauge rotary switches should be left at No 1 tanks, rather than total contents (SUM), between individual tank checks. This will ensure an immediate indication if any reduction in No 1 tank contents, due to incorrect transfer from wing tanks, occurs. This procedure is especially important when there is any fuel malfunction, including fuel pumps switched off for single-engine flying.

18 Flying on one engine and fuel balancing

Open the fuel cross-feed cock, and rotate both the auxiliary fuel pump switches to ALL. Maintain balance by selective use of the Port and Starboard No 1 main fuel pump. Set fuel contents switches to No 1 tanks and monitor SUM only when necessary.

Note ...

Avoid having more than two fuel pumps on at any one time when changing sides.

19 Use of the fuel filter de-icing systems

(a) Hydraulic heater system

(i) The fuel filter de-icing switch is normally to be OFF, and must not be selected to AUTO.

(ii) Select MANUAL (on) only if the filter icing indicator shows striped: select OFF when the indicator reverts to black. If the temperature of hydraulic fluid appears likely to exceed 100°C while the switch is at MANUAL, switch the system off.

(b) Methanol system

The switch should normally be set to AUTO.

20 Fuel jettisoning

(a) To jettison fuel:-

- 1 All fuel pumps ON.
- 2 Fuel cross-feed cock SHUT.
- 3 FUEL JETTISON switch ON (guard raised) Panel H.

(b) The position of the flaps and undercarriage has no effect on the fuel jettison rate. At a height of 2,000 ft at 200 KIAS, fuel in the pinion, No 2 and No 3 tanks is jettisoned in approximately 9 minutes. An increase in airspeed will improve the jettison rate; the same fuel state will be achieved in about 7 minutes at 500 KIAS at the same altitude.

(c) Fuel from the pinion tanks can be jettisoned separately by switching off Nos 2 and 3 tanks pumps. With the pinion tank pumps running, fuel in these tanks is jettisoned in approximately 4 minutes. It should be noted that, when the pinion tanks are empty, fuel jettisoning will continue if the FUEL JETTISON switch is left ON, with only the No 1 tank pumps running (200 lb/min at 300 KIAS).

(d) (i) During jettisoning, the starboard tanks will empty in advance of the port tanks. This asymmetry may be as much as 1,500 lb, but on completion of jettisoning will have reduced to approximately 500 lb.

(ii) When No 3 tank contents are low, both wing groups magnetic indicators will occasionally flicker and show striped, the port magnetic indicator may

stay striped until the jettison switch is selected off: both wing group magnetic indicators will then revert to black.

(iii) During jettisoning, fuel is lost from the starboard No 4 tank, especially at high speed. At 400 KIAS, the loss rate is approximately 40 lb/min until the pinion and No 2 tanks are empty. After both pinion and both No 2 tanks are empty, a loss rate of up to 140 lb/min can be expected. At low forward speeds, nothing will be lost from the starboard No 4 tank until the pinion and No 2 tanks are empty. Thereafter the loss rate is about 50 lb/min. It is essential therefore, to keep the time that the jettison valve is open to a minimum.

(e) To stop fuel jettison, switch the FUEL JETTISON switch OFF (guard lowered).

(f) On completion of jettisoning, check contents of all tanks then, if manual balancing is necessary, select the fuel cross-feed cock to OPEN and balance normally.

WARNING ...

JETTISONED FUEL IS NOT INDICATED ON THE FUEL FLOW RATE/
FUEL GONE INDICATOR.

MALFUNCTIONING OF THE SYSTEM

21 Fuel gauge failure

If a fuel gauge is suspect, select the gauge test switch to Port and Starboard as appropriate and, if the needle fails to rotate anti-clockwise, ignore the gauge.

22 Fuel pump failure

(a) To check for a fuel pump failure.

First ensure that all the circuit breakers are closed. A No 1 fuel pump failure will be indicated immediately by its associated low pressure magnetic indicator showing striped. Failure of No 2, 3 and 4 fuel pumps may be established by switching of all but the suspect pump in that group and checking that the associated wing tank flow indicator shows striped. Failure of a pinion tank fuel pump, before the pinion tank empties, will be indicated by the associated PINION tank flow indicator showing striped. This will result in the affected pinion tank fuel being unusable. It should be noted that, when the pinion tanks are empty, the associated tank flow indicators will show striped whilst the fuel pumps are left running.

(b) Action in the event of fuel pump failure

(i) No 1 pump

Use all fuel normally until only No 1 tank remains and then ensure that the following conditions are not exceeded:

Maximum height	...	...	15,000 ft
Maximum RPM on affected engine	...	...	85%

If either the height or the RPM are exceeded, cavitation may occur at the engine HP pump causing damage to the pump inlet connectors and/or flame-out. If it is not practicable to descend below 15,000 feet, the engine should be shut down until the final descent below 15,000 feet.

(ii) Any wing group fuel pump

Switch the relevant AUXILIARY FUEL PUMP switch to 2, 3 or 4 as applicable.

Note ...

- 1 If circulation is taking place and the auxiliary pumps in No 2 and 3 tanks are operating, switch off the No 1 fuel pump.
- 2 If the tanks on one side are empty except a tank with an auxiliary fuel pump operating, throttle the engine on that side to consume not more than 36 lb/min.

If it is desirable to maintain a balanced fuel state proceed as follows:-

- (1) Find out the amount of unusable fuel by selecting the failed tank on the fuel gauge.
- (2) OPEN the fuel CROSS-FEED cock.
- (3) Switch off No 1 fuel pump on the same side as the failed pump.
- (4) Wait until the difference in the fuel gauge readings (SUM) is the same as the amount of unusable fuel.
- (5) Switch on the required fuel pumps.
- (6) Close the fuel CROSS-FEED cock.
- (7) Assume that the total unusable fuel is twice the amount indicated on the lower gauge reading with the selector at SUM.

(iii) Either pinion tank fuel pump

The fuel in the associated pinion tank will be unusable.

23 Float valve failure

(a) Malfunction of the No 1 tank float valves, due to ice or mechanical failure, is indicated by an abnormal fuel level in the No 1 tanks.

(b) With a valve stuck in the open position, the fuel level in the No 1 tank rises above normal and this rise should be controlled by switching off the wing tank fuel pumps for short periods.

(c) With a valve stuck in the closed position, the fuel level in the No 1 tank falls below normal, and the level should be controlled by switching off the No 1 tank fuel pump, allowing the wing tank to feed to the engines.

24 Use of the system following double generator failure

(a) When the standby battery is selected, open the fuel CROSS-FEED cock and select the fuel gauges as required. The No 2, 3 and 4 tank auxiliary fuel pumps and the No 3 main tank fuel pumps are available to use the fuel remaining. If maximum conservation of battery is necessary, use the auxiliary fuel pumps only.

(b) If electrical failure occurs, any fuel in the pinion tanks will be unusable.

WARNING ...

- 1 WHEN OPERATING ON ONLY ONE FUEL PUMP AND TWO ENGINES, DO NOT EXCEED 90% RPM ABOVE 30,000 ft. _
- 2 BEFORE THE BATTERY EXPIRES, REDUCE HEIGHT TO BELOW 15,000 FEET AND RPM BELOW 85%, REMEMBERING THAT ONLY THE FUEL REMAINING IN No 1 TANKS WILL BE USABLE WHEN ALL THE FUEL PUMPS HAVE STOPPED. No 1 TANKS WILL NOT NECESSARILY REMAIN FULL WHEN OPERATING ON ONE FUEL PUMP BELOW 10,000 FEET.

25 Fuel jettisoning following double generator failure

In the event of double generator failure, selective jettisoning is possible. See Part IV, Chap 3, para 5.

26 Fuel jettison valve malfunction

Should malfunction occur, it will be indicated by a higher than normal rate of starboard fuel consumption. The starboard fuel contents should be carefully monitored. Open the fuel cross-feed cock when fuel in the starboard 1 and 1A tanks falls below metering level (900 lb).

PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 3 - HYDRAULIC SYSTEMS

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DESCRIPTION

1 General

(a) Four independent and separate systems, the Blue, Yellow, Red and Green are provided. Four engine-driven pumps, one for each system, supply hydraulic pressure. In addition, a ram-air turbine driven pump is provided for the emergency operation of the Blue system.

(b) The gearbox drive to the pumps is so arranged that the faster running engine will drive both the Blue and Yellow pumps.

(c) The Red (port) and Green (starboard) pumps are driven only by the engine to which they are connected.

2 Red and Green hydraulic systems

(a) The Red and Green systems operate at a pressure between 2650 psi and 3200 psi. They operate the following services.

RED	GREEN
Wheel brakes - emergency	Wheel brakes - normal
Wheel brakes - park	Airbrake
Undercarriage - emergency down and up	Undercarriage - normal and emergency up
Flaps - emergency operation	Flaps - normal operation
Hook - emergency lowering	Hook - normal operation
	Wing fold
	Nose wheel steering
Fuel filter de-icing - port	Fuel filter de-icing - starboard

(b) (i) The Red and Green system reservoir is divided into four sections by a horizontal and vertical diaphragm and contains a total of $4\frac{3}{4}$ gallons of hydraulic fluid; it is fitted in the starboard mainplane and is accessible through the wheel well.

(ii) The bottom compartments of the reservoir are for the Red and Green system fluid and each is exclusive to its own system. The top compartments are interconnected through transfer valves and pressurised separately from the port and starboard engines respectively. Each dividing diaphragm between the top and bottom compartments contains a non-return valve.

(iii) If one circuit is damaged and loses fluid and pressurising air, the transfer valve closes and maintains fluid and air pressure in the undamaged circuit.

(c) Accumulators are provided as follows:-

System	Service Supplied	No. off	Initial air charge psi	Location of pressure gauges & charge points
Red	General	1	1,500	Stbd. inner-wing
Red	Wheebrakes	1	1,500	Stbd. inner-wing
	Park & Emergency			
Red		1	1,500	Aft of radome
Green	General	1	1,500	Stbd. inner-wing
Red	Arrester hook	1	1,700	Between engine
Green	Arrester hook	1	1,700	tailpipes

3 Blue and Yellow hydraulic systems

(a) The Blue and Yellow systems each have a header tank which is primed, via a handpump and selector cock, from the Green system reservoir. The header tanks are in the port and starboard wheel bays respectively. The priming pump and selector are in the starboard defuelling bay.

(b) The Blue and Yellow systems together operate the flying controls; in addition the Yellow system operates the actuators for the auto-stabilisers. The systems operate at a pressure of 2,650 to 3,200 PSI.

(c) Accumulators are provided as follows:-

Circuit	Service Supplied	No. off	Initial air charge psi	Location of pressure & charge points
Blue	General	1	1,000 + 25	Port inner wing
Blue	Tailplane	2	1,000 + 25	Port and stbd. tail boom
Yellow	Tailplane	2	1,000 + 25	Port and stbd. tail boom
Yellow	General	1	1,000 + 25	Stbd, inner wing

(d) If the hydraulic pump delivery pressure in each system falls below 1,600 psi warning is given on the CWP.

4 Ram air turbine

(a) The ram air turbine driven pump can be used to supply pressure to the flying controls if the Blue hydraulic pump fails. The turbine is normally secured in the retracted position inside the upper rear fuselage between the jet pipes.

(b) Once the pump is extended, it can only be retracted when the aircraft is on the ground.

CONTROLS AND INDICATORS

5 Red and Green pressure and temperature gauges

(a) Two pressure gauges are on the cockpit port wall, one reading RED MAIN SUPPLY pressure and the other RED BRAKE SUPPLY pressure. Forward of the throttle box on panel F is the Green system pressure gauge, which has three pointers. One gives Green system pressure and the other two the Green system brake pressure at each wheel.

(b) The temperature gauges for the Red and Green system hydraulic fluid temperatures are situated in the observer's compartment.

6 Blue and Yellow pressure gauges

A pressure gauge for each system is on panel F.

7 Ram air turbine control

When the emergency FLYING CONTROL HYDRAULIC PUMP handle on panel L is operated, the pump is raised into the airstream with the assistance of a spring-loaded damper strut. When the pump is supplying adequate flow to the Blue system, a HYD PUMP ON magnetic indicator on the instrument panel shows striped.

NORMAL MANAGEMENT OF THE SYSTEM

CAUTION ...

Damage to the trimmers and controls will result if they are operated before at least one engine is running.

8 Before Starting

Check:

Wheelbrakes	...	...	PARK
Red and Green system pressure gauges	...	...	Note any pressure
Blue and Yellow system pressure gauges	...	...	Note any pressure

9 After Starting

After the first engine has started, check:

Blue and Yellow systems ... 2,650 psi - 3,200 psi

When starboard engine has started:

Green system pressure ... 2,650 psi - 3,200 psi

When port engine has started:

Red system pressure ... 2,650 psi - 3,200 psi

10 Before take-off

Check full and free stick movement. With 2° nose-up trim set, a tailplane travel of 12½° nose-up to about 2° nose-down should be obtained with full stick movement. (With 3° nose-up trim set, a travel of 12½° nose-up to about 2½° nose-down should be obtained). Move the stick fully forward and hold it against the stop until the Blue and Yellow systems pressure gauges have stabilized at 2,650 psi - 3,200 psi. Move the stick quickly aft to the fully back position and note that the pressure on either gauge does not fall below 1,600 psi. Extend the flaps and check visually that the elevator tab unlocks. Press the test switch on Panel B, and note that the port undercarriage light shows red. Select flaps UP and check that the lights go out. Note that the air brake test light (nose wheel light) also shows red when the test switch is pressed.

11 Hydraulic fluid temperature checks

If the temperature in a system exceeds 90°C before flight, the sortie should be abandoned.

Note ...

The temperature gauges cannot be observed from the pilot's position.

MALFUNCTIONING OF THE SYSTEM

12 Green system failure

(a) The following services will be completely inoperative:-

- Airbrake
- Wingfold
- Nosewheel steering
- Starboard fuel filter de-icing

Note ...

The airbrake should retract sufficiently to clear the ground at speeds above 130 KIAS but may have to be blown shut by flying at a higher airspeed.

(b) The following services, although also inoperative following a Green system failure when accumulator pressure has fallen below 1,500 psi, have an alternative supply, after their appropriate selection, from the Red system.

Normal braking (select emergency braking system - Maxaret units will be inoperative).
Normal undercarriage operation (select emergency u/c down).
Emergency undercarriage operation (select emergency u/c up).
Normal hook operation (select emergency control).

(c) Nosewheel steering

When the nosewheel steering is lost, turns of more than a few degrees will be impossible at slow speed while using differential braking. If the ability to turn is essential, it may be regained by having the ground crew move the nosewheel steering isolate lever forward.

13 Red system failure

(a) The following services will be inoperative and no alternative supplies are available.

Parking brake
Emergency brakes
Port fuel filter de-icing

(b) In addition, the following emergency services will be lost.

Emergency undercarriage (down)
Emergency flaps
Emergency hook (down)

14 Yellow system failure

This will be indicated on the CWP and, when the accumulator pressure is exhausted, on the Yellow system pressure gauge. Autostabilizers and the manned drone actuators on the flying controls will be inoperative and the FCC should be disengaged.

15 Blue system failure

This will be indicated on the CWP and, when the accumulator pressure is exhausted, by a drop in the Blue pressure gauge reading. Extend the RAM AIR TURBINE. For subsequent action required see Part IV, Chap.2, para.2.

16 Blue and Yellow systems failure

Indication: CWP warning
Pressure gauges
The flying controls and throttle become inoperative

Action:

- (i) Close the airbrake
- (ii) Extend the Ram Air Turbine
- (iii) Select the FCC to DISENGAGE
- (iv) Land as soon as possible (See Part IV, Chap.2, para.3(c)).

Note ...

If the Blue system gauge does not build up to 2000 psi, after extending the RAT, a broken pipeline is indicated and all flying controls are lost.

PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 4 - AIRCRAFT CONTROLS AND DRONE PACK

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FLYING CONTROLS

1 General description

(a) The flying control surfaces, (ailerons, tailplane and rudders), are power-operated by the duplicated Yellow and Blue hydraulic systems. Failure of one system will not materially affect the operation of the controls.

(b) There is no provision for reversion to manual control but failure of both Yellow and Blue pumps does not render the controls inoperative, since a ram-air turbine, when extended into the airstream, re-energises the Blue system and will supply sufficient pressure for restricted operation.

(c) The all-moving tailplane is fitted with a large trailing-edge tab which is normally locked in line with the tailplane; the tab is inoperative except by selection of flaps, when it moves to counter trim changes and then acts as a geared tab.

(d) No trim tabs are fitted since trimming is achieved by direct application to the control surfaces themselves.

2 Artificial feel systems

(a) Aileron spring-feel mechanism

A spring strut is fitted near each aileron hydraulic jack and provides a stick force which increases with stick displacement, but not with airspeed. If the stick is released from an out-of-neutral position the spring strut causes the stick to return to neutral.

(b) Tailplane spring-feel mechanism and stick damper

A spring strut, similar to the aileron spring strut, is provided in the tailplane control system. In addition a stick damper is provided which operates when the stick is moved fore-and-aft only. The damper is oil-dampened and air-operated, one side being connected to pitot pressure and the other to static pressure. Thus stick forces are approximately proportional to indicated airspeed. A G-weight is also included in the control circuit. This increases the stick forces under manoeuvres involving increases in G.

(c) Rudder spring and Q-feel mechanism

Spring struts, similar to the aileron spring struts are provided in the rudder control system. In addition a Q-feel system is provided which operates when the rudder bar is displaced from central. The Q-pot is a sealed cylinder containing a piston linked to the rudder bar. Pitot and static pressure are each applied to opposite ends of the cylinder, and provide forces proportional to

airspeed against rudder movement from central. The pitot and static pressures are obtained from the same source as the tailplane stick damper. In the manned drone condition, when damping is not required, a motorised valve connects pitot to static. A warning lamp on panel AU indicates Q POT OUT when the valve is open. Q pot and spring feel are switched out when FCC engaged.

3 Tailplane trim

(a) When the two linked switches on top of the control column are operated fore-and-aft, the tailplane angle for a given stick position is altered. Either a FAST or SLOW trim motor may be selected by a TP, TRIM, FAST/SLOW switch on panel G. The FAST selection (aft) should normally be used.

(b) The trim circuit may be tested by disconnecting the linking bar and operating either switch. If the system is serviceable, the trim motor should not then operate.

(c) A microswitch in the trim circuit trips out the electrical supply to the actuator when a zero stick-force condition is reached. To continue trimming beyond this position, the switch must be released and then operated again. The automatic trim-stopping system may be disconnected by setting the AUTO STOP switch on panel H, to ISOLATE.

(d) If slow trim is required, selection of the FAST/SLOW switch to SLOW should be made and trimming carried out using the normal controls. When slow trimming is in use, the automatic trim-stopping system is inoperative and the position of the AUTO STOP switch is immaterial.

(e) The tailplane position can be determined by reference to the NOSE UP/NOSE DOWN indicator on panel B.

(f) Tailplane trim must be set to zero trim before engaging the FCC.

4 Tailplane gear change

(a) A gear-change mechanism, controlled by a three-way AUTO (up)/off (central)/LAND (down) switch on panel H, provides low, medium and high gearing of the tailplane/control column to suit varying flight conditions.

(b) When set to AUTO, the gearing selection is dependent upon the position of the undercarriage selector at low speeds and upon the contacting machmeter at high speeds. With the undercarriage down, a medium control column/tailplane gearing is selected. When the undercarriage is selected up, a lower gearing is automatically selected. Above a speed of 1.0M and an altitude of 20,000 ft, a high gear is automatically selected.

(c) The LAND position is provided to meet the case of failure of the AUTO circuit so that the necessary medium gearing can be selected for landing.

(d) When the switch is set to off, the system remains in whatever gearing obtaining at the time. Failure of the electrical supply to the gear change actuator will have the same results.

(e) Indication of the gearing in use is given by two TP GEAR CHANGE lights, an amber and a green on the left of panel B. They show:-

Amber light on - supersonic gear
Green light on - landing gear
Both lights out - normal gear

(f) A TAILPLANE GEAR-CHANGE TEST switch on panel H enables the supersonic gear change to be checked.

5 Rudder trimming and pedal adjustment

(a) Trimming

(i) Trimming is achieved by the RUDDER TRIM (spring loaded) switch on panel G.

(ii) When the switch is operated, the starboard rudder operating rod is trimmed. No rudder pedal movement will result but the foot force will be trimmed out.

(iii) A combined Rudder/Aileron trim indicator is on panel G.

(b) Pedal adjustment

A handle, beneath the instrument panel, is pulled out, turned to adjust the pedals and released to lock the pedals.

(c) Rudder trim must be set to zero trim before engaging the FCC.

6 Aileron trimming

An electric actuator, operated by lateral movement of the two linked switches on top of the control column, is fitted to the starboard aileron. A combined Rudder/Aileron trim indicator is on panel G.

(a) Aileron trim must be set to zero trim before engaging the FCC.

7 Aileron variable gearing mechanism

Lateral stick movements for a given aileron displacement can be varied by rotating the knurled wheel at the base of the control column handgrip in the direction of NORMAL or HIGH. For normal flight the wheel should be in the fully anti-clockwise position (NORMAL), but to reduce hand movements at low speeds, e.g. during approach and landing, the wheel can be turned clockwise to HIGH as desired.

8 Operation of the flying control gears

(a) Tailplane

(i) Before take-off

Select the gear change switch to AUTO and check that the green light is on.

(ii) After take-off

Check that the green light goes out when the under-carriage lever is moved up.

(iii) At high mach number

Check that the amber light comes on when 1.0M is exceeded above 20,000 ft. If the angle of dive is steep, the amber light may be delayed to as much as 1.05M.

(iv) Before landing

Check that the green light comes on when the under-carriage lever is moved down. If it does not do so select LAND on the G/C switch.

(b) Ailerons

(i) Before take-off

Rotate the gearing wheel on the control column to NORMAL.

(ii) Before landing

Set the gear wheel as required.

AUTOSTABILISER

9 General description

An autostabiliser is fitted to provide synthetic damping in pitch and yaw for general flying. For pitch autostabilisation the ailerons act as elevons.

10 Autostabiliser controls

(a) The autostabiliser control box is on panel AU and incorporates the following switches and indicators.

(i) Two three-position ON (up)/STANDBY (centre)/OFF (down) RUDDER and ELEVON switches for the AUTOSTAB CONTROL. The RUDDER switch controls the yaw stabiliser and ELEVON switch the pitch stabiliser. The standby position of the latter switch is disconnected and is to be regarded as an off position.

(ii) An AIRCRAFT trim indicator which shows the mean position of the two ailerons in the elevon sense. The ailerons act as elevons only when the pitch stabiliser is on.

(b) Provision is made for automatically switching off the pitch autostabiliser system if either of the following conditions apply:-

G exceeds +4 or $-1/4$;
Elevon actuator stroke limits are exceeded

Pitch autostabilisation is automatically restored when these conditions return to within normal limits.

11 Use of autostabilisers

(a) (i) The yaw and pitch stabilisers should be selected to STANDBY prior to start up, and to ON before taxiing. The OFF position should only be used on the ground when the aircraft is at rest; and in the air only if malfunctioning of the stabilisers occurs.

(ii) During taxiing check the stabilisers.

(b) In the air if undamped directional snaking occurs switch the yaw stabiliser to STANDBY. Similarly if undamped pitching oscillations occur switch the pitch stabiliser to STANDBY. In these circumstances the autopilot will be inoperative.

(c) After turns at high altitude the pitch stabiliser may tend to continue oscillating. This should damp out quickly, but if it does not, switch the pitch stabiliser to STANDBY, reselecting ON when the oscillation ceases.

(d) The autostabilisers are automatically selected off when the FCC is engaged.

OTHER AIRCRAFT CONTROLS

12 Undercarriage control and position indicator

(a) The pilot's undercarriage control switch on panel E, selects AUTO, UP, DOWN, EMERGENCY UP and EMERGENCY DOWN, via a relay unit and twin motor actuator, operating a hydraulic servo valve. The selections are made by pulling out the selector knob and moving it to the required selection.

- (b) The AUTO selection, protected by a pivoted guard plate, operates only No 1 motor of the actuator for UP, DOWN and EMERGENCY DOWN, via the FCC.
- (c) Microswitches on the main oleo legs and the nose wheel, connected to relays, prevent an UP selection in AUTO or manual, if the main legs are compressed and/or the nosewheel is not straight.
- (d) EMERGENCY UP manual selection, by-passing the micro-switches and relays, permits the undercarriage to be retracted on the ground.
- (e) Normal operation of the undercarriage is by the green hydraulic system. In the event of a green system failure, an automatic change-over valve connects the red hydraulic system, to the green system, for UP and EMERGENCY UP selection.
- (f) EMERGENCY DOWN selection connects the red system, through the servo valve, to lower the undercarriage.
- (g) The undercarriage indicator is situated on panel AU.

13 Flaps control and position indicator

- (a) Each port and starboard Fowler flap assembly consists of an inner, centre and outer flap, the outer and centre being joined together.
- (b) The flaps are controlled by a four-position FLAPS, AUTO/UP/20°/DOWN selector switch on panel G.
- (c) When the flaps are lowered to either 20° or DOWN, a geared tab on the trailing edge of the tailplane unlocks and moves as necessary. Whenever the flaps are at any setting other than fully up and/or the elevator tab is out of its neutral setting, the port red light on the undercarriage position indicator illuminates, provided that the wheels are locked up. A FLAP INTERLOCK AND AIRBRAKE TEST button on panel B when pressed, with the flaps not locked up, also causes the light to illuminate.
- (d) Normal operation of the flaps is by pressure from the Green system, but Red pressure is automatically selected if the Green system fails.
- (e) A FLAP position indicator is at the bottom centre of panel B.
- (f) When the flaps are selected to AUTO, the FCC controls their selection.

14 Airbrake control and position indicator

(a) An underfuselage airbrake is operated by Green hydraulic pressure and is controlled by a switch, on the starboard throttle control handgrip, which allows it to be set at any desired position as shown by the indicator on panel B. In the manned drone role, the FCC controls the selection of the airbrake to in or out when the handgrip switch is in the neutral (mid) position.

(b) When the airbrake is out and the airloads on it are too great, it will close partially until the airloads are reduced.

(c) If electrical failure occurs when the airbrake is out, the airbrake selector valve may be manually selected closed by an AIRBRAKE EMERGENCY SHUT lever on panel G. There is not provision for emergency open selection. If hydraulic failure occurs with the airbrake out, it should retract automatically, but may have to be blown shut by flying at high speed.

(d) When the undercarriage is selected down, the airbrake, if out, is automatically retracted. If the airbrake does not retract fully when the nose leg is locked down, the undercarriage nosewheel red light will show, in addition to the green light, on the undercarriage indicator.

(e) The FLAP INTERLOCK AND AIRBRAKE TEST button on panel B, when pushed with the undercarriage down and the airbrake retracted, causes the nosewheel light to show red.

15 Wheelbrakes control

(a) Disc-type wheelbrakes, with maxaret anti-skid units, are fitted to the main undercarriage wheels. The brakes are controlled by master cylinders on the rudder pedals or by control valves selected by the FCC when engaged. The Green system brake pressure at each wheel is shown on the gauge forward of the throttle box. Red system brake pressure is shown on the gauge on the cockpit port wall.

(b) There are three available selections for braking, normal, emergency and park. The selections are controlled from a three-position PARK/EMERGENCY/OFF (Normal) selector lever on the cockpit port wall.

(c) With the lever at OFF, normal braking is controlled by the toe pedals and is supplied from the Green system. When the lever is set to EMERGENCY, the brakes are again controlled by the toe pedals but are supplied through duplicated pipelines by the Red system and the maxaret units are inoperative. With the lever at PARK, the Red system supplies pressure direct to the brake jacks; differential braking and maxaret units are inoperative.

The FCC only controls the Green system brake pressure, and may be overridden by applying greater toe pedal pressure.

16 Nosewheel steering

(a) The nosewheel may be steered up to 45° either side of central by an hydraulic mechanism controlled by either of two concentrically-mounted handwheels at the pilot's starboard side. The larger handwheel gives coarse control and the smaller gives fine control. Hydraulic pressure is supplied from the Green system.

(b) When the handwheel is released, a spring strut provides nosewheel self centring.

(c) No emergency steering system is fitted.

(d) A nosewheel steering isolation lever on the nosewheel leg is provided for ground use only. When operated, it releases hydraulic pressure from the clutch pressure chamber and permits 360° castering of the nosewheel leg. In this condition the self-centring facility is inoperative. Approximately 12 seconds will elapse after operation of the isolation lever before complete declutching is achieved. When the lever is in the de-clutch position, its reverse side, which is painted red, is visible. When the lever is in its normal position, no red should be visible.

(e) If nosewheel steering is lost, turns of more than a few degrees will be impossible at slow speed or while using differential braking. If turning ability is essential, it may be regained by having the ground crew move the nosewheel steering isolation lever forward.

17 Arrestor hook control

(a) The arrestor hook is controlled by a three-position UP, DOWN, EMERGENCY DOWN selector lever on panel G. Hydraulic pressure for normal operation is from the Green system and for emergency operation from the Red system.

(b) Two damper accumulators, one charged by the Red system and one by the Green system, are fitted in the circuit. If no hydraulic pressure is available from either system, the hook will lower under gravity, following a DOWN selection, but no damping will be provided.

(c) The hook cannot be retracted by Red system pressure. A HOOK DOWN green light is on panel E.

18 Approach lights

No approach lights are connected.

19 Radome

The radome is opened and closed manually. If it is not locked, indication of WFOLD is given by the CWP and by the WING/RADOME LOCKED magnetic indicator showing striped.

20 Wingfold controls

(a) Each wing is folded and spread by one large hydraulic jack. A smaller jack, controlled by a sequence valve, operates the linkage to insert or withdraw the wing locking pins. The system is controlled by two levers on panel L. The right-hand lever (forward-spread, back-fold) selects Green system hydraulic pressure to fold or spread and the left-hand lever (forward-lock, back-unlock), which can only be moved when the wings are spread and the locking pins home, mechanically holds the locking pins in position.

(b) Two separate "wing-locked" indication systems are provided.

(i) Indication WFOLD on the CWP if any of the following is not locked:-

- Main locks
- Radome
- Radome door
- Observer's hatch

(ii) A WING/RADOME LOCKED magnetic indicator forward of the CWP which shows striped if any of the following is not locked:-

- Wing pins
- Main locks
- Radome
- Radome door
- Observer's hatch

(c) If the flaps are down and electrical power is available, an interlock ensures that neither wingfold selector can be moved. An override knob, press and turn clockwise, immediately aft of the wingfold selector levers, can be used to make the interlock inoperative. The inboard flaps can be operated with the wings folded; the outboard flaps cannot.

21 Management of the wingfold system

(a) Spreading

Check that the flaps are up, the flaps lever is in the UP position and the flap override knob is turned fully anti-clockwise. Move the outboard wing fold lever to the SPREAD position and, when the wings are down, move the inboard lever forward to LOCK. Check that WFOLD is extinguished on the CWP and the WING/RADOME LOCKED magnetic indicator is black.

Note ...

WFOLD will remain on and the WING/RADOME LOCKED magnetic indicator will remain striped until the observer's hatch is closed and locked.

(b) Folding

Check that the flaps are up, the flap lever is in the UP position and the flap override knob is turned fully anti-clockwise. Move the inboard WINGFOLD lever aft to UNLOCK, then select the outboard WINGFOLD lever to the FOLD position. Cancel the CWP warning.

UNIVERSAL DRONE PACK (UDP)

22 General Description

The UDP comprises:

FLIGHT CONTROL COMPUTER (FCC)
COMMAND RECEIVER (Main)
COMMAND RECEIVER (Standby)
TELEMETRY INTERFACE UNIT
TELEMETRY TRANSMITTER
RATE GYRO UNIT

The flight control computer is connected to the aircraft instrumentation, control actuators and the rate gyro unit. It functions as an auto-pilot. The computer receives command signals either from the Ground Control Unit via the main or standby receivers or from the Pilots Control Unit and demands the required function from the control actuators fitted to the aircraft control units. Potentiometers fitted to the actuators and controls transmit their position to the computer, which in turn, feeds both the controls position and instrumentation information, via the telemetry interface unit and transmitter, to the Ground Control Unit.

The UDP controls are situated on panel H unless otherwise stated.

- (a) The TRANSPONDER switches (Panel D) control the power supply to the G and I band transponders.
- (b) The HEATERS-MAIN RX and ST/BY RX switches control the power supply to the command receiver heaters. The MAIN and ST/BY switches also control the power supply to the RADIO switch (PCU).
- (c) The TELEMETRY switch controls the power supply to the telemetry interface and transmitter.
- (d) The FCC switch controls the power supply to:

WARNING ...

THE DC POWER LAMP MUST BE ILLUMINATED, BY CONNECTION OF THE STANDBY BATTERY, BEFORE THE FCC SWITCH IS SELECTED ON.

- (i) The FCC
 - (ii) The PCU
 - (iii) The rate gyro unit
 - (iv) The ac power relay to the FCC
 - (v) The contacts of relay APO
 - (vi) The contacts of relay DET
- (e) The AUTO-LOAD SHEDDING double pole switch controls the current from each generator reverse current circuit breaker to the appropriate load shedding relay.
- (f) The TELEMETRY HEADING switch controls the output of the compass heading indicator to the telemetry interface.
- (g) The AILERON, RUDDER, TAILPLANE, BRAKES, THROTTLE and AIR BRAKE channel switches (Panel L) control the power supply from the contacts of relay APO to the respective hydraulic stop valves.
- (h) The press to ENGAGE switch (PCU) controls the power supply from the FCC master switch to the 24 illuminated press switches (PCU) controlling FCC functions, the PITCH, ROLL and YAW indicators (PCU), the Q pot pitot/static valve actuator, the Q POT OUT Indicator (Panel AU) and relay APO via the contacts of PCU engage relay (enabling the FCC signals to control the aircraft).
- (j) The press RADIO switch (PCU) controls the power supply from the MAIN and ST/BY HEATERS switches to the main and standby command receiver/decoder circuits and inhibits the 24 press control PCU switches.
- (k) The press to DISENGAGE switches (PCU, throttle lever, control column and contacting accelerometer) complete the circuit to energise the latching relay APO and its contacts. Depression of any DISENGAGE switch will disconnect the FCC from the aircraft.

- (l) Depression of Pilots ICO trigger switch (control column) breaks the circuit from the standby battery to relay DET. The contacts of the now de-energised relay break a circuit to the DC POWER indicator and completes the circuit to the ICO gas generators (Ref sub-para.r).
- (m) The AUTO position of the UNDERCARRIAGE, FLAPS and LP COCKS selectors (Panel F) connects the FCC to their respective valve actuators.
- (n) The AIRBRAKE switch (Stbd throttle lever) selected to OFF (mid-position) connects the FCC to the airbrake valve actuator.
- (o) The AUTO-LOAD SHEDDING double pole switch controls the current from each generator reverse current circuit breaker to the appropriate load shedding relay.
- (p) The ARMED/OFF ISOLATION double pole switch (Port wing tip) controls the power supply from the THROTTLE channel switch to the throttle hydraulic stop valve and the current from the load shedding relays to earth.
- (r) The ARMING BREAK/green access cover (Port fuselage nose) completes the circuit from the contacts of relay DET to the aileron, rudder and tailplane ICO gas generator cartridges (Ref sub-para.l).
- (s) The ICO piston pins (Port aileron, rudder and tailplane servodynes) secure the drone actuators to the pilot's servodyne input levers.

Requirements for piloted or manned drone role:

- (i) Green arming break/access door fitted to nose arming break.
- (ii) Green locking caps fitted to actuator change-over valves on port aileron and tailplane.
- (iii) ICO gas generator cartridges fitted to aileron, tailplane and rudder actuator/servodyne control levers.
- (iv) ICO connector fitted to PL1 receptacle on drone relay box.
- (v) DP7 connector fitted to dummy stowage on UDP.
- (vi) Wing tip ISOLATION switch selected to ARMED.

24 Pilot Controlled Flight

- (a) Cockpit switch/control configurations for Pilot Controlled flight are as required by Flight Reference Cards FR 11/84-1.

(b) In the event of the aileron, rudder and/or tailplane controls becoming manually inoperative, due to a fault in the drone actuators, the control column trigger switch is depressed to ignite the actuator cartridges. The piston pins are withdrawn, by the gas charge produced, from the joints of the drone actuators and the pilot's servodyne input levers. The controls return to manual operation, irrespective of the actuator's position. The system cannot be re-engaged in flight.

(c) In the event of the port throttle becoming manually inoperative, due to a fault in the drone actuator, the engine is shut down by selecting the PORT LP cock to close. The throttle lever interconnecting latch is released and the starboard throttle operated as required.

25 Manned Drone (PCU) Controlled Flight

(a) Cockpit switch/control configurations for Manned Drone PCU Controlled flight are as required by Flight Reference Cards FR 11/84-2.

(b) The PCU ENGAGE switch engages the FCC to control the aircraft as demanded by PCU commands (PCU RADIO lamp - OFF).

(c) The FCC may be disengaged by depressing either of the DISENGAGE switches located on the PCU, throttle lever or control column. The contacting accelerometer will disengage the FCC if G forces exceed +4.8 or -1.5. The FCC can be re-engaged by depressing the ENGAGE switch on the PCU.

(d) In the event of the aileron, rudder, tailplane or throttles becoming manually inoperative, after disengaging the FCC, refer to sub-paras 24(b) and 24(c).

(e) The aileron, rudder, tailplane, throttle, wheelbrakes and airbrake may be manually operated by selecting the appropriate channel switch to OFF. The wheelbrakes FCC control may also be overridden by applying greater pressure on the toe pedals.

(f) The undercarriage and flaps may be manually operated by moving the appropriate selector from AUTO to the required manual selection.

26 Manned Drone (GCU) Controlled Flight

Comments regarding GCU flight are as those for PCU flight Para 25 with the exceptions:-

(i) The relevant Flight Reference Cards are referenced FR 11/84-3.

(ii) The PCU ENGAGE Switch engages the FCC to control the aircraft as demanded by GCU commands (PCU RADIO lamp - ON).

PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 5 - FLIGHT INSTRUMENTS AND COMPASSES

Contents

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1 Pressure instruments

(a) The following instruments are connected to the port wing pressure head:-

ASI
 Contacting machmeter for the tailplane gear change
 Machmeter
 Altimeter Mk 28
 Rate of Climb
 Ice detector relay unit
 Cabin pressure controller
 Flight control computer

(b) Q feel system and stick damper are connected to the port fuselage pressure head.

(c) The pressure heads are electrically heated and controlled by three Pitot Heater switches on panel H.

Note ...

The starboard pressure head is fitted but is not used.

2 Master reference gyro (MRG)

(a) The MRG installation provides pitch, roll and heading information for the FCC, auto-pilot, the attitude indicator and the compass system. The installation comprises an earth gyro mounted on an inner platform which, in turn, is mounted on an outer platform. The platforms are in effect gimbals and both are capable of being rotated in their respective planes by servo motors activated by signals from the gyro itself. This ensures that the gyro will not topple as the platforms are always in the same relative position to the gyro and the earth. Acceleration and turning errors are eliminated by cutting erection during turns faster than $20^{\circ}/\text{min.}$ or accelerations greater than $1/12G$.

(b) The MRG is switched on when the instruments INVERTER switch and the MRG master switch (on Panel H) are both ON. For the first 3 seconds of the starting cycle the platforms are rapidly set to their datum positions and for the next 17 seconds fast erection of the earth gyro takes place. At the end of this period the MRG is erected to within 1 degree. A FAST ERECTION push button is above the autostabiliser switches on panel AU. Its purpose is to enable the gyro to return to the stabilised position faster than it normally would after the completion of a manoeuvre.

CAUTION ...

Should it be necessary to switch off the MRG within four minutes of it being switched on, a period of four minutes must elapse before it is again switched on.

(c) The inner platform is also used as a mounting for the MK 5 FT horizon gyro unit.

3 Attitude indicator Mk Fl(M)

(a) The attitude indicator (roller blind), which is operated by signals from the MRG, gives a continuous indication of pitch by a roller blind presentation and of roll, by a pointer at the bottom of the blind frame. The blind is half white and half black and the dividing line represents the natural horizon; cruciform markings, whose larger limb points in the direction of the horizon, are at the zenith and nadir positions. On the face of the instrument are two circles which represent 20° and 40° of pitch, and in the vertical plane only, there are additional marks which represent 10° , 30° and 50° . Roll markings are 10° , 20° , 30° , 60° and 90° port and starboard.

(b) An OFF flag is at the top of the instrument. The flag is retracted after 20 seconds, i.e. when the MRG is erected. A fast erection button is provided above the indicator.

4 Horizon gyro unit

(a) The Mk 5 horizon gyro unit is fitted to meet the case of failure of the attitude indicator. The instrument requires a.c. and d.c. supplies. a.c. supplies are normally from the type 103A inverters and d.c. supplies are from either the main or emergency battery via the ART. HOR.NORMAL/EMERGENCY switch on panel H.

(b) If both Type 103A inverters fail, a transistorized inverter unit, coupled to the instrument, automatically converts d.c. (within the limits of 20V-29V) from the battery in use to a.c. to maintain the operation of the horizon gyro.

(c) A fast erection button is provided. It must only be pressed during straight and unaccelerated flight otherwise false attitudes will be indicated. It must be maintained pressed until the gyro axis reaches vertical, but not pressed for longer than 60 seconds.

(d) The gyro cannot be erected initially by d.c. alone.

(e) An OFF flag appears in an aperture in the face of the instrument if any of the following conditions arises:-

- (i) Power supply is lacking.
- (ii) Voltage is too low for correct operation.
- (iii) An open circuit exists in any of the three phases of the stator windings.
- (iv) Phase rotation is incorrect.

5 Gyro compass Mk.5FT

(a) The azimuth gyro on the inner platform of the MRG is monitored and controlled by a detector unit in the port wing tip. Signals from the gyro are transmitted to the compass on the instrument panel.

(b) An OFF flag in the face of the instrument is retracted as soon as the MRG starting cycle is complete and remains retracted as long as current is supplied. The compass will indicate accurately irrespective of aircraft attitude.

(c) Indication of synchronisation is given by a dot/cross annunciator. When the instrument is synchronised, both the dot and the cross are partially visible and a vertical white line is in the centre of the window. Very slight oscillation then occurs. At the bottom right-hand side of the instrument is SYN knob, which can be turned easily in the direction to give quickest synchronisation but tends to resist turn in the wrong direction. If the knob is turned sufficiently in the wrong direction, a slipping clutch comes into operation.

(d) At the bottom centre of the compass is a push button which, when pressed, selects either monitored compass or directional gyro. If the latter is selected, a DG flag appears in a window above the button and the annunciator takes up a rigid neutral position.

(e) Standby azimuth gyro is fitted as an alternative source of supply to the MRG. Beneath the fuel gauge selector switch on panel AN is a NORMAL/ STANDBY switch. When the switch is set to STANDBY, the MRG is isolated from the compass system and the standby gyro is in operation.

(f) When either selection is made, the pilot's indicator may rotate through 140° either way. This is a positive indication that changeover has taken place. The compass should then be re-synchronised.

(g) When the compass is operating from the standby gyro, varying rates of indicator rotation occur during steady turns. Occasional errors of 10° may be experienced on completion of turns but should disappear in less than 5 seconds. Occasional errors of up to 35° may also occur after manoeuvres in the looping plane; the compass should be re-synchronised after such manoeuvres.

6 E2B compass

The E2B compass is on the starboard windscreen arch. It is unreliable if the canopy is open. Its illumination is controlled by the dimmer switch on panel H and, in emergency, by the emergency lights switch.

7 Airstream direction detector - general

A Mk 2 airstream direction system is provided. This comprises a horizontal probe on the port side of the fuselage; a single-pointer incidence indicator has a scale marked at 0, 10, 20 and 30 units and an index set at the optimum angle of attack (about 20 units). There is also an approach index which consists of a small display of three red lights, a circle representing the optimum approach angle and two arrows which show the direction of required correction. The master APPROACH AID-ON switch and a volume control are provided at the bottom of panel H. A heater in the probe is automatically controlled by a thermostat, but the d.c. supply is routed through the pressure head heater switches. The indicator is on Panel B and the index light panel is on the windscreen arch to port of the PCU. The three-tone audio approach system is controlled by the volume control on Panel H.

8 Airstream direction detector - operation

(a) The probe is divided horizontally into upper and lower halves and each half has a slot which faces into the airstream. Each slot is connected to an air passage which feeds the air to opposite sides of a chamber containing a vane, which is mechanically linked to the probe. Under steady airflow conditions the pressure differential at the slots is zero. When a change of airflow direction occurs the vane and the probe rotate to return the pressure differential to zero. Potentiometers detect this movement, and the signal they give is then suitably processed to operate the indicator, the approach index lights and the audio signal.

(b) The three approach index lights, an upper arrow, a circle and a lower arrow indicate as follows:-

Indication	Approach	Correction
Upper arrow	Very slow	Lower nose
Upper arrow and circle	Slow	Lower nose slightly
Circle	Correct	Nil
Lower arrow and circle	Fast	Raise nose slightly
Lower arrow	Very fast	Raise nose

(c) In the ADD when switched on for the approach, the audio signal is first heard as a high-pitched note, interrupted at a rate of 10 per second. As the optimum angle of attack is approached the rate of interruption decreases to 1 per second and is superimposed on a continuous medium-pitched note. As the optimum angle is reached only the medium note is heard. With further increase in the angle of attack a low-pitched note, interrupted at 1 per second, is superimposed on the medium note, which eventually ceases, leaving the low-pitched note. Interruptions of this note increase to 10 per second as the stalling angle is approached.

(d) Depending upon the attitude correction required a corresponding increase or decrease of power must be made.

(e) (i) Provision is made for transmitting the ADD tone over the ground test frequency of the standby UHF set. This is achieved by setting the UHF STANDBY A/G switch to A and holding down the standby press-to-transmit switch on panel L.

(ii) This facility can not be used if the main UHF set has failed and the standby set is in use. In this event the standby switch must be returned to G in addition to other existing switching procedures.

PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 6 - ENGINE CONTROLS AND INSTRUMENTS

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1 Avon 208 engines

(a) General

The two engines are 15-stage axial-flow gas turbines, each developing 11,250 lb. static thrust at sea level. The main engine systems include:-

A low-pressure air starting system (see para.3)
 Relighting facilities (see para.4)
 Top temperature control (see para.5)
 Self-contained oil system.

(b) High pressure fuel pumps

Each engine has a dual HP fuel pump, either side of which will permit approximate take-off RPM to be obtained.

(c) Fuel control system

The system contains the following sensing controls:-

(i) Max. RPM governor

The max. RPM are governed automatically; the RPM may, however, vary with altitude and differing take-off conditions, necessitating manual control to prevent the limitations being exceeded.

(ii) Altitude sensing unit

This varies pump delivery flow in accordance with in-take air pressure resulting from a change in altitude.

(iii) Altitude idling valve

This prevents idling extinction at altitude by providing a minimum limit to fuel flow when the throttle is closed to the idling position.

(iv) Acceleration control

This automatically limits the rate of increase of fuel flow to the burners during throttle movements.

(v) Top temperature control (see para.5)

(d) Oil system

The oil system is self-contained. 9½ pints of oil are carried in each engine sump.

2 Throttle/HP fuel cocks

(a) Each HP cock is controlled by its associated throttle lever. A retractable stop is provided on each throttle lever and controlled by two press-to-trip levers between the throttle levers. To close the HP cocks, the stops must be tripped either by pressing the levers or by energising the lock solenoids via the FCC in the manned drone role (SHUT DOWN) and then the throttles fully closed; when forward of the stops, the HP cocks are fully open and RPM are then controlled by throttle movement.

(b) A friction damper controlling both throttles is operated by a lever on the inboard face of the throttle box and is moved forward to increase friction.

(c) The starboard throttle lever carries a FCC disengage switch.

3 Starting system

(a) The engines are started by low-pressure air starters, one on the front of each engine; an external supply is necessary and is provided by a Palouste Mk.101 low-pressure air starter unit which may be fitted either

to a ground trolley or an airborne pod. In the latter case the pod is attached to a heavy stores pylon and thus enables the starter to be carried with the aircraft if circumstances demand this action.

(b) Two external air and two external electrical supply connections are provided, one pair for each engine, beneath the fuselage. When started and plugged in, the Palouste is under the control of the switches in the cockpit.

(c) The switches, on panel J, are:-

(i) The MASTER ACCUMULATOR ON/OFF

(ii) The IGNITION ON/OFF

(iii) The ENGINE MASTER ON/OFF

(iv) The engine START buttons

(d) (i) With the starter unit coupled to the appropriate engine and the associated ignition and engine master switches on, pressing the start button causes the Palouste starter to accelerate and air to be supplied to the engine starter.

(ii) The engine normally lights up at about 10% RPM and the starter circuit is broken at about 24% RPM by a centrifugally-operated cut-out switch on the engine starter.

(iii) When the starting cycle is broken, the trolley air delivery valve is closed and the engine igniters switched off.

(e) Full starting instructions are given on the Flight Reference Cards (FR 11/84-1, -2 or -3).

4

Relighting system

(a) A relight button for each engine is on the rear face of the throttle box. Provided that electrical power is available either from the normal or emergency supply, and the ignition switches are on, pressing either button causes the associated ignition system to operate for about 30 seconds and then automatically switch off.

(b) Full relighting instructions are given in Part III, Chap 4, para.6 and on the Flight Reference Cards.

(c) Before starting, the relight system must be checked by operating the relight buttons on the throttle quadrant in turn. The ignition switches must be ON before this check is made. Press each relight button for two seconds and release in turn. The igniters will then run automatically for 30 seconds, but switching off the

ignition switch(es) after a brief check will allow the time cycle to expire without igniters operating. If serviceable, an irregular clicking sound will be heard. A regular clicking indicates that only one igniter is working.

5 Top temperature control

(a) An ON/OFF switch for each engine JET PIPE TEMP. CONTROL system is on the rear face of the throttle box. When the switches are ON (up) and one of the Type 103A inverters is running, the JPT is prevented from rising above the maximum permitted value by trimming down the fuel flow. Maximum RPM will then vary according to ambient air temperature, altitude and forward speed.

(b) When the switches are OFF, the systems are inoperative and max. JPT must then be controlled by throttle movement.

6 Engine instruments

Jet pipe temperature gauges and percentage calibrated RPM gauges are on the starboard side of panel B. Oil pressure switches, connected to the centralized warning system, give indication of low oil pressure.

7 Fire detection system

(a) A continuous firewire sensing element is in each engine bay and in the accessory bay. It is arranged around the combustion chambers and exhaust units of the engines and connected to insulators on the forward side of the rear fire walls.

(b) Current for the system is provided by the main and standby inverters which operate a relay to complete the circuit to the appropriate warning lights on the CWP and in the extinguisher buttons. Emergency supply is from the Type DA1 inverter.

(c) A FFPD (fault free fire detection) system is fitted, which is less susceptible to firewire defects leading to false warnings, but which is more sensitive to detecting such faults during the functional test.

(d) Testing

(i) When the CWS is tested (see Pt 1 Chap 1, para.19) with an inverter running, if the CWP fire warning and extinguisher button lights do not come on, or if they fail to go out when the test button is released, the system is unserviceable.

(ii) The system should be tested:

- 1 Just prior to start-up.
- 2 After landing (prior to engine shut-down) since at these times there is the greatest possibility of an abnormal amount of moisture being present. (Moisture contamination is the major source of false warnings). The system should not normally be tested in the air.

8 Fire extinguishing system

(a) The fire protection areas are divided into five zones:

Zone A - The accessory bay forward of the front firewall and common to both engines.

Zone 1 - Port and starboard. - The area between the front and rear firewall.

Zone 2 - Port and starboard. - The area aft of the rear firewall.

(b) Three fire extinguishers are provided, a single-shot extinguisher in the accessory bay for Zone A and a dual-headed extinguisher in each wheel well serving Zones 1 and 2 of the appropriate engine.

(c) Each extinguisher may be fired individually by manual operation of the appropriate extinguisher button FP, FS, FA, just aft of the CWP or they will fire simultaneously if the crash switches operate. Operation of the pushbuttons of the port and starboard extinguishers will fire only one head of each extinguisher, into the associated Zone 1. The second head, which discharges into the appropriate Zone 2, can only be fired by the operation of the crash switches.

(d) After the fire is extinguished, the associated warning light should go out within 30 seconds.

(e) See part IV, Chap 1, para.3 and 4 for engine fire drill.

9 Engine and intakes anti-icing system

(a) Hot air, tapped from the 15th stage engine compressor, is supplied via hot air valves (two per engine) to the intake and front of the associated engine as a protection against icing.

(b) A single DE-ICING MANUAL-OFF-AUTO switch on panel AU controls both engines anti-icing system. The positions and function of the switch are as follows:-

- AUTO (up) - The hot air valves open automatically if ice is detected.
- OFF (mid) - The electric supply to the system is cut off.
- MANUAL (down) - The hot air valves are selected open. The ice detector magnetic indicator (see (d) below) is inoperative.

The system is designed for use with the switch set at AUTO, the other two positions being provided should the automatic system fail.

(c) Before the switch can be moved from one position to another, it must first be pulled outwards. Releasing the switch locks it in the selected position.

(d) Two magnetic indicators are to the left of the switch. The upper DETECTOR indicator is operated by a pressure switch in an ice detector probe on the port side of the fuselage nose to show striped when ice formation occurs. The lower VALVES CLOSED indicator shows striped if any one of the hot air valves is not in the closed position. This occurs simultaneously with the ice detector indication when the system is in AUTO.

(e) When icing conditions have been detected, the hot air disperses the ice formation at the intakes and an electric supply is made to a heater element in the detector head. The electrical supply to the heater element remains on for 30 seconds. It will come on again if ice reforms on the detector head. After a four-minute interval, the hot air valves are closed, and the icing conditions and hot air valves indicators revert to black. The detector head heater is switched off. If icing conditions persist, the whole cycle is repeated until the aircraft is clear of icing conditions.

10 Use of the engine anti-icing system

(a) With the system in use, all throttle movements must be made smoothly. There is a loss of thrust and fuel economy. JPT's usually rise by about 20°C. At full throttle, 100% RPM may be unobtainable if the JPT controllers come into operation. Adequate protection is given over the range of +5°C to -17°C.

(b) Ground running

The system must be used during ground running in icing conditions or when the OAT is below +5°C and visibility is less than 1,000 yards.

(c) Take-off

Under normal conditions, leave the switch at AUTO, but if abnormally cold and moist conditions prevail (below +5°C and 1,000 yards visibility) select MANUAL while ground running and for take-off.

(d) Climbing

Climb at the maximum permissible rate with a power setting not less than 90%. If the ice detector magnetic indicator shows striped, check that the hot air valve magnetic indicator also shows striped. If it does not do so, select MANUAL.

(e) General flying

(i) Loitering in continuous icing conditions must be avoided and such conditions traversed as quickly as possible in climb or descent. Cumulus and cumulonimbus should be avoided.

(ii) Regularly check the operation of the gate valves and indicator with the system in MANUAL. The indicator should alternate between striped and black regularly every 10-15 seconds at engine speeds above 80% below 20,000 feet, or 90% at all altitudes. When flying in AUTO the indicator should indicate similarly, if icing conditions exist or have just ceased to exist, until four minutes clear of such conditions.

(iii) If the indicator fails to show cycling but remains striped in either of the above conditions, assume that the valve has failed and limit both engines to a maximum of 80% except in cases of operational necessity.

(f) Descending

Throttle back to not less than 70% RPM and descend at the maximum permissible rate; maximum protection is obtained at the highest practical RPM.

(g) Landing

If AUTO remains selected, the hot air valves will remain open for 4 minutes after the icing conditions have been cleared. If conditions permit, select DE-ICING OFF prior to landing and wait 10 seconds before making any throttle movement. If icing conditions persist down to ground level, leave AUTO selected and if practicable, maintain engine speed above 70% until finally committed to a landing.

PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 7 - AIR SUPPLY SYSTEMS

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DESCRIPTION1 General

The air supply systems consist of a low pressure system which is supplied from the engine compressors and a high pressure system which is supplied from two NATO air bottles.

2 Low pressure system

Four separate tappings from the 15th stage compressor of each engine supply air to the following:-

- (i) Windscreen rain clearance (see para.9)
- (ii) Engine intakes anti-icing (see Chap.6, para.9).
- (iii) Air conditioning system (see paras.4 etc)
 - Fuel tanks main vent valve
 - Fuel and methanol recuperators
 - Pilot's anti-G suit (see para.4c)
 - Windscreen de-icing (see para.6)

3 High pressure system

Two NATO air bottles beneath the cockpit floor are ground-charged to a pressure of 3,000 PSI and supply air through a reducing valve and air drier to the following:-

Pilot's canopy seal
Observer's hatch seal

4 Air conditioning

(a) The air conditioning system provides controllable ventilation, variable heating, cabin pressurisation and cooling air to equipment.

(b) Hot air is passed through a pressure control valve to two heat exchangers and thence to a cold air unit and water extractor. A temperature control valve permits a variable quantity of hot air to by-pass the heat exchangers and cold air unit and thus provides a means of varying cabin temperature. A supply of ram air from atmosphere is taken to each heat exchanger and then exhausted to the engine bay.

(c) A tapping upstream of the pressure control valve supplies hot air direct to the fuel recuperators, fuel main vent valve, windscreen de-icing system, methanol recuperator and pilot's anti-G systems.

5 Cabin pressurisation

(a) The conditioned air supply is carried to the cabin by a ducting assembly which terminates at a ram air shut-off valve.

(b) The duct supplies air to the windscreen side panels and canopy demisting points, to the crew punkah louvres and to diffusers at the crew's feet.

(c) Pressurisation is only obtainable above 10,000 feet. A pressure controller limits the cabin differential to 3½ psi above 25,000 feet. Above 10,000 feet, the pressures are in accordance with the following table:

Aircraft altitude (ft)	Cabin altitude (ft)
20,000	14,000
30,000	17,500
40,000	24,000
50,000	30,000

Note ...

If the ground test knob on the pressure controller is not set to FLIGHT (aft), cabin pressurisation, at the full pressure differential, will be obtained from the ground upwards.

(d) Air leaves the pressurised cabin via an axial-flow discharge valve.

6 Windscreen de-icing

(a) Hot air is ducted from the air conditioning supply to the bottom of the windscreen interspace and is exhausted to atmosphere by louvres at the top of the windscreen.

(b) The supply and temperature are automatically controlled by a valve incorporating a temperature sensing element. The valve controls the mixture of hot air with air discharged from the cabin.

(c) There are no pilot- operated controls.

CONTROLS AND INDICATORS

7 Cabin pressurisation controls and indicators

(a) The supply of conditioned air to the cabin is controlled by a cabin air supply ON/OFF/RAM lever on panel G. When set to OFF, the flow control valve and the ram air shut-off valve are both closed; when set to ON, the flow control valve is open and the ram air valve remains closed. Pressurisation then obtains above 10,000 feet. If the lever is set to RAM, the flow control valve is closed and a ram air supply is fed through the ram air valve. At the same time, the air discharge valve is fully open thus providing a free circulation of air through the cabin.

(b) A cabin altimeter on panel D shows the equivalent pressure altitude in the cabin. If pressurisation fails and cabin altitude rises to $32,000 \pm 3,000$ feet, indication is given on the CWP.

8 Cabin temperature controls and indicators

(a) Cabin temperature control is only available when the cabin air supply lever is ON. Temperature is controlled by a VENTILATION AIR TEMP AUTO-MANUAL selector on panel G and a rotary cabin temperature control on panel H to the left of the emergency electrical services switch.

(b) With the selector set to AUTO and the desired temperature set by the rotary cabin temperature control, cabin temperature is then automatically controlled electrically. Two ductstats in the duct to the cabin vary the position of the temperature control valve to maintain the selected temperature. Electrical supplies are from the Type 103A inverters. While cabin temperature is achieving the initial setting, the flow control head of the auto-manual selector can be seen to rotate.

(c) If the automatic system fails, cabin temperature can be regulated manually by setting the selector to MANUAL. This disconnects the electrical supplies, and the position of the temperature control valve may then be adjusted mechanically by rotary movement of the flow control head of the temperature selector between COLD, MEDIUM and HOT.

9 Windscreen rain clearance and control

(a) An air blast system of rain shedding is provided. It is controlled by two RAIN CLEARANCE ON/OFF switches forward on the throttle box. With the switches ON, air from the 15th stage compressors of both engines is fed through two air valves (one on each engine) and independent ducts running along the port side of the fuselage, just below the canopy, to the port front windscreen panel. The system provides adequate rain clearance when operated from either engine, but for best results both engines should be running and both switches should be ON.

(b) On the ground, the system should only be switched on just before take-off or when taxiing at RPM below 75%. Prolonged running above 75%, particularly when the aircraft is stationary, can lead to canopy cracking.

NORMAL MANAGEMENT OF THE AIR CONDITIONING SYSTEM

10 Before start-up

Check that the cabin air supply lever is fully forward and that the flow controller selector is at AUTO. In AUTO select the desired temperature (above 15°C) with the rotary cabin temperature control selector.

11 Control of cabin temperature

The system may be controlled in AUTO but if RAM air is selected when flying at high speed at low level, high cockpit temperatures can be experienced. In MANUAL do not select full cold or more than three-quarters hot.

12 High humidity

In conditions of high temperature and humidity the action of the CAU may cause severe internal misting of the windscreen, canopy and flight instruments. To prevent misting, set the ventilation air temperature selector to MANUAL and rotate the selector head to the MEDIUM range.

MALFUNCTIONING OF THE AIR CONDITIONING SYSTEM

13 Pressurisation failure

If the cabin pressurisation warning is given on the CWP, select the oxygen switch to EMERGENCY and descend to below a cabin altitude of 30,000 feet. Selecting the cabin air supply lever to RAM may result in a slight increase of cabin pressure.

14 Inverter failure

If both inverters fail with the system in AUTO control, move the ventilation air temperature selector to MANUAL and physically rotate the rim of the selector head to the desired position.

PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 8 - COCKPIT CANOPY AND OBSERVER'S HATCH

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1 Pilot's canopy control

(a) The canopy is operated electrically. The supply is always from the aircraft battery, unless for ground operation an external supply is connected, in which case the battery master switch must be OFF in order to transfer the load to the external supply. Excessive ground operation on the internal battery will lead to battery failure. A clear sliding canopy gives improved head room and access to the ejection seat face blind. It also enables a lower final approach speed to be used.

(b) (i) A three-position OPEN (down)-OFF (Spring-loaded off)-CLOSE (up) switch on the left of panel AU controls operation of the canopy. To open or close the canopy the switch is selected as required and then released. This causes a rotary selector, every alternate position of which is open circuit, to be moved to complete the circuit to the canopy actuator. To stop the canopy in any intermediate position, the three-position switch should be set to OPEN or CLOSE (either position will be effective) to select an open-circuit position of the rotary selector. At the extremes of movement of the canopy, micro-switches operate a relay to automatically select the rotary selector to open-circuit and a second selection to stop the canopy is not required.

(ii) If, however, when fully closing or fully opening the canopy

- (1) The switch is not released after selecting OPEN or CLOSE but held until the canopy limit is reached or
- (2) The switch is operated again as a check that the canopy is at its limit or
- (3) A micro-switch or the relay malfunctions

it will be necessary to make a double selection to start the canopy moving away from its limit, since the rotary selector will be in a close-circuit condition and the first selection will move it to open-circuit.

(c) The canopy seal is automatically inflated when the canopy reaches the closed position. When OPEN is selected there is a delay before the canopy starts to move to enable the seal to deflate.

(d) The canopy can be operated from outside the aircraft by means of two pushbuttons on the port side of the fuselage. The pushbuttons, which have to be held in while the canopy is in motion, do not operate the rotary selector. To inflate the canopy seal when closing the canopy externally, first operate the switch at the right rear of the pilot's seat and then close the canopy by holding the external closing button pressed continuously until the operation is complete.

(e) A red crank handle, for ground use only, at the top of the starboard switch panel, may be removed from its stowage and inserted in the adjacent socket to wind the canopy open or shut. Before the handle can be inserted fully into the socket, a red-painted lever below the socket must be pulled down.

(f) Retractable rear view mirror

The rear view mirror is automatically retracted when the canopy is opened. It must be moved manually by the pilot to the operational position after the canopy is closed.

2 Canopy jettisoning

(a) The canopy is jettisoned explosively whenever the ejection seat face screen or seat pan firing handle is pulled. Until the canopy is jettisoned a control arm at the top of the seat prevents further movement of the ejection seat firing handles. As the canopy leaves the aircraft the control arm is pivoted allowing for further movement of the firing handles. The ejection gun seat is then withdrawn from the breech time delay firing unit, and, one second later, the seat is ejected from the aircraft.

(b) The canopy may also be jettisoned by means of the CANOPY EMERGENCY RELEASE handle on panel AU. If the canopy jettison gun does not fire when this handle is pulled, the front latches are in any event released and the canopy may be pushed clear.

(c) Whether method (a) or (b) is used, the canopy and rails are forced upwards by gas from a cordite cartridge.

(d) External jettisoning is achieved by a lever aft of the external operating pushbuttons. The lever is released by pressing a stud situated below it to free the canopy latches. The canopy may then be lifted clear.

3 Observer's hatch

(a) The observer's hatch is opened and closed by operation of an external lever forward of the hatch, after first releasing the lever from its stowage by pressing in a central button.

(b) The wingfold warning magnetic indicator gives indication when the hatch is not locked. A WFOLD warning is given on the CWP as well.

(c) If the cockpit has been pressurised the pressure must be relieved by operating the pilot's canopy before the observer's hatch.

PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 9 - AIRCREW EQUIPMENT ASSEMBLY AND OXYGEN SYSTEM

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EJECTION SEAT TYPE 4DSA 1 MK 41 General

(a) A type 4DSA1 Mk 4 ejection seat is fitted. The seat has a combined safety and parachute harness which is fastened by a single quick-release box. A blacktype Mk 50A harness and parachute pack of the horse-shoe type is fitted. The pack is secured by two restraining straps at the upper end. The seat pan accommodates a personal survival pack, type R (N), containing a life-raft and survival equipment. Two leg restraining cords are fitted at the front of the seat pan. An emergency oxygen bottle is stowed behind the seat pan.

(b) At the rear of the seat is the 80 ft/sec ejection gun and a drogue gun. The seat has two firing handles, one on the drogue container attached to the face screen and the other on the front of the seat pan.

(c) A G-stop is incorporated to prevent the opening of the main parachute if the speed of the seat, after ejection, is too high for safe deployment. The switch prevents the operation of the barostatic time delay unit until the speed of the seat has fallen to a safe figure. The seat has a ground level ejection capability-provided that the aircraft's flight path is parallel to the ground and the speed is a minimum of 90 knots. If the aircraft is descending, more than the minimum altitude will be required.

2 Seat adjustment and lean-forward release

The height of the seat may be adjusted by an electric motor controlled by a switch situated on panel J. The harness lean-forward control for the seat is situated on the port side of the seat pan.

3 Personal equipment connector

The PEC is located on the starboard side of the seat and provides intercom, RT, oxygen and anti-G supplies. On ejection, these services are automatically disconnected by static line. Emergency oxygen is supplied through the PEC but is not turned on until ejection or when selected. Disconnecting the man portion of the PEC frees the leg restraining cords.

4 Combined harness quick-release box

The quick-release box, when fastened, secures the occupant to the seat. The box must not be operated when carrying out manual separation in the air, since this will free the occupant from both seat and parachute.

5 Manual separation handle

(a) The handle at the port side of the seat pan has a thumb press safety lock. When it is depressed and the handle pulled up, the locks of the safety harness, the man component of the PEC, and leg-restraint cords are all released.

(b) Guillotine firing unit

The guillotine is on the port side beam of the seat and its seat is connected to a static line from the parachute. When the occupant and parachute are freed from the seat, the sear is withdrawn, firing the guillotine and the

parachute withdrawal line is severed by the guillotine blade. A safety pin is provided for the guillotine sear.

6 Ripcord D-ring

This is provided for manual opening of the parachute should the seat fail to eject or automatic opening of the parachute fail after ejection.

7 Leg restraining cords and adjusting controls

(a) The cords ensure that the occupant's legs are drawn back automatically and restrained close to the seat pan during ejection, thus providing clearance and preventing the legs being blown apart after ejection. The cords are attached to the aircraft structure at their lower ends and pass through snubbing units beneath the front of the seat pan, which allow the cords to pass freely down through the units but prevent them passing upwards. An adjusting ring on each snubbing unit, when pulled forward, allows the occupant to adjust the cords to give comfortable leg movement in the aircraft. The ends of the cords plug into units on the forward face of the seat pan.

(b) After ejection, the legs are held in position until the seat-harness portion of the combined harness is released or until the manual separation lever has been operated. The restraining cords are then pulled through the leg strap D-rings to free the legs.

8 Normal operation of the seat

(a) When the associated firing handle is operated, the canopy is jettisoned immediately by gas pressure from the canopy jettison cartridge. One second after canopy jettison, the seat is ejected and the drogue gun fired half a second later. When using the seat pan firing handle, the occupant must first press his head firmly against the headrest to prevent spinal injury on ejection.

(b) The seat cannot eject unless the canopy has jettisoned.

(c) On ejection, the aircraft part of the PEC is disconnected from the seat portion and on separation, the man portion of the PEC disconnects from the seat.

(d) As the seat is ejected, an operating rod readies the barostatic time-delay mechanism. When the free descent reaches 10,000 feet, or at once if ejection has taken place below that height and provided the G-stop has not operated, the barostat removes an obstruction to the gear train of the mechanism, allowing it to operate. After 11/4 seconds, the seat harness portion of the combined

harness is released, the seat-stabilising drogues are freed and, by a connecting lifting line, the face screen is disconnected and the parachute deployed. The occupant is momentarily prevented from leaving the seat by two sticker straps until deployment of the parachute lifts him clear of the seat.

9 Negative G restraint

A negative G restraint strap is fitted which passes through a bracket on the inside front face of the seat pan, underneath the parachute apron where it divides into two, and through two guide brackets at the rear of the seat pan. The end loops are fitted over the lugs of the parachute harness straps and secured by the lower harness restraint locks. The front end terminates in a Y piece, the two end loops of which are attached to the lap strap lugs before they are connected to the QRB. Tightening the strap by pulling downwards on an adjusting strap prevents forward movement of the PSP and gives improved restraint under all G conditions.

OXYGEN SYSTEM

10 Gaseous oxygen system

A 2250 litre, wire-wound, high pressure cylinder is secured by straps to a bracket fitted under the cockpit floor. The cylinder is charged, in situ, to 1800 psi. A contents gauge is fitted to panel D and a demand regulator is fitted to panel J. An anti-kink hose connects the regulator to the PEC on the seat.

11 Emergency oxygen supplies

A demand emergency oxygen system is fitted to the seat. The system comes into operation automatically upon ejection and supplies oxygen, via a demand regulator on the starboard side of the seat, to the PEC. The bottle remains with the seat after separation occurs. The associated emergency oxygen manual control is moved to the front face of the seat, the operating cable passing beneath the seat.

USE OF PILOT'S EQUIPMENT ASSEMBLY

12 Strapping-in procedure

Having carried out the ejection seat checks as per the Flight Reference Cards, strap in as follows:-

- (a) Leg restraint garters should be adjusted to a position above the calf muscle and below the knee with the quick-release connections facing inboard.

(b) Ensure that the ends of the leg restraining cords are anchored to the cockpit floor.

(c) Connect 'man' position of the PEC to the seat portion.

(d) Pass the left restraining cord through the D-ring of the right leg restraining garter, and insert taper plug into the left leg line lock. Pass the right restraining cord through the D-ring of the left leg restraining garter and insert taper plug into the right leg line lock, taking care that the cords are not interlaced. Adjust the cords to allow for comfortable leg movement.

(e) Centralise the quick-release box on the waist belt, ensuring that it is in the LOCKED position.

(f) Connect the survival pack lanyard to the life jacket; ensure that it passes outside the left leg and under the left lap strap.

(g) Adjust the back pad and lumbar cushion to the most comfortable position, ensuring that the right-hand lap strap passes outside the PEC hoses. Place the loops of the negative G restraint strap over the lugs of the harness lap straps and connect them to the QRB, keeping the loops as near the QRB as possible. Tighten the harness lap strap, positioning the QRB as low as possible consistent with comfort. Finally tighten the negative G restraint strap.

(h) Pass the leg loops through the metal D-rings on the lap straps, bring the shoulder straps down through the leg loops and into the quick-release box. The bight of each leg loop should be moved as close to the QRB as possible, but clear of the disc knob.

(j) Tighten in the following order:-

- (i) Lap straps
- (ii) Negative G restraint straps
- (iii) Parachute harness shoulder straps (blue inner straps)
- (iv) Restraint straps (brown outer straps)

It is essential that these straps are adjusted so that the occupant is strapped in the seat with the base of the spine held firmly against the back of the seat.

(k) Put on the flying helmet and fit the oxygen mask.

(l) Operate the lean-forward release and lean forward as a check that the seat harness is securely fastened to the seat. At this stage, the ground crew should tuck in the loose webbing behind the pilot. The harness should re-engage and lock back on releasing the lever and leaning back. Should an extremely large individual use the seat, it is permissible to release the lift webs from the press-studded beackets to enable nearly all the excess

length to be used. After the flight, the webs must be returned to their positions within the beackets.

(m) Position the seat to bring the head to the centre of the headrest.

(n) Check that the face-screen firing handle is resting on top of the protective helmet, and that it can be reached with both hands. The ground crew remove the face screen firing handle pin and hands it to the seat occupant.

(o) Seat occupant removes seat pan firing handle pin and canopy jettison pin and stows all pins/clips.

13 Normal exit from the seat

(a) When leaving the aircraft after landing, the following procedure should be used: Remove appropriate safety pins from the pin stowage, fit the pin through the seat pan firing handle and hood jettison handle. Hand the remaining pin to the ground crew who fits it through the face screen firing handle lock.

Note ...

If no ground crew member is available, the pilot must fit all safety devices before leaving the aircraft.

(b) Unlock the harness quick-release fitting, free the straps and return the fitting to the locked position.

(c) Disconnect the personal survival pack lanyard.

(d) Disconnect the man portion of the PEC. Do not previously disconnect garter D-rings.

(e) Leave the aircraft.

14 Disconnection of personal equipment when leaving the seat in an emergency

The leg restraining cords are attached to the front of the seat and are released when the 'man' portion of the PEC is disconnected. There is no danger of the leg restraining cords preventing the PSP leaving the seat, but aircrew are warned not to attempt to leave the seat with only the life-raft lanyard connected to the PSP as the danger of snagging in the cockpit exists.

15 AEA drills for take-off, landing and in emergency

(a) For take-off

- (i) Connect all personal connections
- (ii) Ensure regulator set to give 100% oxygen

(b) On ditching or crash landing immediately after take-off

- (i) Jettison canopy
- (ii) Release combined harness, life raft lanyard and side attachments
- (iii) Disconnect PEC
- (iv) Leave the aircraft.

(c) In the landing circuit

- (i) Ensure regulator set to 100% oxygen

(d) On ditching or crash landing in the landing circuit

- (i) Jettison canopy
- (ii) Release combined harness, life raft lanyard and side attachments
- (iii) Disconnect PEC
- (iv) Leave the aircraft.

PART 1 - DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 10 - RADIO CONTROLS

Contents

	Para
UHF equipment	1
Intercom and telebriefing	2
SSR Cossor 1600	3
G & I Band Transponders	4
Malfunctioning of intercom/UHF	5

1 UHF equipment

(a) Two UHF transmitter-receivers are fitted, the main and the standby. The main UHF set controller is on panel J. The UPPER/LOWER aerial selector switch and the standby set G (guard)/A (ground test) and NORMAL/EMERGENCY POWER SWITCHES are on the RADIO switch bank on panel H. A UHF NORMAL/STANDBY switch permits the selection of the main or standby set.

(b) The pilot's press-to-transmit switch is on the starboard throttle and a PRESS TO MUTE switch is on the throttle box.

(c) Power for the standby set is either from the main d.c. system or from the standby battery when the EMERGENCY ELECTRICAL SERVICES switch is at MAIN ACCUMULATOR ON. When the switch is at EMERGENCY ACCUMULATOR ON the standby UHF power is from the standby battery regardless of the position of the power switch.

(d) Auto-tone transmission

A switch assembly is operated by a rod attached to the rear of seat. When the seat ejects, the switch is tripped and a flasher unit effects an interrupted supply to the transmit circuit of whichever UHF set is selected, causing an intermittent tone to be transmitted.

2 Intercom and telebriefing

(a) A separate A1961 amplifier provides intercomm between pilot and ground crew. Should the amplifier fail, emergency intercomm is provided by side tone from the UHF sets.

(b) An INT. COM. ON/OFF/EMERGENCY switch on the RADIO switch bank selects:

ON (Up) - Amplifier ON	)
EMERGENCY (down) - Amplifier OFF	) Intercomm by
OFF (Centre) - Amplifier OFF	) side-tone through
	) the UHF

(c) Telebriefing facilities are installed in the aircraft but are not used. A call light and Press-to-Talk button are situated on panel L. The telebrief and external intercom override switch is on panel H.

3 SSR COSSOR 1600

A Secondary Surveillance Radar (SSR) is fitted for piloted flight and consists of a transponder, a control unit and an aerial. The equipment is suitable for unpressurised flight up to 40,000 ft. The transponder is available for interrogations in modes A and B. Mode C interrogations produce pulse combinations according to setting of switches. Airframe identity code pulses may be transmitted in reply to mode D interrogations.

4 G and I Band Transponders

The transponders enable ground radar to monitor aircraft location. The ON-OFF switches are located on panel D. Four aerials are fitted and are switched automatically. To enhance the radar response at various aircraft heights and attitudes, the aerials are fitted to each fin top and lower boom surface.

5 Malfunctioning of intercom/UHF

If difficulty is experienced with intercom/UHF reception, turn the ADD volume control setting to below $1/4$.

PART II
LIMITATIONS

LIST OF CHAPTERS

				Chapter
Airframe limitations	...	...	...	1
Engine limitations	...	...	...	2

PART II - LIMITATIONS

Chapter 1 - AIRFRAME LIMITATIONS

Contents

	Para
General	1
Speed limitations	2
Acceleration limitations	3
Radio	4
Navigation and other aids	5
Electrical limitations	6

1 General

(a) The aircraft is released for daylight operation in all weathers in temperate and tropical climates.

(b) Intentional spinning is prohibited. Stalling practice is not to be continued beyond the onset of pre-stall buffet.

(c) Normal aerobatics are permitted subject to the G limitations. Inverted flight must not exceed 10 seconds.

(d) In the manned drone role (FCC engaged), exceeding the engine and airframe limitations is inhibited.

(e) With the present oxygen system, the maximum altitude is 45,000 ft.

(f) The airbrakes may be used at any speed.

(g) Maximum speeds for the operation of and flight with the following services in the extended position:-

Flap 0° - 20°	...	...	220 KIAS
20° - DOWN	...	...	175 KIAS
Undercarriage	...	...	220 KIAS
Arrester hook	...	...	350 KIAS

(h) Speed with the canopy open must not exceed 245 knots.

(j) The ram air turbine may be used in emergency at any speed but, for practice operation, it must not be extended at speeds above 400 KIAS.

(k) Speed with Auto stabiliser ENGAGED, (piloted flight), must not exceed 500 KIAS or 0.95M.

(l) The AAL for precision GCA is 300 feet (true) and for search radar is 400 feet (true).

(m) The CG limits are from 7.6" to 22.2" aft of datum.

(n) Maximum all-up weight for airfield operation:-

Max take-off (Nominal at 8 lb/gall)	39,500 lb
Operational weight ...	38,200 lb
Max. landing weight ...	35,000 lb

2 Speed limitations

- (a) Piloted flight
(PCC disengaged) ... 610 KIAS sea level - 1000 ft
0.94M
1000 ft-16000 ft
1.00M
16000 ft-35000 ft
1.20M
35000 ft-45000 ft
- (b) Manned drone flight
(FCC engaged) ... 560 KIAS sea level - 6000 ft
0.94M
6000 ft-25000 ft
0.84M
25000 ft-40000 ft

3. Acceleration limitations (indicated G)

- (a) Piloted flight
(FCC disengaged) ... +5.0 to -3.15
- (b) Manned drone flight
(FCC engaged) ... +4.8 to -1.5

(c) Normal rolls are limited to 360°. In manoeuvres with aileron applied, not more than 3G is to be applied with full aileron. The permitted G value increases with decrease of aileron angle.

4 Radio

- (a) The following are cleared for use:

UHF, main	...	ARI 18124
UHF, standby	...	ARI 23057
Intercomm.	...	A 1961
SSR	...	ARI 23187
Transponders	...	ARI 302 and 319

5 Navigation and other aids

The following are cleared for use:-

Mk 5FT compass
Roller blind attitude indicator
Horizon gyro unit
E2B compass
Autostabiliser
MRG
Universal Drone Pack

6 Electrical limitations

(a) Before deliberately shutting down one engine for single-engine flight or immediately after single generator failure, electrical loads must be reduced to below 350 amps (to 300 amps after 30 minutes) to avoid the possibility of over-heating the remaining generator. (Refer to Pt 1, Ch.1, Para 21, Circuit Load Table).

(b) Under single generator conditions, the restarting of the standby Type 103A inverter is to be avoided due to the heavy electrical loads involved in starting.

PART 11 - LIMITATIONS

Chapter 2 - ENGINE LIMITATIONS

Contents

	Para
Fuel and oil reference numbers	1
Engine limitations, Avon Mk 208	2

1 Fuel and oil reference numbers

The engine is cleared for use with the following:-

(a) Fuels

AVTUR	NATO F35
AVTUR FSII	NATO F34
AVTAG	NATO F45
AVTAG FSII	NATO F40
AVCAT	NATO F44

(b) Oil

OX38	NATO 0-149
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2 Engine limitations, Avon Mk 208

The principal engine limitations are:-

Power rating	Time limit	Engine speed %	max Jpt°C
Take-off and operational necessity	10 minutes	100 + 0.5†	750*
Intermediate	30 minutes	97.5 (max)	720
Max. continuous	Unrestricted	95 (max)	680
Ground idling	Unrestricted	31 +3 -0	625

Note ...

- *Temperatures in excess of 800° may be experienced during certain types of rapid acceleration. The total elapsed time must not exceed 15 seconds before full control at 750°C is achieved.
- The maximum permitted JPT during starting is 700°C.
- †The RPM may be allowed to rise to 102.5% during flight provided that 750°C JPT is not exceeded.

PART IIIHANDLING

LIST OF CHAPTERS

			Chapter
Starting, taxiing and take-off	...	...	1
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Asymmetric flying	...	...	4

NOTE

All Check Lists referred to
in this Part are detailed on
the Flight Reference Cards
(FR 11/84-1, -2 and -3).

PART III - HANDLING

Chapter 1 - STARTING, TAXYING AND TAKE-OFF

Contents

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Starting the engines	2
Failure to start	3
Taxying	4
Take-off	5
Manned drone role	6
Take-off in icing conditions	7
Abandoning	8

1 Preparation for flight

Carry out the "External, Internal and Pre-Start" checks. Strict adherence to these checks will ensure that no item is missed and that the minimum amount of checking remains to be carried out after starting.

2 Starting the engines

(a) Start the engines and carry out the functional checks in accordance with the drills listed on the Flight Reference Cards.

(b) Cross-connected start.

If the aircraft starting circuitry or the plug for the Palouste lead on either engine is unserviceable, a cross-connected start may be made.

The air hose is connected to the engine to be started and the electrical lead of the Palouste is connected to the other engine.

All switches are set as for a normal start. Assuming that the port engine is to be started with the Palouste electrical lead connected to the starboard engine proceed as follows:

(i) Press the port relight button to initiate the igniters.

(ii) At the same time press the starboard start button to start the Palouste.

(iii) Open the port HP cock.

(iv) At 24% RPM switch off the starboard engine master switch. This is necessary because the electrical lead is connected to the starboard engine.

(c) Failure to accelerate Palouste on engine start up

If a Palouste fails to accelerate when the engine start button is pressed, for operational purposes the Palouste may be accelerated by using the Palouste cut-out button. If a start is to be made by this method, proceed as follows:

(i) When ready to start, the pilot gives a wind-up signal. The rating controlling the Palouste will press the cut-out button and accelerate the Palouste.

(ii) When the Palouste accelerates, press the appropriate relight button and open the HP cock.

(iii) At 24% RPM the pilot is to give the engine cut signal when the cut-out button will be released and the Palouste will return to idling RPM.

Note ...

If the engine has to be closed down for any reason during the starting cycle proceed as follows:

(a) With engine RPM at 16% or below, close the HP cock.

(b) With engine RPM above 16%, have the Palouste switched off, wait for a minimum of 15 seconds for the starter to run-down then close the HP cock. If it is not possible to wait 15 seconds the starter must be examined for crash re-engagement damage.

(d) If the aircraft is started on the internal battery the electrical load is to be kept to a minimum and only the engine master and the ignition switches selected. If the generator does not come on line at idling RPM the engine is to be shut down and further starts are to be made with external power.

Note ...

With standby inverter off there is no fire detection.

3 Failure to start

- (a) If an engine fails to start, close the HP cock and select the ignition and engine master switches to OFF.
- (b) Before making a further attempt to start, carry out a "dry" run following the normal drill except for:-

HP cock	...	...	Shut
Ignition switch	...	...	OFF
Fuel pump	...	...	OFF

When satisfied that the excess fuel has drained away, terminate the run by switching OFF the engine master switch.

- (c) If a subsequent attempt to start fails, have the cause investigated.
- (d) (i) If during the starting cycle it becomes necessary to close the HP cock, care must be taken to avoid a crash re-engagement of the starter. When the air supply from the Palouste is cut off, the engine starter will disengage and begin to "run-down". If the HP cock is closed after starter disengagement the "run-down" rate of the engine will be higher than that of the starter and a crash re-engagement may occur.
- (ii) If circumstances permit, wait 15 seconds after the air supply to the starter has been cut off before closing the HP cock. If it is not practicable to delay the closing of the HP cock, the starter and starter drive must be considered unserviceable until after examination.
- (iii) If during a normal start the Palouste fails to cut out at 24% RPM, switch off the appropriate engine master switch.

4 Taxying

- (a) Whilst parked depress the toe pedals and check that the Green system brake pressure gauge registers 1500 psi/1900 psi at each wheel; a moderate pedal pressure and a fairly large movement is required to obtain the maximum reading. Select Green system braking (lever fully forward), have the chocks removed, move forward and test the brakes. Select Red system braking (mid position) and repeat the braking test, checking that the Red system brake pressure gauge "flickers" during brake operation. After confirming that the brakes are serviceable, continue taxiing to FRC requirements. Up to 50% RPM may be required to get the aircraft under way. When the aircraft is moving, idling RPM are sufficient to maintain a normal taxiing speed. If a CWP OIL warning occurs at idling RPM, press the cancel button and, to avoid recurrence of the warning, increase RPM on the associated engine by approximately 2%.

(b) The outer mainplanes and wing tips cannot be seen from the cockpit; exercise extreme care when taxiing in confined spaces. The nosewheel steering should normally be used for all manoeuvring, except during take-off and landing when differential braking must be used to keep the aircraft straight.

(c) Carry out the "Checks during Taxiing".

5 Take-off

(a) Carry out the "Before Take-off" checks.

(b) Align the aircraft on the runway, with the nosewheel straight. Stop the aircraft and apply the toe brakes fully. Open both throttles to give 80% RPM. If the brakes do not hold at this power setting they should be considered unserviceable. Release the brakes and open the throttles fully, checking for any swirl vane malfunctioning by noting that maximum RPM (ref para(e)) is not obtained until the throttles are fully open and that at least 650°C is registered on each JPT gauge. If these conditions are not satisfied, full thrust is not being obtained and the take-off must be abandoned. The aircraft accelerates quickly, there is no tendency to swing except in moderate to strong cross-wind conditions. Gentle differential braking affords adequate directional control until the rudder becomes effective at approximately 70 knots. Nosewheel steering should not be used. Raise the nosewheel clear of the ground at approximately 100 knots, avoiding an excessive attitude and allow the aircraft to fly off at 140/160 KIAS depending upon the AUV. If a crosswind component greater than 10 knots exists a wing drop may be induced if the aircraft is allowed to become airborne at a low airspeed with an excessive nose-up attitude.

(c) Acceleration after take-off is rapid and undercarriage and flaps limiting speeds are easily exceeded. Trim changes on raising the undercarriage and flaps are negligible.

(d) Carry out the "After Take-Off" checks.

(e) (i) Under ISA conditions RPM is governed at $100\% \pm 0.5\%$. Variations of temperature will alter the governed RPM as follows:

Temp °C	% RPM
+15 and above	100
-10	99
-25	98

Governed RPM may also be reduced by action on the JPT controllers.

(ii) With the JPT switches ON, the maximum temperature will be controlled at 750°C, but if the switches are set to OFF, the temperature must be controlled manually by adjusting throttle position. Care must be exercised to avoid exceeding the JPT limitations at 750°C.

(iii) If the main inverter should fail during take-off, the standby inverter will automatically come on-line.

6 Manned drone role

Refer to Pt I, Ch.4, Para 25 and Para 26.

7 Take-off in icing conditions

(a) (i) If visible moisture reduces visibility to 1,000 yards or less and if the OAT is below +5°C, select the engine de-icing switch to MANUAL after starting. Adequate protection is given in the range of +5°C to -17°C.

(ii) Leave the switch at MANUAL until comfortably airborne, then select AUTO.

(b) Whenever engine de-icing is in use, all throttle movements must be made smoothly. JPT is increased by approximately 20°C; 100% RPM may not be obtained if the JPT controllers come into operation.

(c) Use of de-icing reduces thrust by approximately 10%; this does not significantly affect the take-off performance.

8 Abandoning

(a) General

(i) The aircraft's take-off performance is excellent, an engine failure during the latter part of the take-off run can normally be accepted and the take-off continued (see Part IV, Chapter 1, para 1). Therefore, an airfield take-off should only be abandoned if an emergency occurs which would make it perilous to become airborne. The ability to stop the aircraft, or to decelerate to an acceptable speed for entry into the runway arrester gear, will depend primarily upon the AUV, speed and runway distance available at the time action is taken.

(ii) At 45,000 lb, AUV at 90 KIAS, using continuous braking approximately 1000 yards will be required to stop the aircraft. At 45,000 lb, AUV at 120 KIAS approximately 1000 yards will be required to reduce speed to 80 KIAS for entry into the arrester gear, in this case the brakes will probably burn out.

(iii) It can be seen from the above that for normal operation at 45,000 lb AOW from a 2500 yard runway equipped with the uprated arrester gear, 90 KIAS is the highest speed from which, following the decision to abandon the take-off, the aircraft can be stopped safely using wheelbrakes only. Between 90 KIAS and 120 KIAS there is an increasing risk of the brakes burning out. If a dire emergency occurs above 90 KIAS the decision to eject, or to attempt to stop the aircraft in the remaining distance, will depend upon the circumstances.

(iv) The arrester gear is intended as an aid to stopping after landing and, if engaged at high speed/ high weight may only serve to reduce speed to below the minimum for safe ejection before the aircraft "breaks out".

(b) To abandon a take-off, proceed as follows:-

(i) Close both throttles to idling.

(ii) If at the time the decision to abandon take-off is made less than 1000 yds of runway remain. Apply maximum aerodynamic and wheel braking. If sufficient runway length is available delay wheel braking for as long as possible, i.e. commence at 1000 yards from arrester gear end of runway.

(iii) Lower arrester hook approximately 300 yards before the arrester gear.

(iv) If the hook fails to engage the wire or if the aircraft "breaks-out" steer for a clear area and, if space is limited, retract the undercarriage.

(c) See Part IV, Chap 4, para 6 for procedure when entering an airfield arrester barrier.

PART III - HANDLING

Chapter 2 - HANDLING IN FLIGHT

Contents

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1 Climbing

(a) Speed increases rapidly after take-off. After establishing an initial rate of climb of 2,000 ft/minute the speed should be allowed to increase to 400 KIAS. At 400 KIAS a smooth increase in attitude to a 10° climbing angle will stabilise the airspeed at 430 KIAS. Continue climbing at 430 KIAS, converting to 0.83M when that figure is reached.

(b) The rate of climb is not significantly affected below 35,000 feet by small variations in the mach number. Above this height the mach number must be accurately maintained if the optimum time to height is required.

2 Engine handling in flight

(a) The engine RPM will be governed at the selected setting but at full throttle some slight variations in % RPM may occur.

(b) Negative G is permitted for a period not exceeding 10 seconds but the CWP OIL P-S warning may occur within this period.

(c) Except when de-icing is in use, the engines are normally completely surge-free and rapid throttle movements may be made at any altitude. However, when manoeuvring at heights above about 36,000 feet at air speeds below 210 KIAS with the aircraft at or near stall buffet, flame-out may be induced when the throttles are opened. The port engine is more likely to be affected than the starboard, but a double flame-out is unlikely. Normal relight action is effective.

(d) When the engine de-icing is in use all throttle movements must be made smoothly. Climb at a power setting above 90% RPM. Descend at a power setting above 70% RPM and maintain RPM above this minimum figure until committed to a landing. Maximum protection is obtained at the highest practicable RPM.

(e) Full power is available, from 60% RPM, in five seconds; therefore, during any flight condition when a rapid increase in power may be required, RPM should not be reduced below that figure.

3 Flying controls

(a) Ailerons

(i) Spring feel provides an increasing force with stick displacement. Aileron response is good at high air speeds, but deteriorates as speed is reduced below 200 KIAS. Slight adverse aileron yaw is experienced at low air speeds.

(ii) The aileron gearing serves to improve response at low air speeds. It should be selected to NORMAL for take-off and for flight. In the landing circuit HIGH may be selected if required.

(b) Tailplane

(i) A spring mechanism plus an air-operated damper provides an increasing stick force with an increase in airspeed. Tailplane response varies throughout the airspeed/mach number range, improving as airspeed is increased but deteriorating both as the limiting IAS is reached and at the high mach numbers. The automatic gear change serves to improve response, both at low airspeeds after the undercarriage has been lowered and at supersonic speeds.

(ii) If the wrong gear for the configuration is obtained, longitudinal control remains adequate for all normal circuit manoeuvres.

(iii) If an out-of-trim push force is being held at a high airspeed, a change of aircraft attitude may result in slight overcontrolling. This is most marked during formation flying and it is recommended that the aircraft be kept accurately trimmed at airspeeds above 400 KIAS.

(c) Rudder

Q-feel results in control forces proportional to airspeed. The rudder forces are light at low airspeeds becoming very heavy at high airspeeds; response is adequate for all normal manoeuvres. Coarse application of rudder at low airspeeds induces a marked roll. At low airspeeds rudder is required to achieve a smooth co-ordinated turn.

4 Autostabilisation

The rudder and elevon autostabilisers should normally be selected ON before taxiing and left on until after landing. At high altitude or in turbulence, accuracy of lateral and longitudinal control deteriorates if the autostabilisers are selected OFF.

5 Trimming

(a) Tailplane

(i) The neutral (no force) position of the control column remains constant irrespective of the tailplane trim applied. Therefore when trimming out a control force the stick will return to the neutral position. The forces at control positions close to neutral are very light and, until experience is gained, some difficulty may be experienced in achieving accurate tailplane trimming.

(ii) With the tailplane trim auto-stop switch at AUTO, the trim actuator cuts out when the neutral position is reached.

(iii) With the tailplane trim auto-stop switch at ISOLATE, the actuator cuts out when the trim switch is released. Slight over-trimming is likely until experience is gained.

(b) Aileron and rudder

Both trimmers are effective throughout the speed range.

6 Trim changes

Condition	Trim change
Increase/decrease of power	Negligible
Undercarriage down	Slight nose-up
Undercarriage up	Slight nose-down
Flaps 0-20°	Slight nose-up
20°-Full	Slight nose-down
Flaps up from FULL	Slight nose-up
Airbrake out/in	Negligible

These trim changes are with the service fully extended/retracted. During extension/retraction some small transient trim changes will occur. If one flap fails to lower when selected in flight, the asymmetric condition can be held by aileron at landing speeds.

7 Low speed handling and stalling

Note ...

- 1 Deliberate stalling is prohibited. The airspeed should not be allowed to decrease below that at which either moderate buffet is experienced or a deterioration in control characteristics occurs, with wings level, using gentle control movements. The autostabilisers should be ON.
- 2 Deliberate flight into the pre-stall buffet region must be carried out above 20,000 feet.

The following sub-paragraphs describe the aircraft's characteristics at 20,000 feet, with the airspeed decreasing very slowly. These characteristics will vary between aircraft with variations of AUV and height. Further variations will be caused by application of G. Under conditions of negative G it is possible to reduce speed to within 5 knots of the stall before any of the normal stall warnings become apparent. The actual stall is not well defined.

(a) Undercarriage and flaps retracted - AUV 37,000 lb.

Aircraft trimmed at 160 KIAS. Idling RPM. Autostabilisers ON. Very slight buffet is present at 150 KIAS and this increases progressively as airspeed is reduced. At 140 KIAS slight alternate wing heaviness occurs. Only a slight pull force is required to maintain these low speeds. Below 130 KIAS the aircraft is difficult to fly accurately. At 125 KIAS the buffet has reached moderate intensity and recovery action should be taken at this stage. If the airspeed is allowed to decrease further, the aircraft yaws, rolls and pitches simultaneously and if recovery action has not already been taken it should be taken immediately by applying full power, centralising the ailerons and easing the stick

forward. Up to 1,000 ft may be lost during the recovery to level flight at 150 KIAS. If immediate recovery action is not taken the aircraft will continue to roll uncontrollably, the airspeed will fall off rapidly to 90 - 100 KIAS and a spin will probably develop. Even if the spin does not develop, up to 8,000 ft will be required to effect a recovery to level flight.

(b) Undercarriage and full flap lowered - AUV 37,000 lb

Aircraft trimmed at 150 KIAS. Idling RPM. Auto-stabilisers ON. As the speed is reduced to 135 KIAS onset of very slight buffet occurs. As the speed is further reduced there is little or no change in its intensity but alternate wing heaviness occurs. Below 125 KIAS the aircraft is difficult to fly accurately but airspeed control is slightly easier than in the clean configuration. At 120 KIAS there is a marked deterioration in directional control and if speed is reduced further by 2 - 3 knots a pronounced roll occurs, accompanied by a yaw and moderate nose down pitch. Recovery by centralising the ailerons and easing the control column forward is immediately effective. Undercarriage and flaps should be retracted as soon as the airspeed has increased to 130 KIAS. Care is required to avoid exceeding the airspeed limitations. Up to 1,000 ft may be lost during the recovery to level flight.

WARNING ...

IT IS EMPHASISED THAT THE EFFECTS DESCRIBED IN SUB-PARAS 7(a) AND (b) OCCUR AT 20,000 FT.

(Flight trials at 5,000 ft have shown that there is a marked difference in the pre-stall characteristics at low level. At 15 knots below datum speed there is no lateral instability or detectable buffet. Neither is there a marked deterioration in control. However the aircraft should not be flown at these speeds, because there is no flight trial evidence available to show what characteristics there may be.

(c) Autostabilisers at STANDBY

In all configurations selecting the autostabilisers to STANDBY results in the yawing and pitching characteristics becoming marked. Within 10 knots of the stall accurate control of the aircraft is extremely difficult.

(d) Effect of ailerons

(i) If one wing becomes heavy as the stall is approached and aileron is applied to keep the wings level, the aircraft will be in a pro-spin configuration. The effect of aileron as a pro-spin control at the stall is very marked and, if it is decided to reduce airspeed to the actual stall, the ailerons must be centralised during recovery.

(ii) The aircraft is not fitted with an "aileron central" position indicator.

8 G-stalling

(a) Buffet will be induced as G is increased. At high altitude it will occur at approximately $1\frac{1}{4}$ G but variations of AOW will cause variations of this figure. At high altitude the buffet increases with G until, at the stall, a gentle wing drop either way and/or mild pitch-up occurs. At medium altitudes these characteristics are more marked and the G may exceed the limitations. In all cases the buffet gives adequate pre-stall warning and recovery to normal flight conditions is immediate upon easing the control column forward.

(b) Typical figures for G stall (clean aircraft full internal fuel):-

Height (feet)	IMN/IAS	Indicated G
45,000	0.92	$1\frac{3}{4}$
40,000	0.92	2
35,000	0.92	3
30,000	0.92	$3\frac{1}{2}$
25,000	0.92	$4\frac{1}{2}$
20,000	0.92	$5\frac{1}{2}$ (limiting G mod. buffet)
10,000	0.92	$5\frac{1}{2}$ (limiting G)
5,000	500 KIAS	$5\frac{1}{2}$ (no buffet)
5,000	300 KIAS	$3\frac{1}{2}$ (mod. buffet)

9 Spinning

(a) Intentional spinning is prohibited. Provided that the warning given by the pre-stall buffet is heeded and that the airspeed is maintained above 130 KIAS during any slow flying practices, an inadvertent spin is extremely unlikely. Coarse use of rudder or aileron at, or close to, the stall must be avoided.

(b) If a spin does occur the following action is recommended.

(i) If the undercarriage, flaps or airbrakes are extended, immediately select them up, simultaneously initiating the recovery actions below.

(ii) Apply full opposite rudder and with the ailerons central move the control column progressively forward.

(iii) Maintain full recovery action until rotation has ceased. Centralise the rudder immediately the rotation stops and allow the airspeed to increase to 220 KIAS before easing out of the dive.

(iv) If after four turns the aircraft fails to recover it is probably due to the inadvertant application of aileron in the opposite direction to the roll. As it may be difficult to determine if this is so, approximately $\frac{1}{4}$ aileron in the direction of the roll should be applied to assist recovery. The control column should be maintained fully forward.

(v) The ailerons must be centralised immediately the rotation stops, otherwise a spin in the opposite direction will occur. If this action is not effective within two turns, the control column should be released. Provided that the aircraft has not been trimmed nose-up prior to the spin, releasing the control column may effect recovery.

(vi) If recovery action has not been effective by 10,000 feet the aircraft should be abandoned.

Note ...

- 1 The ailerons exert a powerful effect at the stall and use of aileron can induce a spin. Inadvertant application of aileron away from the direction of roll during a spin can prevent recovery.
- 2 From entry at 40,000 feet, the height lost during a spin of two turns and recovery is about 12,000 feet.
- 3 The aircraft has no instrumentation to indicate:
 - (i) The "aileron central" position
 - (ii) When the rotation has stopped

10 High speed flight

(a) Flight at high airspeed

(i) At sea level, using full power, an airspeed of approximately 600 KIAS can be obtained. Aileron response at high airspeeds is good, the maximum rate of roll is achieved at 370 KIAS. Tailplane response increases with an increase of airspeed but deteriorates as the limiting IAS is approached. The rudder forces become increasingly heavy at high airspeeds and the control can only be moved a small amount.

(ii) During tailplane trimming in high speed flight, or if turbulent conditions are encountered, slight overcontrolling may be induced. If longitudinal oscillations are experienced recovery can be effective by one of the following:-

Applying positive G
Reducing airspeed
Releasing the control column

(b) Flight at high mach numbers

(i) At 45,000 feet using full power 0.95M can be obtained in level flight. 1.0M can then be achieved by entering a 15° dive. Above 0.95M slight buffet occurs and at 0.97M either wing may drop; this wing drop is easily corrected by coarse use of aileron. At 0.99M there is a moderate nose-down change of trim which remains until 1.02M is reached when this trim change, together with the wing drop and buffet, are all eliminated. In a steep dive, with rapid acceleration to supersonic mach numbers, these trim changes will be much reduced.

(ii) Above 1.0M manoeuvrability is considerably improved and at 45,000 feet, at 1.05M, 2½G can be applied before any buffet occurs.

11 Aerobatics

(a) Stall turns and manoeuvres involving a likelihood of stalling are prohibited.

(b) Until experience is gained, the following speeds are recommended:-

All level rolls	300-400 KIAS
Loop	450 KIAS
Roll off the top	450 KIAS
Vertical roll	500 KIAS

(c) During flight involving negative G the CWP OIL warning may occur.

12 Rolling manoeuvres

(a) With ailerons in high gear, full aileron may be used in normal circuit manoeuvres.

(b) With the ailerons in normal gear, rolls up to 360° may be made from 1G flight. In rolling pull-outs no more than 3G should be applied with full aileron and aileron deflection decreases as the G increases. At 4G no more than half aileron should be applied.

13 QGH descent

With airbrake extended and RPM at 70% on both engines, maintaining a speed of 0.85M/330 KIAS gives a rate of descent of approximately 8,000 feet/minute. Reducing the RPM to idling and maintaining a speed of 0.9M/400 KIAS increases the rate of descent to 12,000 feet/minute.

14 Flight at reduced speed

(a) An airspeed of 200 KIAS, with 20° flap lowered, gives a comfortable low speed condition with an adequate margin of manoeuvrability available.

(b) Flight with the canopy open is feasible up to the limiting speed of 245 KIAS. With the hood open, the noise level is high and, above 150 KIAS, there is a considerable effect from air blast if the head or shoulders are moved to the side of the cockpit.

15 Flight in severe turbulence

(a) Recommended speeds:-

Level:- Range speed for the appropriate height

Climbing:- 400 KIAS/0.83M

(b) At speeds below 200 KIAS, HIGH aileron gear should be selected.

16 Flight in rain

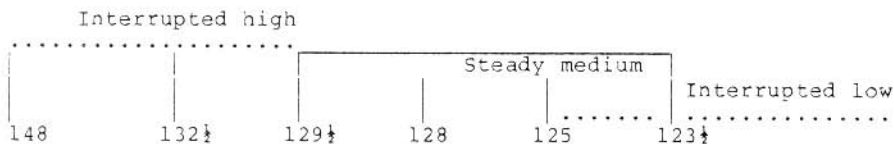
(a) If it becomes necessary to fly in heavy rain or hail, the airspeed should be reduced to a practicable minimum to minimise damage to the radome.

(b) The windscreen rain clearance system is effective at circuit speeds and power settings in up to "moderate" rain. For maximum efficiency, both engines should be running and both RAIN CLEARANCE switches ON.

17 Airstream direction detector

(a) Audio tone pattern

When correctly set up, the audio tone pattern at 31,000 lb, in the approach configuration with full flap lowered, corresponds to the speeds shown below. An allowance for variations in AUV must be made, at the rate of 2 KIAS/1,000 lb.



(Datum speed
at 31,000 lb)

- (b) (i) To check that the audio pattern is correctly set up, the aircraft must be flown in the following conditions to ensure the correct IAS/incidence relationship.

Configuration	...	...	Undercarriage down
			Full flap
Power	...	...	73% RPM
Height	...	...	Commence 2,500 ft
			Completed by
			1,500 ft

(ii) Smooth conditions are essential and no G must be applied. Fly at 2,500 feet and allow the speed to decrease to the datum for the weight. Hold this speed precisely and allow the aircraft to descend.

(iii) With the aircraft at datum speed in the descent, note the incidence reading and audio tone. If the ADD is correctly set up, the incidence reading should be 20 units and the audio tone steady. If these readings are not obtained, the system cannot be used as a stall warning device and must be adjusted on the ground.

PART III - HANDLING

Chapter 3 - CIRCUIT AND LANDING PROCEDURE

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1 Fuel allowance

A minimum of 500 lb in each No 1 tank (1,000 lb total) should be available when downwind for the final landing. 300 lb will be used during an overshoot, circuit and landing.

2 Joining

(a) Prior to joining ensure that the approach ADD aid switch is on. Lower the arrester hook if required.

(b) After joining reduce speed, as required, to 220 KIAS before lowering the undercarriage and 20° flap. Adjust power to approximately 78½ RPM and stabilise the airspeed at 150/180 KIAS on the downwind leg.

(c) Carry out the 'Landing' checks.

3 Approach speeds

- (a) (i) At 31,000 lb AWW, with full flap lowered, the correct final approach speed is 125 KIAS. At higher AWW, increase speed by 2 Kts/1000 lb.
- (b) The speed, calculated as at (a), should be increased by 5 knots under the following landing conditions.
 - (i) Flapless.
 - (ii) Crosswind component greater than 15 knots.
 - (iii) In severe turbulence.
- (c) In the manned drone role the final approach speed is 135 KIAS.

4 Approach and landing

(a) Airfield

- (i) At 150 KIAS with full flap lowered, turn onto the final approach. Maintain an airspeed of datum +10 knots during the turn and, when the correct approach path is intercepted, reduce power to approximately 73% RPM and stabilize the airspeed at the correct value for the AWW. Establish the correct rate of descent, by small adjustments to the power setting, and maintain airspeed and rate of descent until the threshold is reached. The aircraft should then be flown onto the runway. After touchdown ensure that both throttles are fully closed.
- (ii) If the ADD is being used, the audio note/IAS relationship should be checked as soon as the final turn has been completed. When accurately aligned with the runway and with the descent path established at the correct airspeed, continue the approach, maintaining the optimum audio note by means of gentle stick movement. Immediately after touchdown, close both throttles fully.
- (iii) In turbulent conditions, large control movement will be required and accurate control of the airspeed will be difficult. If turbulence is severe, increase the approach speed by 5 knots. If, during the final stages of an approach, numerous coarse control movements are made in rapid succession, it is possible that the excessive demands on the flying controls hydraulic systems may cause the controls to lock after touchdown. Therefore, following a landing from such conditions, stick movements should be restricted to the minimum until the hydraulic pressures return to normal.

5 Crosswind landing

(a) Crosswind landings should be restricted to a maximum crosswind component of 25 knots but, until experience is gained, normal operation should be limited to a 20 knot component. The crab technique is recommended.

(b) Allow a slightly longer final approach than normal in order to stabilize the airspeed and drift. The final correction, to line up with the runway, should be made firmly and smoothly. A roll, pronounced at the higher crosswind components, will occur when the rudder is applied; this should be anticipated and corrected by aileron. At the correct approach speed there is no difficulty in achieving a smooth landing without drift. Extra care is required if the aircraft is in the asymmetric condition due to fuel unbalance, or engine failure.

6 Flapless landing

(a) Use normal circuit speeds. During the final turn maintain a minimum airspeed of 150 KIAS and restrict bank angles to a maximum of 30°. Aileron response is slightly reduced in comparison with the flaps down configuration.

(b) A long straight approach is recommended to allow sufficient time for the airspeed to be reduced. A marked nose-up attitude is required to maintain the final approach speed and care is required, both immediately prior to and after touchdown, to avoid the tail booms touching the runway.

7 Braking

(a) General

On dry surfaces the maxaret units will normally prevent the wheels locking if excessive brake pressure is applied but, unless a short landing run is essential, more gentle use of the brakes is recommended. The maxaret units need to be 'spun up' after touchdown and therefore will not operate at maximum efficiency until the aircraft is firmly on the ground. On wet surfaces additional care is required to prevent wheel locking. If slip or skid is felt, or if difficulty is experienced in keeping straight, release the brakes momentarily. Continuous application of brake pressure during slip or skid can lead to wheel locking and possibly the scuffing or bursting of tyres.

(b) Normal

(i) After touchdown progressively increase the aircraft attitude and use aerodynamic braking down to 90 KIAS, lowering the nosewheel gently to the runway before tailplane effectiveness is lost. When all

three wheels are firmly on the ground begin light braking, increasing the brake pedal pressure as speed is reduced. As the pedal pressure is increased ease the control column slowly aft, thus ensuring that the maximum load is on the main wheels.

(ii) If an emergency occurs that dictates an immediate landing before AUV can be reduced the ground speed must be reduced to below the following figure after touchdown before the brakes are applied continuously, otherwise they will burn out.

31,000 lb - 112 KIAS
Reduced by 2 kts/1,000 lb increase in AUV

(c) Short landing technique

On a dry runway a reduced landing run is achieved by maintaining a nose-up attitude with the control column while applying the brakes, ensuring that the main wheels remain firmly on the ground. The nosewheel should be lowered to the runway at approximately 90 KIAS and braking continued as detailed in sub-para (b).

(d) Crosswind

Do not apply the brakes until the aircraft is firmly on the runway and no longer affected by the crosswind. If aerodynamic braking is employed, the aircraft's attitude should be controlled to prevent the 'into wind' wing lifting. The nosewheel should normally be lowered at approximately 90 KIAS, but variations in the strength of the crosswind component will dictate the speed at which the nosewheel must be lowered and consequently the length of the landing run.

(e) Flapless

Tailplane effectiveness will be lost at a higher speed than normal. The nosewheel should be lowered at approximately 110 KIAS, therefore the landing run will be increased. If sufficient runway length is available (2,500 yds) brake wear can be reduced by delaying braking until the speed is below 90 KIAS.

(f) Maxaret units inoperative (Brake selector lever in mid-position)

If a landing is made with the maxaret units inoperative slightly greater care is required to prevent scuffing of the tyres or locking of the wheels. The technique of using maximum aerodynamic braking is still used, and the nose is lowered at the normal speed. The initial brake pedal pressure must be light, increasing as speed is reduced, simultaneously easing the control column to the rear. If moderate or heavy braking is required the initial applications should be intermittent and if any signs of slip or skid are apparent the pressure must be

reduced. If care is taken it is possible, on a dry runway, to achieve a landing run comparable to that with maxaret units operative.

8 Instrument approach settings

(a) Two engines

Note ...

A single engine approach will require approximately 10% more RPM to maintain the same airspeed.

Stage	% RPM (approx)	Airspeed MN/Kts	Action
QGH	70	0.85/330	Airbrake OUT
Slow descent	78	200	Airbrake IN Undercarriage DOWN
Level	78	150	Flaps 20% Aileron gear HIGH
Glide path	73	At 3 nm 135	Full flap

(b) GCA glide path

WARNING ...

IN THE APPROACH CONFIGURATION, THE ALTIMETER WILL OVER-READ BY 150 FEET, THEREFORE CARE MUST BE TAKEN IN CONDITIONS OF POOR VISIBILITY OR AT NIGHT.

Descend at 700 ft/min to maintain a 3° glide path under nil wind conditions.

9 Overshooting

Open the throttles smoothly to the power required and raise the undercarriage. Raise the flaps at a safe height and retrim as necessary. If full power is used, the aircraft accelerates quickly; care must be taken to avoid exceeding the limiting speeds for the undercarriage and flaps.

10 After landing checks and shut-down procedure

- (a) Carry out the "Landing" checks.
- (b) Shut down procedure.

CAUTION ...

Do not operate the Green Hydraulic services after stopping the starboard engine or the Red services after stopping the port engine.

- (i) The first engine to be stopped should normally be the one that was started first. This procedure ensures that the systems associated with each engine are checked during each sortie.
 - (ii) Close both throttles to the idling position. When RPM have decreased to below 35%, shut the appropriate HP cock. When the associated GEN warning appears on the CWP - isolate the generator.
 - (iii) Test the flying control hydraulic systems by moving the control column fully forward and, after the pressures have rebuilt to 2,650 psi - 3,200 psi, moving it fully aft as rapidly as possible. Pressures should not fall below 1,600 psi. Release the control column and check that both pressures rebuild smoothly and quickly to 2,650 psi - 3,200 psi.
 - (iv) Switch off the INVERTER switch to prevent the standby inverter automatically starting up on the battery when the second generator is isolated. JPT and fire detection circuits will be maintained by the main inverter until the final generator is isolated. Shut the remaining HP cock and, when the associated GEN warning appears, isolate the generator.
- (c) Carry out the "Checks after stopping both engines".

PART III - HANDLING

Chapter 4 - ASYMMETRIC FLYING

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Fuel management on one engine	3
Single-engine circuit and landing	4
Overshoot	5
Relight procedure	6

1 Stopping an engineWARNING ...

SINGLE ENGINE FLYING IS ALLOWED SO LONG AS LOAD SHEDDING IN ACCORDANCE WITH THE TABLE BELOW IS CARRIED OUT.

- (a) Before stopping an engine, reduce electrical loads to below 350 amps, then set:-

FUEL CROSS-FEED COCK	...	OPEN
FUEL PUMPS	...	One No 1 and one wing pump on the same side

AUXILIARY FUEL PUMP switches	...	Both to ALL
-------------------------------------	-----	-------------

In addition set:

GENERATOR ISOLATE switch	...	OFF
HP cock	...	Shut

- (b) (i) The following is a typical load in a loiter condition which should be applied to one generator to ensure that the 350 amps limitation is not exceeded:-

2 Type 103A instrument
inverters

MRG

1 Pitot head heater

Horizon gyro unit

2 Fuel pumps
Intercom. amplifier
Navigation lights

Main UHF radio
All cabin lighting

(ii) If further services are required a compensating reduction in load must be first made. This applies particularly when it is intended to relight the second engine, and when changing fuel pumps (ie switch one off before switching another one on).

2 Single-engine flying

(a) The aircraft has an excellent single-engine performance. Rudder loads are moderate. Speeds in excess of 500 KIAS can be obtained at sea level.

(b) Avoid flight in icing conditions due to the lack of protection on the dead engine.

(c) Services lost

(i) Port engine stopped

Generator (See Pt.IV, Ch.3, para.1)

Engine intake and filter de-icing

Emergency and parking brakes

Emergency operation of flaps, undercarriage
and hook

(ii) Starboard engine stopped

Generator (See Pt.IV, Ch.3, Para.1)

Engine intake and filter de-icing

Normal operation of flaps, undercarriage and
hook

Normal braking

Nosewheel steering (turns not possible at low
taxying speeds)

Wing fold

Airbrake

3 Fuel management on one engine

Open the fuel cross-feed cock. The fuel in each side will not automatically balance. To rectify an out of balance condition switch off the No 1 fuel pump, on the side with the least available fuel, until a satisfactory balance has been achieved. The procedure should be repeated as often as is necessary to maintain the required balance.

4 Single-engine circuit and landing

(a) Use normal circuit and approach speeds; this will require 10% - 15% more RPM.

(b) Select the braking system available from the good engine. The maxaret units are inoperative when the starboard engine is stopped.

5 Overshoot

At the maximum permissible landing weight of 35,000 lb the single engine overshoot performance is good. With full power applied, undercarriage and full flap lowered, the aircraft will climb away at 140 KIAS. If, when landing on a 2,000 yard runway, full power is applied immediately after touchdown the aircraft will take-off safely in the runway distance available.

6 Relight procedure

(a) Confirm or set the following:-

(i)	Airspeed	...	...	Maximum 0.9M, but normally as low as is practicable
	Altitude	...	...	Maximum 35,000 ft but normally as low as is practicable
	RPM	...	...	Ideal 18% Minimum 12%
(ii)	LP cock	...	...	On
	HP cock	...	...	Shut
	Fuel pumps	...	...	ON
	Ignition switch	...	...	ON
	Generator isolate switch	...	...	ON

(b) Press the relight button for two seconds, then open the HP cock to the throttle idling position. When the JPT rises, open up smoothly to half throttle. When the RPM reaches 31%, bring the generator back on-line by means of the isolate switch and check that the CWP GEN warning goes out.

(c) If the engine fails to relight within 20 seconds of pressing the relight button:-

HP cock	...	...	...	Shut
---------	-----	-----	-----	------

Wait one minute, then repeat the relighting drill, preferably at a lower altitude and airspeed, commensurate with a minimum windmilling RPM of 12%.

(d) (i) If necessary the normal engine starter button may be used to attempt a relight.

PART IVEMERGENCY HANDLING

LIST OF CHAPTERS

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PART IV - EMERGENCY HANDLING

Chapter 1 - ENGINE AND FUEL SYSTEM EMERGENCIES

Contents

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Engine failure at take-off	1
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1 Engine failure at take-off

If an engine fails during the take-off run then at airspeeds in excess of 90 KIAS at an AWW of 39,500 lb, the take-off may be continued. The aircraft will become airborne in approximately 1,700 yards (total distance).

2 Engine failure in flight

(a) Mechanical

(i) If an engine fails due to obvious mechanical causes shed the major non-essential electrical loads, then take the following action:-

Throttle/HP cock	...	Closed
Generator isolate switch	...	OFF
Fuel cross-feed cock	...	OPEN. Select fuel pumps as necessary
Auxiliary fuel pumps switches	...	Both to ALL
LP cock	...	Closed
Do not relight		

(ii) Electrical loads on the remaining generator must be reduced below 350 amps as soon as possible. The precedence given to load shedding, over the remaining items of (i) will depend on the circumstances of the failure (see Pt.III, Ch 4, para 1(b)).

(b) Flame-out

(i) If a flame-out occurs a relight may be attempted immediately whilst RPM are decreasing, by pressing the relight button for 2 seconds with the throttle at its set position. A successful relight will be indicated by the RPM stabilising and then starting to rise. Ensure that the maximum permissible JPT is not exceeded, throttling back if necessary. The likelihood of a successful relight is increased if the height and airspeed are below the recommended maxima for relighting.

(ii) If no relight occurs within 10 seconds proceed as follows:-

Electrical load	...	Reduce to below 350 amps (see Pt.III, Ch 4, para 1(b))
Throttle/HP cock	...	Closed
Generator isolate switch	...	Off
LP cock	...	Leave on
If below 35,000 feet	...	Carry out relight drill
If above 35,000 feet	...	Descent to 35,000 feet, or below, before carrying out the relight drill

(iii) If both engines fail and cannot be relit owing to lack of fuel or other causes, extend the RAM AIR TURBINE and maintain sufficient speed to keep the generators charging and hydraulic pressure normal. Glide to a suitable position and abandon the aircraft at a safe height.

3 Engine fire Zone A

(a) Indications

FIRE A warning lamp on CWP
Appropriate firebutton illuminates

(b) Immediate actions

Close both throttles
If at low level, gain height if possible

Check for confirmatory evidence, ie

(i) Loss of, or reduction in, cabin pressure and/or contamination of air conditioning.

(ii) Red or green hydraulic pressure failure or pressure fluctuation.

(c) If fire confirmed

(i) Immediate actions

Close both HP cocks
Close both LP cocks
Switch off all fuel pumps
Press ZONE A fire button
Extend Ram Air Turbine

(ii) Subsequent actions

If FIRE A remains on, abandon the aircraft

If FIRE A warning extinguishes:

Electrical services switch	...	EMERGENCY
Master accumulator switch	...	Off
Artificial horizon switch	...	EMERGENCY
Emergency lighting switch	...	As required
UHF switch	...	STANDBY
UHF power switch	...	EMERGENCY
Intercom. switch	...	EMERGENCY
Fuel cross-feed cock selector	...	Shut

Prolong the glide for as long as practicable to allow cooling of the affected area.

A relight may then be attempted on one engine.
Choose which engine according to symptoms observed.
Ensure one fuel pump is on, then carry out the relight drill.

After relighting, a close watch must be kept for a further outbreak of fire. If this occurs, abandon the aircraft immediately.

(d) If fire not confirmed

The possibility of a genuine fire is remote.
Watch carefully for any secondary symptoms such as smoke or flame or loss of fuel pressure and/or fluctuating RPM.
Land as soon as practicable.

(e) Considerations

The principal items which could be affected by fire in ZONE A are:

(i) Fuel system. No 1 tanks (above forward position of zone), fuel cross-feed cock, LP cocks, pressure warning switch, heat exchangers and piping.

(ii) Air conditioning. Heat exchangers, cold air unit, water extractor, temperature control valve and ducting.

(iii) Hydraulics. Valves and piping of the Red and Green systems.

(iv) Controls. Control cables for throttles, HP cocks. Tailplane, rudder, flaps, undercarriage and engine controls.

(v) Other services. Components of methanol injection system, low and high pressure pipes for rain shedding and air conditioning.

(vi) Structure. Centre section main spar.

An indication in the cockpit is to be expected as a result of the failure of the equipment causing the fire, the equipment concerned being the cold air unit.

Subsequent damage by fire would not necessarily result in any indication in the cockpit, especially in the event of serious damage to controls or structure only. Such damage might not be immediate, but its end result would be loss of control or break up of the aircraft.

4 Engine fire - Zone 1

(a) Indications

FIRE P or FIRE S warning lamp on CWP.
Appropriate firebutton illuminates.

(b) Immediate action

Close the relevant HP cock.
Fuel panel master lever fully aft.
Isolate the appropriate generator.

(c) Subsequent actions

(i) If the lights immediately go out, a hot gas leakage in ZONE 2 is indicated and no further action is necessary. Do not restart the engine except in an emergency.

(ii) If the lights remain on, close the LP cock, shut the fuel cross-feed cock, switch off the associated No 1 fuel pump and press the appropriate firebutton.

(d) Consideration

If, after shutting down an engine and operating the fire extinguisher, the warning light remains on, the aircraft should not be abandoned unless confirmatory evidence of

fire is available. Confirmation from engine instruments, cockpit conditions, behaviour of flying controls and/or visual evidence should be sought. If there is no confirmatory evidence of fire, the aircraft should be landed as soon as is practicable.

5 Fuel pump failures

(a) No 1 fuel pump failure

(i) Nos 2, 3, 4 or pinion tank fuel pumps will supply fuel under pressure to the engine. Continue to operate the fuel system normally.

(ii) When only No 1 tank fuel remains, it will drain by gravity. Either descend to below 15,000 feet, restricting RPM to a maximum of 85%, or shut down the engine until after the final descent.

(b) Pinion tank fuel pump failure

The fuel in the pinion tank will be unusable.

(c) General

Following a fuel pump failure in any tank other than No 1 and pinion tanks, fuel in No 2, 3 and 4 tanks can be transferred using the auxiliary fuel pumps.

PART IV - EMERGENCY HANDLING

Chapter 2 - AIRFRAME EMERGENCIES

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1 Yellow hydraulic system failure

(a) Indications

HYD. Y warning lamp on CWP.
 Yellow system pressure gauge indicates loss of pressure.
 The autostabiliser is lost.

(b) Action

Disengage the FCC.
 Land as soon as practicable.

(c) Considerations

(i) No remedial action is possible.

(ii) It is inadvisable at this stage to extend the Ram Air Turbine to guard against a subsequent Blue pump failure. If such a failure occurs, it may not then be immediately apparent and the decision to attempt a landing on the RAT alone is governed by several factors which must be considered. See para.3.

2 Blue hydraulic system failure

(a) Indications

HYD. BL. warning lamp on CWP.

Blue system pressure gauge indicates loss of pressure.

(b) Action

(i) Disengage FCC.

(ii) Extend the Ram Air Turbine, check the EMER. HYD. magnetic indicator shows white and the Blue system pressure gauge regains a minimum pressure 2000 psi.

(iii) Land as soon as is practicable.

(c) Consideration

If, with the RAT extended, the Blue system gauge does not show pressure, a broken pipeline is probable and the Ram Air Turbine will be of no assistance.

3 Blue and Yellow hydraulic system failure

(a) Indications

HYD. BL. and HYD. Y warnings lamps on CWP.

Blue and Yellow pressure gauges indicate loss of pressure.

(b) Immediate actions

(i) Disengage the FCC.

(ii) Retract air brake.

(iii) Extend the Ram Air Turbine.

Note ...

If the Blue pressure gauge does not build up to 2000 psi, a broken pipe is indicated and flying controls are lost. Abandon the aircraft.

(c) Subsequent actions

Land as soon as possible.

(i) Airfield landings

An airfield landing may be made by day or night. The longest available runway should be used, preferably with chain arrester gear. After extending the Ram Air Turbine, join the circuit in the normal manner, maintaining the airspeed above 150 KIAS until under-carriage and full flap have been lowered. Sub-

sequently keep all control movements to the minimum and make a long final approach, reducing speed to a minimum of 140 KIAS. Cross the runway threshold at 140 KIAS and fly the aircraft on to the runway at 130/140 KIAS. After touchdown, lower the nose firmly on to the runway. Do not use aerodynamic braking. If at any time on the approach prior to crossing the threshold, the CWP indicates low Blue system hydraulic pressure (1600 psi), increase speed and make another circuit. A late overshoot will be extremely hazardous and should not be attempted.

4 Green hydraulic system failure

(a) Indications

Green system pressure gauge indicates loss of pressure. Services fail to operate when selected.

(b) Actions

(i) Immediately circumstances permit, select the landing configuration.

(ii) Land as soon as practicable.

Note ...

As the integrity of the Green and Red systems is dependant upon the serviceability of a number of common components, there is a possibility that a Green system failure may be followed by failure of the Red system. Therefore, following a Green system failure, the landing configuration must be selected immediately circumstances permit.

(c) Emergency operation of services

(i) Undercarriage lowering

If the undercarriage fails to lower, select EMERGENCY DOWN, bringing the Red system into operation. Do not retract except in an emergency.

(ii) Flap lowering

No action is necessary, as Red system pressure will be automatically supplied and unrestricted operation of the flaps will be available. If the flaps remain in a fixed position, both Red and Green supplies to the flap jacks have failed. Return and land using any available flap.

(iii) Arrester hook lowering

Pull up the knob on the selector lever and move it fully aft thus selecting Red system. Once this action has been taken, the hook can only be raised by hand after an UP selection has been made.

(iv) Airbrake operation

A Green system failure will result in the airbrake being selected closed automatically and thereafter being inoperative but it may be necessary to blow it closed. If, due to an electrical failure, the airbrake cannot be selected closed, move the AIR BRAKE EMERGENCY lever aft to CLOSE. Should the airbrake not close sufficiently to clear the ground on landing (one quarter open) fly at high airspeed in an attempt to blow it shut; if committed to a landing with it open, lower the nose-wheel gently on to the ground.

(v) Wheelbrakes

Before landing select the wheel brake selector lever to the mid (RED system) position and, as maxarets will be inoperative, avoid locking the wheels when braking.

(vi) Nosewheel steering

The Green system accumulator may provide this facility for some time but once the accumulator has exhausted it will be impossible to make tight turns. Instruct the ground crew to move the nosewheel steering isolating lever forward, which will allow the nosewheel to caster.

(d) Undercarriage EMERGENCY UP

(i) To raise the undercarriage on the ground in an emergency, select EMERGENCY UP. This action overrides the safety solenoid and, if Green or Red system pressure is available, the undercarriage will collapse.

(ii) Do not use this method when airborne, as the nosewheel may be off-centre, in which case damage to the airframe will result. The use of the nosewheel steering to centre the nosewheel is not recommended, as a true centring indication is not available.

5 Red hydraulic system failure

(a) Indications

Red system pressure gauges indicate loss of pressure.
Red system services fail to operate when selected.

(b) Actions

Immediately circumstances permit, select the landing configuration.

Note ...

As the integrity of the Red and Green systems depends upon the serviceability of a number of common components, there is a possibility that Red system failure may be followed by failure of the Green system. Therefore, following a Red system failure, the landing configuration must be selected immediately circumstances permit.

(c) Considerations

The following services will become inoperative:-

Parking and emergency brakes
Port fuel filter de-icing.

6 Cabin pressurisation failure

(a) Indications

CAB lamp on CWP.

(b) Actions

Depress toggle of oxygen mask.
Check pressurisation ON.
Commence immediate and rapid descent to below a cockpit altitude of 30,000 feet.
Select 100% oxygen.
Select regulator to EMERGENCY and ensure mask is not leaking.
Fly at lowest possible altitude and land as soon as possible.

7 Smoke or toxic fumes in cockpit

(a) Immediate action

Proceed as for pressurisation failure.

(b) Subsequent actions

Select cabin air supply lever to RAM.

8 Oxygen regulator failures

(a) Regulator failure

(i) Indications

Excessive delivery pressure with difficulty in breathing out, pressurisation of the jerkin (if worn) and oxygen leakage at mask, or,
No delivery of oxygen with inability to breathe in.

(ii) Actions

Check all connections.
Operate emergency oxygen bottle control.
Select regulator to OFF.
Make a rapid descent to below a cabin altitude of 10,000 ft.

(b) Indicator ceases to operate correctly

(i) Actions

Check all connections.
Check contents and supply pressure.
If supply pressure between 150/200 psi, select 100% OXYGEN and deflect emergency toggle sideways.

(ii) Subsequent actions

If supply pressure increases regulator is serviceable.
If no delivery:-

Operate emergency oxygen bottle control.
Select regulator to OFF.
Make a rapid descent to below a cabin altitude of 10,000 ft.

9 Jettisoning the canopy

(a) Before pulling the jettison handle lower the seat and keep the head lowered until after the canopy has been jettisoned.

(b) Misting of the windscreen may occur when the pilot's canopy is jettisoned. If a landing is planned the canopy should be jettisoned in sufficient time to allow any misting to clear.

(c) If the canopy is jettisoned (or lost) in flight the cockpit altitude may rise to 5,000 ft above the aircraft altitude.

PART IV - EMERGENCY HANDLING

Chapter 3 - ELECTRICAL EMERGENCIES

Contents

DESCRIPTION	Para
Single generator failure	1
PEA fuse failure	2
Inverter failure	3
Double generator failure	4

DESCRIPTION1 Single generator failure

(a) Indications

Appropriate GEN warning lamp on CWP.

(b) Actions

(i) Isolate the failed generator.

(ii) Reduce the electrical load to 350 amps or lower as quickly as possible.

(c) Considerations

(i) It is essential that the total electrical load is kept below 350 amps therefore, if an additional service is required, a corresponding reduction in load must be made before this additional service is switched on.

(ii) Should the main 103A inverter fail the standby 103A inverter will take over the supply to the flight instruments and the FCC.

(iii) There is no standby to the inverter DAL which is the emergency a.c. supply to the fuel gauges and the fire detection and warning system. The fire extinguishers are however still operable.

2 PEA fuse failure

(a) Indication

(i) Failure of an 'essential service' to operate when selected.

(ii) Loss of the UHF transmit facility, reception normal.

(b) Immediate action

Press T button on the CWP. PEA fuse failure will be confirmed by operation of the audio warning without the flashing 'attention' lamps.

(c) Subsequent action

(i) Flight may be continued, if essential, but the following services will be inoperative:-

Auxiliary fuel pumps (available on standby battery)

Main UHF transmitter with P to TX

Standby UHF on normal P to TX (still available on emergency standby P to TX)

Undercarriage position indicator

Flap actuator motor control

Relight system

Attention lights

Port pitot heater

Oxygen indicator

ADD

Cockpit emergency lights

Undercarriage actuator motor control

Cockpit high intensity lights

Fuel jettison

(ii) All other services will operate normally. When it becomes necessary to use any of those services above which have an emergency supply, open the fuel cross-feed cock, select the auxiliary fuel pumps to ALL and select the EMERGENCY ELECTRICAL SERVICES switch to EMERGENCY ACCUMULATOR ON to bring in the STANDBY Battery.

(iii) Select UHF switch to STANDBY and UHF power to EMERGENCY. Transmission can then be made through the emergency P to TX switch.

3 Inverter failures

(a) Main inverter failure

(i) Indication

The INST a.c. SUPPLY FAIL magnetic indicator changes to striped.

(ii) Action

No action is required by the pilot, the standby inverter automatically takes over the load, shedding non-essential services.

(b) Standby inverter failure

(i) Indication

Loss of flight instruments, fuel gauges, flowmeter, FCC and any other in-use a.c. services.

(ii) Action

If required, the fuel gauges on SUM and the fire warnings can be restored by selecting the EMERGENCY ELECTRICAL SERVICES switch to EMERGENCY ACCUMULATOR ON to bring in the emergency inverter DAL. This selection will however also select the standby battery with a consequent reduction in available battery life. The trickle charge will not offset heavy demand on the standby battery.

4 Double generator failure

(a) The following drill should be carried out in the event of a double generator failure. Dependant on the time at which the failure occurs it may be necessary to reduce to landing weight immediately. Two alternative fuel management actions are detailed below to cover both an immediate and a delayed weight reduction situation. Since weight reduction has to be achieved within the life of the main and standby batteries fuel may have to be jettisoned as well as burnt off and furthermore, because of the high risk of a brake fire existing, the pinion tanks should if at all possible be empty before a barrier engagement

(b) The immediate actions are as detailed in the Flight Reference Cards.

(i) If it is necessary to reduce weight immediately commence fuel jettison as soon as possible.

(ii) Carry out load shedding as detailed in the Flight Reference Cards.

(c) Subsequent actions

(i) Carry out actions as detailed in the Flight Reference Cards. The five-minute period on the standby battery allows the main battery to recover from its initial overload.

(ii) If fuel jettison is required use either No 3 main fuel pumps (Notes 1 and 4). If fuel jettison is not required manage the fuel by selecting auxiliary fuel pumps to ALL and use the No 3 main fuel pumps if required (Note 1 and f(iv) below).

Note ...

- 1 Gravity feed limitations (85% rpm, 15000 ft max) must be observed at ALL times when jettisoning and also if only the auxiliary pumps are being used.
- 2 When the standby battery is in use, individual contents readings may be obtained using the FG PORT/STBD and the two rotary fuel contents switches, on panel H.
- 3 The fuel transfer magnetic indicators are inoperative on the standby battery.
- 4 When using the port No 3 main fuel pump for fuel jettison, all auxiliary fuel pumps may be switched off to conserve the battery power; when using the starboard No 3 main fuel pump the starboard auxiliary fuel pumps may be switched off but ALL the port auxiliary fuel pumps must be ON.

(d) After five minutes

(i) Carry out the drill detailed in the Flight Reference Cards.

(ii) If fuel jettison is required after switching back to the main battery, use fuel pumps in the order: pinions, 2s, 3s. If jettison is not required, select the auxiliary fuel pumps to ALL and use the main fuel pumps as required.

Note ...

- 1 Because the 103 inverter has shut down, fire warnings, fuel gauges, the MRG and the rudder/aileron trim indicator will not be available. No attempt should be made to restart the inverter as this will drastically reduce battery life, may cause the battery contactor to fail and also create a fire risk.

- 2 The standby artificial horizon switch must be left in the EMERG position. Reselecting normal will cause the instrument to fail because the normal power supply is routed through the inverter switch.

(e) Post 5 minute drill

(i) Carry out drill as detailed in the Flight Reference Cards.

(ii) If fuel jettison is not required, select the auxiliary fuel pumps to ALL and switch the No 3 fuel pumps off unless required.

Note ...

- 1 Flap selection is not possible at low voltage. A decision for a flap up or down landing must be made before the electrical services fail.
- 2 After switching to the standby battery, when the main battery has failed, or the voltage is too low to be useful, an indication of the standby battery condition will be given by the horizon gyro unit which becomes unreliable at about 20 volts.
- 3 Main and St/by battery failure will cause the emergency battery to be brought automatically onto line to supply 'vital' services as listed in Pt 1, Chap 1, para 2(c), (Emergency U/C 1, LP cocks, RAT and Standby Rx).

(iii) When the standby battery fails, no further electrical power, except Note 3 above, is available. Pressure instruments are available until pressure head icing occurs. The only fuel available will be that which remains in the No 1 tanks and that will be gravity fed to the engine.

(f) General considerations

(i) In icing conditions with only the port pitot heater ON the following are unreliable.

Rudder Q feel
Control column damping

(ii) If engine de-icing is in use when the main battery fails it will not be possible to switch it off.

(iii) If possible at least one main fuel pump should be on for landing.

(iv) Fuel jettison may be expedited using two main fuel pumps at a time, because of the consequent drain on the battery however this should only be carried out when base is in sight.

(v) Even if a double generator failure occurs immediately after take-off it should be possible to reduce to landing weight within the life of the batteries.

PART IV - EMERGENCY HANDLING

Chapter 4 - ABANDONING AND EMERGENCY LANDING PROCEDURES

Contents

	Para
Abandoning the aircraft	1
Controlled ejection	2
Ditching	3
Crash into the sea	4
Crash and hazardous landing	5
Landing into airfield arrester barrier	6

1 Abandoning the aircraft

(a) General

(i) The limited headroom must be taken into account in determining ejection procedures.

(ii) When the pilot's seat is fully raised there is normally little or no headroom and the seat pan firing handle must be used. Pilots are recommended to fly with the seat lowered sufficiently to allow use of the face screen firing handle (since the extra headroom allows the pilot's head to rise above the top of the seat, reducing support and increasing the risk of injury on ejection) except when it is essential to raise the seat for landing.

(b) (i) Ejection may be initiated at any height.

(ii) Ground level ejection from straight and level flight is feasible within the following limitations:-

Minimum airspeed	...	90 KIAS	
Maximum airspeed	...	350 KIAS	at zero
		feet	
		600 KIAS	at
		100 ft	

Whenever possible, speed should be converted into height.

(iii) The optimum conditions for any ejection are:-
250 KIAS in straight and level flight.

(iv) The minimum safe height for ejection will vary, depending on speed, attitude and bank. Under the worst combination, several thousand feet will be required.

(c) With the elbows drawn in close to the body and the backs of the hands facing forward, grasp the face-screen firing handle. Draw the face-screen handle firmly over the face, keeping the head pressed hard against the headrest. It is not necessary to jerk the handle. If the screen is pulled horizontally away from the face, the seat may not operate. Full movement of the pilot's face-screen will not be possible until the canopy has jettisoned.

(d) After ejection, the drogue gun will fire automatically.

(e) If ejection takes place above 10,000 feet, automatic separation will not occur until $1\frac{1}{4}$ secs after that height has been reached. If ejection takes place at or below 10,000 feet, automatic separation will not occur until at least $1\frac{1}{4}$ seconds have elapsed, depending on the airspeed at ejection.

(f) If the automatic separation fails after ejection, proceed as follows:

(i) When forward speed is sufficiently low, discard the face-screen.

(ii) Operate the manual separation handle by depressing the catch and pulling the lever upwards.

(iii) Pull rip cord D-ring.

(g) Failure to eject

Should the seat fail to eject, the following actions should be carried out:-

(i) Jettison the canopy if this has not already been done. Pull either or both firing handles again.

(ii) If the seat fails to fire

Grasp the parachute lift webs above and behind the shoulders with the right hand. Operate the manual separation handle; this releases the harness and fires the guillotine. Then:

A Invert aircraft, apply negative G and fall clear of seat and aircraft.

B If A not possible, retain grasp on lift webs with right hand.

- C Pull body up, turn and face port side. Endeavour to avoid slipstream and prevent parachute pack snagging objects in cockpit by holding it close to the shoulders.
- D Stand up, hold PEC clear and dive towards port intake.
- E When clear, pull parachute D-ring.

Note ...

The seat is not drogue-stabilised and the lifejacket is not inflated on ejection.

2 Controlled ejection

If a situation arises which necessitates ejection, the following procedure will ensure both a safe ejection for the pilot and that the aircraft crashes in a clear area.

(a) FCC DISENGAGE

(i) Establish the following configuration:-

Flaps - u/c - airbrake	...	Retracted
Height	...	9,000 feet
Power	...	Idling RPM
Speed	...	250 KIAS

Apply aileron trim for 3 seconds. When aileron trim has previously been applied to counteract an asymmetric condition, it should now be applied to bring the control column back to the central position. (This will reduce the danger of the control column fouling the knees during ejection).

(ii) Position the aircraft with the selected area 1½ miles ahead.

(iii) Release control column and carry out a normal ejection.

(iv) The aircraft will now spiral down into the selected area.

(b) The above procedures eliminate the possibility of the aircraft continuing unpredictable flight after the pilot has ejected. However, considerable scatter of impact points must be expected.

3 Ditching

(a) The aircraft should always be abandoned by ejection in preference to ditching.

(b) If ditching is inevitable set:-

Oxygen	...	...	...	100% Regulator to EMERGENCY Mask toggle depressed
Flaps	...	...	...	Fully down
Airbrake	...	...	...	Half-open
Undercarriage	...	...	...	Retracted
Canopy	...	...	...	Jettison if possible

Land into wind or, if the swell is steep, along the swell. Early model tests of the DH 110 show that, in a calm sea, a well executed ditching has a high probability of success and that a double impact is likely.

4 Crash into the sea

(a) If possible select oxygen regulator to EMERGENCY and jettison the canopy.

(b) If aircraft floats, release QRB, PEC, and vacate quickly.

5 Crash and hazardous landings

(a) When crash landing, if possible, the undercarriage should be lowered regardless of terrain. Immediately prior to touchdown close both HP cocks, operate all three extinguishers and switch master accumulator OFF. Brace before impact.

(b) In the event of a hazardous landing where undercarriage units are partially or fully retracted, the canopy should not be jettisoned.

6 Landing into airfield arrester barrier

(a) Damage to pinion tanks may occur on engagement. As this may result in fuel being spilt on to hot brakes, every effort should be made to empty pinion tanks, by fuel jettison if necessary.

(b) (i) Aim to make a central engagement, between the verticals, at the minimum speed possible.

(ii) Immediately prior to engagement

(Canopy closed, seat lowered, harness locked and tight).

Nosewheel on ground.

Brakes off.

Close HP cocks, operate all 3 extinguishers. Master accumulator OFF.

Duck head forward.

(iii) After engagement

Use brakes as required to prevent barrier pulling aircraft backwards. Carry out normal after-landing checks, ejection seat safe, etc.

PART V
OPERATING DATA

LIST OF CHAPTERS

				Chapter
Landing and CG data	...	...	...	1
Miscellaneous data	...	...	...	2

PART V - OPERATING DATA

All operating data has been removed from this publication.

Operating Data Manual AP 101B-3002-16 contains full information. In addition the Flight Reference Cards (FR 11/84) contain the following:

- Take-off distances
- Climb data
- Descent data
- Landing distances
- Recovery data

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Cockpit - PCU and control column	...	...	D
Cockpit - Panels D and H	...	...	E
Cockpit - Panels J, K and L	...	...	F

PART VI - ILLUSTRATIONS

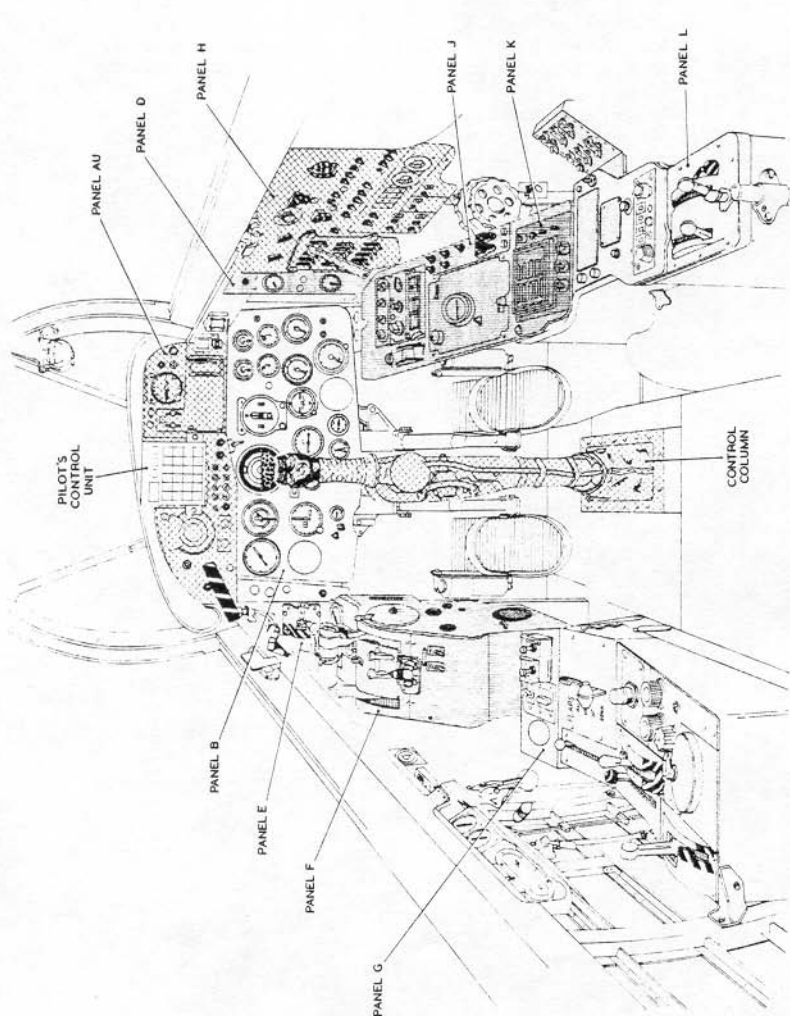
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Key to Fig A

Fig

B Panels F and G
C Panels AU, B and E
D PCU and control column
E Panels D and H
F Panels J, K and L



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Fig A - Cockpit, Panel Positions

Key to Fig B

- 1 Ventilation air temperature control
- 2 Airbrake emergency shut lever
- 3 Cabin air supply lever
- 4 Anti-G system cock
- 5 Red main supply hydraulic pressure gauge
- 6 Red brake supply hydraulic pressure gauge
- 7 Wheelbrakes lever
- 8 High intensity light switch
- 9 Aileron & Rudder trim indicator
- 10 Airbrake switch
- 11 Ejection seat & canopy safety pin stowage
- 12 Press-to-mute switch
- 13 Rain clearance switches
- 14 Blue hydraulic system pressure gauge
- 15 Green hydraulic system triple pressure gauge
- 16 Yellow hydraulic system pressure gauge
- 17 Throttles friction damper
- 18 Throttle levers & press to trip throttle stops
- 19 R/T button
- 20 FCC disengage switch
- 21 Jet pipe temperature control switches
- 22 Tailplane trim switch
- 23 Rudder trim switch
- 24 LP fuel cock switches
- 25 Flap selector switch
- 26 Fuel cross-feed selector
- 27 Arrestor hook selector
- 28 Test connector (wheelbrakes testing)
- 29 Floodlight dimmer switch
- 30 Oxygen regulator panel dimmer switch
- 31 Instrument panel dimmer switch

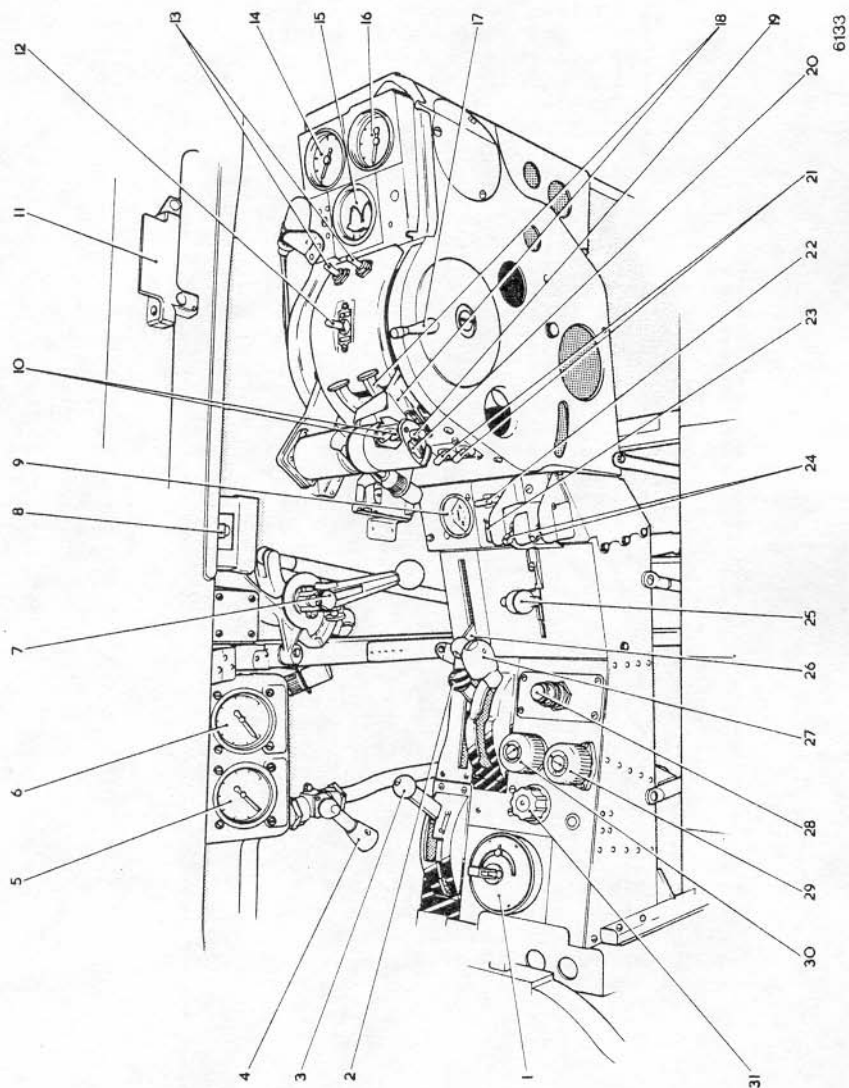


Fig B - Cockpit, Panels F and G

Key to Fig C

- 1 Undercarriage control switch
- 2 Hook down warning lamp
- 3 Tailplane gear change warning lamps
- 4 CWS 'attention' lamp
- 5 LP cock indicators
- 6 Canopy emergency release handle
- 7 Canopy operating switch
- 8 RAT hydraulic flow indicator
- 9 Undercarriage indicator
- 10 Q pot out lamp
- 11 Recorder ident push button
- 12 Fuel flow indicators
- 13 Pilot's control unit
- 14 Fuel filter de-icing indicator
- 15 Fuel filter de-icing switch (hydraulic)
- 16 Fuel filter de-icing switch (methanol)
- 17 Low altitude warning lamp
- 18 Autostabiliser switches
- 19 MRG fast erection button
- 20 Accelerometer
- 21 Engine intake ice detector indicator
- 22 Engine intake de-icing valves position indicator
- 23 Engine intake de-icing switch
- 24 Elevon position indicator
- 25 CWS 'attention' lamp
- 26 JPT gauges
- 27 Instrument a.c. supply fail indicator
- 28 RPM gauges
- 29 Fuel contents gauges
- 30 Fuel flow rate/fuel gone indicator
- 31 Heading indicator
- 32 Horizon gyro unit
- 33 Flap position indicator
- 34 Rate of climb/descent indicator
- 35 Tailplane position indicator
- 36 Attitude indicator
- 37 Angle of attack indicator
- 38 Slip indicator
- 39 Airbrake position indicator
- 40 Altimeter
- 41 Flap lock and airbrake test switch
- 42 Emergency lights switch
- 43 Airspeed indicator
- 44 Machmeter

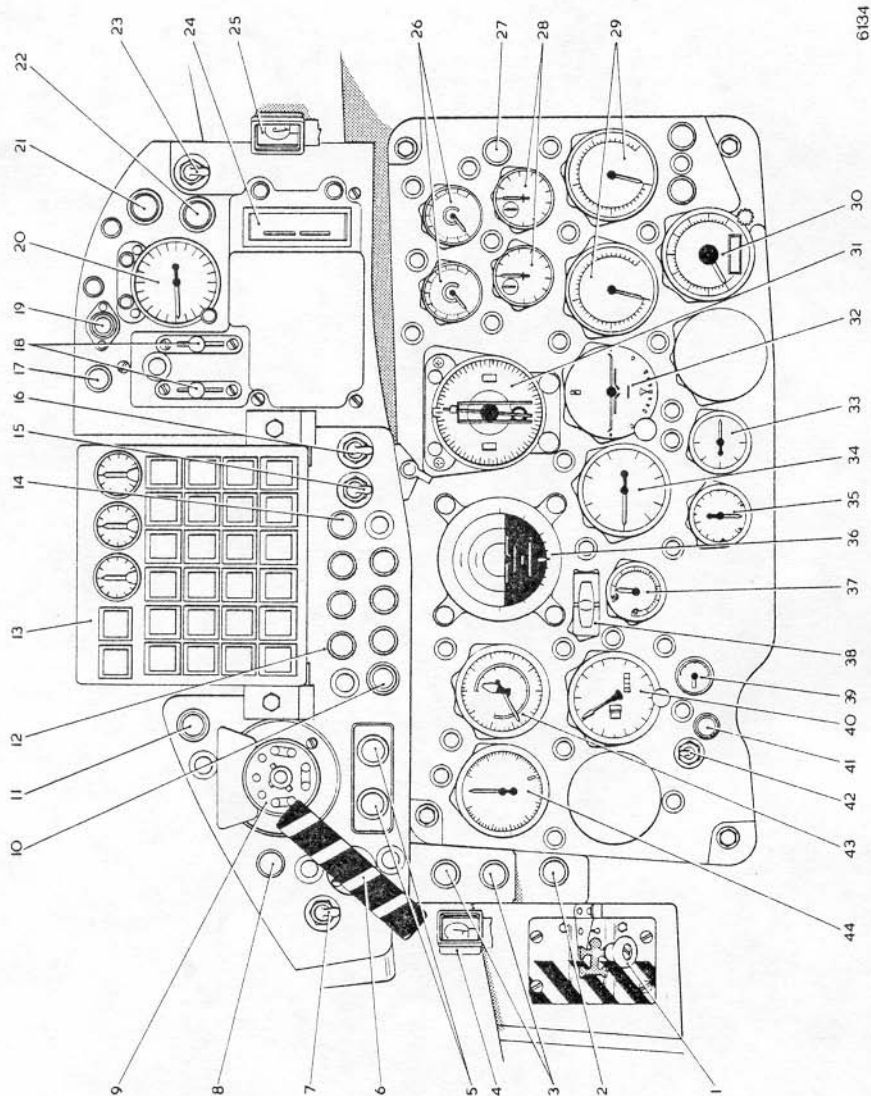
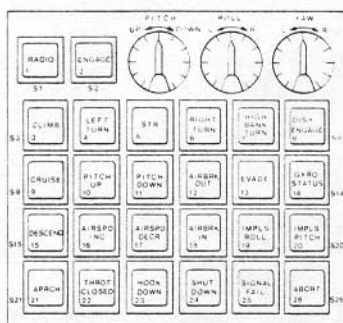


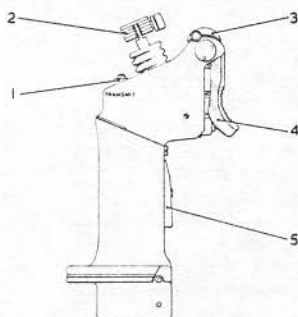
Fig C - Cockpit, Panels AU, B and E

Key to Fig D

- 1 Transmitter switch
- 2 Tailplane and Aileron trim switch
- 3 ICO trigger safety lever
- 4 ICO trigger
- 5 FCC disengage switch



PILOT'S CONTROL UNIT



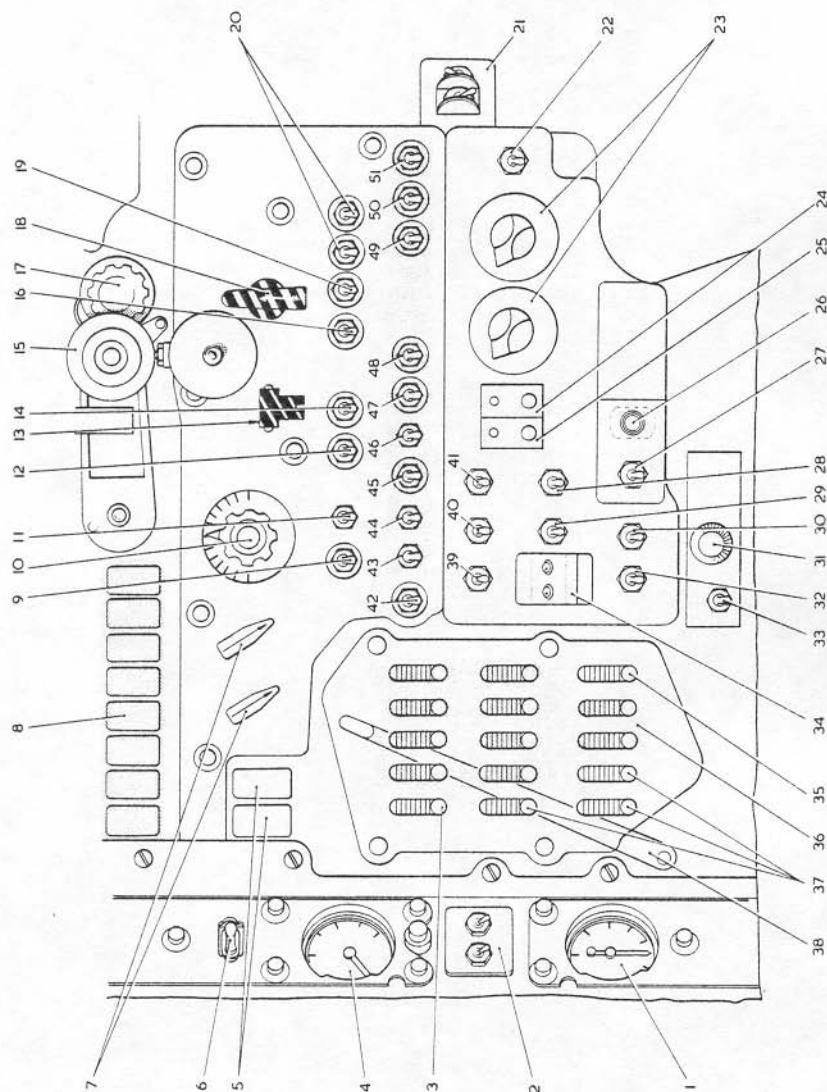
CONTROL COLUMN

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Fig D - PCU and Control Column

Key to Fig E

- 1 Cabin altimeter
- 2 Transponder switches
- 3 MRG switch
- 4 Oxygen contents gauge
- 5 Circuit breakers, (pinion tank fuel pumps)
- 6 Fuel gauges test switch
- 7 Auxiliary fuel pump switches
- 8 Circuit breakers, (fuel pumps)
- 9 Tailplane gear change switch
- 10 Cabin temperature selector
- 11 Artificial horizon switch
- 12 Fuel gauge switch
- 13 Fuel jettison switch
- 14 Tailplane trim auto stop switch
- 15 Hood crank handle
- 16 Tailplane gear change test
- 17 Panel lamps dimmer switch
- 18 Emergency electrical services switch
- 19 Telemetry heading switch
- 20 Navigation lights switches
- 21 AUTOTONE/CANCEL and compass NORMAL/STANDBY switches
- 22 Auto load shedding switch
- 23 Fuel contents gauge selectors
- 24 Flaps circuit breaker
- 25 Undercarriage circuit breaker
- 26 DC power indicator
- 27 FCC switch
- 28 Instrumentation switch (N/A)
- 29 Telemetry switch
- 30 Instrumentation reset switch (N/A)
- 31 Approach aid volume control
- 32 Recorder switch (N/A)
- 33 Approach aid switch
- 34 Recorder fault & reset indicators
- 35 Inverter switch
- 36 Fuel pump switches
- 37 Pitot head heaters switches
- 38 Switch panel lever
- 39 Main RX heater switch
- 40 St/by RX heater switch
- 41 Camera heater switch (N/A)
- 42 108 inverter switch (N/A)
- 43 Transponder switch (N/A)
- 44 UHF switch
- 45 UHF standby switch
- 46 UHF Standby power switch
- 47 UHF aeralis switch
- 48 Intercom switch
- 49 Ext intercom & Telebrief switch
- 50 UHF homer meter sense switch
- 51 UHF homer switch



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Fig E - Cockpit, Panels D and H

Key to Fig F

- 1 UHF channel selector
- 2 UHF control panel
- 3 Engine master switches
- 4 Ignition switches
- 5 Master accumulator switch
- 6 Generator isolate switches
- 7 Engine starter buttons
- 8 CWP 'T' test button
- 9 CWP 'M' mute button
- 10 CWP 'C' cancel button
- 11 Ground 'GT' test button
- 12 Inverter ground test switch
- 13 Nosewheel steering handles
- 14 Emergency st/by P to TX switch
- 15 Auto control channel isolating switches
- 16 Wing-fold selector
- 17 Wing-fold lock lever
- 18 RAT control lever
- 19 Flap interlock override
- 20 SSR control panel
- 21 Telebrief button
- 22 Ext intercom & telebrief call lamp
- 23 Fire warning light/extinguisher buttons
- 24 CWP panel
- 25 Oxygen demand regulator
- 26 Seat height switch
- 27 Wing/radome/hatch locked indicator

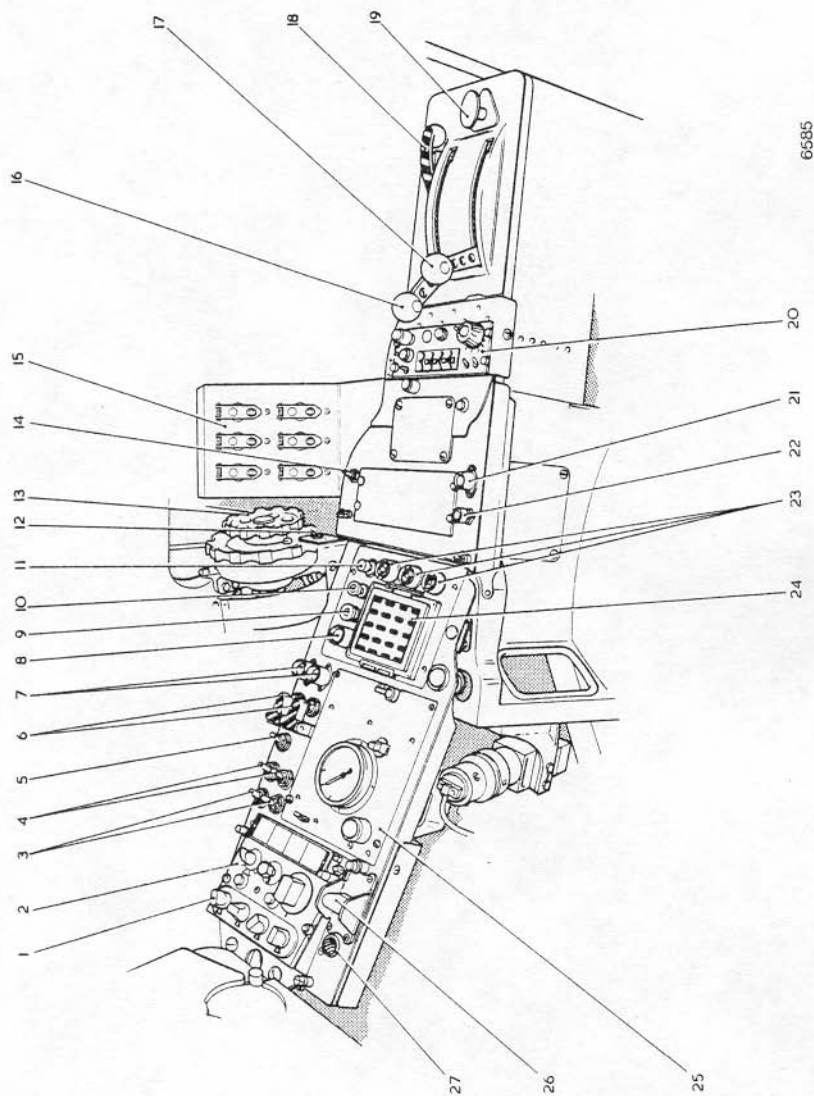


Fig F - Cockpit - Panels J, K and L

