RESTRICTED

AP 101B-3101 & 2-15A

JAGUAR GR Mk 1 and T Mk 2

AIRCREW MANUAL

Book 1 — AIRCRAFT

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JAGUAR GR Mk 1 and T Mk 2

AIRCREW MANUAL

BOOK 1 - AIRCRAFT

BY COMMAND OF THE DEFENCE COUNCIL

Frank Cooper.

Prepared by Procurement Executive, Ministry of Defence

NOTES TO USERS

1. This Manual is complementary to the Jaguar GR1 and T2 Aircrew Manul, Book 2—Navigation/Attack and Armament Systems (AP 101B-3101 & 2-15B) and to the Jaguar GR1 and T2 Flight Reference Cards (AP 101B-3101 & 2-14A).

2. The Manual is divided by marker cards as follows:

Preliminary Matter
Part 1 — Description and Management of Systems
Part 2A — Limitations — GR Mk 1
Part 2B — Limitations — T Mk 2
Part 3 — Handling Procedures
Part 4 — Emergencies and Malfunctions
Part 5 — Illustrations

Each Part is divided into Chapters as listed on its marker card. Each sheet is identified by a Part, Chapter, Page reference at the foot of the page. Thus a page bearing the reference 1—3 Page 7 is Page 7 of Part 1, Chapter 3.

3. The chapters of Part 1 of this book are arranged to relate to the Jaguar GR Mk 1 and to the T Mk 2 excluding the accommodation and equipment provided in the rear cockpit. A supplement is given at the end of the book relating to the rear cockpit of the T Mk 2. Part 2A and Part 2B are given to separate the limitations for the GR Mk 1 and T Mk 2 respectively. The remainder of this book relates to both marks of aircraft, any differences being identified as necessary in the main text.

4. The limitations quoted in Part 2 are mandatory. ▶◀ Instructions containing the word 'must' are also mandatory.

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

6. Amendment Lists will be issued as necessary and each amendment list instruction sheet will state the main purpose of the amendment and will include a list of modifications covered. The List of Pages will also be updated with each 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 odd-numbered pages and any triangles on either page forming a sheet 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.

7. The following conventions are observed throughout the Manual:

a. The actual markings on controls are indicated in the text by capital letters.

b. Unless otherwise stated all speeds, temperatures, altitudes and accelerations quoted are indicated values, and all incidence values refer to HUD incidence indications.

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

d. Information requiring emphasis is printed in italics.

e. Notes are inserted to clarify the reason for a procedure or to give information which, while not essential to the understanding of the subject is useful to the reader.

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

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

AMENDMENT RECORD SHEET

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

A L No	AMENDED BY	DATE
1	B. McConnell	13.1.78
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3	B. McConnell	10.7.78
4	[illegible]	1.11.79
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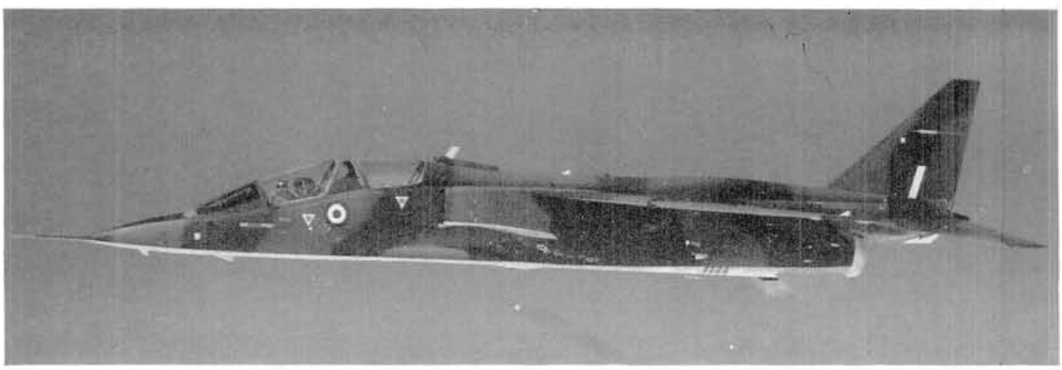
LIST OF ABBREVIATIONS

Abbreviation	*Explanation*
AAR	Air-to-air refuelling
ADC	Air data computer
AGL	Above ground level
AMSL	Above mean sea level
C	Celsius (Centigrade) temperature
CBLS	Carrier, bomb, light stores
CCS	Communication control system
CSI	Combined speed indicator
CWP	Centralised warning panel
EHP	Electro-hydraulic pump
ERU	Ejector release unit
F	Farad
ft	Feet, foot
g	Gramme or acceleration due to gravity
HFD	Horizontal fuselage datum
Hr	Hour(s)
HSI	Horizontal situation indicator
HUD	Head-up display
Hz	Hertz (cycles per second)
Imp gall	Imperial gallon(s)
in	Inch(es)
IVS	Inertial velocity sensor
k	Kilo
kt	Knot(s)
lb	Pound(s)
LFD	Longitudinal fuselage datum
LRMTS	Laser ranging and marked target seeker
m	Milli, metre(s)
M	Mega
MAS	Master armament switch
MC	Medium capacity
min	Minute
NavWASS	Navigation and weapon aiming sub-system
NCU	Navigation control unit
NLG	Non-linear gearing (controls)
NWS	Nosewheel steering
PCP	Pilot's control panel
PDR	Pilot's display recorder
PDU	Pilot's display unit
PFCU	Powered flying control unit
PMD	Projected map display
PSI	Pounds per square inch
PTR	Part-throttle reheat
PTU	Power transfer unit
PWR	Passive warning receiver
QDM	Magnetic track
q-feel	IAS-related artificial control feel
RCP	Reconnaissance control panel
RF	Radio frequency
RPM	Revolutions per minute
sec	Seconds
TRU	Transformer-rectifier unit
V	Volt(s)
VA	Volt-ampere(s)
W	Watt(s)
WAMS	Weapon aiming mode selector
WCP	Weapon control panel
WCS	Weapon control system
WFG	Waveform generator
WMP	Weapons monitor panel

Jaguar GR Mk 1



Jaguar T Mk 2

INTRODUCTION

1. The Jaguar GR Mk 1 is a single-seat, high-wing, land-based monoplane designed for the tactical support role. The T Mk 2 is a two-seat version designed for training in the tactical support role. Both marks are powered by two RR/Tm Adour bypass turbofan engines incorporating reheat and mounted side-by-side in the fuselage. The engines provide compressed air for various services and drive hydraulic pumps and AC generators.

2. Each pilot is provided with a rocket-assisted ejection seat in a sealed, pressurised cockpit. Aircraft layout is shown on Fig 1 (GR1) and Fig 2 (T2): cockpit layout for the GR1 and T Mk 2 front cockpit is shown on Fig 3 and 4. The T Mk 2 rear cockpit is shown in Supplement No 1.

3. The flying controls are hydraulically operated by duplicated units and there is no manual reversion. Hydraulic power is also used for the operation of the landing gear, flaps and slats, airbrakes, nosewheel steering, wheelbrakes and, on the GR1, the extension and retraction of the air-to-air refuelling probe.

4. Fuel is carried in wing and fuselage tanks and, if required, in external jettisonable tanks. Fuel transfer is normally automatic and arranged to maintain the centre of gravity within limits. Provision is made for single-point pressure refuelling, partial gravity refuelling and fuel jettison. The GR1 is also equipped for air-to-air refuelling.

5. Air conditioning and canopy sealing uses air tapped from the engine compressors, but ram air can be selected if ventilation alone is required.

6. Airframe and engine ice protection is not fitted but electrical heating is provided for the windscreen and for the pitot sensors.

7. Electrical supplies are derived from engine-driven, constant-speed alternators feeding to AC busbars and to Transformer Rectifier Units which supply the aircraft DC system. The system is arranged so that either alternator can feed the whole system and either TRU can support the full DC load. A battery is used to back up certain DC ser-

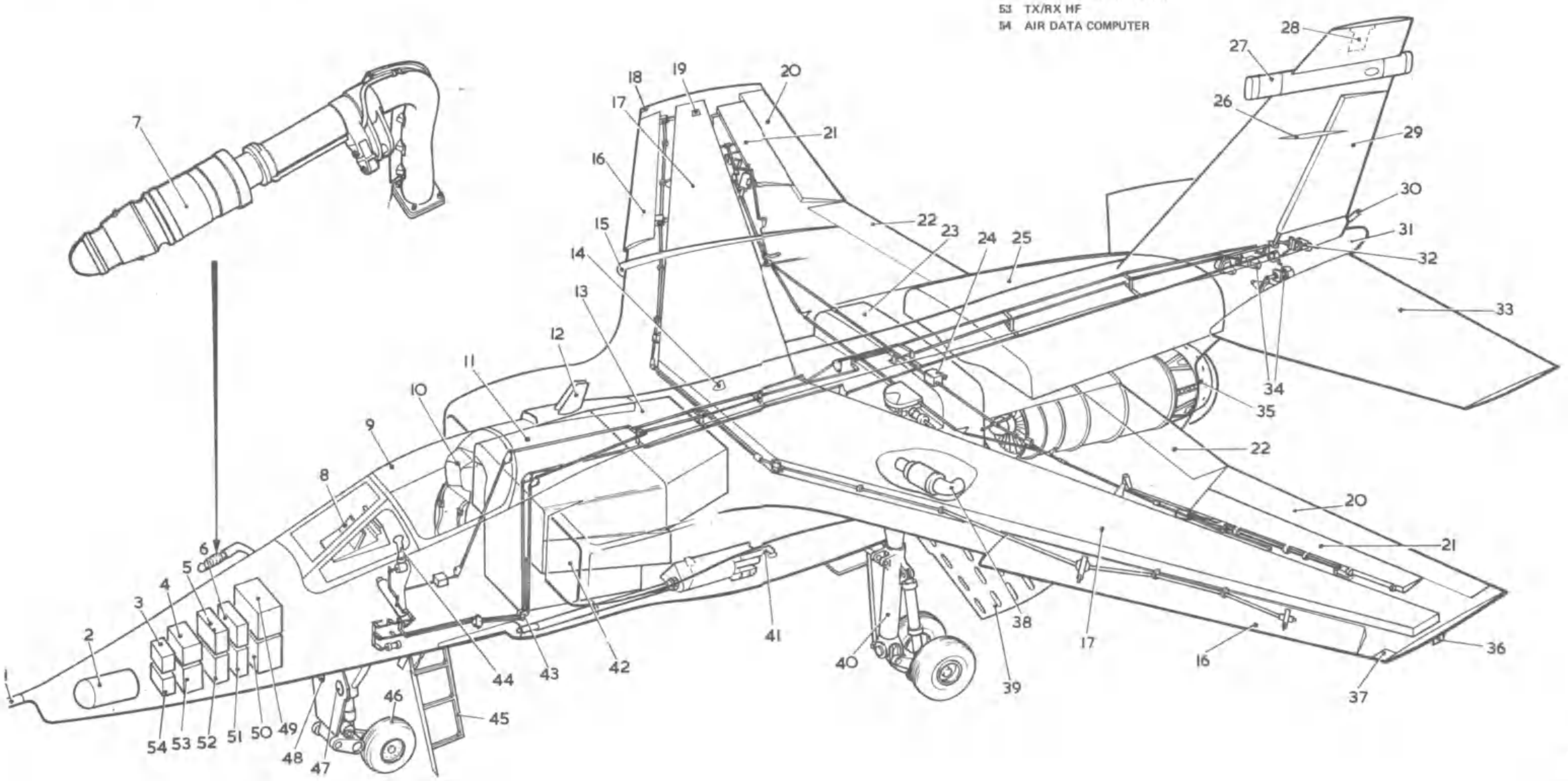
vices and to feed a static inverter in the event of total AC failure. An external AC supply can be connected to supply the entire aircraft system.

8. A centralised warning system is installed to warn the pilot of failures arising at critical points in the aircraft systems. Initial warnings are audio/visual or visual only to direct the pilot's attention to the appropriate caption on a Centralised Warning Panel.

9. The integrated Nav/Attack system includes an inertial Navigation and Weapon Aiming Sub-System (NavWASS) together with other sub-systems such as a Head-Up Display (HUD) system, C2J gyromagnetic compass, radio altimeter, ILS, Tacan, UHF homing and an Air Data Computer system. A 920M digital computer, which is part of the NavWASS, makes all the computations required for navigation and weapon aiming. The NavWASS produces a head-up display of the relevant data on the Pilot's Display Unit (PDU), a head-down display at a Horizontal Situation Indicator (HSI), a continuous display of aircraft present position at a Projected Map Display (PMD) and a digital read-out on a Navigation Control and display Unit (NCU). Controls are provided on the NCU for operation of the computer, for the storage and digital display of navigation and weapon aiming data and for alignment of the inertial platform of the NavWASS. The computer also makes the calculations necessary for accurate bombing of ground targets, for the aiming of guns in air-to-ground attacks and in air-to-air attacks according to selections on the Weapons Aiming Mode Selector (WAMS) and the Weapons Control Panel (WCP), and provides the required sighting data at the HUD appropriate to the weapon and the attack mode selected.

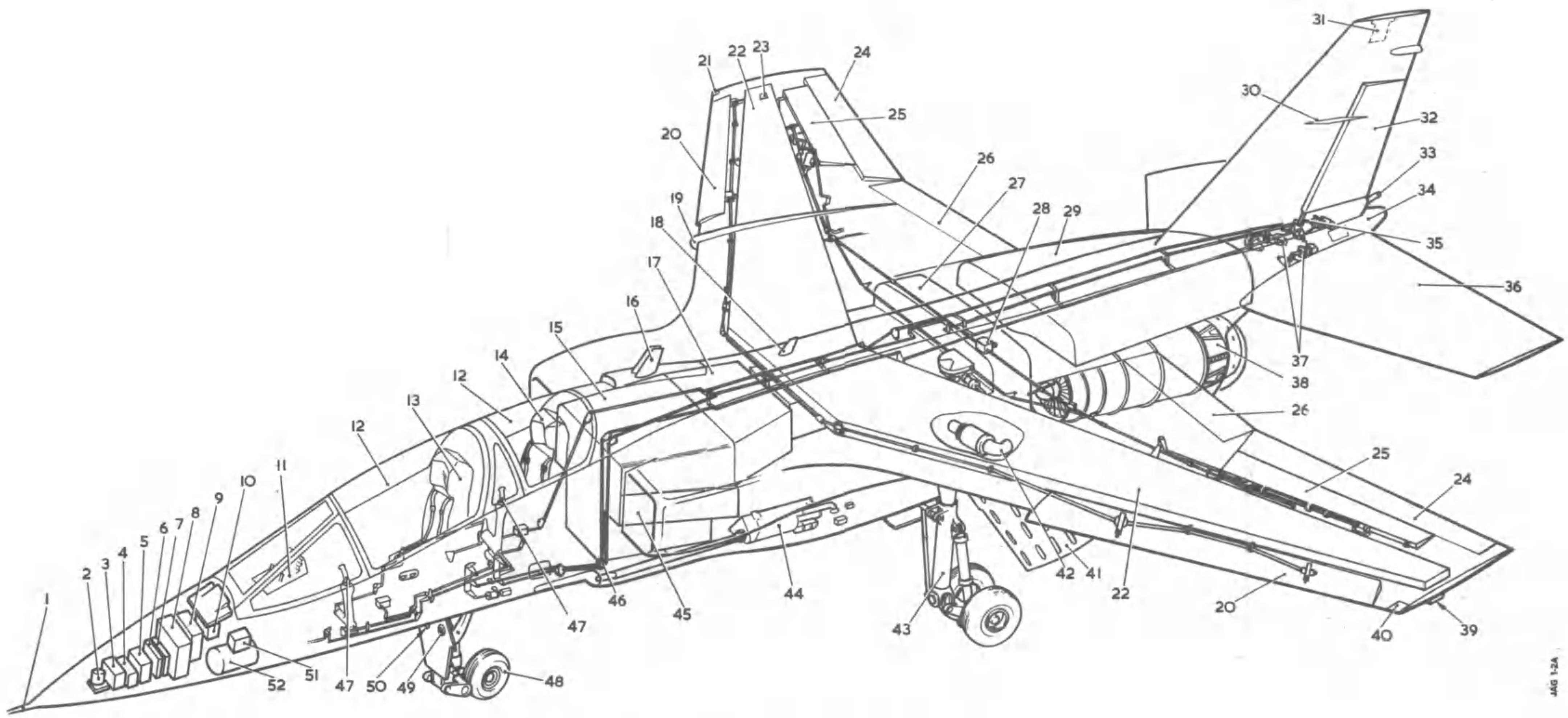
10. The communications radio installation consists of a main V/UHF transmitter-receiver, a standby UHF equipment and a communications control installation. GR1 aircraft are also provided with an HF transmitter-receiver and voice recorder, and a telebriefing facility is added to the communications control system. All aircraft are fitted with IFF/SSR.

1 PITOT-STATIC PROBE
2 LASER
3 GYRO AMPLIFIER MASTER UNIT
4 TX/RX STANDBY UHF
5 TX/RX RADAR ALTIMETER
6 POWER AMPLIFIER HF/VHF
7 AIR-TO-AIR REFUELLING PROBE
8 HUD UNIT
9 CANOPY (JETTISONABLE)
10 EJECTION SEAT
11 FUEL TANK FI
12 STANDBY UHF AND UHF HOMING AERIALS
13 FUEL TANK F2
14 IFF AERIAL (UPPER)
15 WING FENCE
16 SLATS
17 FUEL TANKS V1/V2
18 NAVIGATION LIGHT
19 UPPER TACAN AERIAL
20 WING FLAPS (OUTBOARD)
21 SPOILERS
22 WING FLAPS (INBOARD)
23 FUEL TANK F3
24 FLAP MOTOR
25 FUEL TANK F4
26 ILS LOCALISER/GLIDESLOPE AERIAL
27 PASSIVE WARNING RX AERIAL
28 V/UHF AERIAL
29 RUDDER
30 FUEL VENT/JETTISON OUTLET
31 BRAKE PARACHUTE
32 RUDDER ACTUATOR
33 TAIL PLANE
34 TAIL PLANE ACTUATOR
35 RR/TM ADOUR
36 IFF AERIAL (LOWER)
37 NAVIGATION LIGHT
38 MICROTURBO AIR GENERATOR
39 AIR BRAKES
40 MAIN LANDING GEAR
41 ADEN GUN
42 AIR INTAKE
43 FLYING CONTROLS LINKAGE
44 CONTROL COLUMN HANDGRIP
45 COCKPIT ACCESS LADDER (Inoperative) AL3
46 NOSE WHEEL
47 TAXY LAMP
48 LANDING LAMP
49 INERTIAL PLATFORM (WITH AJAX SERVO UNIT)
50 DIGITAL COMPUTER
51 TX/RX - VHF/UHF
52 WAVEFORM GENERATOR
53 TX/RX HF
54 AIR DATA COMPUTER

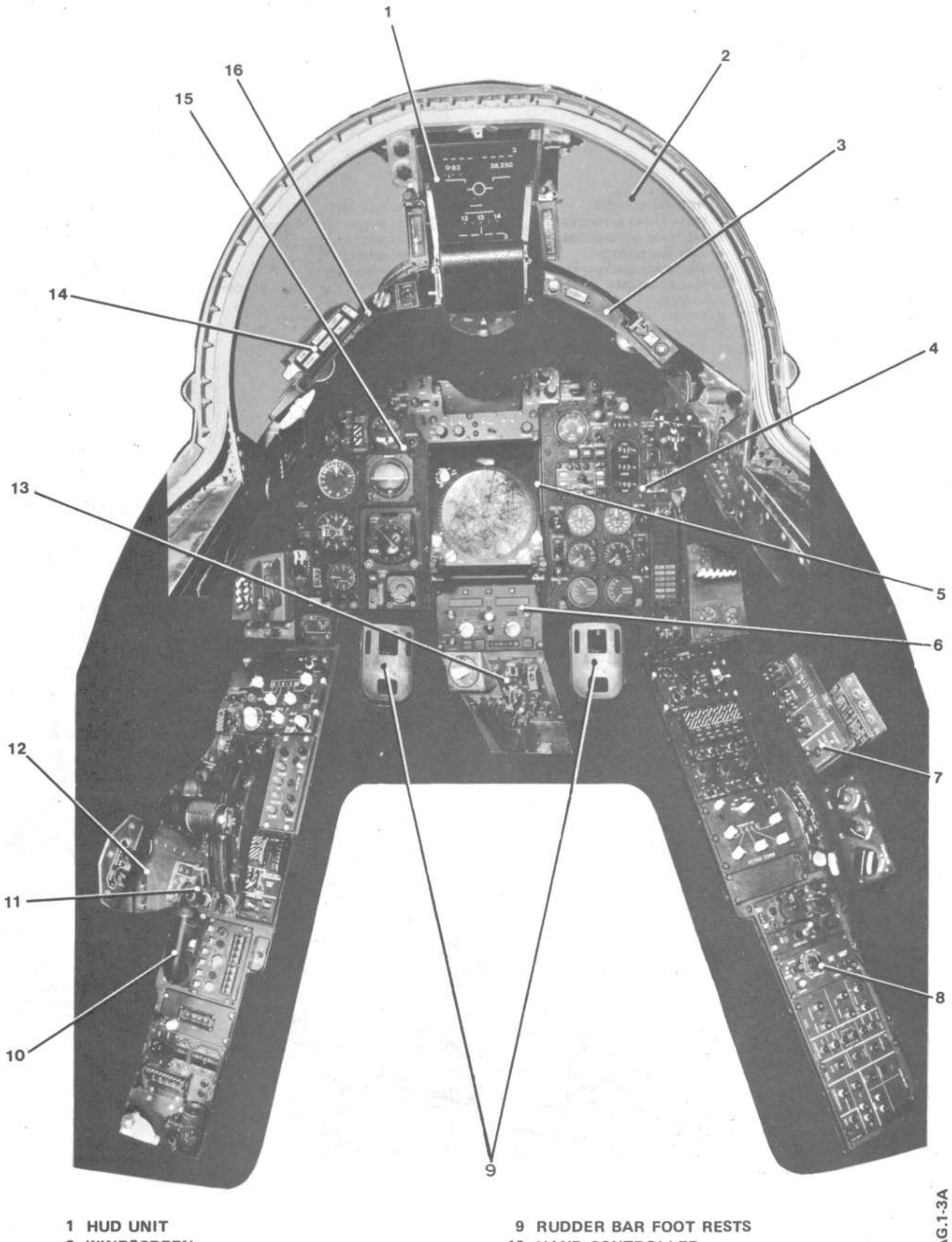


Prelims Fig 1 GR1 Aircraft Layout

1 PITOT-STATIC PROBE
2 TX/RX RADAR ALTIMETER
3 TAILPLANE DIFFERENTIAL UNIT
4 AJAX ELECTRONICS
5 INTERCOMM JUNCTION BOX
6 AJAX SERVO UNIT
7 VOR/ILS
8 TACAN
9 AUTOSTAB UNIT
10 DIFFERENTIAL TAILPLANE ELECTRONICS UNIT
11 HUD UNIT
12 CANOPY (JETTISONABLE)
13 EJECTION SEAT
14 EJECTION SEAT
15 FUEL TANK F1
16 STANDBY UHF AND UHF HOMING AERIALS
17 FUEL TANK F2
18 IFF AERIAL (UPPER)
19 WING FENCE
20 SLATS
21 NAVIGATION LIGHT
22 FUEL TANKS V1 V2
23 UPPER TACAN AERIAL
24 WING FLAPS (OUTBOARD)
25 SPOILERS
26 WING FLAPS (INBOARD)
27 FUEL TANK F3
28 FLAP MOTOR
29 FUEL TANK F4
30 ILS LOCALISER/GLIDESLOPE AERIAL
31 V/UHF AERIAL
32 RUDDER
33 FUEL VENT/JETTISON OUTLET
34 BRAKE PARACHUTE
35 RUDDER ACTUATOR
36 TAILPLANE
37 TAILPLANE ACTUATOR
38 RR TM ADOUR
39 IFF AERIAL (LOWER)
40 NAVIGATION LIGHT
41 AIRBRAKES
42 MICROTURBO AIR GENERATOR
43 MAIN LANDING GEAR
44 ADEN GUN
45 AIR INTAKE
46 FLYING CONTROLS LINKAGE
47 CONTROL COLUMN HANDGRIP
48 NOSE WHEEL
49 TAXY LAMP
50 LANDING LAMP
51 RADIO INTERFACE UNIT
52 INERTIAL PLATFORM

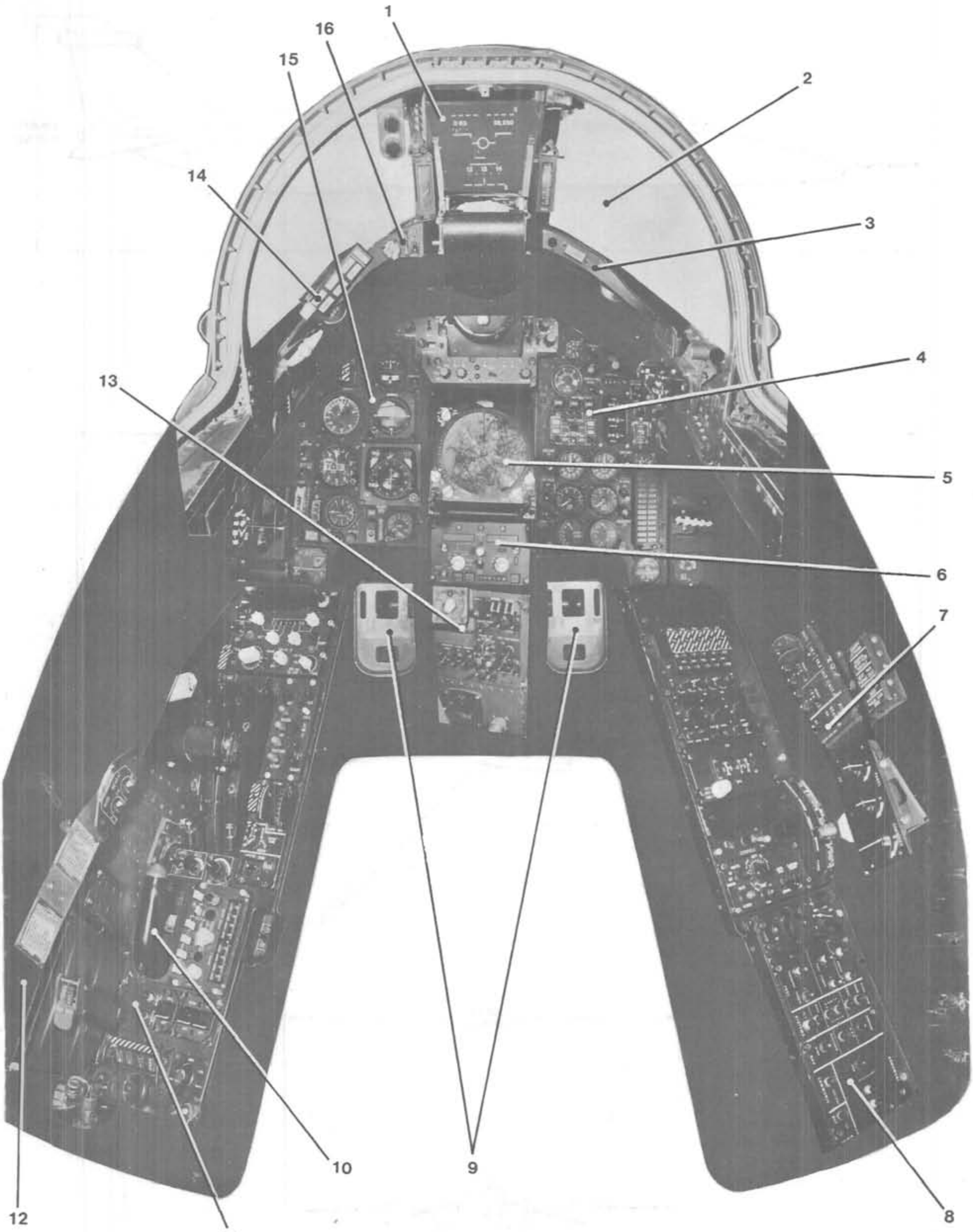


Prelims Fig 2 T Mk 2 Aircraft Layout



1 HUD UNIT	9 RUDDER BAR FOOT RESTS
2 WINDSCREEN	10 HAND CONTROLLER
3 MAIN INSTRUMENT PANEL COAMING, RIGHT	11 LEFT CONSOLE
4 MAIN INSTRUMENT PANEL, RIGHT	12 LEFT SILL
5 PROJECTED MAP DISPLAY	13 CENTRE CONSOLE
6 NAVIGATION CONTROL UNIT	14 WEAPON AIMING MODE SELECTOR
7 RIGHT SILL	15 MAIN INSTRUMENT PANEL, LEFT
8 RIGHT CONSOLE	16 MAIN INSTRUMENT PANEL COAMING, LEFT

Prelims Fig 3 GR1 Cockpit Layout



1 HUD UNIT
2 WINDSCREEN
3 MAIN INSTRUMENT PANEL COAMING, RIGHT
4 MAIN INSTRUMENT PANEL, RIGHT
5 PROJECTED MAP DISPLAY
6 NAVIGATION CONTROL UNIT
7 RIGHT SILL
8 RIGHT CONSOLE
9 RUDDER BAR FOOT RESTS
10 HAND CONTROLLER
11 LEFT CONSOLE
12 LEFT SILL
13 CENTRE CONSOLE
14 WEAPON AIMING MODE SELECTOR
15 MAIN INSTRUMENT PANEL, LEFT
16 MAIN INSTRUMENT PANEL COAMING, LEFT

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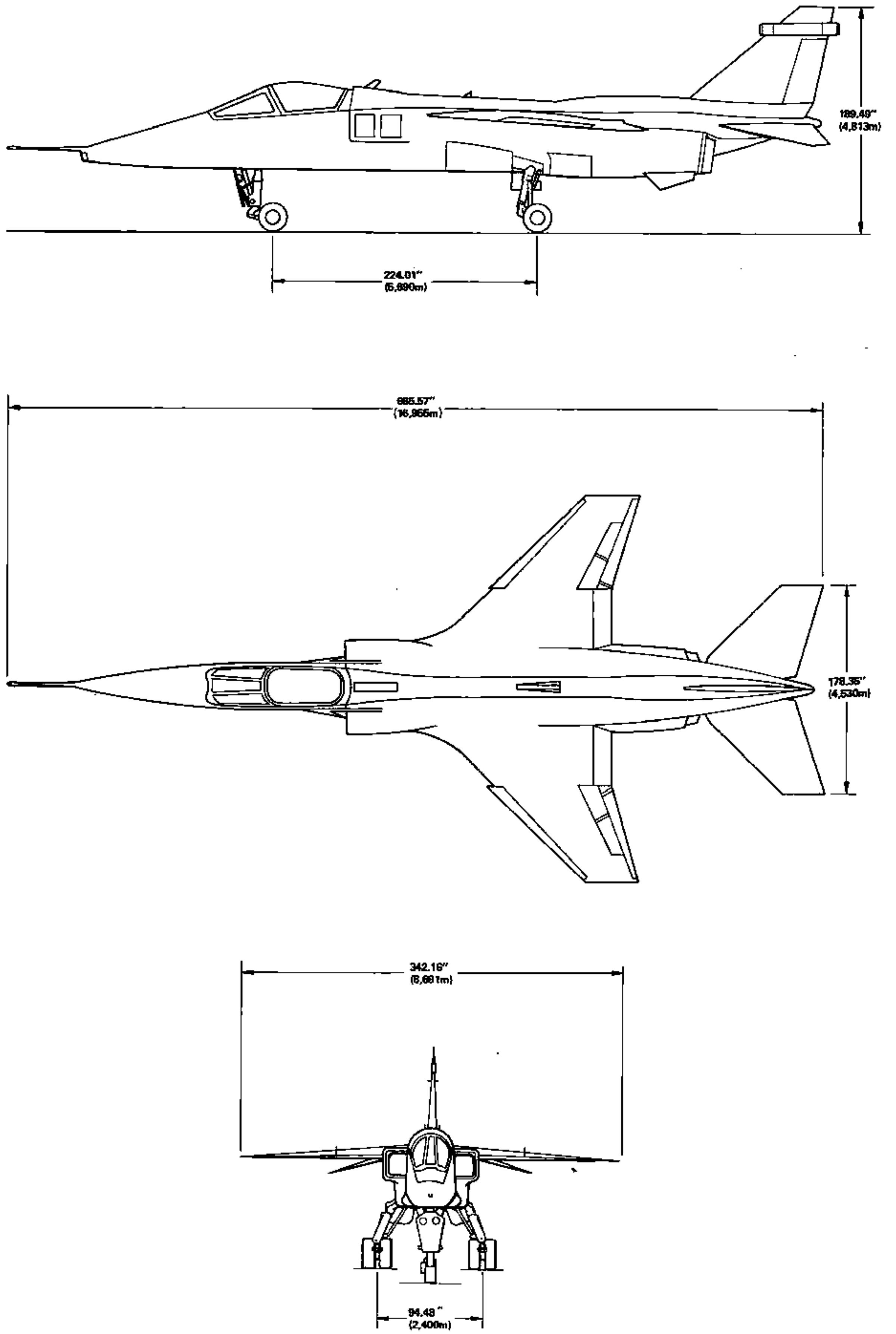
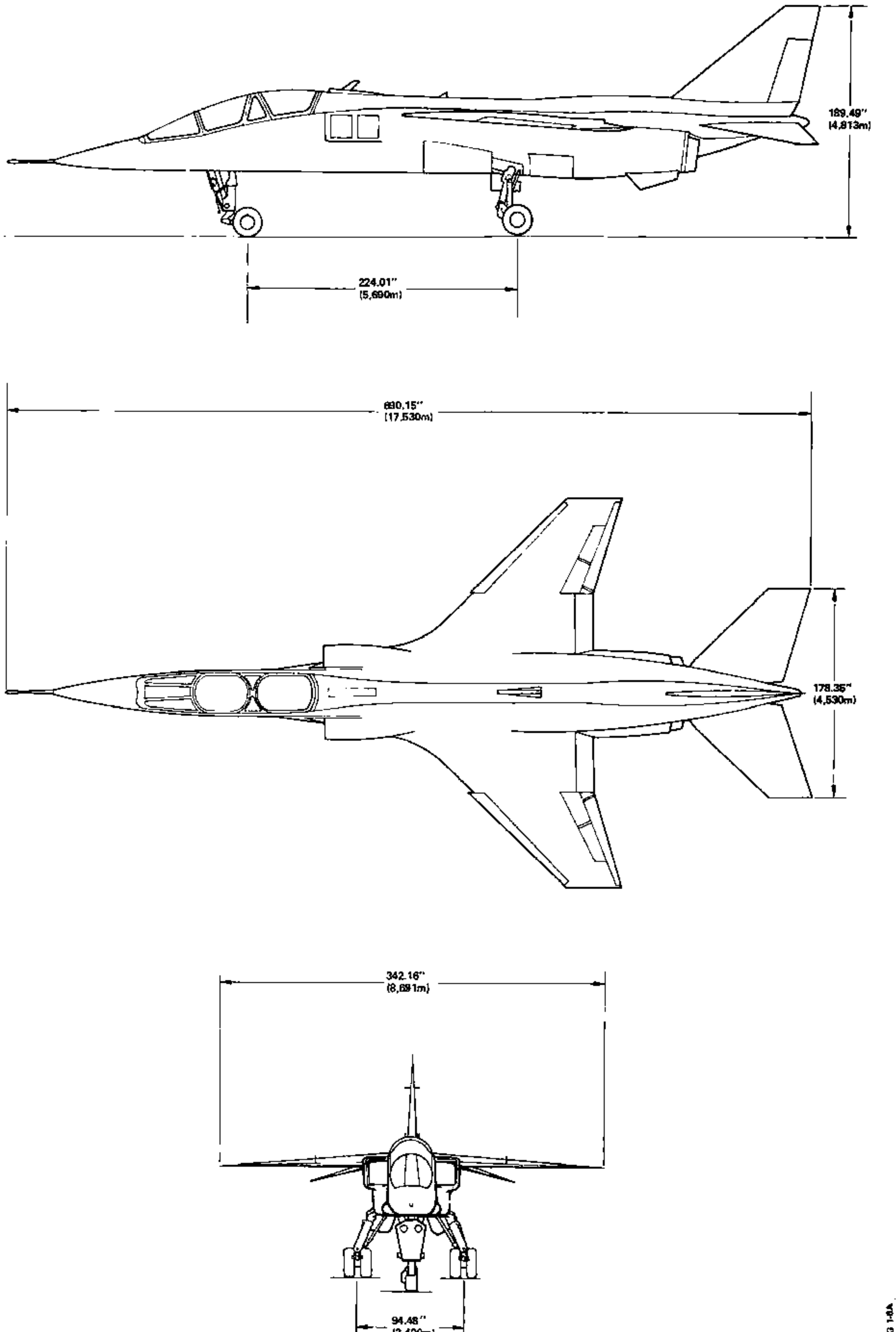
Prelims Fig 4 T Mk 2 Cockpit Layout — Front



Prelims Fig 5 GR1 Aircraft Dimensions



Prelims Fig 6 T Mk 2 Aircraft Dimensions

LEADING PARTICULARS

Principle Dimensions

Aircraft dimensions are shown on Prelim Fig 5 (GR1) and Prelim Fig 6 (T Mk 2). The measurements relate to an empty aircraft.

Electrical System

Generation	3-phase AC, 400 Hz, 115/200V engine-driven alternators, 12/15 kVA.
DC supply	Two 28V TRU, 150 A nominal
Inverter	115V, 400 Hz, single-phase
Transformer	26V, 400 Hz, single-phase
External AC	3-phase, 400 Hz, 200V
Battery	24V, 40 ampere-hours

Fuel System

Fuel Specifications. The aircraft and engines are cleared for use with the approved fuels listed in Table 1.

Table 1—Approved Fuels

NATO Code No	*UK Joint Service Designation*	*UK Specification*	*US Designation*	*US Specification*
F-35	AVTUR	DERD 2494	JET A-1/JET A	ASTM D1655
F-34	AVTUR/FSII	DERD 2453	JP-8	MIL-T-83133
F-40	AVTAG/FSII	DERD 2454	JP-4	MIL-T-5624

Alternatively, the aircraft and engines, except for Mk 102 engines fitted with JP 102 jet pipes (single catalyst), are cleared for use with the following types of fuel which may only be used if the above approved fuels are not available (F-43 must not be used if there is a risk of ice forming in the fuel):

F-43	AVCAT	DERD 2498	—	—
F-44	AVCAT/FSII	DERD 2452	JP-5	MIL-T-5624

Fuel Capacities. Table 2 shows the fuel tank capacities and equivalent fuel weights for specific gravities of 0·78, 0·79 and 0·80.

Table 2—Fuel Tank Capacities—Usable Fuel

Tank	*0·78 SG* *Kg*	*0·79 SG* *Kg*	*0·80 SG* *Kg*	*Litres*	*Imp Gall*
F1	475	481	487	609	134
N1	116	117	119	149	33
N2	116	117	119	149	33
V1	372	377	382	477	105
V2	372	377	382	477	105
F2 & F3	912	924	935	1169	257
F4	890	901	913	1141	251
RL1	924	936	948	1185	261
RL2	924	936	948	1185	261
RLF	924	936	948	1185	261
TOTAL	6026	6102	6181	7726	1701

Engines

Engine	RR/Tm Adour Mk 102 or Mk 104 turbofan with re-heat. Air starter
Starting air supply	Aircraft mounted Microturbo gas generator
Engine oil capacity	11·9 litres (21 pints)

Engine and Microturbo oil

Type	*NATO Code*	*UK Joint Service Designation*	*Equivalent Specifications UK*	*French*
5cST	0-160*	OX-26	DERD 2497	—
3cST	0-150	—	—	AIR 3514

*In addition to the 0-160 oils, the 5cST oils Esso 2380 and Mobil Jet 2 are also approved for use.

Hydraulic Systems

No 1 Circuit

Pump	One driven from No 1 engine
Operating pressures	186 to 206 bar (2700 to 3000 PSI)
Reservoir capacity	6·2 litres (10·85 pints)

No 2 Circuit

Pumps	One driven from No 2 engine One electrically operated

Operating pressures	Engine-driven pump: 186 to 206 bar (2700 to 3000 PSI) Electric pump: 140 to 150 bar (2030 to 2175 PSI)
Reservoir capacity	6·2 litres (10·85 pints)
Fluid	MIL-H-560A, French AIR 3520 (NATO H-515)

Services

Flying controls operation	No 1 and/or No 2 circuit
Flap/slat operation	No 1 and/or No 2 circuit
Landing gear	No 1 circuit (normal) No 2 circuit (emergency)
Wheelbrakes	No 1 circuit (normal) No 2 circuit (emergency)
Airbrakes	No 2 circuit only
Nosewheel steering	No 2 circuit only
Air-to-air refuelling probe (GR1)	No 1 circuit (normal) No 2 circuit (emergency extension)

Air Conditioning and Pressurisation

Air conditioning supply	Engine compressors Ram air
Pressurisation (automatic control)	Maximum differential (controller) ... ... 4·35 PSI Maximum differential (safety valve) ... ... 4·85 PSI Maximum negative differential ... ... 0·3 PSI

Radio Installation

◀V/UHF	ARI 18220/3 or ARI 23315/4 ▶
Standby UHF	ARI 23159
HF (GR1 only)	ARI 23181
Communications control	ARI 23228 (telebrief on GR1 only)
Voice recorder (GR1 only)	ARI 23208
ILS	ARI 18227/1

Tacan	ARI 23205/4
Radio altimeter	ARI 23232
IFF/SSR	ARI 23134/3
Passive warning receiver (GR 1 only)	ARI 18223

Pilot Equipment

Ejection seat	Martin Baker 9B Mk 2 with liferaft, PSP and emergency oxygen
Oxygen	LOX system, man-mounted regulator

LIST OF ASSOCIATED PUBLICATIONS

Jaguar GR Mk 1 and T Mk 2, Aircrew Manual Book 2—Navigation/Attack and Armament Systems	AP 101B-3101 & 2-15B
Jaguar GR Mk 1 and T Mk 2, Flight Reference Cards	AP 101B-3101 & 2-14A
Jaguar Aircraft Operating Data Manual	AP 101B-3100-16
Jaguar Aircraft Servicing Manual	AP 101B-3101 & 2-1 Series

Note: A detailed list of associated publications and air diagrams is given in the Aircraft Servicing Manual.

MODIFICATION NUMBERS MENTIONED IN THE TEXT

(*Completely revised at AL6*)

Mod No	*Brief Description*	*Location of Details*
641	Improved response time of cabin temp sensors	1—8 para 9
716	Airbrake pitching compensation	2A/2B—1 para 8 and 3—2 para 24
758	To improve HF system	2A—5 para 7
787	Modifies AJAX law	1—6 para 20
792	Introduces audible stall warning	1—9 Table 5, para 33 and 3—4 para 16
803	Introduces rudder/spoiler coupling	1—6 para 17, 3—2 para 42 and 2A/2B—1 Table 2
805	Improved strip incidence gauge	1—9 para 37
807	Alternative static source for pressure instruments (GR1)	1—9 Table 4 and 3—3 para 5
842	Oxygen system operating pressure increased	1—12 para 35
843	Enlarged cut-out in leading edge panel (slat improvement)	2A/2B—1 para 7
845	Improves RHAG trampling limits	2A/2B—4 para 8
854	Secures refuelling pipe at frame 11	2A/2B—5 para 15/10 and 3—9 various
872	Increases torque limiter setting on slat operating unit	2A/2B—1 para 7 and 3—2 para 6
876	TRU reverse current protection value increased	1—1 para 12
887	Introduces filters into HF frequency control selectors	2A—5 para 7
891	Improved water extraction	1—8 para 29, 2A/2B—1 para 4 and 3—2 WARNING
919	Stall warning incidence selection	1—9 para 33A, 3—2 various, 3—3 para 6, and 3—4 para 16
921	Introduction of 12-ply tyres	2A/2B—1 para 10 and 2A/2B—4 para 4
934	Modifies AAR refuelling valve closing time (GR1)	1—3 para 14 and 3—9 various
955	Introduces low height warning light	1—9 para 42A
964	MAX RATING facility added	1—4 para 13
967	BCF replaces methyl bromide in fire extinguishers	1—4 para 32
972	See STI 245	—
979	Introduces a mute facility for the audio alarm	1—2 para 12
1014	Attitude indicator on/off switch	1—9 para 49
1097	See STI 197/198	—
1098	Low height audio warning	1—9 para 42B to 45
1099	Introduces Marconi/Magnavox V/UHF radio	1—10 various and 2A/2B—5 para 2
Adour 143	Activation of reheat prevented until above 75% RPM	1—4 para 21, 2A/2B—2 para 7, 3—2 para 18/22 and 3—3 para 12
STI 197/198	High intensity anti-collision lights	1—11 para 28
STI 243	Provides head-up warning of landing gear not lowered	1—7 para 30
STI 245	Combat slat and landing gear speed switches modified	1—7 para 9 and various, 2A—1 para 7 and 3—2 para 27
STI 320	Removal of radio transmission inhibition with telebrief connected	1—10 para 14
SRIM 3975	Recce aircraft stall warning valves changed	1—9 para 33

PART 1

DESCRIPTION AND MANAGEMENT OF SYSTEMS

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FUEL SYSTEM	3
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HYDRAULIC POWER SYSTEM	5
FLIGHT CONTROLS AND PILOTING AIDS	6
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PART 1

CHAPTER 1 — ELECTRICAL POWER SYSTEM

Contents

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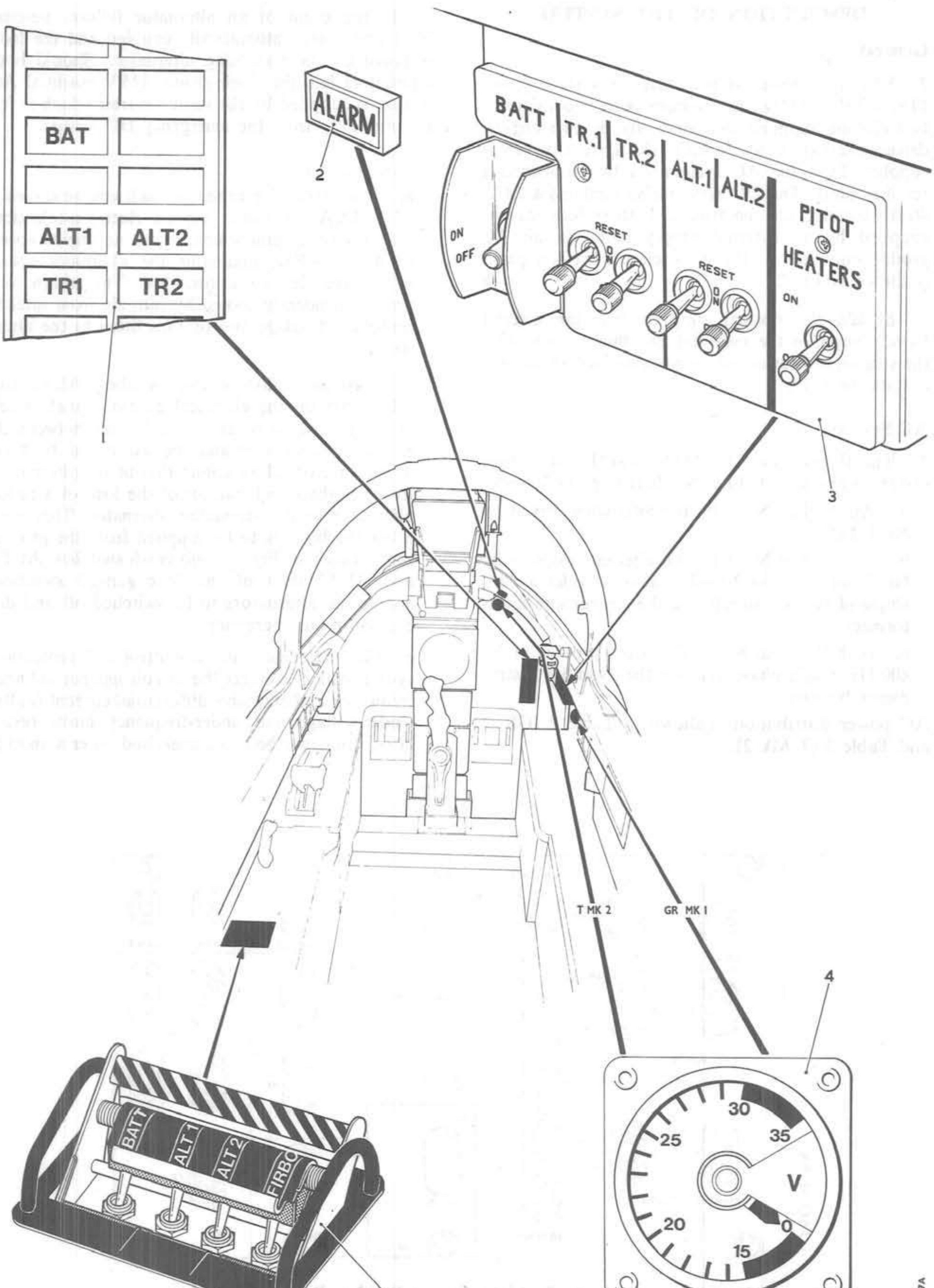
CONTROLS AND INDICATORS

1. Details concerning the controls and indicators shown in Fig 1 are listed in Table 1.

Table 1 — Electrical System Controls and Indicators

Item No	*Item*	*Location*	*Markings*	*Remarks*
1	Centralised warning panel	Right instrument panel	—	—
	Battery failure warning	CWP	BAT	Red warning — activates audio alarm and attention-getter
	TRU failure	CWP	TR1, TR2	Amber warnings — activate attention-getter
	Alternator	CWP	ALT1, ALT2	Amber warnings — activate attention-getter
2	Attention-getter	Right coaming	ALARM	Flashing red
3	Electrical control panel	Right side-wall of cockpit	—	—
	Battery switch	Electrical control panel	BATT—Blank/ ON/OFF	3-position switch spring-loaded from upper (inoperative position) to ON
	TR switches (2)	Electrical control panel	TR1, TR2 — RESET/ON/ OFF	3-position switches spring-loaded from RESET to ON
	Alternator switches (2)	Electrical control panel	ALT1, ALT2— RESET/ON/ OFF	3-position switches spring-loaded from RESET to ON
4	DC emergency busbar voltmeter	Right instrument panel extension (GR1) Right instrument panel (T2)	V	Scaled from 0 to 35 volts. Red failure arcs 0 to 15V and 30 to 35V
5	Crash switches (4)	To rear of left console	BATT, ALT1, ALT2, FIRBOT	A yellow and black ganging bar enables simultaneous operation. ◀With the bar forward and wired, individual switches can still be selected ▶



1—1 Fig 1 Electrical Power System — Controls and Indicators

DESCRIPTION OF THE SYSTEM

General

2. Electrical power is provided by a three-phase, 115/200 V, 400 Hz, AC system, which consists of two circuits supplied independently by two engine-driven alternators, and a 28 V DC system, which is supplied from the AC system via two transformer rectifier units. The DC system also contains a 24 V, 40 Ah battery. On the ground, both systems can be supplied by an external supply unit, via an AC ground connection. The main circuit breaker panel is shown at Fig 2.

3. Should the normal supplies fail, the aircraft battery supplies the essential DC busbars and also the single-phase essential instruments busbar through a static inverter.

AC System

4. The three-phase 115/200 V, 400 Hz AC power system is normally fed by the alternators as follows:

a. AC busbar No 1 by the alternator driven by No 1 engine.

b. AC busbar No 2 by the alternator driven by No 2 engine. (No 2 busbar also provides a 26 V single-phase AC supply via the instrument transformers.)

c. Both No 1 and No 2 AC busbars provide 115V, 400 Hz, single-phase AC for the essential instruments busbars.

AC power distribution is shown in Table 2 (GR 1) and Table 3 (T Mk 2).

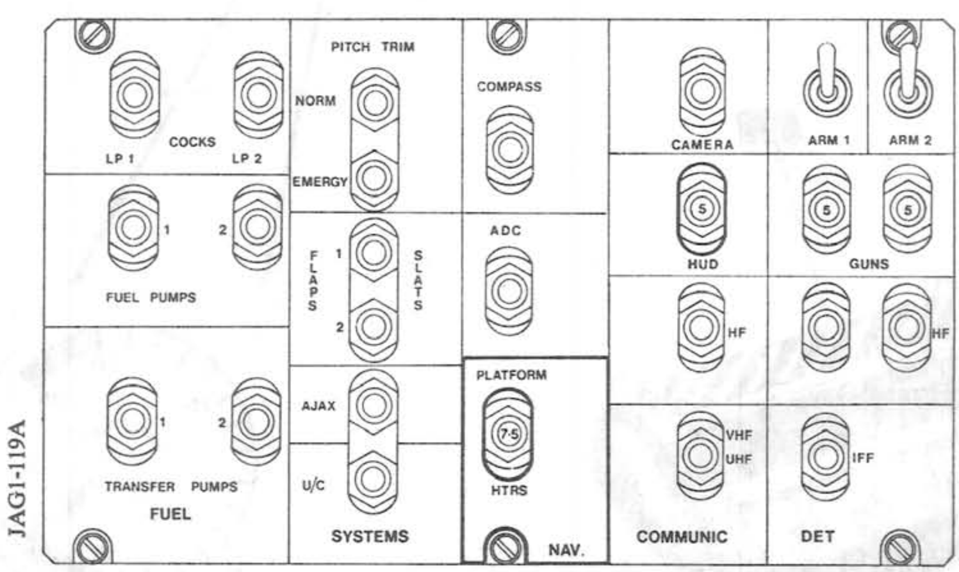
5. In the event of an alternator failure, busbars No 1 and 2 are automatically coupled and the load is taken by the remaining alternator. Should both alternators fail, the single-phase, 115 V essential AC busbar is supplied by the static inverter which is fed automatically from the emergency DC busbar.

6. *Alternators*

a. The external gearbox of each engine drives a 12/15 kVA alternator, via an electro-mechanical constant speed unit which, above an engine speed of 47·5% RPM, maintains the alternator speed within the desired limits. The alternators are independently cooled by ram air from intakes under the fuselage and by fans fitted to the alternator unit.

b. Two alternator control switches, ALT1 and ALT2 are on the electrical control panel. Each switch controls a contactor in the line between its respective alternator and the associated busbars. The contactors allow connection of the alternators to the busbars and transfer of the load of a failed alternator to the remaining alternator. They also allow the busbars to be supplied from the ground connection (see Fig 3). Two crash switches, ALT1 and ALT2 (two of the four ganged switches) enable the alternators to be switched off and de-excited in an emergency.

c. Each alternator has a control and protection system which protects the circuit against voltage, frequency and excessive differential current faults. Under-voltage and under-frequency faults result in the contactor being de-energised, after a short



1—1 Fig 2 Main Circuit Breaker Panel

time delay to cater for transients, thus disconnecting the alternator from its busbar; should the fault subsequently disappear, the contactor is automatically re-energised to bring the alternator back on line. Over-voltage, over-frequency and differential current faults also result in the alternator being de-excited but in this case automatic reconnection does not occur.

d. If a single alternator fails or is switched off, its contactor, in opening, forms a link between the AC1 and AC2 busbars which are fed by the remaining alternator so that there is a minimum interruption of supplies to the distribution circuits. The disconnection of the alternator is indicated by flashing of the attention-getter and by the relevant ALT amber warning on the CWP.

Table 2 — AC Power Distribution — GR 1

*AC*1 115/200*V*, 400 *Hz*	*AC*2 115/200*V*, 400 *Hz*
Single-phase	*Single-phase*
ADC	Autostabiliser
Autostabiliser	Engine ignition
Cockpit lighting	Equipment bay cooling
Cockpit temperature control	HSI
Engine ignition	Interface unit
Probe heating	Projected map display
Radar altimeter	Turn-and-slip indicator
Radio interface unit	Laser window demisting
Seat height adjustment	AJAX
Tacan	NCU, WAMS, HC
PWR	
Three-phase	*Three-phase*
Left collector tank pump	Right collector tank pump
Fuel transfer pumps	Fuel transfer pumps
HF	Gyrocompass
HUD waveform generator	Inertial platform (heaters)
No 1 TRU	ADC
Gun firing	No 2 TRU
Recce pod	
Essential AC bus 115*V*, 400 *Hz* *Single-phase AC*1 + *AC*2 *or static inverter*	*Single-phase* 26*V*, 400*Hz bus* *Transformer from AC*2
Attitude indicator (AC2)	Tacan
IFF (AC2)	Gyrocompass
Fuel gauges (AC1)	
TGT control & ind: No 1 (AC1), No 2 (AC2)	
Oxygen gauging (AC1)	

Table 3 — AC Power Distribution — T Mk 2

*AC*1 115/200*V*, 400 *Hz*	*AC*2 115/200*V*, 400 *Hz*
Single-phase	*Single-phase*
ADC	Autostabiliser
Autostabiliser	Cockpit lighting
Cockpit lighting	Engine ignition
Cockpit temperature control	Equipment bay cooling
Engine ignition	AJAX
Probe heating	Fuel gauging units
Radar altimeter	Hand controllers
Radio interface unit	HSI (front and rear)
Seat height adjustment	Projected map display
Tacan	Turn-and-slip indicator
Three-phase	*Three-phase*
Left collector tank pump	Right collector tank pump
Fuel transfer pumps	Fuel transfer pumps
HUD waveform generator	Gyrocompass
No 1 TRU	Inertial platform (heaters)
Gun firing	ADC
	No 2 TRU
Essential AC bus 115*V*, 400 *Hz* *Single-phase AC*1 + *AC*2 *or static inverter*	*Single-phase* 26*V*, 400 *Hz bus* *Transformer from AC*2
Attitude indicator (AC2)	Tacan
IFF (AC2)	Gyrocompass
Fuel gauges (AC1)	
TGT control & ind: No 1 (AC1), No 2 (AC2)	
Oxygen gauging (AC1)	

e. Up to four attempts should be made at intervals to restore a failed alternator by use of the alternator RESET facility, after first reducing the associated engine RPM to 85% to ensure that alternator speed is below the overfrequency limit. Selecting the switch to RESET activates relays in the protection unit through which supplies are fed to bring the failed alternator back on line, provided that the fault has cleared. If the control and protection unit incorrectly follows the reset attempt by restoring a failed alternator back on line, indicated by lighting of the associated TR caption, or if the reset attempt fails, select the ALT switch to OFF and, if necessary, reset the TRU (para 14).

f. Should both alternators fail, a static inverter is automatically switched into use to feed the essential AC instrument busbars.

7. *Static Inverter.*

a. The emergency AC supply is provided by a static inverter; a self-excited, self-regulated unit which starts immediately on the application of a DC supply.

b. DC input is from the 28V, emergency DC busbar via a relay which is energised to isolate the static inverter when No 1 or No 2 alternator or the ground supply is on line. Feed to the 115V essential instruments busbars passes via contacts in the relay from inverter output or from AC1 and AC2 respectively.

8. *External Supply.*

a. An external AC supply can be connected to the aircraft for use during ground servicing and preparation for flight. No provision is made for external DC supply on the aircraft.

b. An electrical supply trolley providing 115/200V, three-phase 400 Hz at 15 kVA can be connected to the aircraft ground supply point which is on the left side of the aircraft forward of the main landing gear. When connecting the external supply, the aircraft BATT switch must be on because power to operate the ground supply contactor is obtained from the emergency DC busbar. A detector in the aircraft inhibits the contactor if the phase sequence of the ground supply is incorrect. If the ground supply is to be used for any length of time there is a possibility that, in conditions of light load, the battery will overheat and boil. To prevent this the BATT switch should be returned to OFF once the ground supply is on line.

c. If, during engine starting using an external supply, No 1 engine is started first, the No 1 alternator supplies its associated busbars only, while the busbars associated with No 2 alternator continue to be supplied from the external supplies. When No 2 engine is started first, No 2 alternator supplies all the busbars and isolates the external supply.

DC System

9. The 28V DC supply is provided by two transformer rectifier units (TRU) supplied from AC busbars No 1 and No 2 (see Fig 3).

10. A 24V, 40 ampere-hour battery continuously energises the battery busbar and is connected to the emergency busbar via a contactor when the BATT switch is selected on.

11. *DC Supply.*

a. DC power is available on the following busbars:

Normal 28V busbar supplied by TRU No 1.
Emergency 28V busbar supplied by TRU No 2 (feed to services essential for flight).
Battery busbar permanently connected to the 24V battery.

b. During normal operations, the Normal and Emergency DC busbars are linked and their TRU are paralleled. A voltmeter (graduated 0 to 35V, with red arcs on the 0 to 15V and 30 to 35V sections) gives a continuous reading of the voltage on the DC emergency busbar; with TRU off and the battery switch on, the reading should be approximately 24V; with TRU on line the reading should be approximately 28·5V.

DC power distribution is shown in Table 4 (GR1) and Table 5 (T Mk 2).

Table 4 — DC Power Distribution — GR 1

	BATTERY BUSBAR	
Battery contactor supply	Wander lamp	
Fire extinguishing	Starter and DC ignition	
Refuelling and defuelling control		
	NORMAL DC BUSBARS	
Air conditioning	HUD	Tacan
Autostabiliser	ILS	~~Telebriefing (pre-mod 791)~~ AL 5
Cockpit lighting	Laser	Radar altimeter
Equipment bay cooling	NCU (lighting and opticators)	Recce pod
External lighting	Probe heating	PWR
HF	Pilots display recorder	Voice recorder
	HSI	Gun selection and control
		UHF
		WAMS

(continued)

Table 4 — DC Power Distribution — GR1 — *continued*

EMERGENCY BUSBAR

Air conditioning
- Temperature control
- Ejector control
- Cockpit pressure warning

Engines
- Starting
- Overheat indication
- Oil low pressure indication
- Fire detection
- Part throttle reheat
- ◀ TGT control ▶
- Nozzle position indication
- Fuel LP warning
- Bleed valves

Flight controls
- Trims and indication
- Slats and flaps
- AJAX
- Tailplane differential
- Airbrakes
- Rudder limiter

Fuel
- LP cocks and engine crossfeed
- Flowmeters
- Transfer—control and indication
- Fuel pumps—control and indication
- Air-to-air refuelling probe control
- Collector tank low level indication and interconnect
- Refuelling and jettisoning control
- Tank low air pressure

Hydraulics
- Pressure indication
- Reservoir contents warning
- Electro hydraulic pump

Instruments
- I N platform (PSU)
- Probe heating
- Incidence indicator
- Interface unit
- Altimeter

Landing Gear
- Control and indication
- Nosewheel steering
- Wheelbrakes

Radio and Navigation
- VHF/UHF
- IFF
- Standby UHF
- CCS
- Telebriefing ~~(mod 791)~~ AL5

Miscellaneous
- CWS
- Weapon system
- Lighting (internal and external)
- Arrester hook indication
- Oxygen
- Laser compt shut-off valve
- Static inverter
- Special weapons
- Fatigue meter

Table 5 — DC Power Distribution — T Mk 2

BATTERY BUSBAR

- Battery contactor supply
- Fire extinguishing
- Refuelling and defuelling control
- Starter and DC ignition
- Wander lamp

NORMAL DC BUSBARS

- Air conditioning
- Cockpit lighting
- Equipment bay cooling
- External lighting
- HUD
- ILS
- Probe heating
- Pilot's display recorder
- Tacan
- Projected map display
- HSI
- Master armament switch
- Radar altimeter
- Autostabilisation
- UHF

EMERGENCY BUSBAR

Air conditioning
- Temperature control
- Ejector control
- Cockpit pressure warning

Engines
- Starting
- Overheat indication
- Oil low pressure indication
- Fire detection
- Part throttle reheat
- ◀ TGT control ▶
- Nozzle position indication
- Fuel LP warning
- Bleed valves

Flight controls
- Trims and indication
- Slats and flaps
- AJAX
- Tailplane differential
- Airbrakes
- Rudder limiter

Fuel
- LP cocks and engine crossfeed
- Flowmeters
- Transfer—control and indication
- Fuel pumps—control and indication
- Collector tank low level indication and interconnect
- Refuelling and jettisoning control
- Tank low air pressure

Hydraulics
- Pressure indication
- Reservoir contents warning
- Electro hydraulic pump

Instruments
- I N platform (PSU)
- Probe heating
- Incidence indicator
- Interface unit
- Air data computer

Landing Gear
- Control and indication
- Nosewheel steering
- Wheelbrakes

Radio and Navigation
- VHF/UHF
- IFF
- Standby UHF
- CCS

(*continued*)

Table 5 — DC Power Distribution — T Mk 2 — *continued*

	EMERGENCY BUSBAR	
Miscellaneous	Lighting (internal and external)	Static inverter
CWS	Arrester hook indication	Fatigue meter
Weapon system	Oxygen	

12. *Transformer Rectifier Units.* The TRU produce 28V DC from AC busbars No 1 and No 2. The DC output of each TRU is fed through a contactor in an associated protection unit to the Normal (No 1 TRU) and Emergency (No 2 TRU) busbars. Whichever TRU contactor closes first, automatically closes a busbar tie contactor which links the two busbars, ie either TRU can energise both busbars. The protection unit controls the connection of the TRU to its busbar; it automatically isolates its TRU in the following circumstances:

a. A reverse current in excess of 20A ± 0·5A (10A ± 0·5A pre-mod 876).

b. TRU overheating.

c. No output following a TRU failure or an AC supply failure.

13. *Battery.*

a. The 24V, 40 ampere-hour battery continuously energises the battery busbar and is connected to the emergency busbar via a contactor when the BATT switch is set to ON. The contactor disconnects the battery from the emergency busbar when the BATT switch is set to off: secondary contacts close to operate the CWS. The DC supply to the battery switch is connected through a BATT crash switch (one of four ganged switches) on the left console. The crash switch enables the battery to be switched off in an emergency.

b. With the battery switched on and the AC busbars de-energised, a DC supply is routed from the emergency DC busbar to the static inverter. When AC becomes available the static inverter is automatically isolated.

14. *DC Failure.*

a. In the event of failure of a TRU, its contactor opens and disconnects the failed TRU from its busbar. The busbar tie contactor remains energised and the remaining TRU supplies both busbars. The failure is indicated by the attention-getter flashing and the relevant TR amber warning on the CWP. Up to four attempts at intervals to restore the failed TRU may be made using the RESET facility of the TR switch. If the fault persists, the cause may be a failure in the AC supply system not isolated by the control and protection unit and is usually accompanied by other symptoms. Such a failure can be determined by setting the associated ALT switch to OFF and repeating the TRU reset attempt. If the reset is successful, the alternator is at fault: leave the ALT switch OFF and land as soon as practicable. If the reset attempt is unsuccessful, land as soon as possible; all DC services are supplied by the remaining TRU.

b. Failure of the second TRU leaves the emergency DC busbar supplied by the battery. With the battery at 80% capacity, 80% charge, and the temperature at 0°C, the minimum battery duration is as follows:

Supplying services on the emergency DC busbar only — 28 minutes.

Supplying services on the emergency DC busbar plus NavWASS inertial platform and computer — 17 minutes.

Supplying services on the emergency DC busbar plus the electro-hydraulic pump — 5 minutes.

c. Disconnection of the battery from a live emergency busbar is indicated by the audio warning, the attention-getter flashing and the red BAT warning on the CWP.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

15. Carry out the following checks on the electrical system:

a. Check crash switches forward and gang bar forward and wired.

b. If external power is on but no groundcrew available carry out a power check as follows:
Select the BATT switch ON and check that the voltmeter reads approximately 24V. Check that the fuel gauges are operating and the attitude indicator erecting, indicating that static inverter output is satisfactory. With the AC busbars energised from external power set the TR1 switch to ON and the BATT switch to OFF. Check that the voltmeter reading is approximately 28V (this also confirms that the busbar tie contactor is operating). Set the TR2 switch to ON and check the TR1 and TR2 warnings on the centralised warning panel are out.

c. Set the ALT switches to ON and check that the ALT1 and ALT2 captions are on.

Note: During the air generator start-up cycle, provided one or both TRU are on line, the BAT warning remains on. This occurs because the battery is automatically isolated from the TRU thereby ensuring that the starter motor is fed from the battery only and thus protected against high TRU voltage.

d. As each engine starts check that the corresponding ALT warning goes out and, if starting on internal power, check *both* TR warnings go out as the first alternator comes on line.

Before Take-Off Checks

16. Before take-off, check that the ALT1, ALT2, TR1, TR2 and BAT warnings are out and the voltmeter indicates 28V.

MALFUNCTIONS OR USE IN ABNORMAL CONDITIONS

Indications and Actions

17. Indications and actions relating to system malfunction are given in Table 6.

Load Shedding Considerations

18. In the event of complete alternator and TRU failure the emergency DC busbar is supplied by the battery only. Items considered non-essential to the immediate safety of the aircraft are as follows:

	Item	*Watts*
a.	Nav Attack, PSU IFU	880
b.	VHF/UHF	243
c.	IFF	19
d.	Pitot heaters	224 (Subject to weather conditions)
e.	Cockpit lighting	180 (GR1) 277 (T Mk 2)
f.	Recce pod	130 (GR 1)

Flight instruments and navigation aids available are:

ADI, HDD altimeter, CSI, E2 compass and main and standby radios (turn-and-slip indicator not available).

19. Lighting in the cockpit is still available because the panel ultra-violet and red lighting is connected direct to the emergency busbar and the wander lamp is supplied from the battery busbar.

Total Electrical Failure

20. Loss of all electrical power (except battery busbar) results if the crash switches are moved rearwards. Both alternators, both TRU and the battery are disconnected from the main power system and both fire extinguisher heads are fired. The failure warning system has no electrical supply and thus the only indications of such failure (by day) will be:

Voltmeter zero
CWP test inoperative
Fuel MI cross-hatched
Transfer pumps MI indicating OFF
Flowmeters zero
Hydraulic pressures zero
Flight instrument failure flags visible

To restore supplies, set the crash switches forward (CWP now operative) and carry out the alternator and TRU resetting drills as appropriate. No fire extinguishing facilities are available. The wander lamp remains usable.

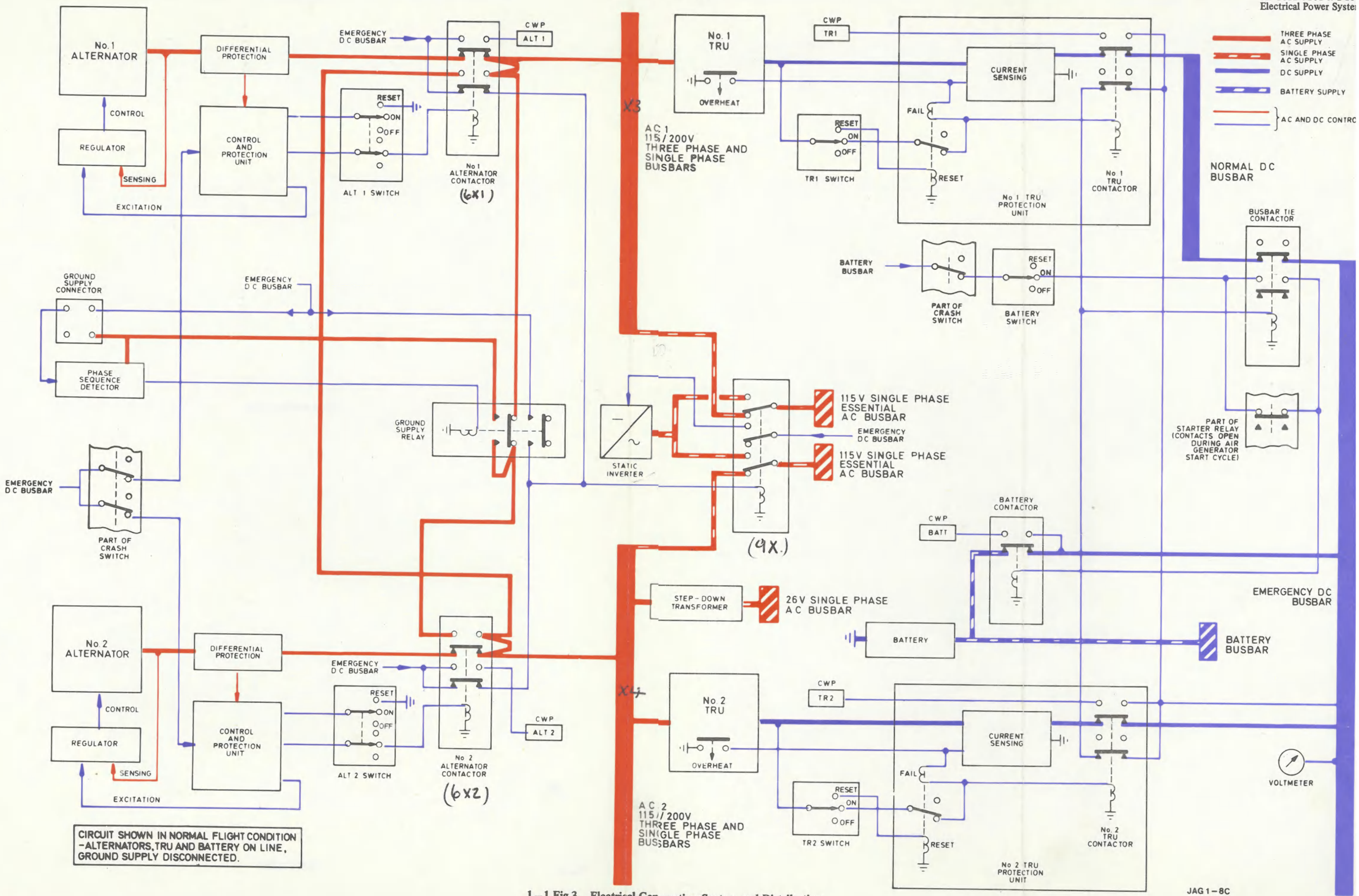
Table 6 — Electrical System Malfunctions

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
SINGLE TRU FAILURE			
Attention-getter flashing. TR1 or TR2 warning on the CWP	Cancel warning. TR switch to RESET then ON (up to four attempts)	If no reset, monitor voltmeter: if voltage drops below 24V, land as soon as practicable	Other TRU normally supplies all DC services if TRU will not reset
TR1 plus: LP1 light HUD display failure Oxygen contents zero Fuel gauge fail flags No 1 TGT control failure — OR — TR2 plus: LP2 light All attitude reference PMD dump STAB caption HSI failure flag No 2 TGT control failure	Associated ALT switch OFF. TR switch to RESET then ON (up to four attempts)	If successful: Leave ALT switch OFF Land as soon as practicable If unsuccessful: Land as soon as possible	All services supplied by other alternator

(continued)

Table 6 — Electrical System Malfunctions — *continued*

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
DOUBLE TRU FAILURE			
Attention-getter flashing. Both TR amber warnings on CWP	◀ Cancel warning. Set both TR switches to OFF. Attempt to RESET one TRU at a time (Up to four attempts each). If one is regained, leave the other at OFF	If the fault remains, switch off all non-essential DC loads. Leave BATT switch on. Use standby UHF. Establish VMC below cloud. Land as soon as possible	The normal DC busbar is disconnected and the battery is no longer being charged. The emergency DC busbar and battery busbar will be available while battery power lasts. Consider lowering landing gear and flaps before battery is exhausted Avoid unnecessary trimming ▶
SINGLE ALTERNATOR FAILURE			
Attention-getter flashing. ALT1 or ALT2 warning on CWP	◀ Attempt to reset (max 2 attempts). If no reset, reduce associated engine RPM to 80 to 85%. Set the appropriate ALT switch to RESET then ON (max 2 attempts). Check both TR ▶ warnings out	If reset is unsuccessful or AC failure symptoms persist, set the ALT switch to OFF. If necessary, reset the TRU Land as soon as practicable	If the fault persists, all AC services should be supplied from the other alternator
DOUBLE ALTERNATOR FAILURE			
Attention-getter flashing. Both ALT and both TR warnings on CWP	◀ Cancel warning. Set both ALT switches to OFF. Try to reset one alternator at a time (2 attempts each). If no reset, make further attempts to reset with the associated engine RPM reduced to 80 to 85%	When one alternator regained, leave the other switched off. Reset both TRU. If neither alternator will reset, load shed and use standby UHF: leave the BATT switch on. Establish VMC below cloud and land as soon as possible.	With a double alternator failure: 1. Fuel management is as given in the FRC 2. After load shedding, battery should last 60 minutes. 3. Consider lowering gear and flaps before battery voltage less than 21V 4. AI, HDD alt, CSI, E2, stby UHF available. **No turn and slip** ▶
BATTERY DISCONNECTION			
Audio alarm, attention-getter flashing and red BAT warning on the CWP	Cancel warning. Check voltmeter reading is 28 V.	◀ Land as soon as practicable ▶	Normal AC and DC services are available if one alternator and one TRU are on line. The battery has been disconnected from the emergency DC busbar. Battery busbar services may fail. Should a total AC failure occur all electrical services will be lost



1–1 Fig 3 Electrical Generation System and Distribution
◀ (Minor Amendments) ▶

PART 1

CHAPTER 2—FAILURE WARNING SYSTEM

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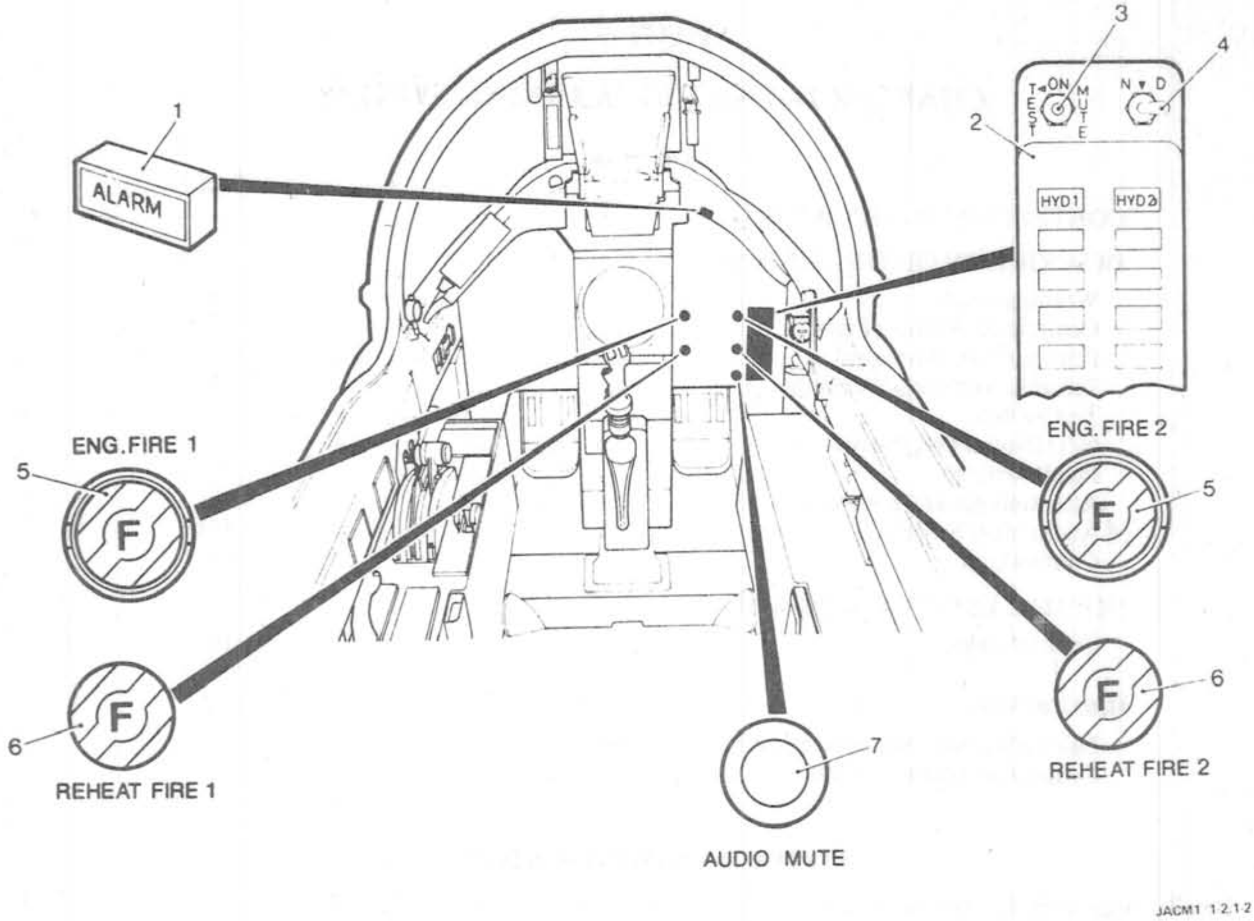
CONTROLS AND INDICATORS

1. Details concerning the controls and indicators shown in Fig 1 are listed in Table 1.

Table 1—Failure Warning System Controls and Indicators

Item No	*Item*	*Location*	*Markings*	*Remarks*
1	Combined attention-getter and cancel switch	Right coaming panel	ALARM	Flashing red warning—push to cancel
2	Centralised warning panel (CWP)	Right instrument panel	Refer to Fig 2	Red and amber warning captions
3	CWP—TEST/ON/MUTE	On CWP	TEST/ON/ MUTE	Three-position toggle switch; spring return from TEST to ON
4	CWP—Night/Day switch	On CWP	N/D	Two-position toggle switch
5	No 1 and No 2 engines fire warning lamps (zone 1) incorporating fire extinguisher buttons	Right instrument panel	ENG FIRE 1 ENG FIRE 2	Red lamp under striped guard
6	No 1 and No 2 engines reheat fire warning lamps (zone 2)	Right instrument panel	REHEAT FIRE 1 REHEAT FIRE 2	Red lamp
◀ 7	Combined AUDIO MUTE button and indicator light	Right instrument panel	AUDIO MUTE	Pull to mute audio warning; light comes on when muted ▶



1—2 Fig 1 Failure Warning System Controls and Indicators
(Mod 979 embodied)

DESCRIPTION OF THE SYSTEM

General

2. The warning system provides the pilot with immediate indications of failure or emergency conditions arising in the aircraft systems. The principal components of the system are a warning panel, engine zone fire warning indicators, a combined attention-getter/cancel switch (ALARM), an audio warning and a control unit. Two types of warning are provided, primary and secondary respectively. The system is supplied with 28 V from the emergency DC busbar.

Centralised Warning Panel (Fig 2)

3. The warning panel comprises primary (red) and secondary (amber) warning captions, a TEST/ON/MUTE switch and a N/D (Night/Day) switch. Each caption window is provided with two filaments in parallel. Post-mod 979 there is an adjacent AUDIO MUTE pull-button and integral light.

Primary (Red) Warnings

4. The appearance of any of the red warning captions (except HYD) is accompanied by operation of the attention-getter and the audio alarm. One HYD warning initiates the attention-getter but not the audio alarm. Two simultaneous HYD warnings are accompanied by the attention-getter and the audio alarm. The OIL 1 and OIL 2 warnings appear on the CWP immediately, but the attention-getter and audio warnings are held off for 10 seconds to avoid nuisance warnings resulting from transient low oil pressure conditions.

Secondary (Amber) Warnings

5. The appearance of any of the amber warning captions on the CWP is accompanied by the attention-getter only.

Test Switch

6. To check the system, the switch is held in the TEST (spring-loaded) position; the following indications occur:

a. All the captions on the warning panel come on except F DET (Fig 2, item 16)

b. The attention-getter flashes.

c. The audio warning operates.

d. The four fire warning lights come on and the serviceabiltiy of the fire detection circuit is checked.

e. The red warning light in the landing gear lever flashes.

f. The five indicator lights on the fuel management panel come on.

g. The air generator starter indicator light (green) comes on.

7. The MUTE setting of the TEST/ON/MUTE switch is used during ground servicing and renders the following warnings inoperative:

a. All the captions on the warning panel.

b. The audio alarm.

Note 1: The fire warning system with audio alarm is still operative.

Note 2: The ALARM caption in the attention-getter remains on continuously to indicate that MUTE is selected.

N/D (Night/Day) Switch

8. The N/D switch controls the brightness of the following filaments:

a. All the warning captions on the warning panel.

b. The attention-getter.

c. The red warning light in the landing gear lever.

d. The flaps, slats and landing gear position indicating lights.

e. The lights on the fuel management panel.

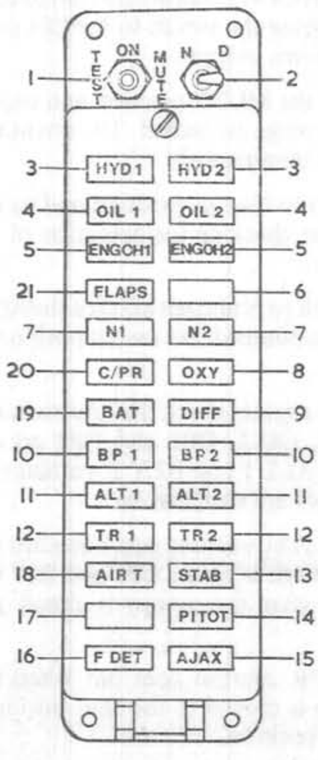
f. The IFF failure indicator light.

g. The radar altimeter low level warning light.

h. The ILS marker light.

i. The HF controller panel lights.

Note: The four fire warning lights cannot be dimmed.



ITEM NO.	ITEM	REMARKS
1	TEST-ON-MUTE SWITCH	
2	NIGHT AND DAY SWITCH (N-D)	
3	HYDRAULIC PRESSURE CIRCUITS 1 & 2 $\leq$ 100 BAR	RED + AUDIO ALARM
4	LOW OIL PRESSURE (WHEN DIFFERENTIAL PRESSURE FALLS BELOW 10 PSI)	RED + AUDIO ALARM
5	OVERHEATING (ENGINES 1 & 2 BEARING COOLING AIR) TEMP $\geq$400°C	RED + AUDIO ALARM
6		
7	COLLECTOR TANKS 1 & 2, LOW FUEL CONTENTS 100 KG	RED + AUDIO ALARM
8	OXYGEN PRESSURE < 2 BAR (30 PSI)	RED + AUDIO ALARM
9	DIFFERENTIAL TAIL PLANE FAILURE	RED + AUDIO ALARM
10	LOW FUEL PRESSURE (ENGINES 1 & 2 $\leq$ 35 PSI)	AMBER
11	ALTERNATOR OFF-LINE (1 & 2)	AMBER
12	TRU OFF-LINE (1 & 2)	AMBER
13	YAW AUTOSTABILIZER OFF	AMBER
14	PROBE HEATERS OFF	AMBER
15	AJAX FAILURE	AMBER
16	FIRE DETECTION CIRCUIT FAILURE (INOPERATIVE)	AMBER
17		
18	CABIN AIR C.A.U. INLET TEMPERATURE OVER 80°C	AMBER
19	BATTERY DISCONNECTED	RED + AUDIO ALARM
20	CABIN PRESSURE ALTITUDE > 27000 FT OR CANOPY LOCKING HANDLE NOT IN SHUT POSITION	RED + AUDIO ALARM
21	FLAPS EXTENDED MORE THAN 0° 30' WITH AIRSPEED > 260 KNOTS	RED + AUDIO ALARM

JAG 1-108

1—2 Fig 2 Centralised Warning Panel

Fire Warnings

9. Two ENG FIRE warning indicators and two REHEAT FIRE warning indicators are on the right hand instrument panel (Fig 1). The ENG FIRE 1 and ENG FIRE 2 indicators incorporate fire extinguisher buttons. Pressing either of these buttons discharges the fire extinguisher into the appropriate Zone 1. The fire warnings go out when the fire is extinguished. Lighting of any of these warnings is accompanied by the flashing of the attention-getters and the audio alarm.

10. Indication of a fire is obtained through fire detectors which are units comprising a resistor and a contactor in parallel. Under normal conditions the contacts of all the fire detectors are closed, the electrical resistance throughout the circuit is therefore low and all lamps are unlit. Should a high temperature condition occur, the contacts of the fire detector nearest the fault condition open, causing an effective increase in the resistance of the detection circuit. This increased resistance de-energises a solenoid and enables the associated warning lamps, the audio alarm and the flashing attention-getters to be activated. When the excessive temperature condition returns below the detector contact opening temperature, the contacts close and the system reverts to normal.

Attention-Getter Cancellation

11. A condition which results in the appearance of either a fire warning or a red or amber warning caption also activates the flashing attention-getter and, if applicable, the audio warning. Both the flashing warning and the audio warning can be cancelled by pressing the attention-getter; however, the warning caption or fire warning remains on as long as the fault which produced it exists. If, after taking cancelling action another warning appears, the attention-getter and, if applicable, the audio alarm again operates.

Note: The attention-getter and audio alarm self cancel when triggered off by a transient warning.

Audio Mute Switch

12. Post-mod 979, an audio mute button, which is labelled AUDIO MUTE and incorporates a warning light, is fitted adjacent to the CWP. Pulling out the switch mutes the audio warning function and brings on the light. In the T Mk 2, a red light adjacent to the rear cockpit CWP comes on when the mute switch in the front cockpit is pulled out. Both lights have integral dimmers and are not associated with the N/D switch.

Control Unit

13. The control unit incorporates a flasher unit, an audio tone generator and muting relays. It receives warning signals from the aircraft and engine systems and passes them to the CWP, the attention-getter, and, if applicable, to the pilot's headset via the communications control system (CCS).

NORMAL USE OR MANAGEMENT

Cockpit Checks

14. On entering the cockpit and before starting the engines set the CWP TEST/ON/MUTE switch to ON, the N/D switch to D, and check that the AUDIO MUTE switch is in.

15. With ground power connected, set the BATT switch and both TRU switches to ON. The attention-getter flashes and the audio alarm operates. Cancel the alarms by pressing the attention-getter. The number of captions displayed on the CWP depend on the condition of the aircraft but normally the following warnings are displayed:

a. Red—HYD1, HYD2. OIL1, OIL2, C/PR.

b. Amber—BP1, BP2, ALT1, ALT2, PITOT.

Set and hold the TEST/ON/MUTE switch in the TEST position and ensure that all the indicators referred to in para 6 are present. Release the switch to the ON position and cancel any alarms present.

16. Set the switch to the MUTE position and ensure that all alarms and warnings are muted. The attention-getter light remains on continuously.

17. Return the switch to the ON position and cancel any alarms present after checking the operation of the AUDIO MUTE switch.

18. Set the N/D switch to N and ensure that the lights referred to in para 8 are dimmed. Set switch position as required.

19. After starting the engines check that the warnings HYD1, HYD2, OIL1, OIL2, BP1 and BP2 go out automatically and the ALT 1 and ALT 2 warnings go out when the alternators are switched on.

20. Check that the PITOT warning goes out when the PITOT HEATERS switch is set to ON and that the C/PR warning is out when the canopy is closed and locked.

WARNING: The C/PR caption goes out when the canopy locking handle is moved to the shut position, irrespective of canopy position.

HQ486
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Procurement Executive
Ministry of Defence
January 1982

JAGUAR GR MK 1 & T MK 2 AIRCRAFT

AIRCREW MANUAL - BOOK 1

ADVANCE INFORMATION LEAFLET NO 1/82

Insert this leaflet in AP101B-3101 & 2-15A to face Part 1, Chapter 2, Page 4

FIRE DETECTION (F DET) INTEGRITY SYSTEM

The fire detection (F DET) integrity system in the Jaguar GR Mk 1 and T Mk 2 was withdrawn from service because the sensitivity of the fire warning control units was causing spurious warnings. The sensitive control units are replaced under mod 959 and, in aircraft with that modification, STI/Jaguar/162A re-activates the F DET system. This leaflet explains the operation of the system and, in conjunction with AL 2 to the current FRC (AP101B-3101 & 2-14A, Issue 3), lays down the drills in the event of the appearance of an F DET caption on the CWP.

General

1. This leaflet should be read in conjunction with the Aircrew Manual, Book 1, Part 1, Chapter 2, para 9 and 10, and with Part 1, Chapter 4, para 31 to 33.

2. Post-mod 959 and post-STI/Jaguar/162A, the fire detection (F DET) integrity system is re-introduced to the Jaguar GR Mk 1 and T Mk 2. The system provides an indication that one of the four fire detection circuits in the aircraft is unserviceable. This is achieved by enabling the control unit within a particular zone, after sensing a fault, to de-energise that circuit and to bring on the F DET caption on the CWP. By testing the CWP after an F DET warning, the affected zone is identified because the warning appropriate to that zone fails to come on.

Fire Detection System Faults

3. The following faults in a fire detection circuit cause the illumination of the F DET caption:

a. An open circuit in the detector chain.

b. Destruction of the wiring of the detector chain by an intense fire.

Indications and Actions

4. Open Circuit Fault. In the case of an open circuit fault, the cockpit indications are the F DET caption on the CWP and the attention-getter, but the audio warning does not operate. The F DET caption indicates that one of the four detection chains is inoperative and that zone is identified by testing the CWP: the ENG FIRE or REHEAT FIRE warning of the affected zone does not come on and that zone lacks fire warning protection. After an F DET warning, set a maximum of 80% RPM on the affected engine and land as soon as practicable, minimising throttle movement on that engine. Carefully monitor the engine instruments of the affected engine during the recovery and landing.

5. Destruction of Wiring. A fire of the intensity required to destroy the wiring of a detector chain is first indicated by the appropriate ENG FIRE or REHEAT FIRE warning coming on together with the attention-getter and audio

warning. If the F DET caption subsequently comes on and the previously lit ENG FIRE or REHEAT FIRE warning goes out, it can be assumed that an intense fire has occurred in that zone and the wiring has been destroyed. Testing the CWP confirms which fire detection zone is inoperative by the associated warning light remaining out, and the full fire drill for that zone must be completed.

Note: If there is an extremely rapid build-up of intense fire, there may be a very short operation of the ENG FIRE or REHEAT FIRE warning light before the destruction of the detector chain. In this case there is a momentary operation of the ENG FIRE or REHEAT FIRE warning which is immediately replaced by the F DET caption. However, the momentary operation of the fire warning triggers the audio warning (unlike an open circuit situation), allowing the identification of an actual fire after what is otherwise apparently an open circuit warning.

Summary

6. An F DET caption indicates only that there is a fault in the integrity of one of the four fire detection systems. The caption with attention-getter alone simply requires identification of the faulty circuit and care during recovery. In the rare event of an intense fire destroying a detector chain, the F DET caption appears after the ENG FIRE or REHEAT FIRE warning has gone out and, even if the fire warning was on very briefly, the audio warning indicates that a real fire has occurred, not simply a fire detector fault, and the affected zone can be identified and the appropriate fire drill completed.

Note 1: The information contained in this leaflet will be incorporated by amendment action in due course.

Note 2: If, after receipt of this leaflet, an amendment list with a prior date and conflicting information is received, the information in this leaflet is to take precedence.

PART 1

CHAPTER 3 — FUEL SYSTEM

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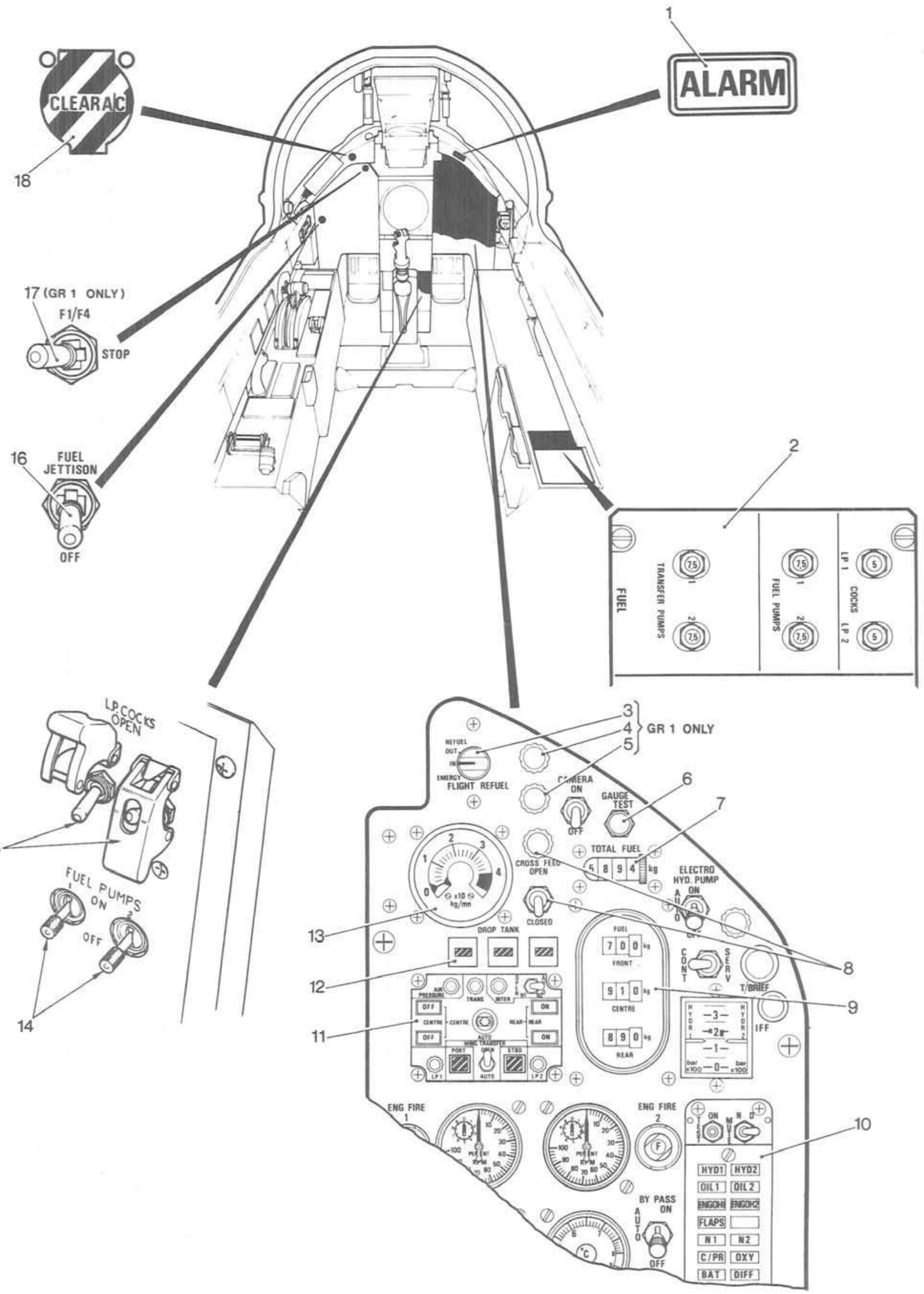
CONTROLS AND INDICATORS

1. Details concerning the controls and indicators shown on Fig 1 are listed in Table 1.

Table 1 — Fuel System Controls and Indicators

Item No	*Item*	*Location*	*Marking*	*Remarks*
1	Attention-getter	Right coaming	ALARM	Flashing red
2	Fuel supply circuit breaker panel	Right console	Refer to Fig 1	Six circuit breakers
3	Air-to-air refuelling selector switch (GR1 only)	Right instrument panel	FLIGHT REFUEL — REFUEL/OUT/IN/ EMERGY	—
4	Refuelling probe unlocked warning light (GR1 only)	Right instrument panel	—	Red light when probe unlocked
5	Air-to-air refuelling system operative indicator light (GR1 only)	Right instrument panel	—	Green light when system is ready for refuelling
6	Fuel tank contents press-to-test button	Right instrument panel	GAUGE TEST	For testing the integrity of the fuel tank contents indicator
7	Fuel remaining digital indicator (detotaliser)	Right instrument panel	—	Usable fuel contents to be set on indicator before engine start
8	Fuel crossfeed selector switch and 'valve open' light	Right instrument panel	CROSSFEED — OPEN/CLOSED	Opens crossfeed valve IM. Amber light on when valve is open
9	Fuel contents digital indicator	Right instrument panel	FUEL — FRONT kg/ CENTRE kg/REAR kg	Fuel contents of fuselage tanks
10	Centralised warning panel	Right instrument panel	(1) N1, N2 (2) BP1, BP2	(1) Collector tanks low contents warning (2) Low fuel pressure to engines
11	Fuel transfer panel	Right instrument panel	Refer to Fig 3	—
12	Drop tank magnetic indicators	Right instrument panel	DROP TANKS	—
13	Fuel flowmeter	Right instrument panel	× 10 kg/min	Dual pointer instrument
14	LP pump switches	Centre console	FUEL PUMPS 1 & 2 — ON/OFF	LP pumps switches and transfer pump operation with fuel transfer switch to AUTO
15	LP cocks switches	Centre console	LP COCKS — OPEN/ CLOSED	Lock toggle switches
16	Fuel jettison switch	Left instrument panel	FUEL JETTISON — OFF	—
17	F1/F4 isolating switch (GR1 only)	Left instrument panel	F1/F4 — STOP	Isolates F1 and F4 tanks from refuelling. Normally set to unmarked position (outboard)
18	Drop tank jettison button	Left coaming	CLEAR A/C	Guarded button. Press to jettison all external stores



1 – 3 Fig 1 Fuel System – Controls and Indicators
LP cock switches moved

DESCRIPTION OF THE SYSTEM

General

2. Fuel is carried in four fuselage tanks, two wing tanks and up to three drop tanks, and flows to two collector boxes located beneath the forward fuselage tank. Air pressure is used to transfer fuel from the wing and drop tanks to the centre group (refer to para 3) fuselage tanks; fuel from these tanks is then transferred by electrically operated fuel transfer pumps to the collector tanks. The fuel from the front fuselage tank is transferred under air pressure direct to the collector tank N1 and the fuel from the rear fuselage tank is transferred by fuel transfer pumps direct to both collector tanks or to N2 collector tank as required. Two LP pumps, one in each collector tank, pump fuel to the engines. The fuselage tank contents are gauged with reference to their grouping, contents gauges are not provided for the wing and drop tanks.

Fuel Tanks

3. The fuselage tanks are identified from front to rear: F1 with the collector tanks N1 and N2 beneath, F2, F3 and F4. The wing tanks are identified V1 (left) and V2 (right). The drop tanks are mounted on pylons and are identified RL1 (left wing), RLF (fuselage) and RL2 (right wing). For management and gauging purposes the fuselage tanks are divided into three groups:

a. *Front Group.* Comprising tanks F1, N1 and N2. Normally N1 supplies No 1 engine and N2 supplies No 2 engine.

b. *Centre Group.* Comprising tanks F2 and F3 (wing and drop tanks feed into F2).

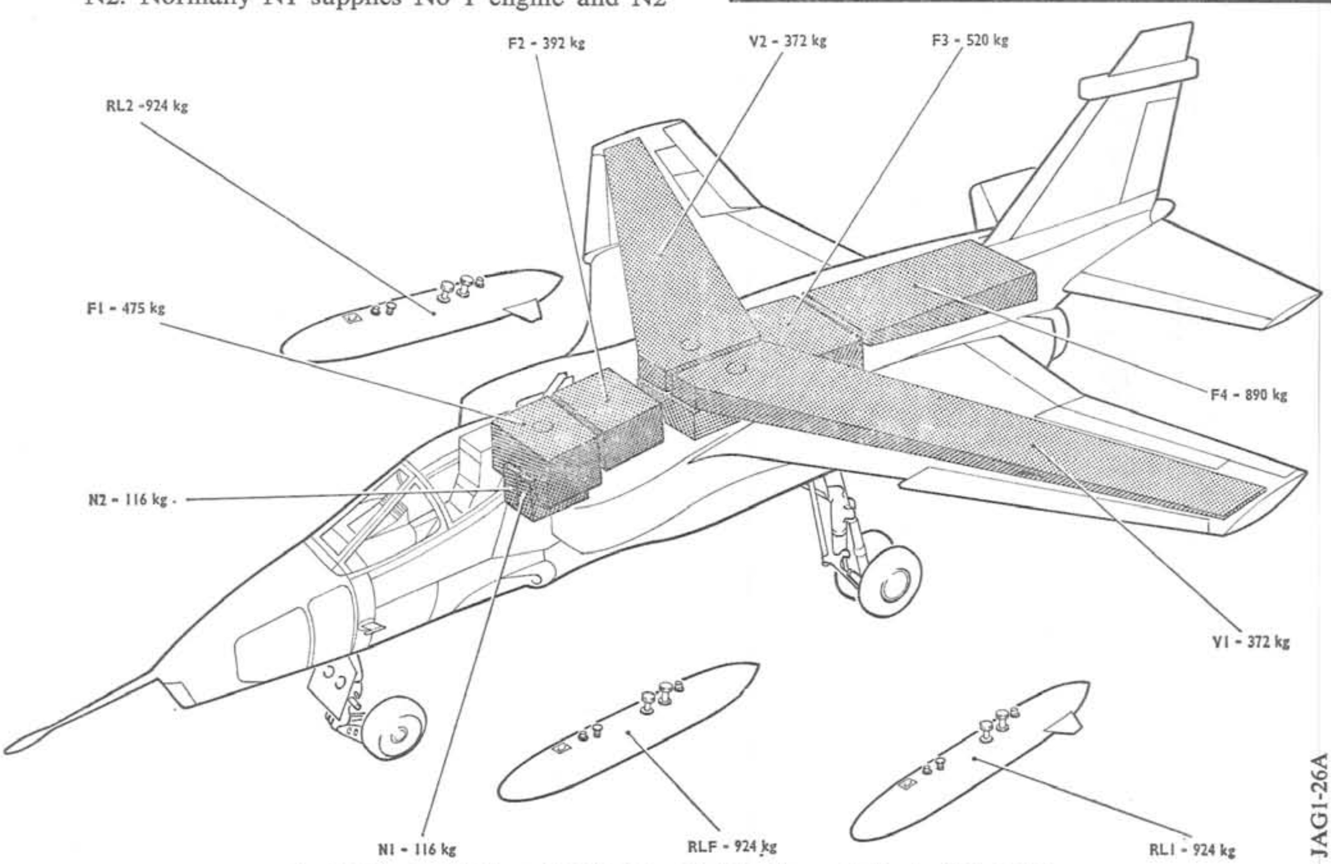
c. *Rear Group.* Tank F4.

Tank Capacities

4. The fuel tank capacities are shown in Table 2. Usable fuel is calculated at a specific gravity of 0·78. Equivalent capacities for fuel at SG of 0·79 and 0·80 are given in Preliminaries, Table 2.

Table 2 — Fuel Tank Capacities

Group	*Tank*	*Usable Weight (kg) (0·78 sg)*	*Group Total (Usable)*	*Gauged*
Front	N1 N2 F1	116 116 475	707	700
Centre	F2/3	912	912	910
Rear	F4	890	890	890
Wings	V1/V2	745	745	MI
Drops	RL1 RL2 RLF	924 924 924	2772	MI MI MI
Total		6026	6026	



1—3 Fig 2 GR1 and T Mk 2 Distribution of Fuel (SG 0·78)

Fuel Tank Pressurisation and Venting

5. Fuselage tank F1, the wing tanks and drop tanks are pressurised by air tapped from the LP compressor casing of each engine, and reduced to 0·35 bar (5 PSI) by a reducing valve in the supply line; each engine is capable of individually maintaining pressurisation. The air supply is connected to the tanks via a three-way valve AL (refer to Fig 11). Inward and outward venting is through an outlet (also used for fuel jettison) above the fuselage tail cone via a vent control valve (vent valve box). A differential pressure switch connected between the pressure and vent systems operates to light the red AIR PRESSURE warning on the Fuel Transfer Panel if the differential falls to 70 ± 20 mbar (approximately 1·2 PSI). Valve AL, referred to as 'open' when in the 'vent to atmosphere' condition and 'closed' when in the 'pressure' condition, is initially closed when either FUEL PUMPS switch is selected ON and remains closed unless a refuel selection is made. When valve AL is open the pressurising supply is shut off and the tanks are vented direct to atmosphere, bypassing the vent valve box. Fuselage tanks F2/F3, F4 and the collector tanks N1 and N2 are unpressurised and are vented direct to atmosphere through the common outlet; additional inward venting for these tanks is provided from a ram air inlet in the spine, via a non-return valve.

Fuel Transfer Panel

6. The Fuel Transfer Panel comprises:

a. Five magnetic indicators identified DROP TANKS (three) and WING TRANSFER, PORT and STBD, which indicate the fuel state in the associated tank as follows:

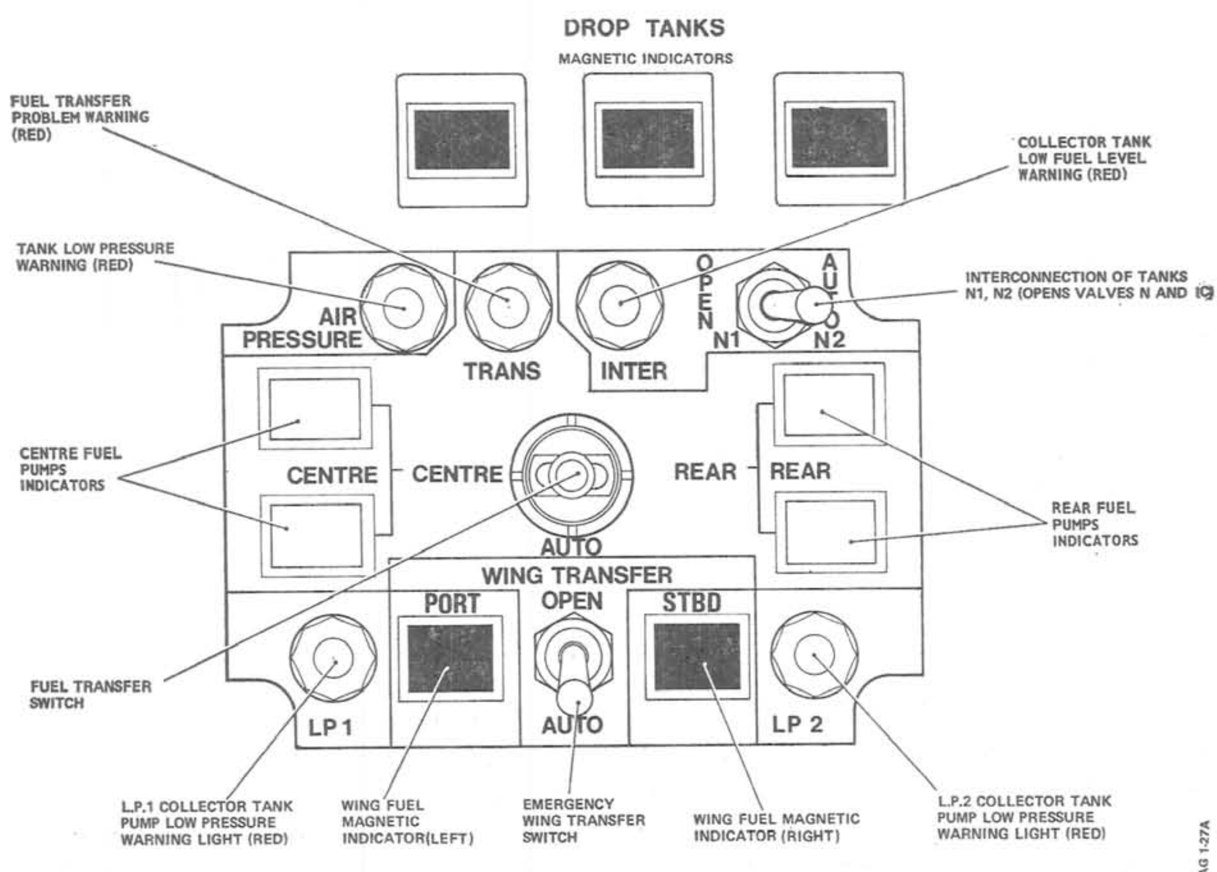
Black	—	tank full
Striped	—	not full/not empty (transferring implied)
White	—	tank empty

b. Five red lights which come on to indicate the following:

AIR PRESSURE	—	tank pressurisation low or failed
TRANS INTER	} —	transfer malfunction

Note: The TRANS and INTER lights come on during the normal transfer sequence as follows:

GR1	—	TRANS warning when F1 tank empty INTER warning when only collector tank fuel remains
T Mk 2	—	Both warnings come on simultaneously when only collector tank fuel remains



1—3 Fig 3 Fuel Transfer Panel

LP1 and LP2 — Collector tank LP pump failure warnings

c. Four magnetic indicators, one for each F3 (CENTRE) and F4 (REAR) transfer pump, giving the following indications:

ON — fuel pumps running and generating pressure

OFF — no fuel pressure (pumps may be running with no fuel available)

d. Three switches which are operated as follows:

(1) WING TRANSFER switch, which, when selected from AUTO to OPEN, opens valves RV1 and RV2 allowing drop tank fuel to reach F2 via the wing tank lines or wing tank fuel to reach F2 via the drop tank lines and valve TRL.

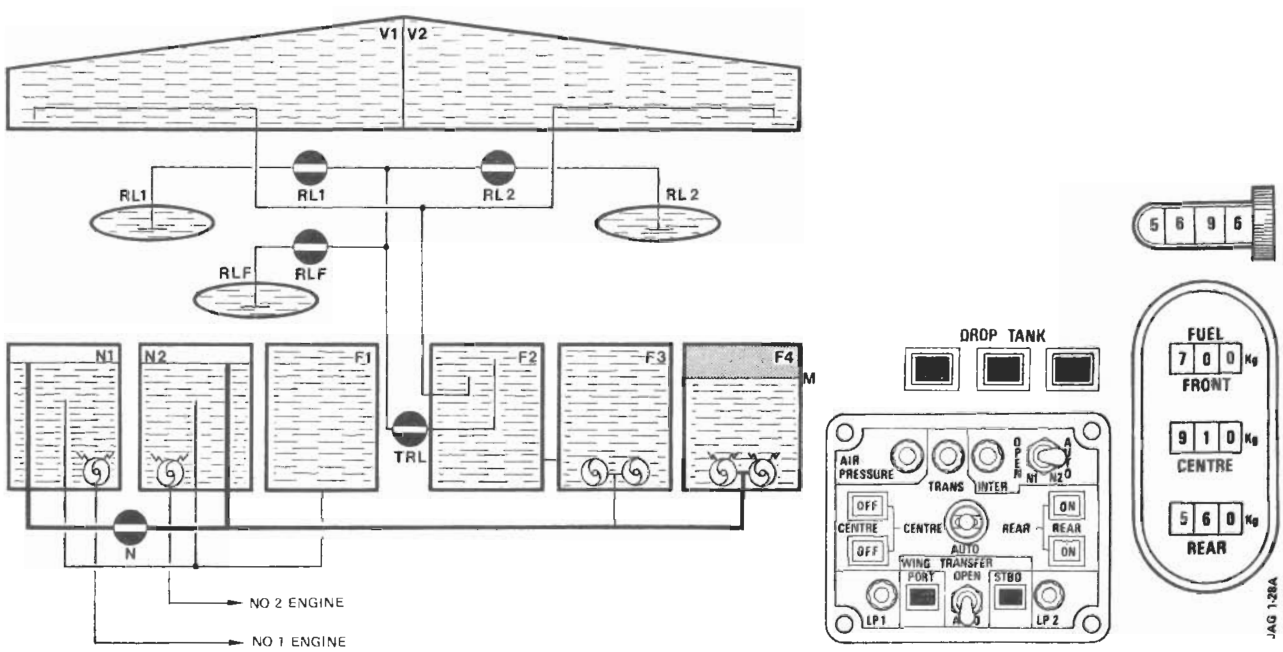
(2) N1, N2 switch, which, when selected from AUTO to OPEN, interconnects the collector tanks N1 and N2 (valves IC and N open).

(3) Fuel transfer switch marked CENTRE/AUTO/REAR which is used for the manual control of the centre and rear group fuel transfer pumps (refer to para 8). For AUTO operation, the fuel pump master switches must be on: manual selection is independent of the master switches.

Fuel Transfer

7. *Automatic Transfer Sequences.* With the fuel transfer switch on the Fuel Transfer Panel set to AUTO, and the FUEL PUMPS 1 and 2 switches set to ON, the automatic (normal) transfer of fuel is as shown on the following diagrams and a summary of the sequence is given at Table 3. The fuel quantities shown are the approximate values to be expected at the *end* of the transfer stage and are intended only to show correct sequencing. The sequences for the GR1 and T Mk 2 vary due to the CG requirement to maintain the front group contents greater than the rear group in the GR1 and the opposite situation in the T Mk 2.

Note: The diagrams assume the engines at equal consumption.



1—3 Fig 4 **Fuel Transfer (1) (GR1 only)**

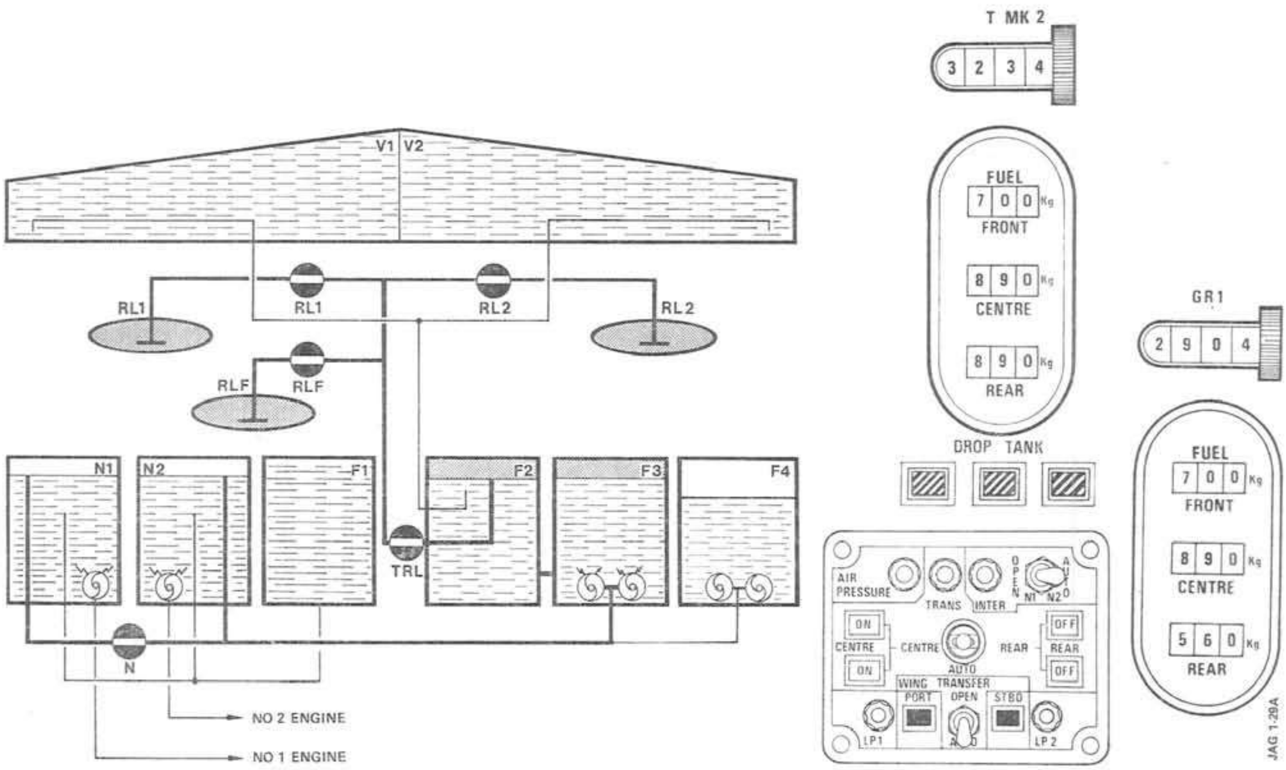
a. *F4 Tank Transfer to Level M — GR1 only (F4 remains full on T Mk 2).*

F4 transfer pumps feed fuel to N1 and N2; both REAR pump indicators ON.

High level float valves in collector tanks open to admit F4 fuel.

Level in F4 reduces to 'M' position; a float switch operates to stop F4 pumps and start F3 pumps.

Rear contents decrease to 560 kg, front contents remain at 700 kg.

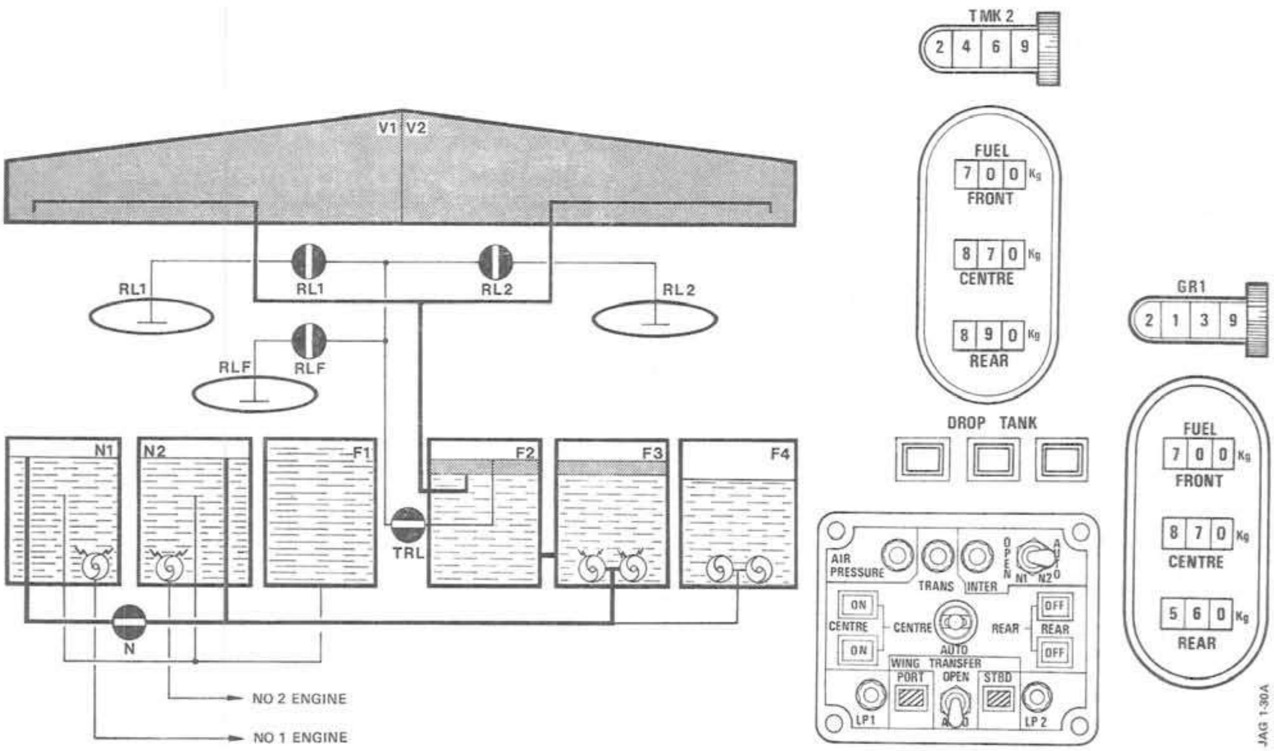


1—3 Fig 5 Fuel Transfer (2) (GR1 and T Mk 2)

b. *Transfer of Drop Tanks (if fitted) (F4 full on T2).*

CENTRE pump indicators ON, REAR pump indicators OFF, approximately 20 kg used from centre group; float valve operates ▶◀ to allow fuel to flow under air pressure from drop tanks into F2 through valve TRL, thence via F3 pumps to N1 and N2.

Drop tanks magnetic indicators striped (fuel transferring).



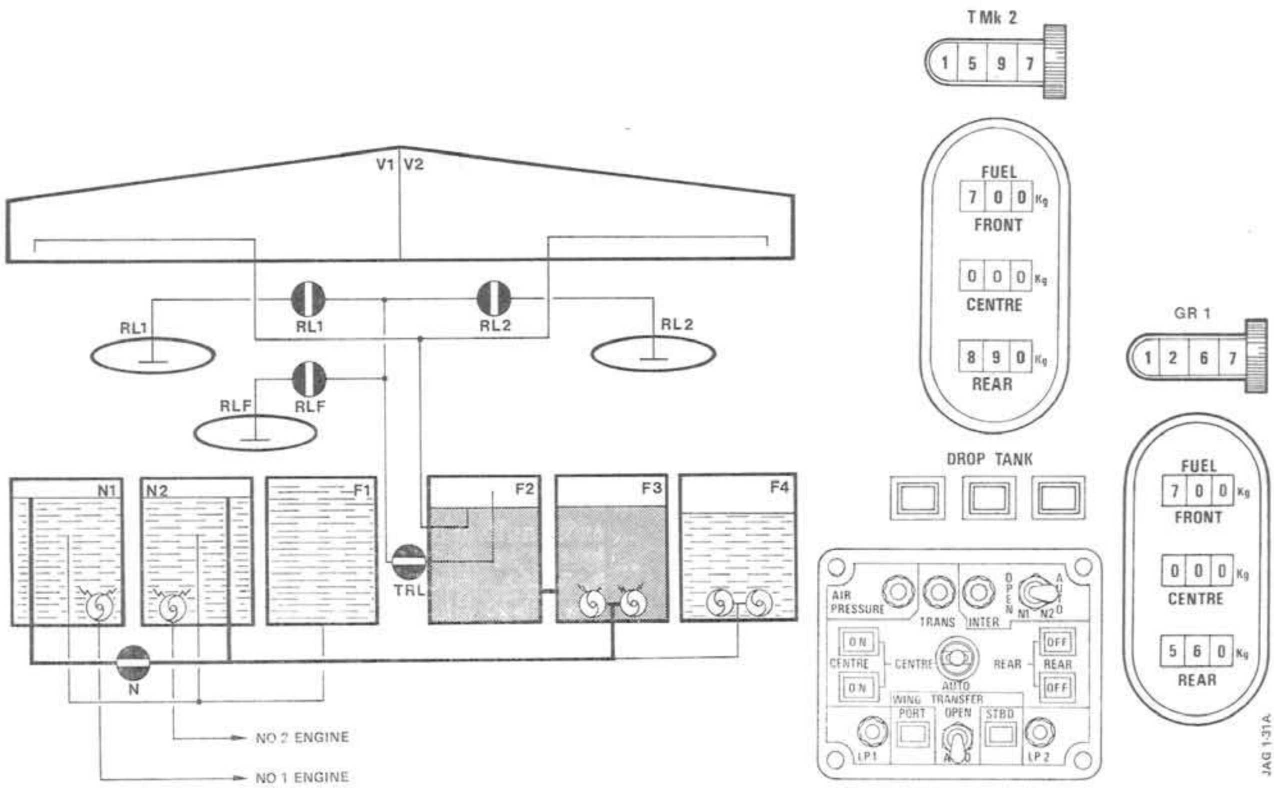
1—3 Fig 6 Fuel Transfer (3) (GR1 and T Mk 2)

c. *Transfer of Wing Tanks* (*F4 full on T2*).

Drop tanks empty (magnetic indicators white); low-level float switches in drop tanks operate to close valves RL1, RL2 and RLF.

Small amount of fuel (approximately 20 kg) used from centre group; float valve in F2 operates to admit fuel from V1 + V2 under air pressure.

Wing tank magnetic indicators striped (fuel transferring).

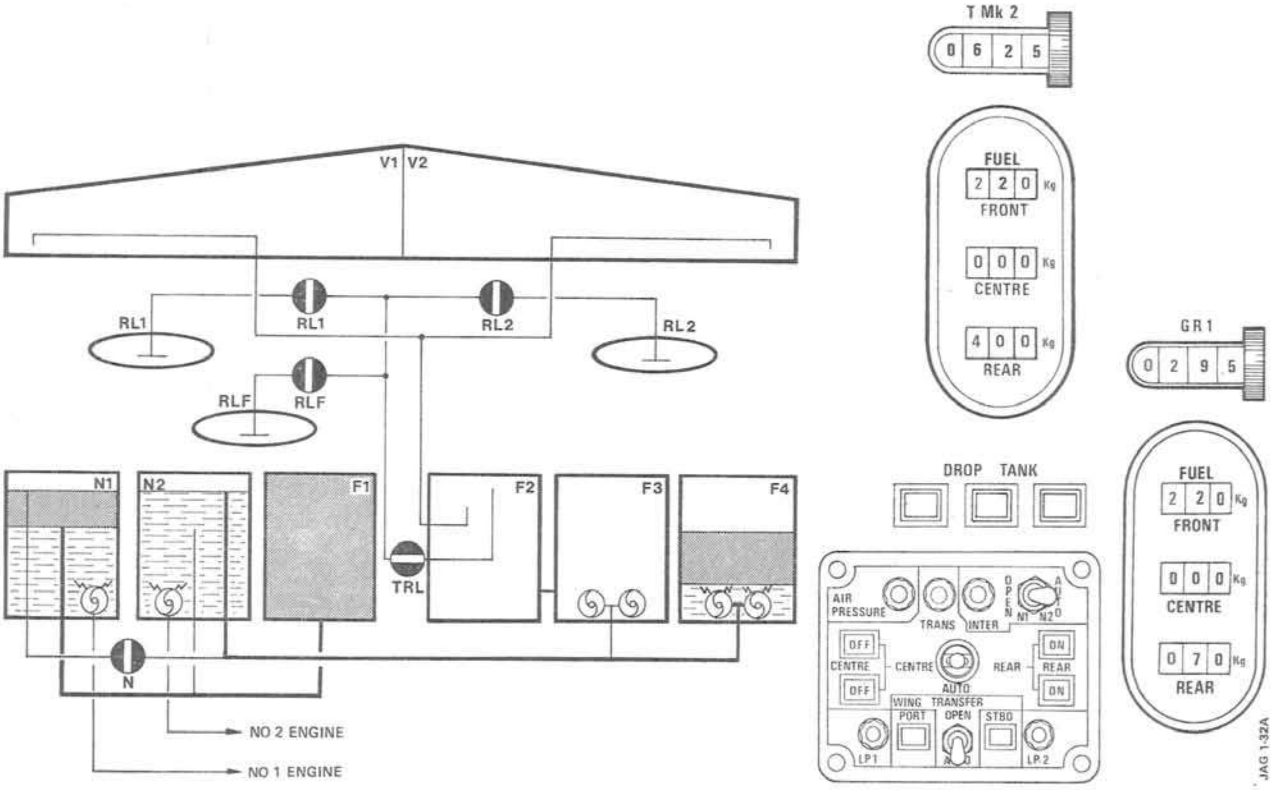


1—3 Fig 7 Fuel Transfer (4) (GR1 and T Mk 2)

d. *Transfer of Centre Group* (*F4 full on T2*).

Wing tanks empty (magnetic indicators white); fuel continues to flow from centre group via F3 pumps to N1 and N2.

When F2/F3 tanks are empty, low-level float switch in F3 operates to stop CENTRE pumps, start REAR pumps and close valve N.



1—3 Fig 8 Fuel Transfer (5) (GR1 and T Mk 2)

e. *Simultaneous Transfer of F1 and F4.*

REAR pumps ON; CENTRE pumps OFF.

Valve N is closed, thus F4 feeds N2 and F1 feeds N1 as follows:

Transfer of F4 into N2.

F4 fuel transferred to N2 under transfer pump pressure.

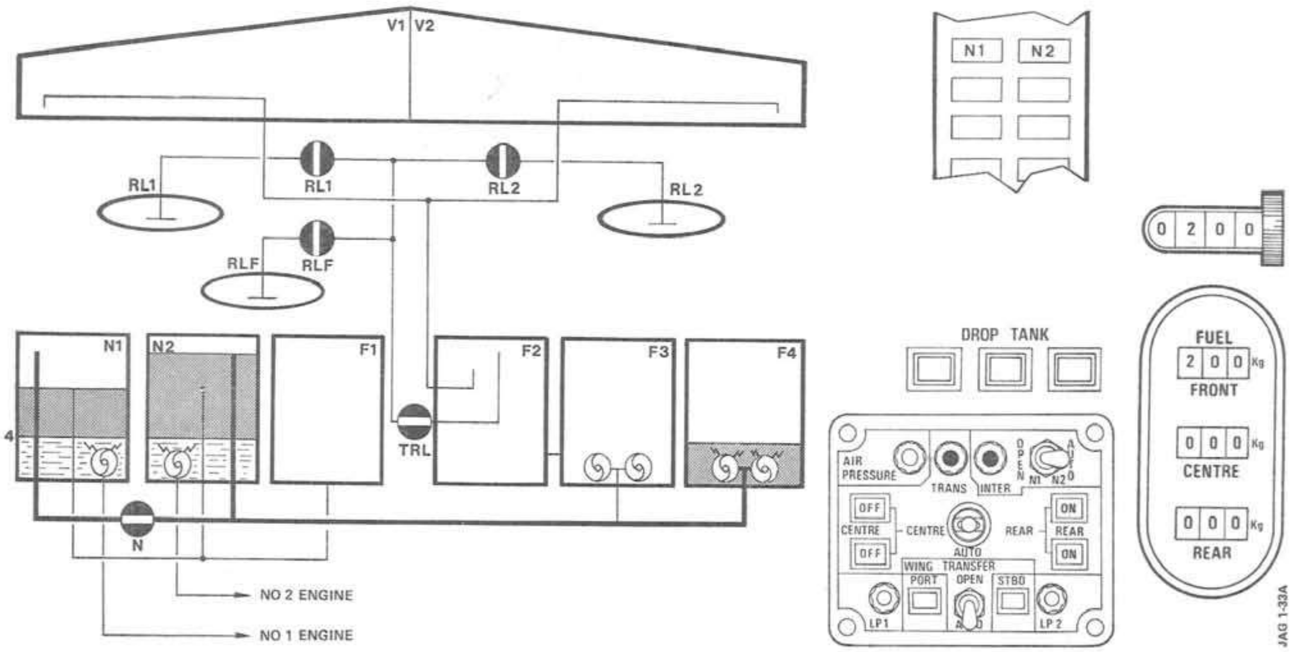
Note: At the end of this stage, rear group contents have decreased to approximately 70 kg (GR1) or 400 kg (T Mk 2).

Transfer of F1 into N1

N1 float valve opens to admit fuel from F1 under air pressure. When F1 tank empty, its low-level float switch operates to re-open valve N.

Note 1: At the end of this stage, front group contents show collector tank fuel contents only.

Note 2: On GR1 aircraft only the TRANS warning comes on when valve N re-opens.



1—3 Fig 9 Fuel Transfer (6) (GR1 and T Mk 2)

f. *Transfer of Remaining F4 Fuel.*

REAR pumps ON, CENTRE pumps OFF.

Valve N is open, thus F4 feeds both N1 and N2.

When F4 tank empty, pumps continue to run but REAR captions show OFF (zero pressure).

N1 and N2 contents reduce to the INTER warning level, triggering the INTER warning on the Fuel Transfer Panel so that TRANS and INTER warnings are both lit (GR1). In the T Mk 2, the TRANS and INTER lights come on simultaneously at this stage.

AL6 N1 and N2 contents reduce to the 100 kg level to light the collector tank low-level warnings (N1, N2 ~~or 100 kg~~) on the CWP.

g. *Fuel Transfer Summary.* Table 3 summarises the fuel usage stages shown in the foregoing illustrations.

Table 3 — Summary of Fuel Transfer Sequence

Transfer Stage	*F3 Pumps*	*F4 Pumps*	*Drops MI*	*Wing MI*	*Front — kg*	*Centre — kg*	*Rear — kg*	*Total — kg*
GR 1								
All tanks full	OFF	OFF	Black	Black	700	910	890	6026
F4 to M level	OFF	ON	Black	Black	700	910	560	5696
Drop tanks transfer	ON	OFF	Striped	Black	700	890	560	2904
Wing tanks transfer	ON	OFF	White	Striped	700	870	560	2139
Centre group transfer	ON	OFF	White	White	700	000	560	1267
F1+F4 to F1 empty	OFF	ON	White	White	220	000	070	295
T Mk 2								
All tanks full	OFF	OFF	Black	Black	700	910	890	6026
Drop tanks transfer	ON	OFF	Striped	Black	700	890	890	3234
Wing tanks transfer	ON	OFF	White	Striped	700	870	890	2469
Centre group transfer	ON	OFF	White	White	700	000	890	1597
F1+F4 to F1 empty	OFF	ON	White	White	220	000	400	625
F4 transfer	OFF	OFF	White	White	230	000	000	232

8. *Manual Transfer.* Four switches provide manual control of the fuel transfer system and operate as follows:

a. *Fuel Transfer Switch.* The fuel transfer switch on the Fuel Transfer Panel, when placed to either the CENTRE or the REAR position, overrides the automatic control, opens valve 'N' and starts the fuel transfer pumps in the group selected. With the switch set to REAR the TRANS light comes on.

b. *WING TRANSFER Switch.* Selecting the WING TRANSFER AUTO/OPEN switch to OPEN, opens the refuelling valves RV1 and RV2 (Fig 11). Fuel can then be transferred to tank F2 as follows:

From the drop tanks via the refuelling valves RV1 and RV2, through the wing tanks fuel transfer lines and the wing tank feed float valve ▶◀ of tank F2 (Fig 11).

From the wing tanks to tank F2 via the refuelling valves RV1 and RV2, through the drop tanks fuel transfer lines, transfer valve TRL and the drop tank feed float valve ▶◀ of tank F2 (Fig 11).

c. *N1, N2 Switch.* Selecting the N1, N2 switch from AUTO (automatic control) to OPEN opens valve IC to interconnect the collector tanks N1 and N2, and opens valve N to ensure that fuel is fed to both collector tanks. If the fuel transfer switch is manually set to CENTRE and the N1/N2 switch set to OPEN, the refuelling valves RF1 and RF3 are opened allowing the transfer of F1 fuel to tank 3 from which it is pumped to the collector tanks.

d. *CROSSFEED Switch.* A CROSSFEED — OPEN/CLOSED switch above the Fuel Transfer Panel when selected to OPEN, opens the engine fuel crossfeed valve IM to allow both engines to be supplied from one LP pump.

Fuel Feed to the Engines

9. The LP feeds to the engines are identical, each comprising:

a. An LP pump, open at either end and fitted in the bottom of a collector tank, which is energised when the associated FUEL PUMPS switch ▶◀ is set to ON. The pump is powered by 3-phase, 200 volt, 400 Hz AC and is protected by a circuit breaker on the circuit breaker panel.

b. A pressure switch which brings on the relevant

LP1 or LP2 light on the fuel transfer panel whenever the pressure falls to 130±20 mb (2·5 PSI) indicating a collector tank LP pump failure.

c. A non-return valve.

d. A fuel crossfeed valve, controlled by the CROSSFEED—OPEN/CLOSED switch, permits fuel to be supplied to both engines should one collector tank LP pump fail or both collector tanks to feed one engine when the other is shut down. An amber warning light, adjacent to the switch, comes on when the valve is open.

e. A fuel-flow straightener which consists of anti-swirl vanes in an elbow joint of the fuel line.

f. A flowmeter/transmitter which can be adjusted for the SG of the fuel in use.

g. A hydraulic fluid/fuel heat exchanger (refer to Chapter 5).

h. An electrically-operated LP shut-off cock, controlled by an LP COCK — OPEN/CLOSED switch which is powered by 28 volt DC from the emergency busbar and protected by a 5 amp circuit breaker on the circuit breaker panel.

i. A reheat fuel filter.

j. An LP fuel filter.

k. A pressure switch which energises the relevant BP1 or BP2 caption on the CWP should the fuel pressure to the HP pump fall to 2·4 bar (35 PSI).

Fuel Contents Gauging

10. A triple digital indicator on the right instrument panel labelled FUEL FRONT (kg), CENTRE (kg), and REAR (kg), indicates the contents of the front, centre and rear tank groups (the last digit is always zero). The gauge can be tested by pressing the test button adjacent to the indicator. With the button pressed, the indicators decrease to zero in each of the three windows; on releasing the button the indicators should register the previous contents reading for each group. Power supply to the gauge is 15 volt single phase AC. Indication of the wing and drop tanks contents is by five magnetic indicators (refer to para 6).

Fuel Flowmeter System

11. A fuel flow transmitter is fitted to each fuel feed pipe upstream of the LP cock. A dual pointer indicator on the right instrument panel shows fuel flow in kg/min. A four digit counter shows fuel remaining. Before starting, total usable fuel is set on the counter by means of a resetting knob. The system can be compensated for changes in fuel specific gravity by means of a setting device on the transmitters. The fuel digital counter does not account for fuel jettisoned or for leakage upstream of the flowmeter.

Refuelling/Defuelling

12. *Pressure Refuelling.* Pressure refuelling is carried out using a single NATO type ground refuelling connector in the airbrake compartment on the right side of the aircraft. The refuel/defuel panel gives access to the refuelling controls and indicator lights (Fig 10). On making a ground refuel selection, valve AL is opened irrespective of the position of the FUEL PUMPS switches and valve TRL is closed.

13. *Gravity Refuelling.* Gravity refuelling can be carried out by means of the filler caps at the top of F1, V1, and V2 tanks. If fitted, the drop tanks are filled via filler caps on the top of each tank. With gravity refuelling total internal capacity is limited to approximately 2700 kg and this takes up to two hours to complete.

14. *Air-to-Air Refuelling — GR1 Aircraft Only.* Air-to-air refuelling is carried out by means of a hydraulically extending and retracting refuelling probe located on the right side of the fuselage. When retracted, the probe is housed in a recess in the side of the fuselage and is enclosed by a door. Air-to-air refuelling is controlled as follows:

(a) *FLIGHT REFUEL Switch.* This is a 4-position REFUEL/OUT/IN/EMERGY rotary switch. With the FLIGHT REFUEL switch to IN, the probe is retracted and the normal automatic fuel feed sequence takes place. When OUT is selected, the probe extends and locks out for practice (dry) engagements; valves RL1, RL2 and RLF are closed to prevent out-of-sequence transfer during dry engagements and, with mod 934 embodied, valve RF4 opens to reduce the effect of the pressure surge which could result from fuel in the tanker hose. When the probe is in transit (unlocked) between the 'locked in' and 'locked out' positions, a red light to the right of the FLIGHT REFUEL switch comes on. When actual refuelling is intended, the pilot selects REFUEL which depressurises the tanks and opens all refuelling valves (green light on). In addition, selecting REFUEL opens valves N and IC to interconnect tanks N1 and N2 to assure fuel supply to both engines. The EMERGY setting of the switch is used to extend the probe if it fails to extend when REFUEL is selected. When EMERGY is selected, all valves are moved to their normal AAR positions.

WARNING: After selecting EMERGY (with HYD 1 failure) the probe cannot be retracted.

b. *F1/F4 Switch.* A 2-position switch having an unmarked, outboard, normal position, and an inboard STOP position, at the top of the instrument panel. The STOP position is selected to isolate tanks F1 and F4 if either is seen not to be filling during air-to-air refuelling, thus averting a potentially hazardous CG situation.

15. *Suction Defuelling.* Suction defuelling is carried out via the same NATO type connector as refuelling. The tanks are selectively defuelled by means of a switch on the refuel/defuel panel (Fig 10). When a defuel selection is made the relevant fuel valve is electrically operated to the open position. Valve AL is actuated as in para 12.

16. *Draining.* Draining can be carried out by means of the drain valves fitted to the base of each tank, with the exception of F2 where the drain valves are fitted in the transfer lines between tanks F2 and F3.

Refuel/Defuel Control Panel

17. The refuel/defuel control panel (Fig 10) is on the right side of the aircraft immediately to the rear of the right main landing gear bay. When the flap covering the ground refuelling panel is opened, 28V battery power is automatically utilised for the refuelling operation. The panel contains two rotary switches, a number of informative captions, and a TEST button which is associated with the captions. The controls and indications are as follows:

a. A 4-position rotary refuelling selector switch which, when selected to any other position than STOP, opens valve AL, closes the TRL valve and selects within a limit of three positions, the capacity to which the aircraft is to be refuelled. The four switch positions are:

STOP	— AL open to pressure, TRL open to transfer
PARTIEL	— Partial refuelling to include, F1 — full N1 — full N2 — full F4 — GR1 to 460 kg T2 to full
TOTAL	— full internals
TOTAL, RL1, RL2, RLF	— full internals plus drop tanks

b. Four refuelling indicator captions which are off when a refuelling selection is made and which come on individually when the selected refuelling is complete.

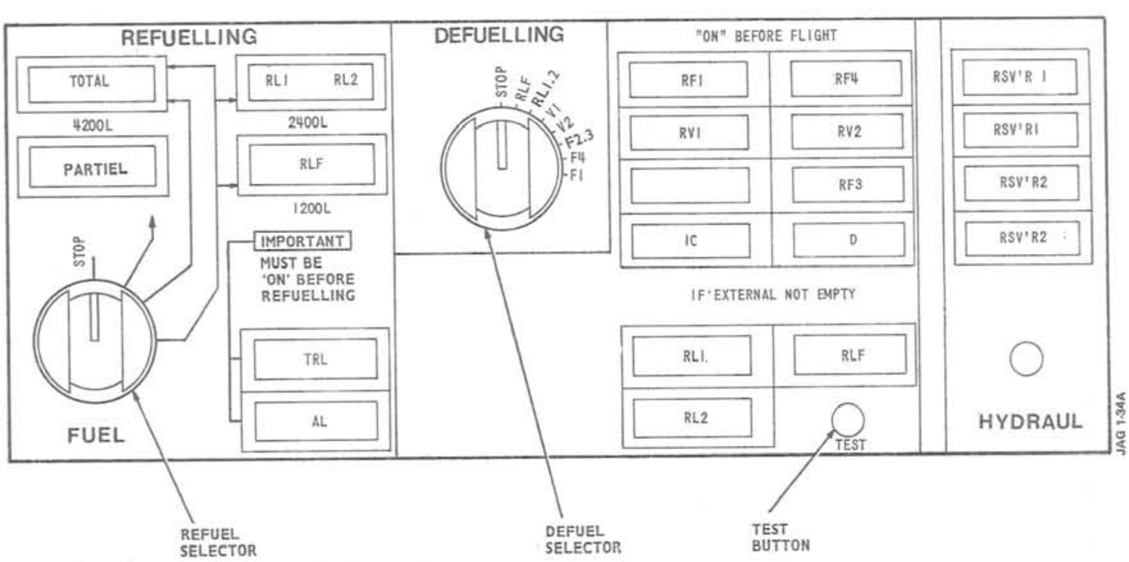
c. Two indicator captions for valves AL and TRL which come on when the refuel selector is placed to any position other than STOP, and which must be on before refuelling commences.

d. An 8-position defuelling selector which, when selected to any position other than STOP, opens valve AL to vent, closes valve TRL and selects individual tanks for defuelling.

e. Seven valve indicator captions which must be on before the fuel system can be considered serviceable.

f. Three drop tank indicator captions, RL1, RL2 and RLF, which come on when these tanks are full.

g. A TEST button, which when pressed, tests the filaments of the indicator captions.



1—3 Fig 10 Refuel/Defuel Control Panel (GR1 and T Mk 2)

◀ Fuel Dumping

18. Drop tanks and wing fuel, the centre group fuel and, on the GR1, F4 fuel down to a level of 300 kg can be dumped by placing the FUEL JETTISON switch to JETTISON. This opens the fuel dump valve (Fig 11) allowing fuel to dump via a pipe above the tail cone, in the same sequence as fuel transfer. Fuel dump rates vary according to altitude and fuel temperature and type, but the mean rates are as follows:

GR1 — 300 kg/min
T Mk 2 — 275 kg/min

19. During fuel dumping the collector tanks should continue to be supplied normally. However, if the supply is interrupted, tank F1 automatically supplies both collector tanks. Dumping continues until:

GR1 — F4 contents reach the 'D' level switch (approximately 300 kg remaining). Total fuel remaining approximately 1000 kg.

T Mk 2 — The F3 low level float valve switches off the F3 transfer pumps. Total fuel remaining approximately 1500 kg.

The dump valve is then automatically closed and the normal fuel transfer sequence is continued. The dumping sequence can be stopped before the automatic closure of the valve by selecting the FUEL JETTISON switch to OFF.

Note: Following fuel dumping, reset the de-totaliser to agree with the total fuel remaining.

20. If the fuel dump rate plus the engine fuel usage rate exceeds the rate of transfer of the drop tank and wing fuel into tanks F2/F3, the system continues with its normal sequence as F3 empties, turning off the F3 pumps, switching on the F4 pumps and closing valve N. In the GR1 the dumping continues from F4 until level 'D' is reached but if more fuel is transferred from the drop or wing tanks during this time, dumping and fuel feed continue from the centre group. However, once level 'D' is reached in tank F4, no further fuel can be dumped and the remaining fuel in the system transfers to the collector tanks following the normal sequence.

21. In a similar situation in the T Mk 2, dumping ceases when the centre group is empty and restarts when more drop or wing tank fuel enters the centre group. ▶

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

22. During the cockpit checks, check the following:

a. FUEL circuit breakers (six) are set.

b. LP COCK switches are to CLOSED.

c. FUEL JETTISON switch is to OFF. F1/F4 switch to the unmarked outboard position (GR1 only).

d. FLIGHT REFUEL switch to IN, probe lights tested and then remain out (GR1 only).

e. Fuel tank contents. Press the GAUGE TEST button and confirm that counters zero slowly and return to previous readings when test button is released.

f. TOTAL FUEL (detotaliser) counters are set for appropriate fuel state.

g. CROSSFEED switch to CLOSED. Select OPEN and confirm that the crossfeed light comes on, indicating that the valve is open. Return the switch to CLOSED and check the light goes out.

h. Flowmeter reads 0-0.

i. DROP TANK indicators giving correct indication.

j. On the Fuel Transfer Panel:

(1) Fuel tank AIR PRESSURE warning	On
(2) TRANS light	Out (on if collector tanks completely full)
(3) INTER light	Out
(4) N1, N2 switch... ...	AUTO
(5) CENTRE/AUTO/REAR fuel transfer pump switch	AUTO
(6) CENTRE and REAR transfer pump indications	OFF
(7) WING TRANSFER switch	AUTO
(8) PORT and STBD wing contents indicators ...	Correct
(9) LP1 and LP2 warnings	On

k. Check that the N1 and N2 warning captions on the CWP are out and that the BP1 and BP2 captions are on.

Starting Engines

23. The fuel pump master switches are left OFF until the engine bleed valves have been closed after starting. This ensures that, when starting on internal power, the AC fuel pumps do not start as the first alternator comes on line. If the pumps are started at this stage (low RPM, bleed valves open) the fuel pressure surge would affect the bleed valve sensor and could result in engine stall.

24. If the TRANS light was on prior to starting, it should go out as soon as some fuel is used from the collector tanks during the starting sequence.

25. After starting, with the engines at idling RPM, the AIR PRESSURE warning may remain on or flicker, but it should always be out with the engine RPM above 80%.

26. Having started both engines, set 65% RPM on each and check bleed valve closure. Check that the BP warnings are out (see Note). Maintaining 65%, set the transfer pump switch to REAR, check that the TRANS light comes on (REAR magnetic indicators show ON, CENTRE magnetic indicators show OFF). Set the transfer pump switch to CENTRE and check that the TRANS and INTER lights are both on within 12 seconds (CENTRE magnetic indicators ON, REAR indicators OFF). Select the transfer pump switch to AUTO: check the REAR indicators are ON (OFF in T2) and the CENTRE indicators OFF (ON in T2). Set the LP fuel pump switches to ON: check that the TRANS, INTER, LP1 and LP2 warnings go out. Confirm that the AIR PRESSURE light is out. When the throttles are closed to idle, check that the BP1 and BP2 warnings remain out.

Note: With high fuel/ambient temperatures, higher RPM may be needed to extinguish the BP warnings. Provided the warnings are out before maximum dry power is reached, backing pump output is satisfactory.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Manual CG Balance

27. In the GR1, the front group contents must exceed the rear group contents by 200±100 kg; in the T Mk 2, the rear tank contents must exceed the front group contents by the same amount. If incorrect, the proper balance is restored by selecting the fuel transfer switch to REAR to feed fuel from F4 or by selecting CENTRE and the N1/N2 switch to OPEN to feed fuel from F1 via RF1, RF3 and tank F3.

Fuel System Malfunctions

28. Indications and actions relating to fuel system malfunctions are given in Table 4.

Table 4—Fuel System Malfunctions

Indication	*Immediate Action*	*Subsequent Action*	*Considerations*
ENGINE BACKING PUMP FAILURE			
Amber BP1 or BP2 warning on CWP	Cancel appropriate reheat. Monitor fuel contents: if reducing rapidly, refer to FUEL LEAKS	If LP1 or LP2 warning on, refer to COLLECTOR TANK LP PUMP FAILURE Maintain power above BP warning level If BP warning remains at all power settings, shut down affected engine Monitor fuel contents, refer to Manual CG Balance. Land as soon as practicable	—
COLLECTOR TANK LP PUMP FAILURE			
Red LP1 or LP2 warning on Fuel Transfer Panel, with or without corresponding BP warning on CWP	Throttle back affected engine to between 70 and 80% RPM	Check FUEL PUMPS c/b set Check for fuel leaks If warning persists: CROSSFEED switch OPEN (not with fuel leak) Monitor fuel contents, refer to Manual CG Balance	If BP1 and 2 warnings are out, full power is available on both engines. To minimise the risk of engine surge due to change of fuel pressure, affected engine should be between 70 and 80% RPM before opening the CROSSFEED cock or restarting an LP pump

continued

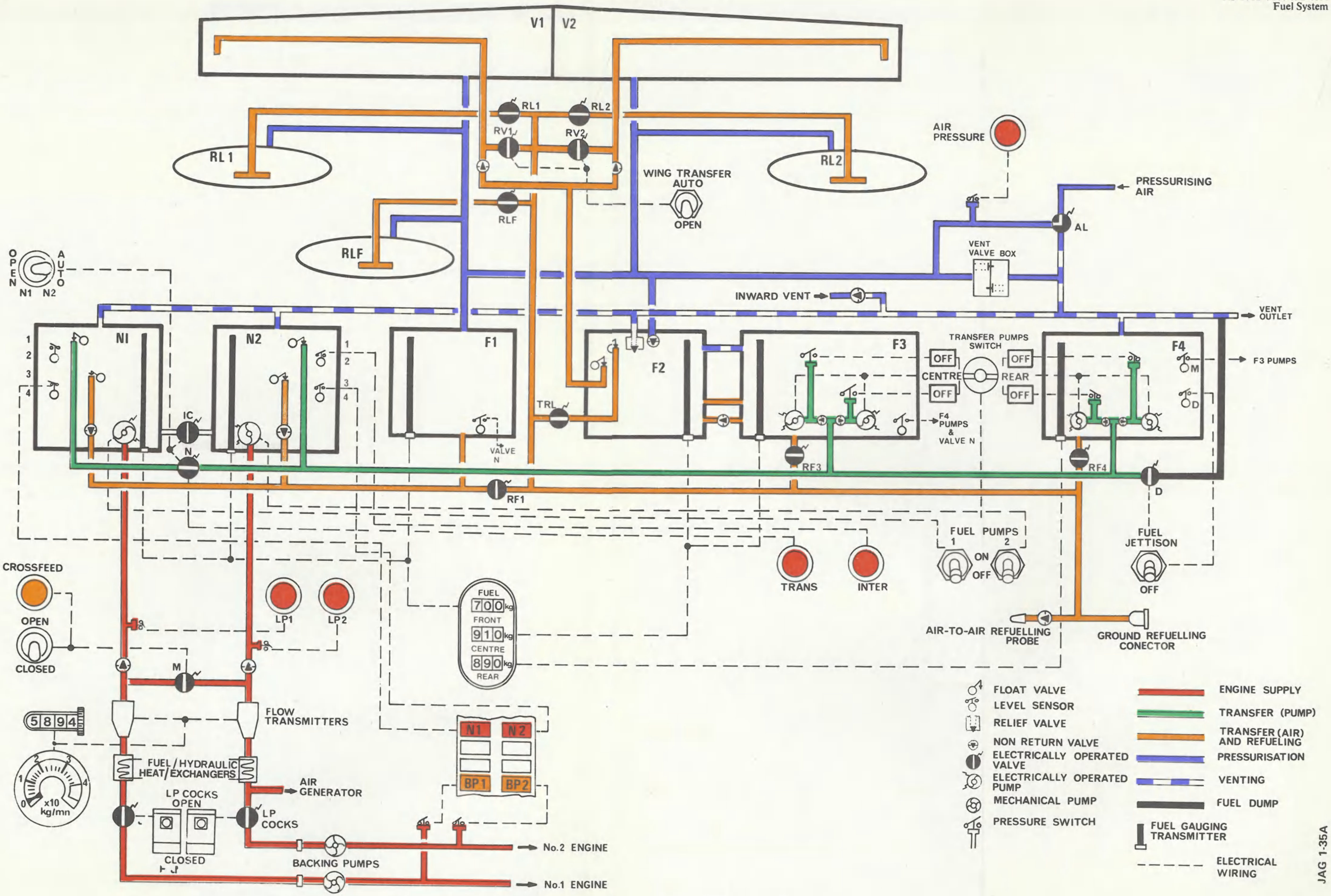
Table 4—*continued*

Indication	*Immediate Action*	*Subsequent Action*	*Considerations*
FUEL TANK AIR PRESSURE FAILURE			
Red AIR PRESSURE warning on Fuel Transfer Panel	Temporary increase of RPM on both engines may cancel transient warning	If warning persists, rely on centre and rear fuselage fuel only. Set transfer switch to CENTRE and N1 N2 switch to OPEN. Balance fuel manually. When F1 fuel drops to 250 kg or F1 fuel flow ceases, set transfer switch to AUTO	Approx 250 kg of F1 fuel is unusable. If warning is caused by air escaping from a damaged drop tank (birdstrike/ricochet) jettisoning the tanks should restore fuel pressurisation
FUEL TRANSFER TO COLLECTOR TANKS FAILURE			
Red N1 or N2 on CWP	Throttle affected engine to idle. Monitor fuel contents: if reducing rapidly, refer to FUEL LEAKS	If no leaks, N1/N2 switch to OPEN. Maintain engine power below warning level. Monitor fuel transfer, refer to Manual CG Balance	—
WING TANKS AND/OR DROP TANKS TRANSFER FAILURE			
Centre group contents decreasing steadily before WING TRANSFER or DROP TANK magnetic indicators show white	WING TRANSFER switch to OPEN	—	1. Indication may be caused by high fuel demand (system normal) 2. Wing transfer magnetic indicators may show striped with drop tanks transferring due to high fuel demands
FUSELAGE TANKS TRANSFER FAILURE			
Red TRANS and/or INTER warning on Fuel Transfer Panel	Check transfer and N1 N2 switches to AUTO (correct pump M1 black). Confirm all six FUEL c/b are set. Monitor contents for fuel leak. Check transfer sequence, if correct—no action	Take action appropriate to warning and stage of transfer as shown in the FRC	—

continued

Table 4—*continued*

Indication	*Immediate Action*	*Subsequent Action*	*Considerations*
UNDEMANDED FUEL DUMPING			
Fuel jettison fails to shut off automatically or to stop when selected off	Trip FUEL TRANSFER PUMPS circuit breakers	Reduce speed and avoid high nose attitudes, if practicable, to minimise siphoning effect. If required, maintain CG by periodically resetting circuit breakers (dumping resumes). Land as soon as possible	Plan recovery based only on front group fuel available. Do not land whilst dumping
FUEL LEAKS			
Rapidly reducing fuel contents	Cancel both reheats, check for additional indications: 1. Abnormally high flowmeter reading *and/or* 2. N1 N2 red warning on CWP *and/or* 3. BP1 or BP2 amber warning on CWP at idle power *and/or* 4. LP1 or LP2 light on	If additional indications, shut down the appropriate engine as follows: Throttle ... Stop LP cock ... CLOSED Fuel pump master ... OFF Crossfeed ... CLOSED N1 N2 switch AUTO Land as soon as possible If time permits: Appropriate FUEL PUMPS c/b ... ... Tripped Fuel pump master ... ON	Do not set N1 N2 or CROSSFEED switches to OPEN. Do not attempt fuel balance before landing. Consider jettisoning external stores to improve handling. Minimise use of PTR to reduce fire risk
		If no additional indications (fuselage tank leak): Do not shut down an engine: consider fuel gauge failure If leak still suspected or confirmed, do not rely on fuel in the suspect group. Land as soon as possible	If range is critical with a confirmed fuselage tank leak, transfer fuel out of suspect group if possible



1—3 Fig 11 (GR1 and T Mk 2) Fuel System — Schematic
All aircraft now embody mod 371

PART 1

CHAPTER 4 — ENGINES

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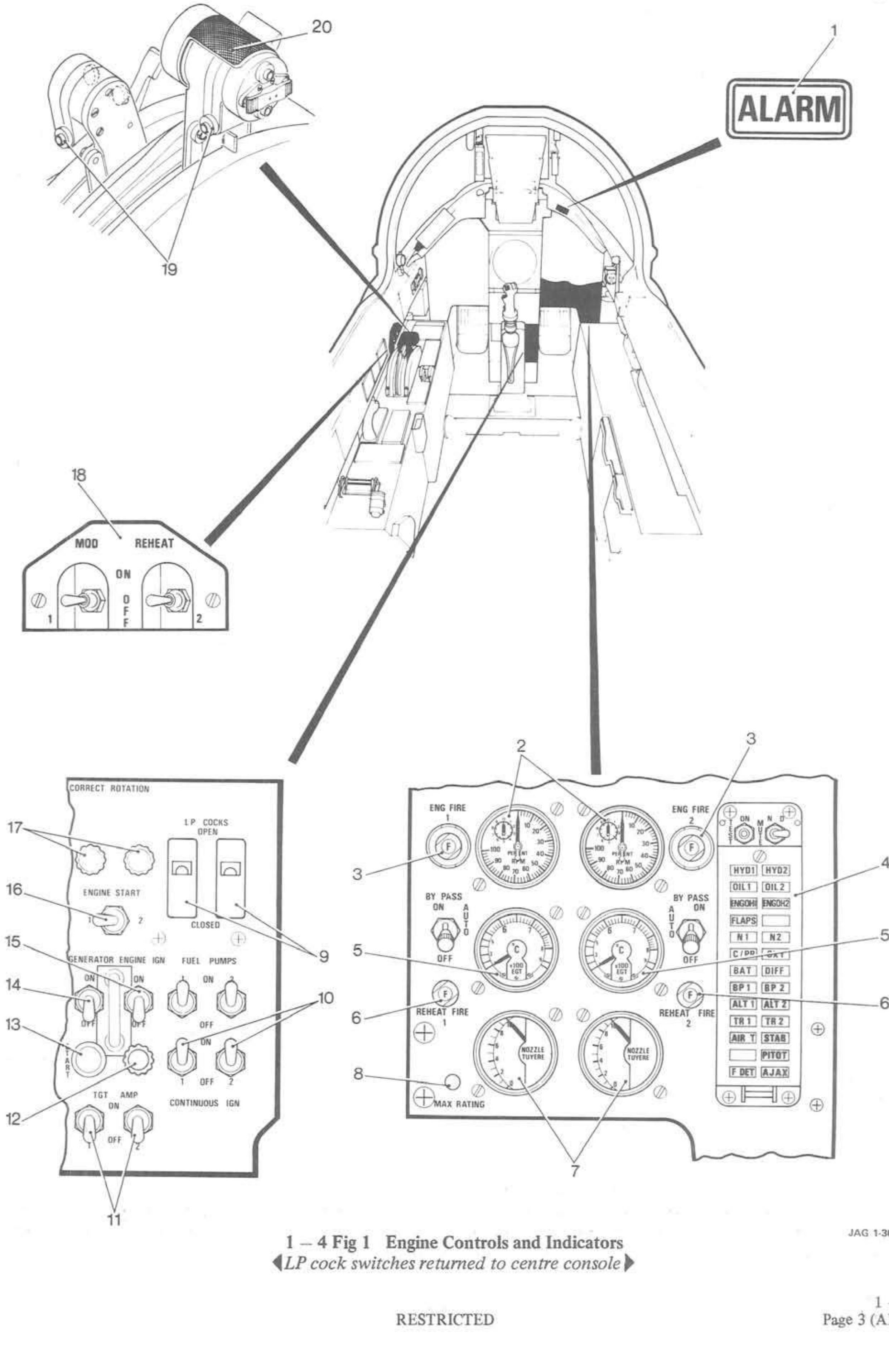
CONTROLS AND INDICATORS

1. Details concerning the controls and indicators shown on Fig 1 are listed in Table 1.

Table 1 — Engine Controls and Indicators

Item No	*Item*	*Location*	*Markings*	*Remarks*
1	Attention-getter	Right coaming	ALARM	Flashing red
2	RPM indicators	Right instrument panel	PERCENT RPM	HP shaft speed
◀ 3	Engine fire warnings and extinguisher buttons (zone 1)	Right instrument panel	ENG FIRE 1 F ENG FIRE 2 F	Red warnings. Press buttons to discharge extinguishers
4	Engine oil low pressure warnings	Centralised warning panel	OIL 1, OIL 2	Red warnings
	Engine overheat warnings		ENG OH1, ENG OH2	Red warnings
	Engine fuel low pressure warnings		BP1, BP2	Amber warnings
5	TGT indicators	Right instrument panel	× 100 EGT	Degrees C × 100
6	Reheat fire warnings (zone 2)	Right instrument panel	REHEAT FIRE 1 F REHEAT FIRE 2 F	Red warnings
7	Nozzle position indicator	Right instrument panel	NOZZLE TUYERE	Scaled 0 to 10
8	MAX RATING switch	Right instrument panel	MAX RATING	Integral green light
9	LP cocks switches	Lower centre panel	LP COCKS — OPEN/ CLOSED	Lock toggle switches
10	Continuous ignition switches	Lower centre panel	CONTINUOUS IGN 1, 2 — ON / OFF	3 joule AC ignition
11	TGT amplifier switches	Lower centre panel	TGT AMP 1, 2 — ON / OFF	—
12	Engine starter air valve open light	Lower centre panel	—	Amber light
13	Air generator start button/light	Lower centre panel	GENERATOR START	Integral green light
14	Air generator start master switch	Lower centre panel	GENERATOR — ON / OFF	—
15	Engine ignition switch	Lower centre panel	ENGINE IGN — ON / OFF	One switch for both engines
16	Engine start switch	Lower centre panel	ENGINE START — 1 / 2	One switch for both engines
17	LP shaft correct rotation lights	Lower centre panel	CORRECT ROTATION	Two green lights
18	Part throttle reheat switches	Above left console	MOD REHEAT 1, 2 — ON / OFF	—
19	Relight buttons	On throttle levers	—	—
20 ▶	Throttle levers	Left console	—	—



1 – 4 Fig 1 Engine Controls and Indicators
LP cock switches returned to centre console

DESCRIPTION OF THE SYSTEM

General

2. The aircraft is powered by two Rolls-Royce Turbomeca Adour Mk 102 or 104 turbofan engines, each having a fully controllable variable nozzle-area reheat system. They are mounted in separate bays, one each side of the keel unit in the lower part of the rear fuselage. A fireproof bulkhead separates each bay into zone 1 (containing the engine) and zone 2 (reheat). Both zones in each bay have separate fire detection systems but only zones 1 have fire extinguishing facilities. Engine principal features are shown on Fig 2. The Adour Mk 104 is basically similar to the Mk 102 but is to a higher modification standard, permitting operation at higher thrust.

Engine Ratings

3. At sea level ISA, the static thrust of each engine is:

	Mk 102 (*JP* 102)	*Mk* 102 (*JP* 103)	*Mk* 104
a. Max without reheat	2295 daN (5165 lb)	2275 daN (5115 lb)	2344 daN (5270 lb)
b. Max reheat	3285 daN (7380 lb)	3255 daN (7305 lb)	3514 daN (7900 lb)
c. Min PTR	1000 daN (2250 lb)	1000 daN (2250 lb)	1068 daN (2400 lb)

Pilot's Throttle Controls

4. The throttles are conventional and mounted in a quadrant on the left console. Each throttle lever controls the high pressure (HP) cock for the associated engine and provides control of engine power. The throttle lever positions starting from the rear of the quadrant are:

a. Stop — HP cock closed.

Note: With the throttle to 'stop' a small quantity of fuel can seep past the HP cock if the LP cock is open and the associated LP pump is running.

b. Idle — Latch prevents inadvertent selection of HP cock closed.

c. Max dry — Latch prevents inadvertent selection of reheat.

d. Min reheat — Detent position.

e. Max reheat.

When part throttle reheat (PTR) is selected ON, a minimum PTR detent is activated at a throttle position corresponding to 80 to 86% RPM in sea level static conditions.

5. A relight button for each engine is on the rear of the associated throttle lever.

Compressors and Turbines

6. The engine has a two-stage low pressure (LP) compressor driven by a single-stage LP turbine and a five-stage HP compressor driven by a single-stage HP turbine. As shown in Fig 2, the LP and HP shafts are concentric and each assembly rotates independently in a clockwise direction when viewed from the front of the engine.

Engine Airflow

7. Air entering the engine passes directly to the LP compressor; there are no inlet guide vanes. On leaving the LP compressor the air divides into two streams (ratio 0·85 : 1 approximately), one stream passes through the HP compressor, combustion system and turbines, the other stream flows through an annular bypass duct into a mixer section where the two streams meet and mix. The combined streams flow into the reheat and exhaust sections.

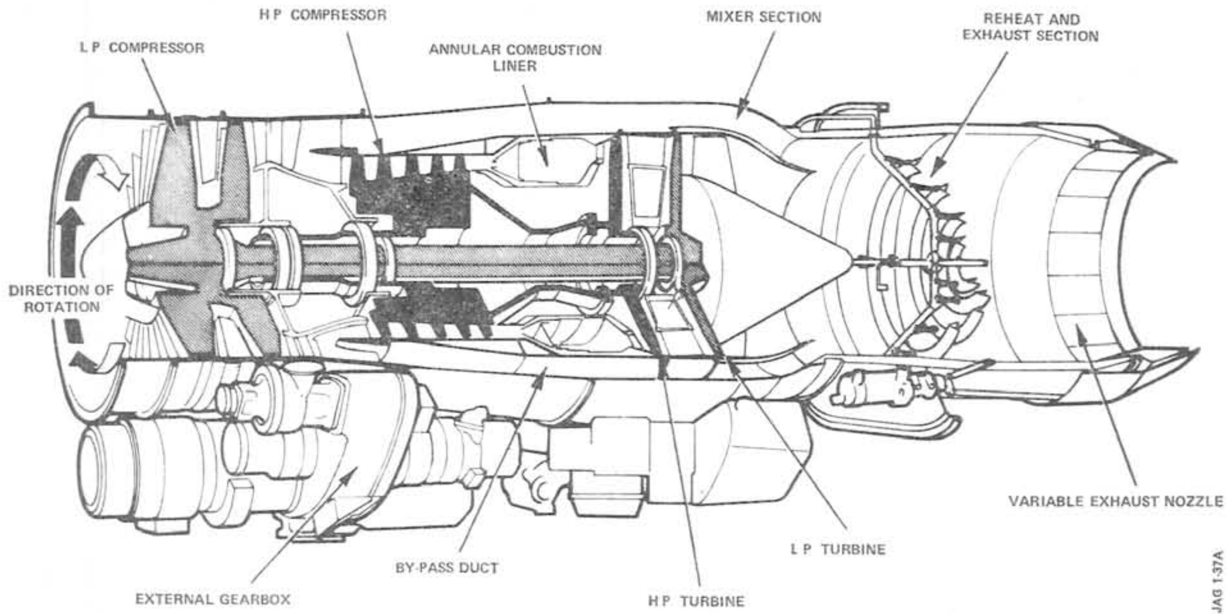
Bleed Valves

8. Compressor stalls during the start and initial acceleration to idle are prevented by bleeding off HP air into the bypass duct. Bleed valve operation is entirely automatic. The valve is open with the engine stationary or decelerated to below approximately 45% RPM; the valve closes with rising RPM at 61 ± 4% RPM. Thereafter the valve remains closed under all conditions at or above idle, re-opening only when the RPM falls through 45%.

Internal Air Cooling, Sealing and Overheat Detection

9. Air is tapped from the compressor for cooling bearings and turbine discs, and for pressurising oil and air seals. Some of the air passes forward through the LP shaft to provide continuous anti-icing for the LP compressor nose fairing. Surplus air from inside the LP shaft is dumped overboard via an outlet which incorporates a temperature switch. If the air temperature reaches approximately 400°C due to engine internal fire, turbine disc seal failure or a holed LP turbine nozzle guide vane, the switch closes and lights the appropriate red ENG OH warning on the CWP and activates the attention-getter and the audio alarm.

Note: Failures resulting in ENG OH warnings could lead to serious overheating of the turbine discs.



1—4 Fig 2 Engine Principal Features

Control Amplifier System

10. The control amplifier system provides:

⧓

a. Maximum TGT limiter control (dual datum for Mk 104).

b. LP shaft maximum speed control.

c. LP shaft correct rotation indication.

d. Activation of the ignition system during engine starting on the ground.

The system is controlled by the TGT AMP — ON/OFF switches.

11. *TGT Indication.* ⧓ TGT indication is independent of the control amplifier, the indicators being coupled direct to the temperature sensors. Although the indicators are labelled EGT, the term TGT will continue in use.

12. *Maximum TGT and LP Shaft Speed Limiting.* In addition to the TGT signal, the amplifier receives a signal representing LP shaft speed. When these parameters fall below the limiting values, a maximum current is fed from the amplifier to the solenoid controlling a spring-balanced valve in the HP pump servo circuit. If either reaches its limiting value the amplifier current is reduced and the solenoid valve opens progressively to trim (reduce) HP fuel flow, maintaining TGT or LP shaft speed below the limiting value.

13. *MAX RATING Facility (Increase of Take-Off Power).*

a. *General.* A push-on, pull-off switch marked MAX RATING, on the right instrument panel, switches the facility into or out of use. The switch has an integral amber light which comes on when the switch is 'on'. The system is to be used only for take-off in conditions when the ODM calculations show the take-off distance to be marginal. The system is effective only in the TGT limiting mode and has no effect on LP shaft speed limiting.

b. *Mk* 102 *Engines.* When mod 964 is embodied the pilot is provided with a facility for selecting a thrust value higher than the normal maximum rating. This is achieved by introducing a resistor into the circuit which transmits the TGT signal to the control amplifier, thus effectively increasing the actual TGT control limit by 15°C (this increase is not seen on the TGT gauge).

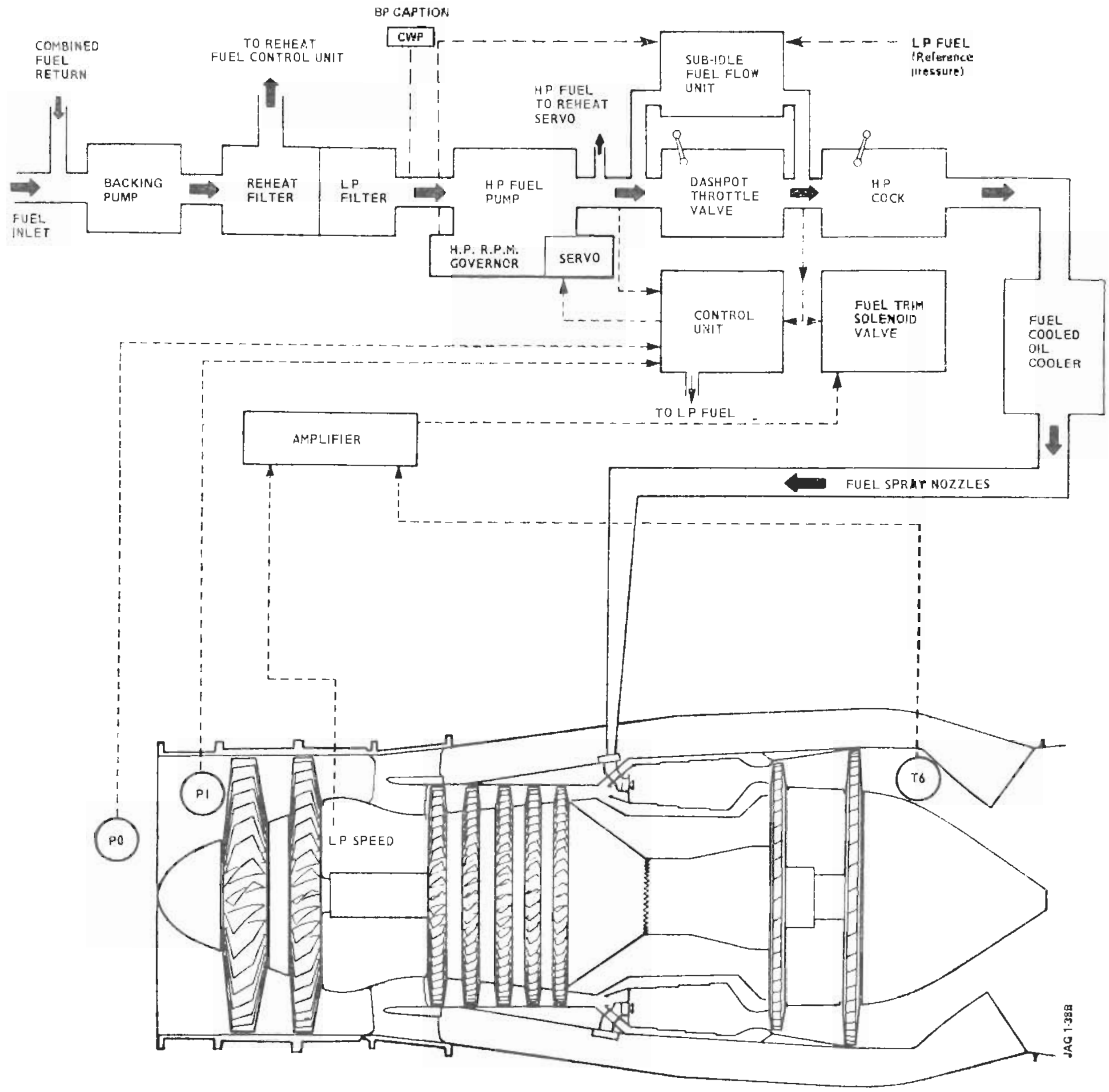
c. *Mk 104 Engines.* On this engine, the TGT amplifier incorporates two maximum TGT datums, the higher being set 6 ± 1°C above the other (normal) datum and selected by setting the MAX RATING switch 'on'. The increase (with TGT limiting) is seen on the TGT gauge and is accompanied by an HP RPM increase of 0·25 to 0·5%. Changeover from one datum to the other takes approximately 2 seconds.

14. *LP Shaft Correct Rotation Indication and Activation of Ignition System.* When the LP shaft reaches 100 RPM in the correct direction, the associ-

ated green CORRECT ROTATION light comes on and the ignition system is activated during engine starting on the ground. The light goes out and the ignition system is de-activated when the starter motor cut-out operates. The light also comes on when the relight button is pressed in flight, provided LP shaft speed is greater than 100 RPM.

Power Offtakes

15. A tapping from the HP compressor delivery supplies the air conditioning, and a tapping from the LP compressor delivery supplies air for fuel tank pressurisation. An external gearbox driven from the HP shaft, drives, through suitable gearing, a hydraulic pump, a constant-speed alternator, a backing (LP) fuel pump, an HP fuel pump, engine oil pumps, a reheat fuel pump, and an HP shaft tachometer generator. The latter provides an output to drive the RPM indicator and to control the associated hydraulic pump bypass valve when its switch is to AUTO. During engine starting, the drive from the starter motor is transmitted through the gearbox to rotate the HP shaft.



1—4 Fig 3 Engine Fuel System

Oil System

16. The engine oil system is self-contained on the engine. The oil tank at the rear underside of the bypass duct may be pressure or gravity replenished. Oil is circulated by one pressure pump and three scavenge pumps. The oil is cooled by a fuel-cooled oil cooler and a differential pressure switch monitors the pressure difference across the gearbox oil metering nozzles. If the differential falls below approximately 10 PSI the appropriate red OIL warning is lit on the CWP. ~~Post-mod 421~~ the attention-getter and audio alarm are held off for 10 seconds to avoid nuisance warnings resulting from transient low oil pressure conditions.

Engine Fuel System

17. *LP Fuel Supply.* Fuel from the aircraft system enters an engine-driven low pressure (backing) pump and is fed into a unit which contains two filters: a reheat fuel supply filter and an LP filter for engine fuel supply. From the LP filter the engine fuel supply is fed to an HP pump. A pressure switch in the line between the LP filter and HP pump is set to close and light the BP1 or BP2 (amber) caption on the CWP and operate the attention-getter if the fuel pressure falls below approximately 35 PSI absolute. The warning may come on when the engine is windmilling.

18. *HP Fuel Supply.* The engine-driven HP pump has a servo mechanism which controls pump delivery. Fuel flows from the pump via a fuel control unit (FCU), HP cock and fuel-cooled oil cooler to the main spray nozzles. Basic control is by a throttle valve in the FCU which modulates servo pressure. For a fixed throttle setting, servo pressure adjusts HP pump output to give the selected power, subject to changes in airspeed and altitude, provided engine speeds and temperatures are within limits. The FCU further controls the HP pump output in response to changes in altitude, airspeed and throttle valve setting. A hydro-mechanical governor, integral with the HP pump, cuts back pump output via the servo system should the HP shaft speed tend to rise above its permitted maximum of 103 to 104% RPM (104% on Mk 104 engine). Servo pressure may be further modified by a fuel trim solenoid valve which, when energised by signals from the amplifier, varies the fuel flow to maintain LP shaft speed and TGT within limitations (para 12).

19. *Sub-Idling Fuel Flow Control.* During starting and initial acceleration to idle, fuel flows from the HP cock to the fuel spray nozzles. The fuel flow is automatically controlled after selecting the throttle lever to the idle position by a sub-idling fuel flow (SIFF) control unit which contains a diaphragm subjected on one side to HP RPM governor pressure and to LP fuel pressure on the other side. The pressure difference between these two signals is proportional to HP RPM. Movement of the diaphragm activates a spool which moves within a sleeve to meter the fuel during acceleration to idle.

Exhaust System

20. The system comprises a diffuser, an exhaust gas collector and a variable-area nozzle. The diffuser allows mixing of the turbine and bypass flows and reduces the velocity of the gases sufficiently to ensure reheat combustion. The diffuser also contains the reheat main burner manifold and four vapour gutters. The exhaust nozzle consists of a set of overlapping flaps pivoted at their leading edges so that the trailing edges form a conical nozzle. The flaps are opened or closed to increase or decrease the nozzle area, by four hydraulic rams using fuel as a hydraulic medium. In the dry power range the nozzle is fixed closed; when reheat is in operation the nozzle area is varied between a part-open position and fully open. This ensures that exhaust system pressure is held at a value such that pressure changes through the engine are maintained at the same values as those experienced in non-reheat operation.

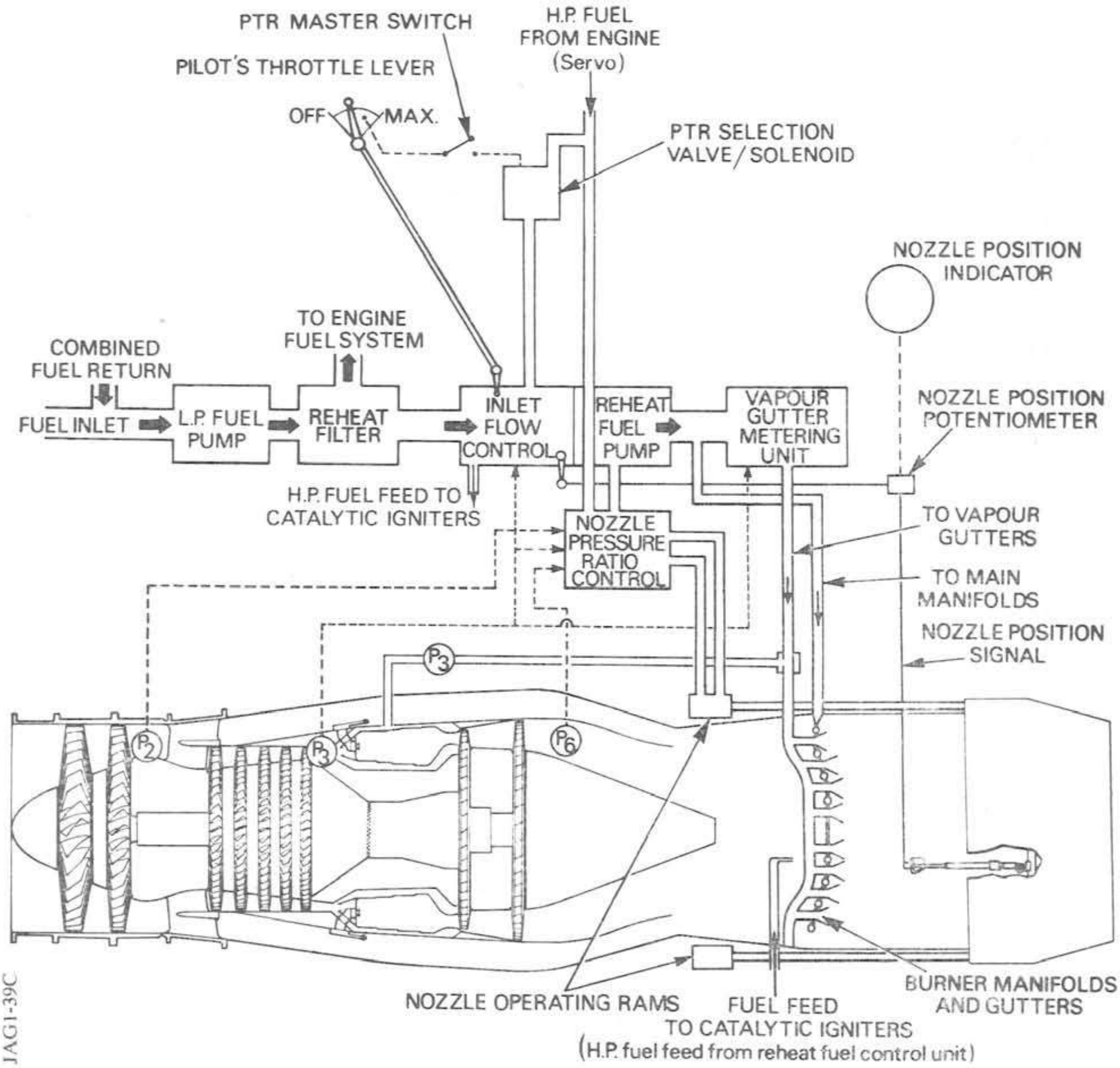
Reheat System

21. The normal reheat system provides an increase in thrust when maximum RPM is selected and the throttle lever is moved into the reheat range; the degree of reheat can be varied between normal minimum reheat and maximum reheat positions. Part throttle reheat (PTR) is incorporated to enable reheat to be used below maximum RPM, thus improving thrust response. PTR is activated by selecting the appropriate MOD REHEAT switch ON with the throttle at or above the maximum dry position. The degree of PTR may be reduced by closing the throttle below the maximum dry position; the RPM reduce in the normal way. The minimum PTR position is determined by a detent which is felt in each throttle quadrant at a position corresponding to approximately 85% stabilised RPM, sea level static conditions, when either PTR is activated; closing the throttle below the detent results in PTR being deselected and the engine decelerates normally. Post-Adour mod 143 (and on Mk 104 engines), the activation of reheat (normal or PTR) is prevented until approximately 75% RPM is reached. Each detent incorporates a spring which allows the throttle lever to advance smoothly over the detent position but provides a detent with an appreciable break-out force when the throttles are retarded.

Note: The PTR thrust at the maximum dry power position corresponds to the normal minimum reheat thrust.

22. The reheat fuel control system (Fig 4) consists of an inlet flow control, a reheat fuel pump, a nozzle pressure ratio control, and a vapour gutter metering unit. The system is supplied with fuel from the engine feed downstream of the backing pump. HP fuel from the engine HP pump is used for servo purposes in the reheat fuel flow control system and for catalyst fuel supply. The inlet fuel flow control receives signals of throttle lever position, HP compressor delivery pressure and nozzle position. Throttle lever position controls fuel flow for the degree of reheat selected. HP compressor delivery pressure modifies this flow, taking into account the effects of altitude and airspeed, and nozzle area signals ensure that reheat is within predetermined limits. The flow is then proportioned between the gutters and main burners by the vapour gutter metering unit. On Mk 104 engines, the fuel supply to the vapour gutters is mixed with P3 air to provide a fuel/air mixture which improves burning.

23. As fuel is burned in the reheat jet pipe the turbine pressure ratio decreases. This is sensed by the nozzle pressure ratio control which routes fuel pressure to the nozzle rams, increasing nozzle area and restoring the correct nozzle pressure ratio.



JAG1-39C

1—4 Fig 4 Reheat Fuel System

P3 air to vapour gutters (Mk 104 engines only) added

During reheat selection, the nozzle pressure ratio control is biased to position the nozzle rams and adjust the nozzle to the pre-open position used for reheat lighting. This raises the turbine pressure ratio so that the transient pressure changes experienced during light-up will not cause engine surge.

24. *Reheat Ignition (JP (jet pipe) 102 standard).* This is effected by a single catalytic igniter which, when subjected to a fuel spray, promotes a chemical reaction which generates sufficient heat to ignite the fuel spray, and subsequently, the fuel from the vapour gutters and the main burner manifolds. Igniter fuel flow is cut off just before the nozzle reaches the minimum reheat area.

◀25. *Reheat Ignition—Mk 102 (JP (jet pipe) 103 standard) and Mk 104.* This is effected by two▶ catalytic igniters, the operation of which is similar to the single catalytic igniter, except that the second igniter also operates continuously whilst PTR is selected.

26. *Reheat Pump Cooling.* When reheat is cancelled, a flow of fuel is initiated through the reheat control unit for cooling the reheat pump. When reheat is selected, cooling is effected by the reheat fuel flow and the cooling fuel flow is cancelled by the nozzle position feedback. If during non-reheat conditions, the cooling fuel flow is cancelled, eg by the nozzle opening, overheat will occur rapidly and result in reheat pump seizure.

Engine Starting System

27. *General.* A starter motor, fitted to the engine external gearbox, drives the engine HP shaft through the gearbox train. The starter is powered by air supplied from an air generator in the left airbrake well. The airbrakes must be fully open during ground starting. The air generator is an electrically-started gas turbine which drives a compressor to provide air for starting the main engines. The unit has a self-contained oil system and the oil pressure line incorporates a pressure switch. Fuel is supplied from the aircraft system and electrical power for starting the air generator is supplied from the aircraft battery. The unit can be run continuously for up to 10 minutes, after which it shuts down automatically; it also shuts down automatically when both engines have been started and each engine is running at or above 39% RPM. The system is shown on Fig 5.

28. *Ignition.* Two high-energy igniter units are fitted to each engine, one AC (3-joule) and one DC (12-joule), each energising an associated igniter plug. Both plugs are operative during relighting and during ground starts providing AC supplies are available: the ENGINE IGN switch must be ON. Two continuous ignition switches permit the AC igniter to be energised for extended periods (ENGINE IGN switch ON).

29. *Ground Starting Sequence.*

a. After selecting the air GENERATION start master switch to ON and pressing the GENERATION START button, the air generator starts and accelerates to idling RPM; air pressure output is vented to atmosphere via a dump valve. A green light in the START button comes on when the air generator starts. If, after 20 seconds, the generator has not attained idling RPM or if oil pressure is low, the air generator shuts down automatically. Before engine starting, the ENGINE IGN switch is set to ON and the throttle set to 'stop'. The BAT caption on the CWP comes on until the air generator reaches idling RPM.

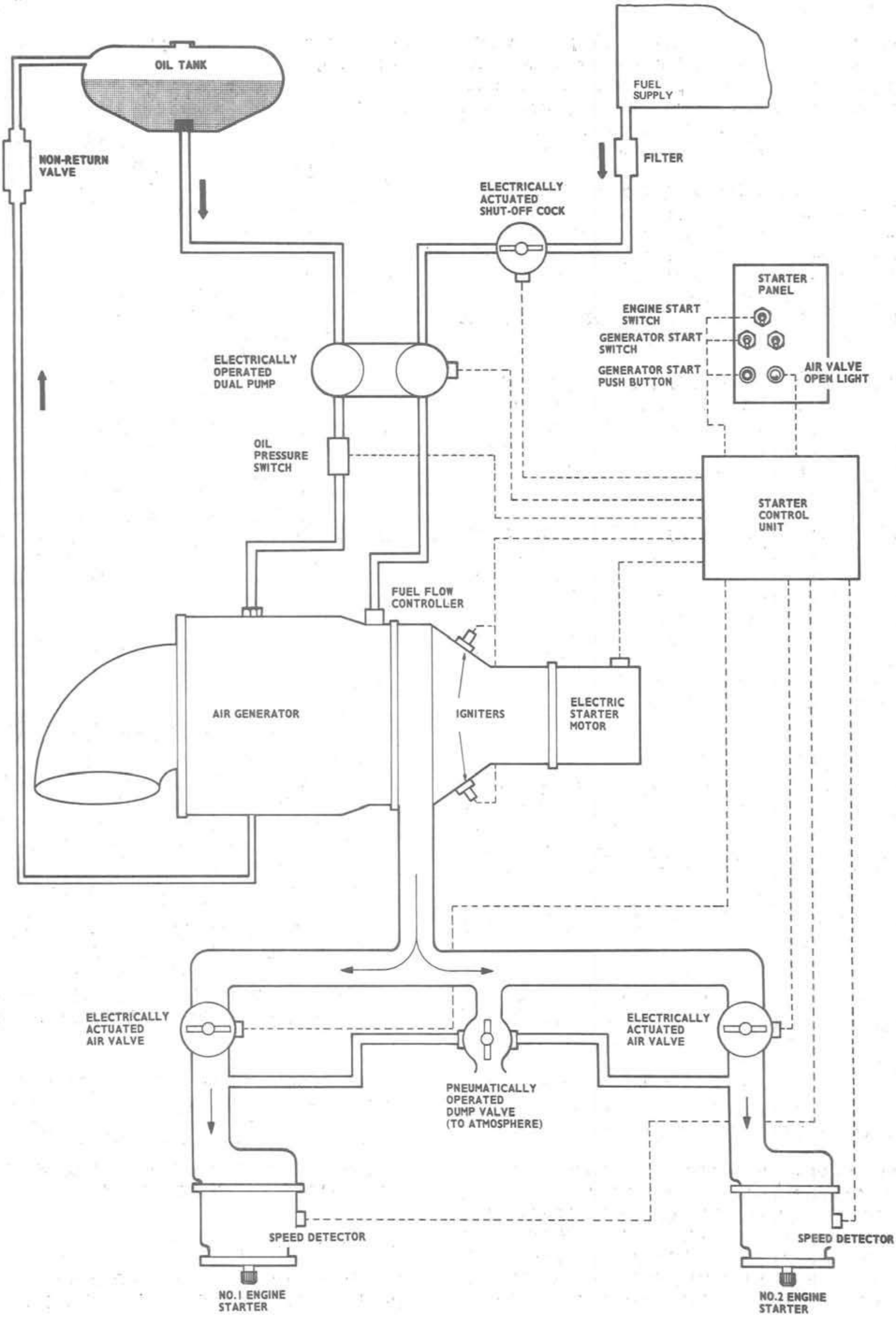
b. Selecting the ENGINE START switch to either No 1 or No 2 opens the air supply valve to the starter motor of the engine to be started (starter air valve open light on), accelerates the air generator to full power and closes the valve which was dumping air supply to atmosphere. Air pressure rotates the starter motor and, via the gear train, the HP assembly which induces an airflow through the engine to rotate the LP assembly. When LP shaft speed reaches 100 RPM and rotation is in the correct direction, the associated CORRECT ROTATION light comes on and the engine ignition circuits are energised.

c. When RPM reach approximately 15%, the throttle lever is moved to the idle position. At this position the HP fuel valve is fully open and fuel, metered by the sub-idle fuel flow control unit, is fed to the fuel spray nozzles. When the engine reaches starter cut-out speed (approximately 39% RPM) the air supply valve closes, the air generator decelerates to idle and the air dump valve opens, venting air generator supply to atmosphere. Simultaneously, the air valve open light and the CORRECT ROTATION light go out and the engine igniters are de-energised. A start can be discontinued at any time by selecting the throttle lever to 'stop'. When the second engine has been started and reaches 39% RPM, the air generator automatically stops.

30. *Relighting in Flight.* With the ENGINE IGN switch ON, pressing the relight button on the throttle energises both ignition units on the associated engine and the CORRECT ROTATION light comes on for as long as the button is pressed, provided LP shaft speed is greater than 100 RPM.

Fire Detection and Extinguishing

31. *Fire Detection.* There are four separate fire detection systems, one for each engine fire zone,



1 – 4 Fig 5 Engine Starting

JAG 1–40B

Zone 1 (forward of the firewall) and Zone 2 (to the rear of firewall). In each zone are a number of self-resetting fire detectors and a control unit. Operation of the fire detection system is detailed in Part 1, Chapter 2. The systems use 28V DC from the emergency busbar and warning is given by two ENG FIRE (Zone 1) and two REHEAT FIRE (Zone 2) lights on the right instrument panel together with the audio alarm and attention-getter. The ENG FIRE lights also incorporate fire extinguisher buttons.

32. *Fire Extinguisher.* Fire extinguisher is provided in Zone 1 of each engine only. There is one, dual-head fire extinguisher bottle containing methyl bromide (BCF post-mod 967). Pressing the ENG FIRE warning light/button discharges the entire contents of the bottle into the appropriate Zone 1; should a second warning occur, no extinguishant is available. Operation of the crash FIRBOT switch on the left console fires both cartridges to discharge the extinguishant in both Zones 1 simultaneously.

33. *Extinguishant Discharge Indication.* Two indicator fuses, visible through a window in the skin below the left tailplane, normally appear transparent but are coloured red if the extinguisher has been discharged electrically. If the contents of the extinguisher bottle become overheated, a safety disc ruptures and spills the contents overboard through an outlet just above the fuse indicators. The outlet is normally covered by a green disc but the disc is blown off when the contents spill and the outlet appears bright red.

NORMAL USE OR MANAGEMENT

Engine Starting and Operation

34. For engine starting and operation, refer to Part 3 of this publication and the Flight Reference Cards. Engine limitations are given in Part 2.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Engine Surge, Stall or Overtemperature

35. An engine surge may be indicated in several ways, ranging from a loud rapid gun-firing sound to a dull pop, or just a sudden rise in TGT. A surge is most likely to occur during reheat handling close to the reheat burning ceiling or during rapid reheat re-selections (reheat must not be re-selected within less than 3 seconds). The engine is of robust construction and the surge itself, even though it may be very loud, is unlikely to cause internal damage. It may, however, result in damage to the intake doors if experienced at low altitude.

36. It is important to stress that there are two forms of surge; a surge which self-clears and the type which causes an engine stall.

37. If the surge is accompanied by stall, severe turbine damage may occur if the TGT rises rapidly above the limits and is not immediately controlled by the pilot.

38. Following recovery from a surge, stall or overtemperature condition, prove the engine by opening the throttle slowly, monitoring TGT, to maximum dry power, to check that the engine controls normally.

Note: An engine surge, stall or overtemperature condition must be recorded and reported.

39. Action to be taken in event of surge, stall or overtemperature in flight is given in Table 3. If such a condition occurs on the ground, throttle back to idling immediately. If this action does not reduce TGT to the normal idling value (below about 450°C) within 6 seconds, set the throttle lever to 'stop' and abandon the sortie.

Control Amplifier Failure

40. Amplifier failure may result in RPM and TGT increasing, or decreasing, or fluctuating. In the event of any such failure, set the amplifier switch to OFF: this results in a maximum downward trim condition with a resultant loss of thrust. If the amplifier is switched off following a failure on the ground, do not take off. If the amplifier fails in flight and is switched off, the engine may be used but allowance must be made for the reduced maximum power available. The greatest reduction in thrust and RPM occurs at low altitude, low speed, on a cold day when thrust may be reduced by up to 30%, together with an RPM reduction of up to 6%. In other flight conditions the reductions will be less severe.

41. With the amplifier switched off, idle RPM will be lower than normal and to avoid surge during accelerations, and flame-out during decelerations, the throttle must be handled carefully, particularly at or near the idle position. Do not use the idle stop as a datum: as a guide, do not allow the RPM to decrease below 75%.

42. In an emergency, normal reheat or PTR may be selected with an amplifier switched off. PTR should be selected with the throttle at the maximum dry position to effect the fastest light-up.

43. An amplifier should not normally be reselected on in flight after a failure. However, if such action is essential (eg, after a major power loss on the other engine) the RPM must be in the range 75 to 85%

and TGT must be carefully monitored to avoid exceeding engine limitations: above 90% RPM the limitations are likely to be exceeded.

44. With the amplifier failed in the 'no trim' or 'partial trim' condition, any attempt to select maximum dry or normal reheat may result in the engine limitations being exceeded: PTR may be selected provided the selection is made with reduced throttle.

Indications and Actions

45. Indications and actions relating to system malfunctions are listed in Table 3.

Table 3 — Engine System Malfunctions

Note: If when an engine is shut down, the associated ALT warning does not come on, set the appropriate ALT switch to OFF

Indication	*Immediate Action*	*Subsequent Action*	*Considerations*
SURGE — Mk 102 ENGINES			
Engine surge (audible + TGT increase)	Throttle to Idle Monitor TGT		
OR			
Engine stall (decrease or stagnation in RPM + TGT increase)	*TGT exceeded 790°C or was above 640°C for more than 30 seconds*	Shut down the engine	Do not relight
OR			
Excessive TGT	*TGT below 450°C in 6 seconds*	Prove the engine	Use engine normally
	TGT not below 450°C in 6 seconds	Throttle to Stop	
		Maximum TGT less than 670°C Relight engine Prove engine	Use engine normally
		Maximum TGT above 670°C Relight engine Prove engine Leave at Idle	◀Use in an emergency provided there are no other indications of failure ▶

WARNING: If the overtemperature or surge recurs when proving the engine, shut down and do not relight.

(continued)

Table 3 — *continued*

Indication	*Immediate Action*	*Subsequent Action*	*Considerations*
SURGE — Mk 104 ENGINES			
Engine surge (audible + TGT increase) OR Engine stall (decrease or stagnation in RPM + TGT increase) OR Excessive TGT	Throttle to Idle Monitor TGT		
	TGT exceeded 850°C or was above 700°C for more than 30 seconds	Shut down the engine	Do not relight
	TGT below 450°C in 6 seconds	Prove the engine	Use engine normally
	TGT not below 450°C in 6 seconds	Throttle to Stop	
		Maximum TGT less than 730°C Relight engine Prove engine	Use engine normally
		Maximum TGT above 730°C Relight engine Prove engine Leave at Idle	Use in emergency provided there are no other indications of failure
		WARNING: If the overtemperature or surge recurs when proving the engine, shut down and do not relight.	
OIL LOW PRESSURE			
OIL 1 or OIL 2 warning on on CWP in stable level flight	Throttle to Stop. Complete the **Engine Shutdown** drill	Land as soon as practicable	The warnings can come on with negative g but should go out when positive g is restored
ENGINE OVERHEAT			
ENG OH warning on CWP	Throttle to Stop. Complete the **Engine Shutdown** drill	Land as soon as possible Monitor the appropriate ENG FIRE light	Do not discharge the fire extinguisher unless the ENG FIRE warning is also on. Do not attempt to re-start the engine or open the LP cock
TGT AMPLIFIER FAILURE			
Refer to para 40			

(continued)

Table 1 — Hydraulic Power System Controls and Indicators

Item No	*Item*	*Location*	*Markings*	*Remarks*
1	Attention-getter	Right coaming panel	ALARM	Flashing red
2	Electro-hydraulic pump switch	Right instrument panel	ELECTRO HYD PUMP — ON/AUTO/OFF	3-position switch
3	Electro-hydraulic pump indicator light	Right instrument panel	—	Amber light on when power fed to EHP
4	Hydraulic pressure selector switch	Right instrument panel	CONT/SERV	2-position switch
5	Dual hydraulic pressure gauge	Right instrument panel	HYDR 1, HYDR 2 — BAR × 100	Graduated 0 to 350 bar in increments of 50 bar
6	Hydraulic circuit failure warnings (2)	CWP, right instrument panel	HYD 1, HYD 2	Single failure — red caption with attention-getter Double failure — red captions with attention-getter and audio warning
7	Hydraulic pump bypass switches (2)	◀Right instrument panel▶	HYD BY PASS ON/AUTO/OFF	3-position switches

c. A heat exchanger in the airbrake compartment for cooling the hydraulic fluid, using fuel as a cooling medium.

d. An accumulator to damp pressure fluctuations from the pump. The accumulator is charged with nitrogen to 100 bar.

e. An electrically-operated services isolation valve, controlled by the reservoir low-level switch and dividing the circuit into two parts. When the reservoir contents reduce to 1 litre the valve closes, leaving the flying control jacks fed from the system and isolating the remaining services. The valve can only be re-opened manually on the ground.

f. An electrically-operated bypass valve which reduces engine load during starting, relighting or during a dry crank, by routeing pump output back to the reservoir. The valve is controlled by a BY PASS switch having three settings:

(1) ON — valve open.

(2) AUTO—valve remains open whenever the engine RPM are less than 42%. Closed by signal from engine tacho generator.

(3) OFF — valve closed.

g. A pressure switch in the engine-driven pump output line closes if pressure reduces to 106 bar and operates the attention-getter and the HYD 1 caption of the centralised warning system. Closing the switch also part-completes the automatic control circuit for the electro-hydraulic pump and the audio warning of the centralised warning system.

h. Two pressure transmitters, one in each side of the circuit, connected to the dual pressure indicator via a CONT/SERV selector switch.

Table 3 — *continued*

Indication	*Immediate Action*	*Subsequent Action*	*Considerations*
SURGE — Mk 104 ENGINES			
Engine surge (audible + TGT increase) OR Engine stall (decrease or stagnation in RPM + TGT increase) OR Excessive TGT	Throttle to Idle Monitor TGT		
	TGT exceeded 850°C or was above 700°C for more than 30 seconds	Shut down the engine	Do not relight
	TGT below 450°C in 6 seconds	Prove the engine	Use engine normally
	TGT not below 450°C in 6 seconds	Throttle to Stop	
		Maximum TGT less than 730°C Relight engine Prove engine	Use engine normally
		Maximum TGT above 730°C Relight engine Prove engine Leave at Idle	◀ Use in emergency provided there are no other indications of failure ▶
		WARNING: If the overtemperature or surge recurs when proving the engine, shut down and do not relight.	
OIL LOW PRESSURE			
OIL 1 or OIL 2 warning on on CWP in stable level flight	Throttle to Stop. Complete the **Engine Shutdown** drill	◀ Land as soon as practicable	▶ The warnings can come on with negative g but should go out when positive g is restored
ENGINE OVERHEAT			
ENG OH warning on CWP	Throttle to Stop. Complete the **Engine Shutdown** drill	Land as soon as possible Monitor the appropriate ENG FIRE light	Do not discharge the fire extinguisher unless the ENG FIRE warning is also on. Do not attempt to re-start the engine or open the LP cock
TGT AMPLIFIER FAILURE			
Refer to para 40			

(*continued*)

Table 3 — *continued*

Indication	*Immediate Action*	*Subsequent Action*	*Considerations*
REHEAT — NOZZLE MALFUNCTIONS			
a. Reheat selected but nozzle fails to open	Cancel reheat	Use the engine in the dry range, provided no other signs of engine malfunction	—
b. Reheat lit — nozzle moves rapidly towards closed	Immediately cancel reheat	Monitor engine for signs of surge or over-temperature	—
c. Reheat lit — nozzle wanders / becomes unstable	Cancel reheat	Do not reselect	—
d. Reheat cancelled — nozzle fails to close, and:			
(1) Flow decreases to approx max dry flow	Shut down the engine	—	No cooling flow to reheat fuel control unit
(2) Flow remains high	Slowly re-select reheat, monitoring RPM, TGT and nozzle position: then slowly cancel reheat	If fault persists, reduce RPM below 70% to cancel reheat. If reheat still fails to cancel, shut down the engine unless reheat is necessary	The reheat may rearm if RPM advanced beyond 75%. Above 20,000 feet a satisfactory reheat light-up may not be achieved, giving a considerable loss of thrust and unburned fuel in the jet pipe
e. Nozzle opens without reheat selection	Shut down the engine		—
f. Reheat not selected— indicator fluctuates:			
(1) RPM, TGT and possibly thrust also fluctuate	Shut down the engine	—	—
(2) RPM, TGT and thrust stable (nozzle indicator fault)	—	Restrict use of reheat to only one selection if possible	—

Note: Small nozzle position indicator errors or fluctuations around '0' $\pm 0{\cdot}2$ are acceptable provided there are no other indications of malfunction. Record and report.

PART 1

CHAPTER 5 — HYDRAULIC POWER SYSTEM

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CONTROLS AND INDICATORS

1. Details concerning the controls and indicators shown in Fig 1 are listed in Table 1.

DESCRIPTION OF THE SYSTEM

General

2. The system consists of two circuits, identified 1 and 2. Each circuit is pressurised by a hydraulic pump driven by the accessory drive of the respective engine. No 1 engine pump supplies No 1 circuit and No 2 engine pump supplies No 2 circuit. In the event of loss of either system due to engine failure, the system normally supplied by the failed engine is maintained in operation by means of a power transfer unit (PTU). An electro-hydraulic pump (EHP) is provided to supply No 2 circuit should both engine driven pump supplies fail.

3. The system provides hydraulic power to operate the services listed in Table 2.

No 1 Circuit

4. No 1 circuit comprises:

a. A pressurised 6·15 litre (1·35 Imperial gallon) capacity reservoir in the hydraulic equipment bay in the left rear fuselage. Reservoir pressurisation is provided by a small integral piston, subject to pump delivery pressure, which produces a reservoir pressure of 3 bar; a pressure relief valve set at 4·9 bar prevents excessive reservoir pressure. A contents switch and a low-level switch are also provided.

b. A self-regulating engine-driven pump (EDP) providing a delivery flow of 55 litres per minute at a pressure of 206 bar.

Table 1 — Hydraulic Power System Controls and Indicators

Item No	*Item*	*Location*	*Markings*	*Remarks*
1	Attention-getter	Right coaming panel	ALARM	Flashing red
2	Electro-hydraulic pump switch	Right instrument panel	ELECTRO HYD PUMP — ON/AUTO/OFF	3-position switch
3	Electro-hydraulic pump indicator light	Right instrument panel	—	Amber light on when power fed to EHP
4	Hydraulic pressure selector switch	Right instrument panel	CONT/SERV	2-position switch
5	Dual hydraulic pressure gauge	Right instrument panel	HYDR 1, HYDR 2 — BAR × 100	Graduated 0 to 350 bar in increments of 50 bar
6	Hydraulic circuit failure warnings (2)	CWP, right instrument panel	HYD 1, HYD 2	Single failure — red caption with attention-getter Double failure — red captions with attention-getter and audio warning
7	Hydraulic pump bypass switches (2)	Right instrument panel	HYD BY PASS ON/AUTO/OFF	3-position switches

c. A heat exchanger in the airbrake compartment for cooling the hydraulic fluid, using fuel as a cooling medium.

d. An accumulator to damp pressure fluctuations from the pump. The accumulator is charged with nitrogen to 100 bar.

e. An electrically-operated services isolation valve, controlled by the reservoir low-level switch and dividing the circuit into two parts. When the reservoir contents reduce to 1 litre the valve closes, leaving the flying control jacks fed from the system and isolating the remaining services. The valve can only be re-opened manually on the ground.

f. An electrically-operated bypass valve which reduces engine load during starting, relighting or during a dry crank, by routeing pump output back to the reservoir. The valve is controlled by a BY PASS switch having three settings:

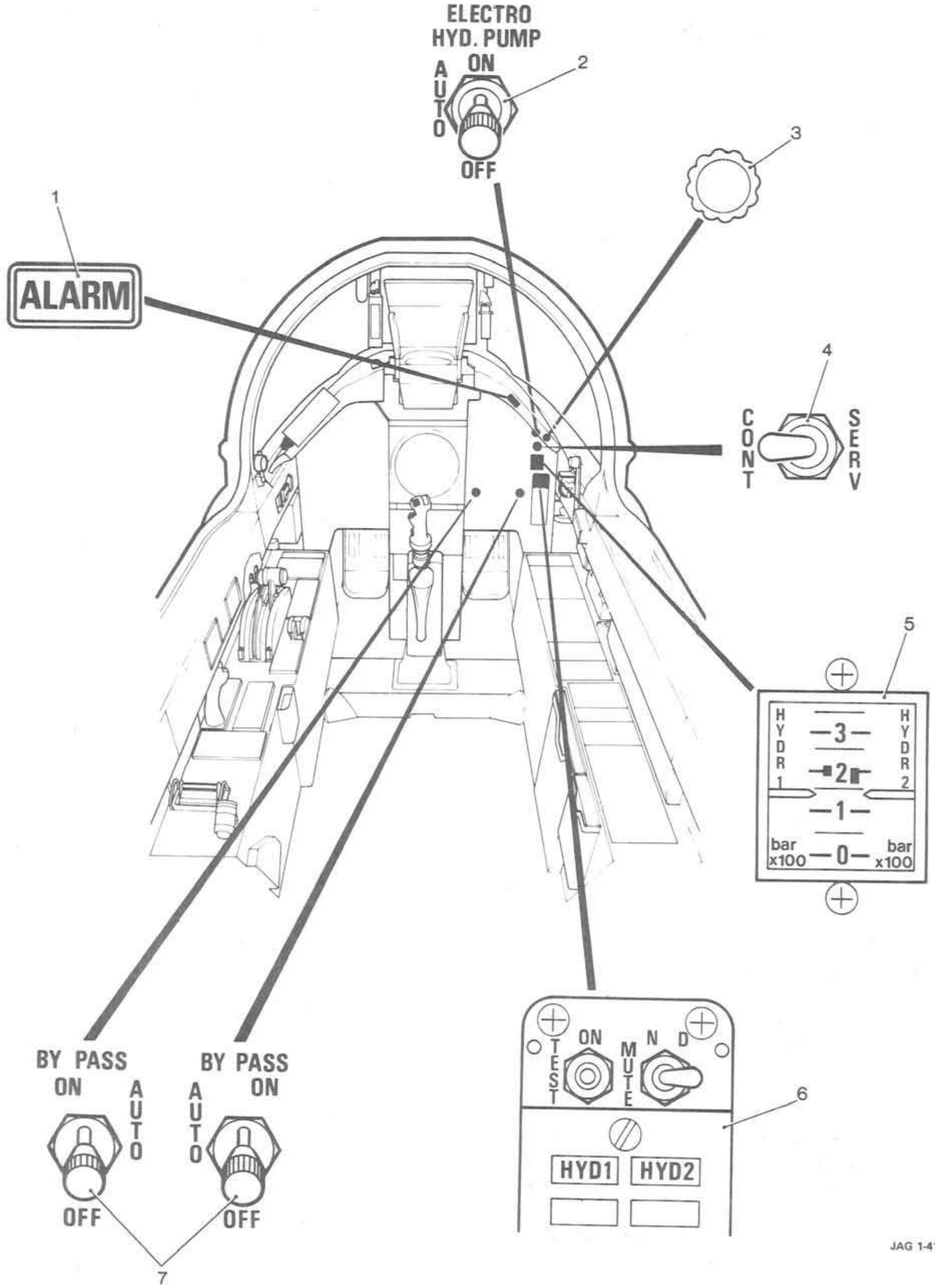
(1) ON — valve open.

(2) AUTO — valve remains open whenever the engine RPM are less than 42%. Closed by signal from engine tacho generator.

(3) OFF — valve closed.

g. A pressure switch in the engine-driven pump output line closes if pressure reduces to 106 bar and operates the attention-getter and the HYD 1 caption of the centralised warning system. Closing the switch also part-completes the automatic control circuit for the electro-hydraulic pump and the audio warning of the centralised warning system.

h. Two pressure transmitters, one in each side of the circuit, connected to the dual pressure indicator via a CONT/SERV selector switch.



1 – 5 Fig 1 Hydraulic Power System Controls and Indicators
◀By-pass switches returned to right instrument panel▶

Table 2 — Hydraulic Services

No 1 Circuit	*No 2 Circuit*
CONTROLS	**CONTROLS**
Rudder and autostabiliser Tailplane Spoilers	Rudder Tailplane and autostabiliser Spoilers and autostabiliser
SERVICES	**SERVICES**
Flaps and slats Wheelbrakes and anti-skid Landing gear — normal Air-to-air refuelling probe — normal (GR 1 only)	Flaps and slats Wheelbrakes — emergency (no anti-skid) Landing gear — emergency down Air-to-air refuelling probe — emergency extension (GR 1 only) Parking brake Nosewheel steering and anti-shimmy Airbrakes

No 2 Circuit

5. No 2 circuit is similar to No 1, but also incorporates an emergency circuit. In addition to the items described for No 1 circuit, No 2 circuit includes:

a. An electro-hydraulic pump drawing fluid from No 2 reservoir and feeding No 2 circuit only.

b. A restrictor which prevents a large demand service, eg landing gear lowering, causing a pressure drop in the supply to the flying controls.

c. A relay valve which bypasses the restrictor during normal operation. The valve is closed by pressure output from the electro-hydraulic pump.

d. Two accumulators, one each for wheelbrakes and nosewheel steering. The former is charged with nitrogen to 100 bar (with hydraulic pressure released) and the latter is charged to 16 bar.

e. A pressure maintaining valve incorporating a small accumulator charged with nitrogen to 100 bar which maintains reservoir pressurisation to ensure priming of the electro-hydraulic pump.

Power Transfer Unit

6. To ensure that the landing gear can be raised in the event of a No 1 engine failure on take-off, a power transfer unit (PTU) is connected across the No 1 and No 2 systems. The unit consists of two pump/motors connected back-to-back so that if one is driven, the other acts as a pump.

7. Normally the unit is isolated from the controls pressure circuit of each system by two selector valves which are basically electrically-operated non-return valves. Should the speed of an engine reduce below 42% RPM the selector valve for the opposite circuit is automatically energised open, provided that the BY PASS switch for the failed engine is at AUTO, the EHP is not running, and the contents of the reservoir associated with the failed engine are adequate. With this selector valve open, pressure is applied to the 'live' side of the PTU which acts as a motor and drives the other side which functions as a pump. The pump side draws fluid from its reservoir and provides an output pressure of 130 to 180 bar via its de-energised selector valve.

8. The selector valves can also be operated by setting the appropriate BY PASS switch to ON. This facility is provided for pre-flight checking of the PTU and should not normally be used in flight. (Refer to WARNING at para 24.)

Electro-Hydraulic Pump

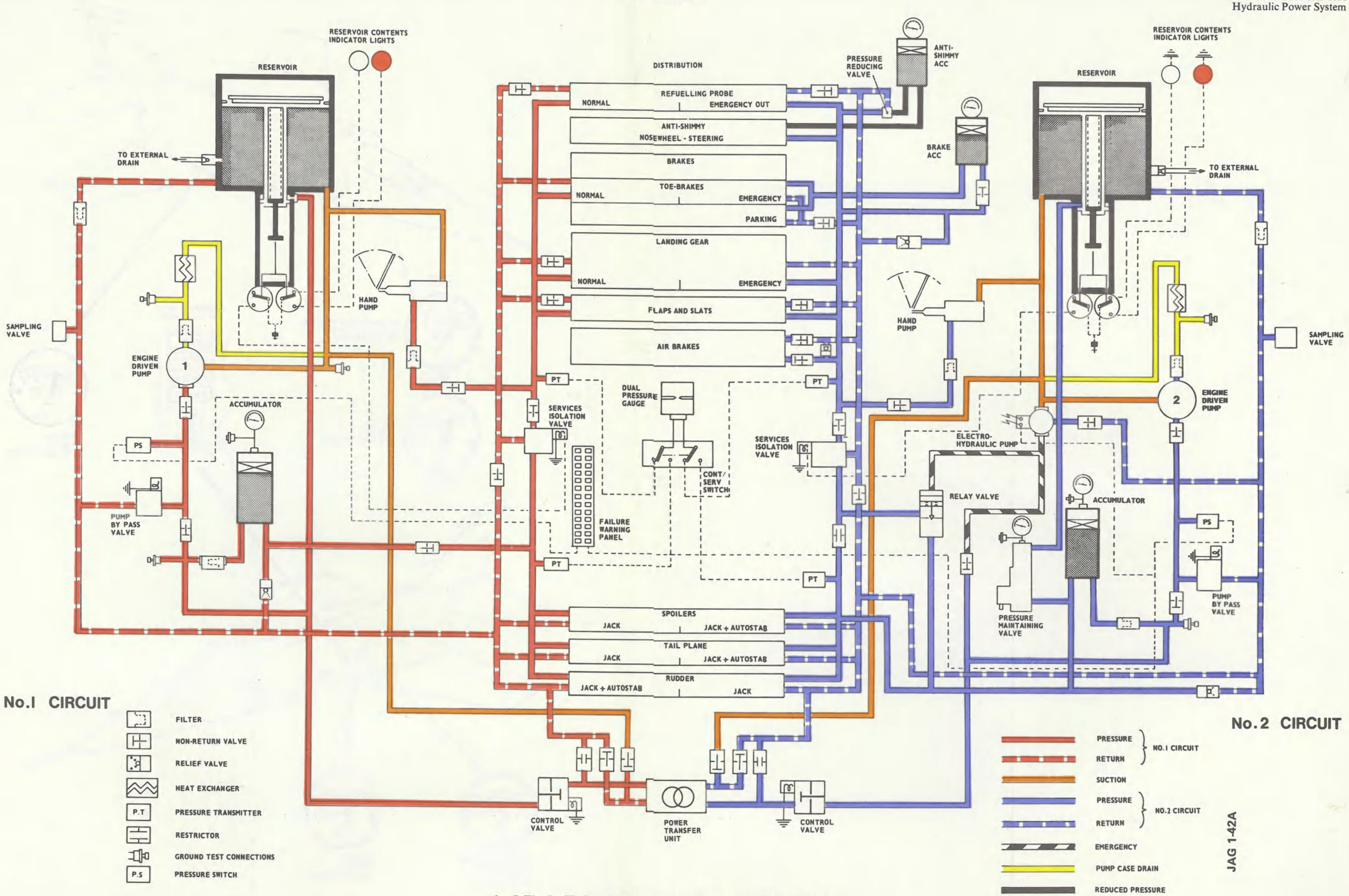
9. In the event of failure of both engine-driven hydraulic pumps, the electro-hydraulic pump (EHP) can maintain a reduced pressure to the following essential services:

a. Flying control jacks (one body of each unit, plus the pitch and roll autostabilisers).

b. Nosewheel anti-shimmy.

c. Flaps and slats (one hydraulic motor only).

d. Emergency landing gear lowering (doors remain open).



1—5 Fig 2 Hydraulic Power Generation and Distribution

e. Airbrakes

f. Wheelbrakes (emergency and parking).

g. Air-to-air refuelling probe emergency extension (GRI only) (it may not be possible to retract probe).

Note 1: Nosewheel steering is not available because the pressure output of the EHP is insufficient to keep the steering coupler engaged (refer to Chapter 7).

Note 2: With normal electrical supplies available, the maximum recommended running time for the EHP is 30 minutes provided that the total time on load (ie operation of any of the listed services) does not exceed 10 minutes; this limitation is imposed by pump overheat considerations. In emergency, with only the aircraft battery available, the battery duration, and consequently EHP running time, is approximately 5 minutes.

Note 3: The EHP is not to be used indiscriminately as a substitute for other pressure supplies to No 2 circuit. Ground testing of the EHP must be carried out before the NavWASS is switched on, otherwise the high starting current drawn by the pump will cause the NavWASS to be dumped.

10. The EHP is fed from the 28V DC emergency busbar and has an output of 8·5 litres per minute at 160 bar. Control is provided by a three-position ELECTRO HYD PUMP—ON/AUTO/OFF switch which operates as follows:

a. ON — pump running (indicator light on).

b. AUTO — pump switched on automatically (indicator light on) when both No 1 and No 2 circuit pressure switches close due to low pressure (caused by failure of both pressure systems or by the RPM of both engines being below 42%). The pump continues to run until switched OFF manually or until the RPM of either engine is increased above 42%.

c. OFF — pump electrically isolated.

11. With the EHP supplying No 2 circuit, the operating times of the hydraulically-driven services are as follows:

Airbrakes:	out	— 20 seconds
	in	— 7 seconds
Slats:	out	— 5 seconds
	in	— 5 seconds
Flaps:	out	— 20 seconds
	in	— 20 seconds
Landing gear	down	— 60 seconds
Air-to-air refuelling probe (GRI):	out	— 15 seconds

Hydraulic Pressure and Contents Indication

12. Pressure is shown by a dual pressure indicator on the right instrument panel and by five accumulator pressure gauges in the aircraft skin (refer to Fig 3). Low pressure warning captions are on the CWP. System contents are indicated by lights on the refuelling panel.

13. *System Pressure Indication.* Readings on the duel pressure indicator (Fig 1) are controlled by the CONT — SERV hydraulic pressure selector switch. When CONT is selected, the pressure in each flying controls circuit is indicated. When SERV is selected the indicator shows the pressure in No 1 and No 2 general services supply circuit.

14. *Accumulator Pressure.* The five accumulator pressure gauges in the aircraft skin indicate:

a. No 1 and No 2 circuit accumulator pressure.

b. Nosewheel steering and anti-shimmy accumulator pressure.

c. Pressure maintaining valve accumulator pressure.

d. Wheelbrake accumulator pressure.

The pressures which the pilot should expect during his external inspection are given in the FRC.

15. *Low Pressure Indication.* A pressure switch in the output line of each EDP closes when pump output reduces to 106 bar and operates the attention-getter and lights the HYD 1 or HYD 2 caption on the CWP. If both systems have low pressure warnings, the audio warning also operates. Due to their location, the pressure switches are not sensitive to PTU output, neither does the No 2 circuit switch sense EHP pressure; thus, once a caption is on, it remains on until the associated EDP output is restored.

16. *Reservoir Contents.* Reservoir contents are indicated by lights on the refuelling panel in the right main landing gear bay (refer to Fig 3). A red light and a green light are provided for each circuit: when fluid in a reservoir is more than 4 litres the green light is on and if the level is less than 4 litres the red light is on. When the panel is closed, the lights go out.

Ground Pressure Supply

17. Each circuit can be pressurised separately on the ground via hose connections adjacent to the respective system accumulator pressure gauge. Two hand pumps, one for each power circuit, are located in No 1 and No 2 engine bays respectively and permit operation of the services on the ground without the use of a hydraulic ground rig.

NORMAL USE OR MANAGEMENT

External Checks

18. Check the pressure in the accumulators on the associated pressure gauges on each side of the fuselage.

Before Engine Start

19. Check that the dual hydraulic pressure gauge reads 0-0. Select the CONT/SERV switch to SERV. Ensure that the ELECTRO HYD PUMP switch is set to OFF and the BY PASS switches are set to AUTO.

Engine Starting

20. As No 1 engine accelerates through 42% RPM, check that No 1 circuit pressure rises to stabilise at approximately 206 bar, the No 2 circuit pressure reads 130 to 180 bar (PTU operating) and the HYD 1 caption on the CWP goes out. As the No 2 engine accelerates through 42% RPM check that the pressure in No 2 circuit rises to approximately 206 bar and that the HYD 2 caption on the CWP goes out. After starting, set the CONT/SERV switch to CONT and set No 1 BY PASS switch to ON: check that the associated circuit pressure reduces to 130 to 180 bar (PTU operating). Reset the No 1 circuit BY PASS switch to AUTO and check that pressure is restored to 206 bar. Repeat for other circuit. Return the CONT/SERV switch to SERV and leave at this setting throughout the flight unless a specific check of controls pressure is required. Set the EHP switch to AUTO and check that its light is out.

In Flight

21. During flight periodically check that the hydraulic pressures are satisfactory.

Landing

22. Before and after landing check that the hydraulic pressure in each circuit is 206 bar.

During Engine Shut-Down

23. Set the ELECTRO HYD PUMP switch to OFF. When the engines are shut down, as the RPM of each engine falls below 42%, check that the associated HYD caption on the CWP comes on. Check that when the second HYD caption on the CWP comes on, it is accompanied by an audio warning.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

24. Indications and actions relating to system malfunctions are listed in Table 3.

WARNING: A BY PASS switch must not be set to ON following a hydraulic failure caused by either a leak or a failed pump, because the system is then pressurised by the PTU, and the risk of fire or system contamination is increased. A contaminated hydraulic system can lead to flying control failures.

Table 3 — Malfunctioning or Use in Abnormal Conditions

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
No 1 SERVICES LOW PRESSURE			
Loss of HYD 1 services pressure on gauge	Set CONT/SERV switch to CONT and check controls pressure 206 bar	Reset CONT/SERV switch to SERV and monitor No 2 circuit pressure. Land as soon as possible	Cause may be leak in No 1 services circuit. Services lost are as in Table 2. All No 1 circuit may be eventually lost through leakage
No 1 EDP OUTPUT FAILURE			
Attention-getter flashes, HYD 1 caption on CWP	Cancel attention-getter. Set BY PASS switch to OFF	Check HYD 1 caption: if out, no further action	Pressure will rise to 206 bar. All controls and services available. Warning caused by tacho-gen or bypass valve failure with BY PASS switch to AUTO

continued

Table 3—*continued*

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
No 1 EDP Output Failure—*continued*		If HYD 1 caption remains, set CONT/ SERV switch to CONT. If pressure zero, hydraulic failure is confirmed. Set the associated BYPASS switch to AUTO. Land as soon as possible. Avoid unnecessary use of reheat (fire risk)	Flying controls operated by one actuator. All No 1 controls and services lost (see Table 2). If fuel reserve is sufficient, lower 20° flap and landing gear
No 2 SERVICES LOW PRESSURE			
Loss of HYD 2 services pressure on gauge	Set CONT/SERV switch to CONT and check controls pressure 206 bar	Reset CONT/SERV switch to SERVE and monitor No 1 circuit pressure. Land as soon as possible	Cause may be leak in No 2 services circuit. Services lost are as in Table 2. Emergency braking and parking available while brake accumulator lasts. All No 2 system may eventually be lost through leakage
No 2 EDP OUTPUT FAILURE			
Attention-getter flashes, HYD 2 caption on CWP	Cancel attention-getter. Select BY PASS switch to OFF	Check HYD 2 caption: if out, no further action	Pressure will rise to 206 bar. All controls and services available. Warning caused by tacho-gen or bypass valve failure with BY PASS switch to AUTO
		If HYD 2 caption remains, set CONT/SERV switch to CONT. If pressure zero, hydraulic failure is confirmed Fly at reduced speed and monitor No 1 circuit pressure. Land as soon as possible Avoid unnecessary use of reheat (fire risk)	Flying controls operated by one actuator. All No 2 circuit controls and services lost except emergency braking and parking while brake accumulator lasts (see Table 2). If fuel reserve is sufficient, lower 20° flap and landing gear

continued

Table 3—*continued*

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
No 1 & No 2 EDP OUTPUT FAILURE			
Attention-getter flashes, accompanied by audio alarm. HYD 1 and HYD 2 caption on CWP	Cancel alarms. Set EHP switch to ON. ◀Minimise use of controls. Set both BY PASS switches to OFF▶	◀Set CONT/SERV switch to CONT. If normal pressure is regained in either HYD 1 or HYD 2 system, land as soon as possible. If normal pressure is not regained, confirm HYD 2 pressure is 160 bar (EHP operating)▶ and land as soon as possible on longest runway available: use brake parachute. Use arrester hook if necessary	The following controls and services are available but at a reduced rate: tailplane, spoilers, rudder, pitch and roll autostabs, airbrakes, flaps, slats, emergency landing gear lowering, emergency wheelbrakes and parking and emergency probe extension (GR1). Nosewheel steering is not available. The maximum recommended running time for the EHP is 30 minutes

PART 1

CHAPTER 6 — FLIGHT CONTROLS AND PILOTING AIDS

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General

1. The primary flight control surfaces, fully power-operated and with no manual reversion capability, comprise a conventional rudder, an all-moving tail-plane, and spoilers outboard on each wing upper surface. The control column and rudder pedals are conventional.

2. The two tailplane sections, having no direct mechanical interconnection, operate independently. In addition to their principal functions, they also move differentially to augment rolling performance at low airspeeds.

3. Routed via the fuselage spine, control column and rudder pedal movement is transmitted by rod

and bellcrank to powered flying control units (PFCU); each flight control surface being operated by an individual unit. The power source is the aircraft hydraulic system.

4. Artificial feel is incorporated: simple spring feel in roll and yaw; 'q' feel in pitch. Longitudinal, lateral, and directional trimming facilities are provided, as well as autostabilisation about all three axes.

5. Except for the 115 V AC supply to the autostabilisers taken from No 1 and No 2 AC busbar, all the remaining electrically operated components of the system derive power from the 28 V DC emergency busbar.

6. Air data employed in the autostab and 'q' feel systems is obtained from the pitot/static system (refer to Chapter 9).

CONTROLS AND INDICATORS

7. Details concerning the controls and indicators shown on Fig 1 and 2 are listed in Table 1.

Table 1 — Flight Controls — Controls and Indicators

Item No	*Item*	*Location*	*Markings*	*Remarks*
1	Tailplane differential master switch	Left instrument panel	DIFF T/P—MAX/NORMAL/EMERGY	Guarded in NORMAL
2	Tailplane maximum differential light	Left instrument panel	DIFF T/P SPIN REC	Blue light (P to T)
3	Ajax artificial feel master switch	Left instrument panel	AJAX—RESET/AUTO/EMERGY	Normally in AUTO and guarded for flight. Spring-loaded from RESET
4	Attention-getter	Right coaming	ALARM	Flashes red if DIFF, STAB or AJAX warnings are triggered
5	Tailplane diff, yaw autostab and Ajax failure warning	On CWP	DIFF, STAB, AJAX	DIFF — red STAB — amber AJAX — amber
6	Ajax feel circuit breaker	Right console	AJAX	5A
7	Rudder pedal adjuster	Lower centre panel	—	A handle. Adjusts both pedals for leg length; clockwise to shorten. Remove foot load before adjusting
8	Rudder gearing master switch and indicator	Left instrument panel	RUDDER SENS—HI/AUTO/LO	Normally in AUTO and guarded

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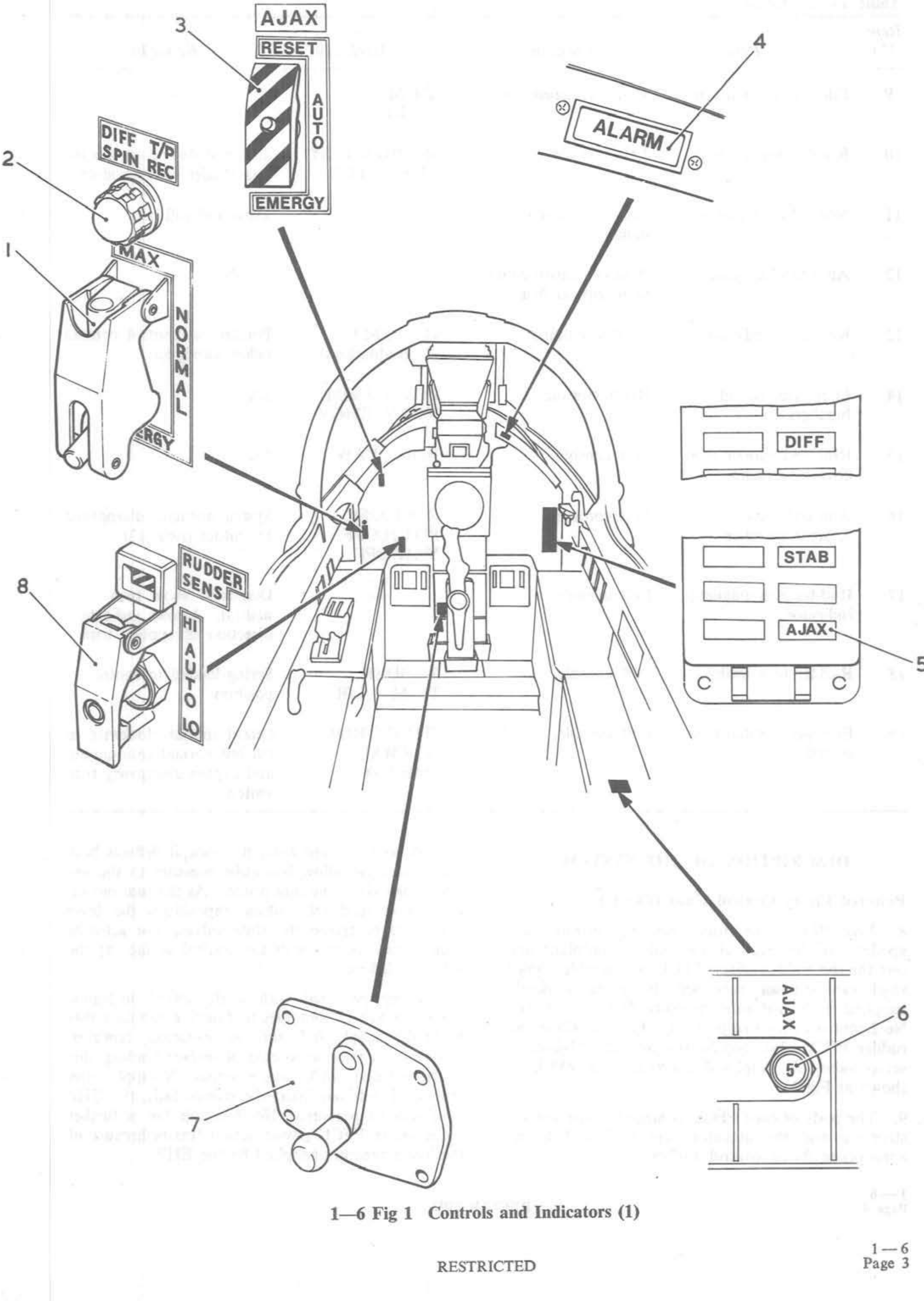


1—6 Fig 1 Controls and Indicators (1)

Table 1 — *continued*

Item No	*Item*	*Location*	*Markings*	*Remarks*
9	Pitch trim indicator	Left instrument panel	TRIM 5-0-5-10	—
10	Rudder test switch	Left console	RUDDER TEST LEFT/RIGHT	Lift and deflect switch to test rudder compensation
11	Normal trim button	Control column handgrip	—	Pitch and roll trim
12	Autostabiliser cutout	Base of control column handgrip, at front	—	—
13	Roll trim indicator	Control column	18-10-10-18 (2° graduations)	Pointer on control column below handgrip
14	Pitch trim circuit breakers	Right console	PITCH TRIM— NORM, EMGY	5A
15	Roll and rudder trim circuit breakers	Left console	ROLL, YAW	5A
16	Autostabilisation selector switches	Left console	ROLL/OFF, PITCH/OFF, YAW/OFF	System normally disengaged by cutout (item 12)
17	Rudder trim magnetic indicator	Left console	—	Diagonals show trim neutral. Arrows indicate direction of applied trim
18	Rudder trim switch	Left console	RUDDER TRIM — L/R	Spring-loaded to centre position
19	Emergency pitch trim switch	Left console	PITCH TRIM— NORMAL / EMERGY	Guard rotates clockwise to cut out normal trim circuit and expose emergency trim switch

DESCRIPTION OF THE SYSTEM

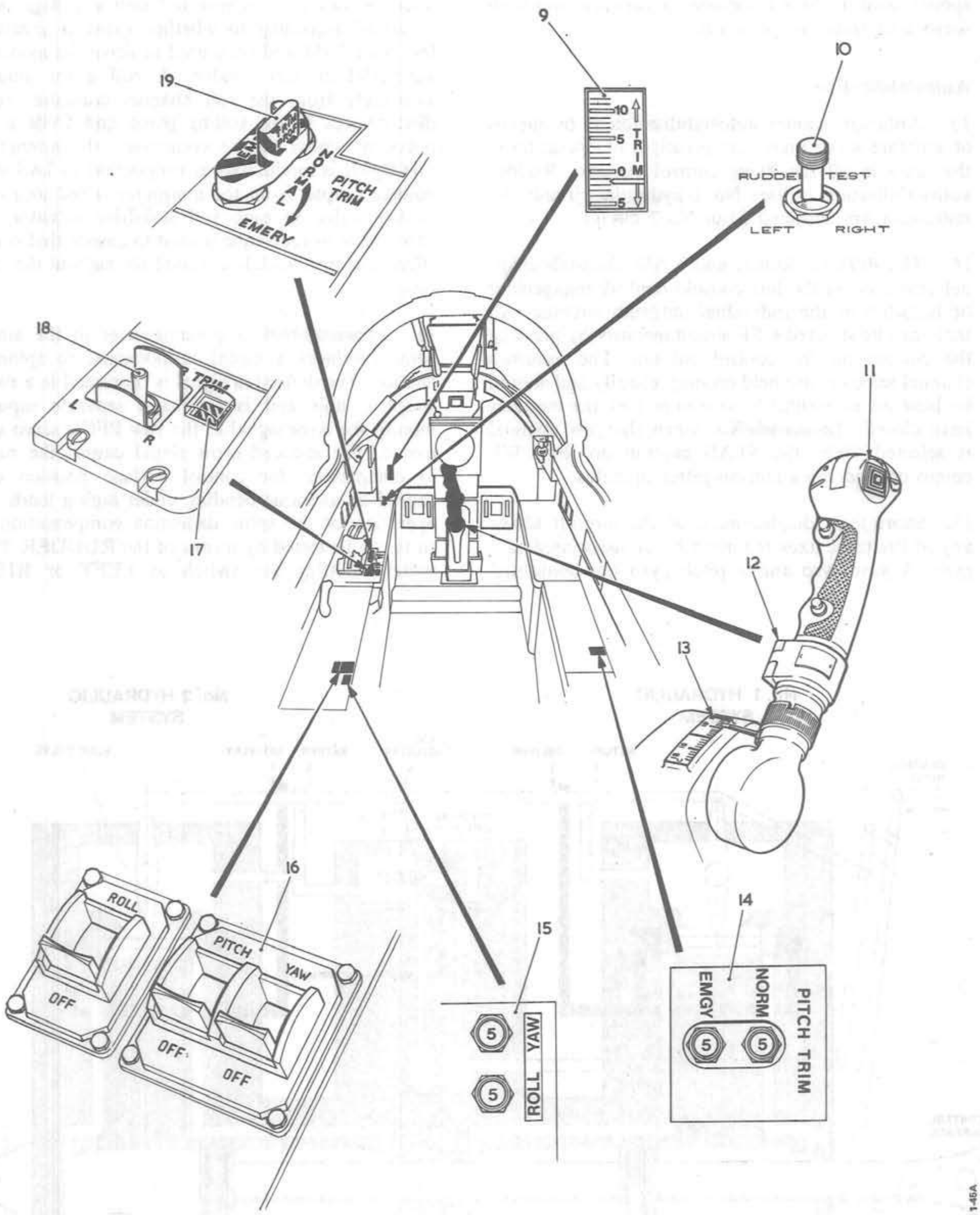
Powered Flying Control Units (PFCU)

8. Five PFCU are fitted; one to operate each spoiler, one for each element of the tailplane and one for the rudder. Each PFCU is a double-bodied single-ram actuator, each body being independently supplied with hydraulic pressure from No 1 and No 2 controls circuit respectively. Each tailplane and rudder PFCU also incorporates an autostabilisation servo valve. A simplified diagram of a PFCU is shown at Fig 3.

9. The body of each PFCU is hinged to the aircraft structure and the actuator ram is linked to its appropriate flying control surface.

10. A control input from the cockpit deflects both slide valves to allow hydraulic pressure to the appropriate side of the ram pistons. As the ram moves, a position feedback linkage repositions the lever system to centralise the slide valves. The actuator then comes to rest with the control surface at the selected deflection.

11. Being provided with a duplicated hydraulic supply, a PFCU continues to function should either hydraulic supply fail; rate of operation, however, may vary in relation to control surface loading, due to the reduced PFCU power output. If supply from both engine-driven hydraulic pumps fails, the EHP continues to pressurise No 2 circuit but a further reduction in PFCU power output occurs because of the lower pressure supplied by the EHP.



1—6 Fig 2 Controls and Indicators (2)

12. Each tailplane PFCU and the rudder PFCU incorporates an autostabilisation servo valve. Each spoiler control circuit includes a separate autostab servo unit (refer to para 13).

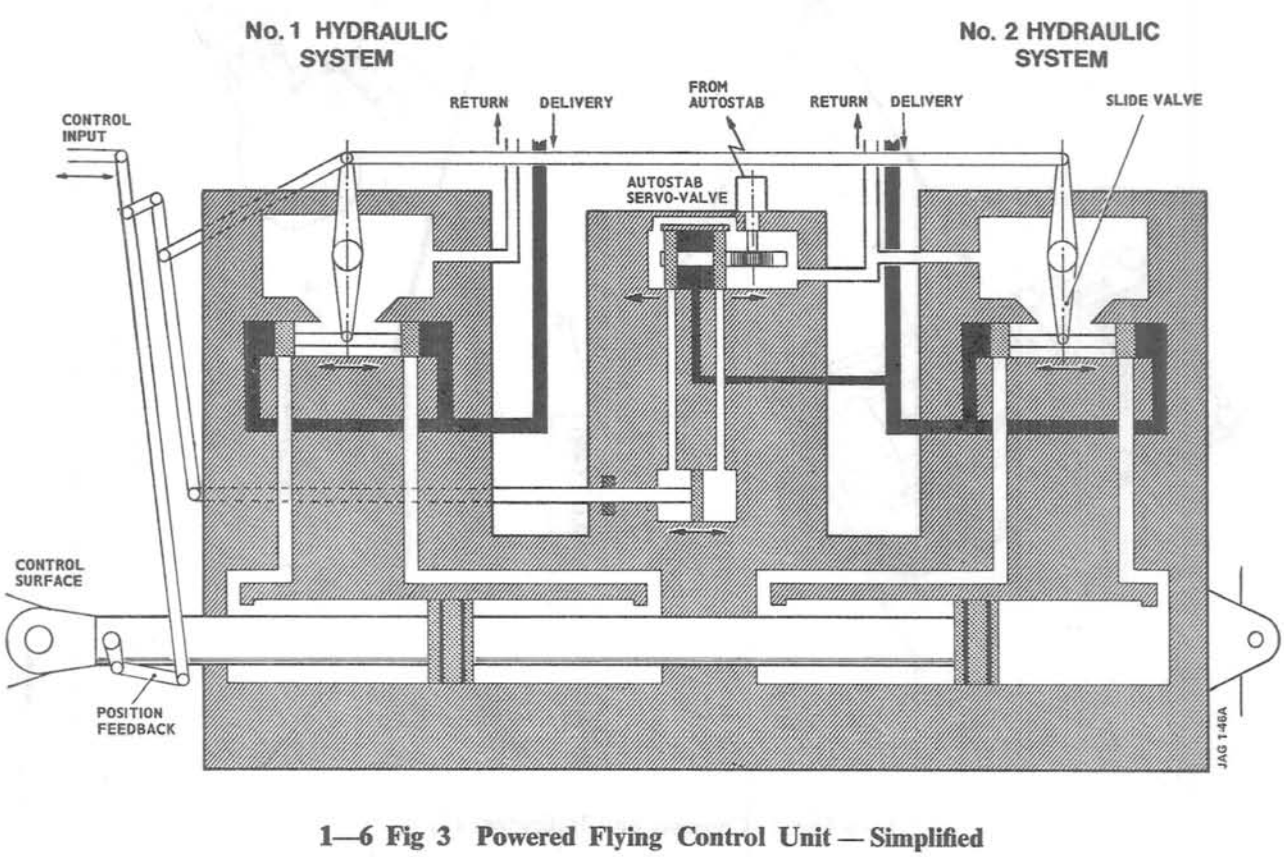
Autostabilisation

13. Although spoiler autostabilisation is by means of separate servo units, the principle of operation is the same in all the flying control circuits. Rudder autostabilisation utilises No 1 hydraulic circuit; the remainder are supplied from No 2 circuit.

14. The PITCH, ROLL and YAW autostab channel selectors on the left console control engagement or isolation of the individual autostab circuits. All three can be selected OFF simultaneously by pressing the cut-out on the control column. The autostab channel selectors are held on magnetically and should be held on momentarily to ensure that the contacts AL2 have closed. ~~Post-mod 703~~, when the yaw channel is selected OFF, the STAB caption on the CWP comes on and the attention-getter operates.

15. Short term displacement of the aircraft about any of the three axes is sensed by an associated rate gyro. A yaw gyro and a pitch gyro are contained within a pitch-yaw computer unit which also receives pitot-static inputs. A displacement signal from a pitch or yaw gyro is resolved into a voltage which is varied according to whether speed is greater or less than 0·9M and then used to drive the associated autostabiliser servo valve. A roll gyro, mounted separately from the roll channel computer senses disturbances in the rolling plane and feeds a proportional signal to the computer: the strength of this signal is modulated in proportion to IAS and a voltage output from the computer is fed to a servo control valve in each roll stabiliser actuator. The speed term in each case is used to ensure that control effect is approximately constant throughout the speed range.

16. ~~Post-mod 703~~, a potentiometer in the aircraft spine produces a signal proportional to spine deflection. The deflection signal is processed in a rudder coupling unit and is fed as a separate input to modify the error signal to the yaw PFCU servo valve motor. The induced error signal causes the rudder to compensate for control surface position error caused by airframe bending under high g loads. The operation of the spine deflection compensation circuits can be tested by means of the RUDDER TEST switch. Setting the switch to LEFT or RIGHT AL2.



1—6 Fig 3 Powered Flying Control Unit — Simplified applies a false deflection signal to the rudder coupling unit which causes the rudder to compensate by moving a small amount in the appropriate direction.

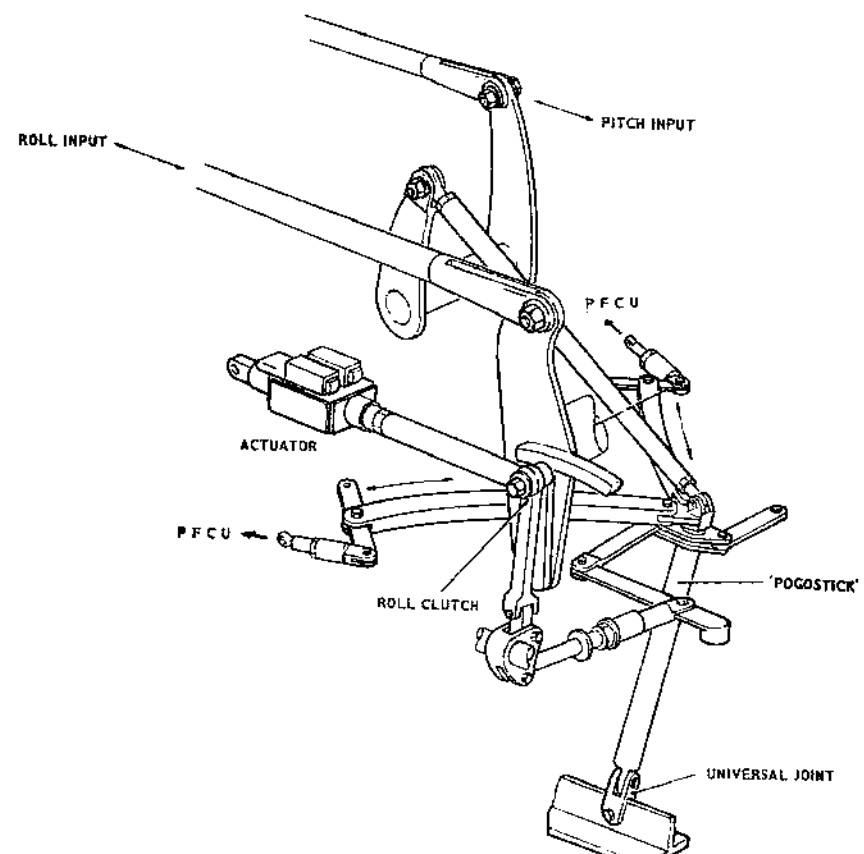
17. Post-mod 803, the rudder coupling unit is modified to include spoiler/rudder coupling. A spoiler position signal is fed to the rudder coupling unit and is amplified as a function of incidence. The incidence signal (high incidence - high signal) is then summed in the coupling unit with the spine deflection signal to modify the rudder coupling unit output to the yaw error circuit. An accelerometer inhibits the incidence signal at accelerations less than +3 g.

Tailplane Operation

18. Pitch and roll inputs (excluding roll input to the spoilers) from the control column terminate between the two tailplane elements at a single mechanical component of a linkage assembly (Fig 4). This component, called the 'pogostick', is an upright tubular lever, hinged at its base by a universal joint. Pitch input is linked direct to the top of the 'pogostick'; roll input is linked via a differential gearing mechanism (para 30) to a rotatable collar immediately below. As a result, the 'pogostick' moves in unison with the control column. If the controls are 'stirred', the 'pogostick' follows. From the top of the 'pogostick', a geometrically arranged lever system transmits the movement individually to each tailplane PFCU.

Pitch Control

19. Full fore-and-aft travel of the control column corresponds to travel of both tailplane elements of



1—6 Fig 4 Tailplane Control Mechanism

6 degrees (aircraft nose-down) to 25 degrees (aircraft nose-up). Driven by its individual PFCU, each element moves simultaneously through the same degree of travel and in the same sense, provided there is no roll input. The non-linear gear shown on Fig 5 increases control column pitch deflection with respect to tailplane movement for small angles of deflection, and improves flying control accuracy about the neutral position.

Pitch Feel

20. Pitch feel is generated by Ajax which is a 'q' feel simulator. The Ajax unit includes an input lever linked to the control run and incorporating a twin-profile cam moving against a roller which is held against the cam profile by a spring-loaded lever. The lever arm available to overcome the tension of the spring is varied by an electrically-operated actuator which extends or retracts in response to signals from a computer which is fed airspeed and altitude data. At low airspeed, the computer output is such that the lever arm is long and control forces are low. To avoid very light control forces, the Ajax actuator is prevented from following the aircraft speed below 300 knots in the AUTO mode. As airspeed increases, the lever arm is reduced and control forces rise. ◀ Above 450 knots (590 knots pre-mod 787), control ▶ force is maintained at a computed constant.

21. The actuator is dual-motored: normal and emergency. With electrical power on, the normal motor runs continuously, and its drive is connected to the actuator by means of two clutches: one for extension, one for retraction. The clutches are engaged by the computer. The emergency motor is independently controlled (para 23). The dashpot (Fig 5) is a 'q' sensitive viscous damper which serves to oppose rapid movement of the stick, damping being appropriate to airspeed. Dashpot heating is thermostatically controlled, and is powered by the pitot heaters circuit.

22. The Ajax computer has two channels; control and monitoring. Airspeed and altitude data are supplied to both channels by a pressure capsule unit; additionally, position feedback is transmitted from the Ajax actuator to the computer. Pitot/static data is processed by the control channel to provide the output to the normal motor clutches while, simultaneously, a comparison is made between the monitoring channel output, the control channel output, and actuator feedback. If a difference is detected which exceeds a predetermined value, a failure detector should trigger the attention-getter and the AJAX (amber) warning on the CWP. However, due to adverse manufacturing tolerances, and pending modification, the failure detector can under some circumstances fail to trigger the warning.

23. The AJAX switch is normally in AUTO and the actuator clutches are controlled by the computer. At RESET, the failure detector is reset and cancels the AJAX caption on the CWP if a malfuction was temporary or a warning spurious. With the switch in EMERGY, the circuits to both the computer and normal motor are de-energised, and the emergency motor, reversible and clutchless, is powered direct from No 2 busbar to position the actuator at a point where the feel remains at and is appropriate to a constant airspeed, irrespective of aircraft speed. Except when the aircraft is required for flight, the AJAX switch is left at EMERGY to prevent unnecessary wear on the normal motor.

Pitch Trim

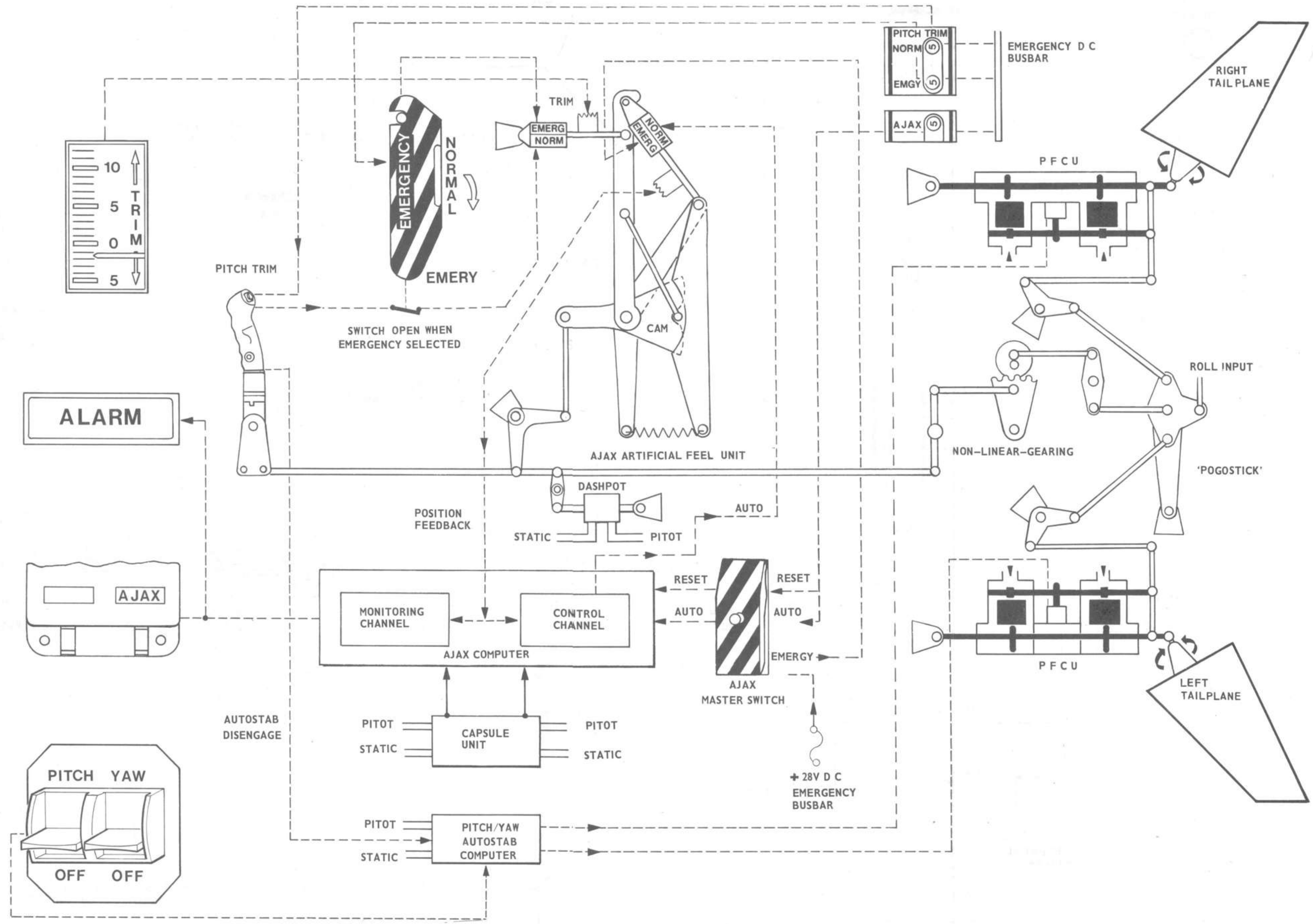
24. The aircraft is trimmed longitudinally by adjusting the datum of the Ajax mechanism.

25. The trim actuator is operated by either of two reversible motors: normal or emergency. The two circuits are separately powered via circuit breakers on the right console. The normal pitch trim motor is controlled by the conventional thumbswitch on the control column handgrip; the emergency motor by the guarded PITCH TRIM switch on the left console. Rotating the guard from NORMAL to EMERGY in order to operate the switch and, thereby, the emergency circuit, isolates the normal circuit. The degree of trim set is shown by the indicator on the left instrument panel. Maximum tailplane trimming is 4 degrees nose-down and 11 degrees nose-up. In the event of a trim runaway with the thumbswitch neutral, trimming in the opposite direction freezes the trim position.

26. When the airbrakes and/or spoilers cycle, a position signal is fed to the autostabiliser computer to counteract automatically the change in longitudinal trim due to the movement of these surfaces. With autostab disengaged, the trim change must be manually counteracted.

Roll Control

27. The single roll control run from the cockpit divides in mid-fuselage as shown on Fig 6. One run is routed to a 'crab' unit to control the spoilers (maximum deflection 45°), the other via a tailplane differential mechanism produces differential deflection of the tailplane. Below 200 knots, lateral control of the aircraft is effected by spoiler deflection plus differential deflection of the tailplane elements up to plus and minus six degrees (zero pitch input). The differential tailplane component of roll control reduces as speed increases until, above 450 knots, it has reduced to zero (see para 34).



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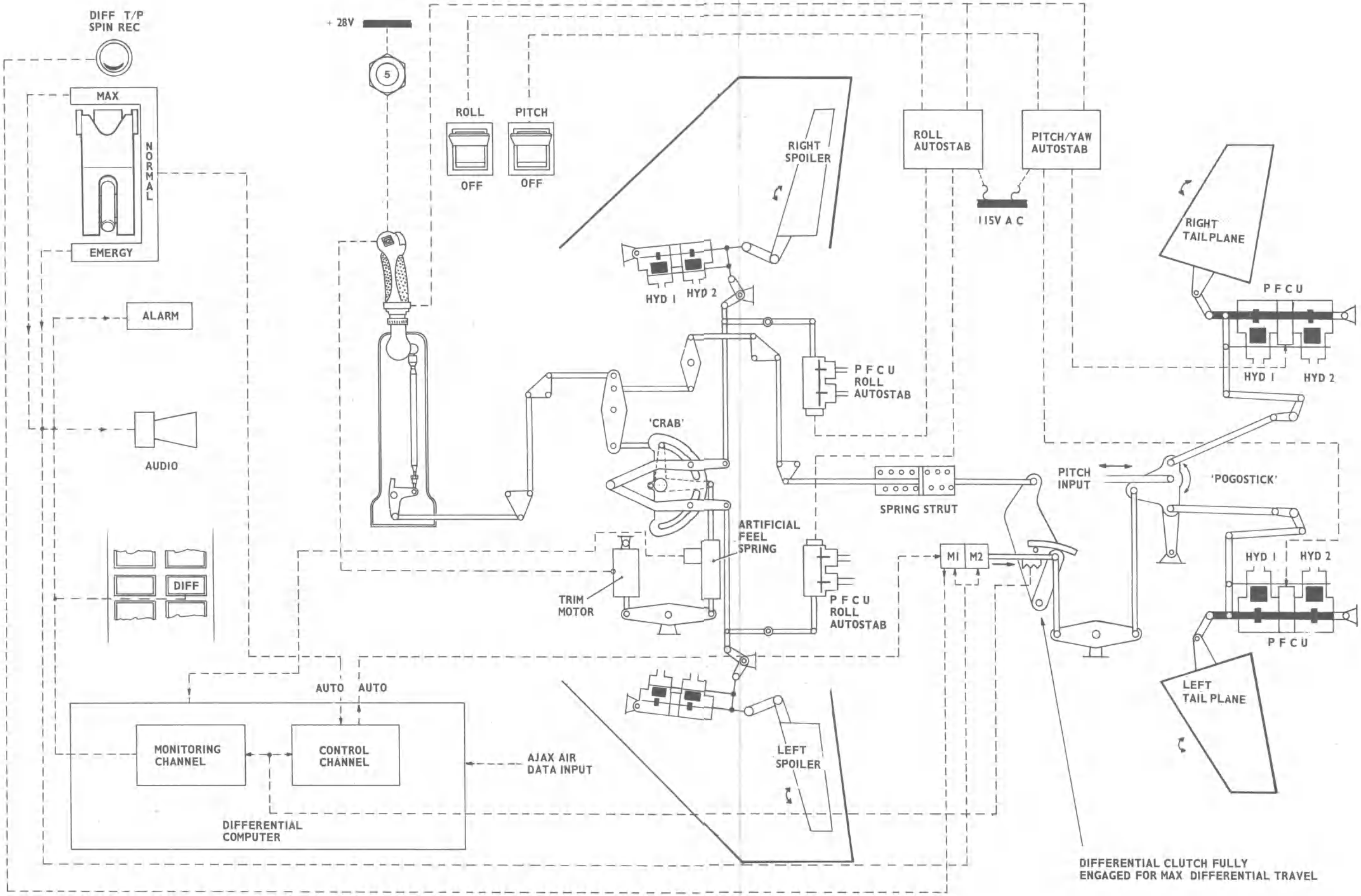
1—6 Fig 5 Pitch Control



1—6 Fig 6 Roll Control

28. *Spoilers.* From the initial separation in mid-fuselage, the spoiler control run further separates at a mechanical device called the 'crab', where the control run forks to the respective spoiler PFCU. A roller on each lever of the fork runs within an internal slot in the 'crab' unit; each slot has a double curvature, one concentric, one eccentric to the unit pivot. As the 'crab' unit is rotated, the action of the rollers in the slots is such that one lever moves while the other remains stationary. Thus, only one spoiler (of the down-going wing) extends.

Spoiler Feel and Trim

29. Lateral feel is provided by an artificial feel spring connected to the rotating assembly of the 'crab'. At its opposite end, this spring rod is linked to the ram of the electrically-operated spoiler trim actuator. The actuator circuits are controlled by the thumbswitch on the control column handgrip. The actuator moves the feel spring rod bodily, thereby adjusting the neutral position of the 'crab'; resulting movement of the roll control linkage deflects the control column laterally, partially extends one spoiler and, depending on the position of the tail-plane scissors (a function of airspeed) may also apply some differential tailplane. At its maximum travel, switches automatically de-energise the trim actuator motor. The circuit is powered via a circuit breaker on the left console. A mechanical indicator is provided at the base of the control column hand-grip, travel being 22½ degrees either way.

Differential Tailplane Operation

30. The differential movement of the tailplane elements, used to supplement the rolling force of the spoilers below 450 knots, is produced by moving the 'pogostick' laterally to produce contrary selections between the tailplane PFC units.

31. From the mid-fuselage point where the roll control run separates, input to the differential tail-plane control circuit is via a spring strut which permits continued spoiler selections even if the differential tailplane circuit is jammed or at the limit of permitted deflection due, for instance, to a large pitch input. A rod from the spring strut connects to the tailplane differential clutch.

32. As shown diagramatically on Fig 6, roll input from the control column is applied to one arm of a pivoted crank; a gain rod is hinged to the other arm of the crank. The other end of the gain rod is linked to an output rod and the ram of an electrically-operated actuator. When the actuator is fully retracted, the pin connecting the actuator with the gain rod is concentric with the crank torque tube and roll input is not transmitted to the 'pogostick'. As the actuator extends progressively, greater differential tailplane is applied for a given input.

Tailplane Differential Control

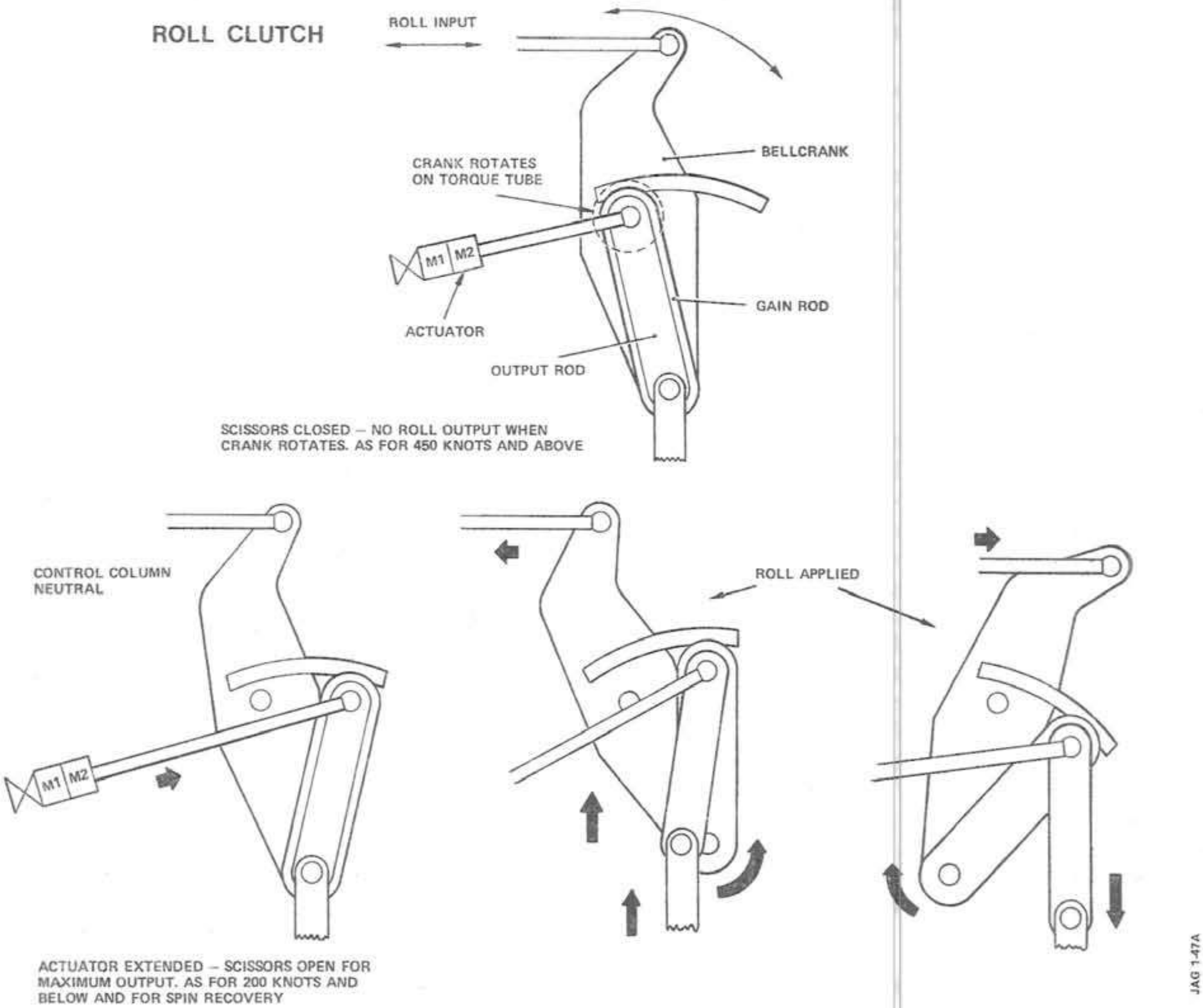
33. The actuator incorporates two motors M1 and M2. The mode of operation is controlled by the DIFF T/P — NORMAL/EMERGY/MAX switch. The switch is guarded away from MAX; movement of the switch between NORMAL and EMERGY is by moving only the switch toggle, leaving the guard lowered. When the guard is raised, the switch is automatically set to MAX.

34. *Switch to NORMAL.* Automatic control of the differential tailplane gearing is by a differential computer having two channels, control and monitoring, both of which receive airspeed signals from the Ajax computer, and feedback signals from a gain rod position potentiometer. The control channel drives the M1 motor to position the gain rod such that differential tailplane movement reflects the airspeed signal. Below 200 knots, maximum gain and therefore maximum differential tailplane is obtained. Above 200 knots, the actuator progressively retracts until, when airspeed reaches 450 knots (and above) the actuator is fully retracted to reduce gain to zero and no differential tailplane movement occurs. The monitoring channel of the differential computer continuously compares Ajax airspeed signals with gain rod position and if the resultant signal exceeds a certain value, the monitoring channel disengages the control channel, isolates M1 and triggers the audio alarm, attention-getter and the red DIFF caption on the CWP. The failure signal is latched on and the system remains in the failed state, even if the monitoring channel returns within tolerance, until reset by setting the control switch to EMERGY.

Note: The DIFF caption may appear as a result of an Ajax failure and may or may not be accompanied by an amber AJAX caption on the CWP. If the AJAX warning is present, the Ajax system must be reset first.

35. *Switch to EMERGY.* Motors M1 and M2 are both energised to retract the actuator fully. This gives roll response equivalent to that required for high speed flight. Adequate response is available for lower speeds except when carrying on asymmetric store or in severe turbulence/slipstream. This setting also allows resetting of the monitoring channel if a transient fault occurs: the switch must be held at EMERGY for at least 3 seconds.

36. *Switch to MAX.* Motors M1 and M2 are both energised to extend the actuator fully (blue DIFF T/P SPIN REC light on). The DIFF caption may also come on. This setting is appropriate for landing



1—6 Fig 7 Differential Tailplane Gearing

following a DIFF warning, or for prolonged flight at airspeeds below 200 knots. MAX should not be selected above this speed because the increased roll response may cause handling difficulties or may strain the aircraft.

Rudder Control

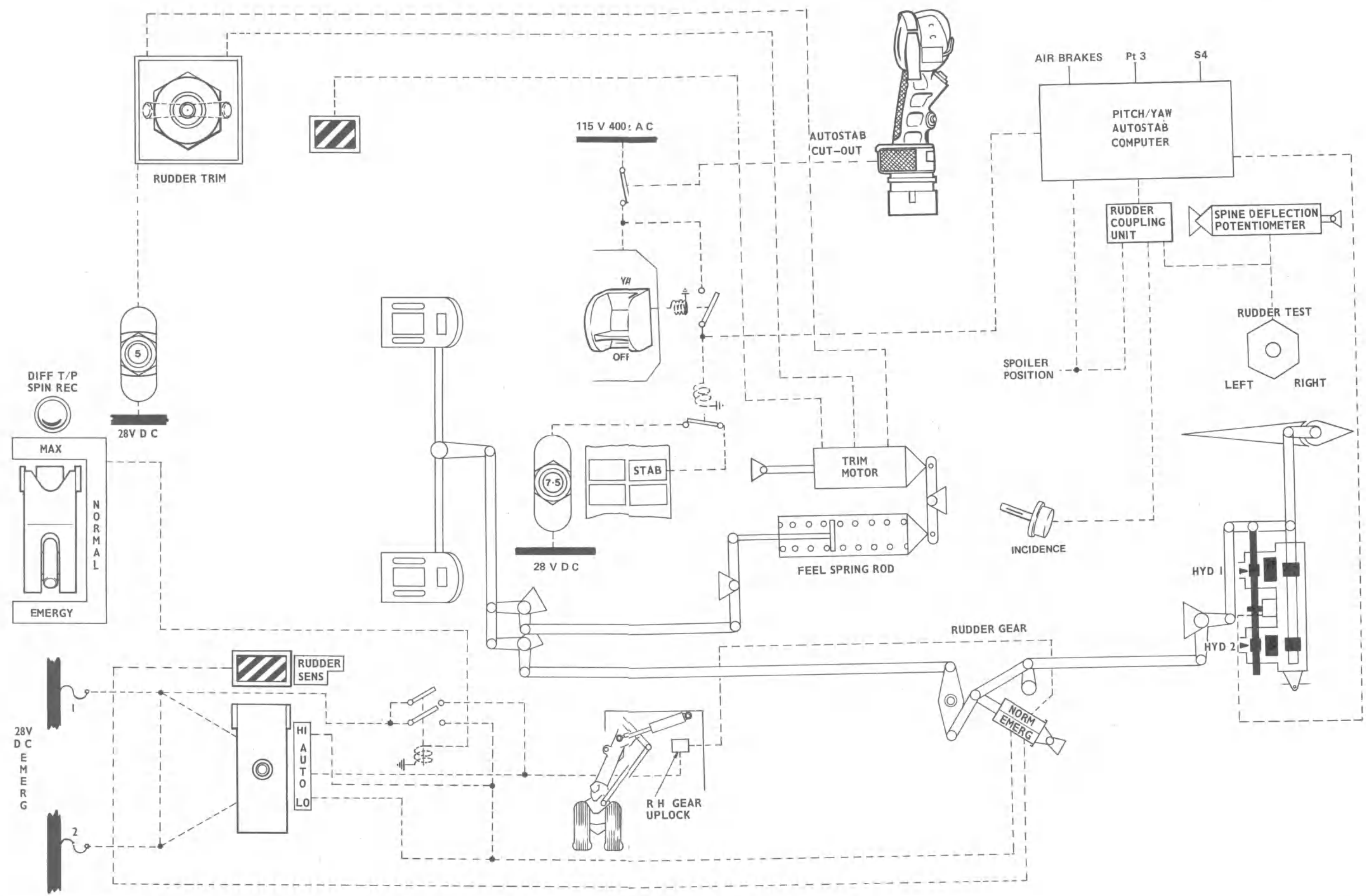
37. In a manner similar to the other control surfaces, the rudder is operated by a rod-and-bellcrank control run which terminates at a PFCU. The circuit is shown on Fig 8. Maximum rudder travel is approximately ±21 degrees. Artificial feel and trim are similar to that of the spoiler system: having a spring rod connected at one end to the control run and, at the other, to an actuator. The actuator moves the spring rod bodily to a desired datum; maximum rudder trim travel is ±10½ degrees.

38. The trim actuator in this instance has a single reversible motor, powered via a circuit breaker on the left console, and controlled by the RUDDER TRIM — L/off/R switch. An adjacent magnetic indicator shows the direction of trim applied.

Rudder Gearing

39. Rudder gearing is provided to improve manoeuvring precision at high airspeeds and to avoid the loads imposed by uncontrolled travels during turbulent air penetration. The installation provides two operating sensitivities: high range, used at low airspeeds and utilising full travel of the rudder; and low range, used at all airspeeds above those of take-off and landing, which gears down maximum rudder travel to ±7 degrees with a trim travel of ±3 degrees. There are no intermediate rudder gearing settings. Full travel of the rudder pedals remains unchanged.

40. Selection of rudder gearing is controlled by the RUDDER SENS — HI/AUTO/LO master switch. Above the switch, a magnetic indicator shows a



1—6 Fig 8 Rudder Control

small triangle (low range) and a large triangle (high range), with black and white diagonals when power is off or when the gear is changing. The actuator has two motors: normal and emergency.

41. With the switch in AUTO and the landing gear down, the system is in high range (full rudder travel). When the landing gear retracts, the normal motor is energised via the right uplock microswitch and the system automatically changes to low range (± 7 degrees of rudder travel). The normal motor reverts the system to high range when the landing gear is extended. With either HI or LO selected, the normal motor is inoperative and the emergency motor is used to operate the actuator to give the selected gear.

42. If the DIFF T/P switch is moved to MAX, both motors of the rudder sensitivity system are automatically energised to drive the actuator to high range (full rudder available), irrespective of the RUDDER SENS switch position.

NORMAL USE OR MANAGEMENT

Before Engine Start

43. Before strapping in, adjust the rudder pedal reach as required.

44. Confirm the circuit breakers AJAX, YAW, ROLL and PITCH TRIM (NORM and EMGY) are set. Set the autostabiliser switches ON, operate the cut-out (STAB caption on), then reselect the switches ON. Check that the pitch emergency trim switch guard is at NORMAL.

45. When electrical power is connected, check that the RUDDER SENS indication changes from diagonals to a large or small triangle according to the setting of the switch. Check the RUDDER SENS switch is to AUTO and guarded; the large triangle (high range) should be visible.

46. Confirm the DIFF T/P SPIN REC switch is to NORMAL and guarded. Press-to-test the blue light.

47. Set the AJAX switch to RESET, hold for 3 to 4 seconds, then select AUTO and close the guard. Ensure the AJAX warning is out. The switch will usually be found in EMERGY, having been used to isolate the normal motor during a protracted period with external power applied.

After Engine Start

48. *Trim Controls*

a. Operate the rudder trim over the full range, checking for switch centring and direction arrows on the indicator (either side of the neutral diagonals). Leave the trim at neutral.

b. Using the normal trim thumbswitch, operate the pitch trim over the full range 4 degrees nose-down to 11 degrees nose-up, checking corresponding movement on the indicator. While guarded, operate the pitch emergency trim switch and confirm the circuit is dead. Rotate the switch guard to EMERGY and check the pitch emergency trim circuit by operating the emergency switch both ways. Check that the normal thumbswitch control is ineffective. Close the guard and, using the thumbswitch, set the trim as required (GR 1: 0°, T 2: 2° nose-up).

c. Using the normal trim thumbswitch, operate the roll trim over the full range. Check spoiler travel reaches 22½ degrees either side.

49. *Primary Controls.* Operate the primary controls over their full range of travel, checking for freedom of movement, normal forces, and self-centring.

50. *Tail Unit Auxiliary Controls.* The functional tests of Ajax, rudder sensitivity, and tailplane differential are closely related; therefore, the procedures are grouped accordingly and, where possible, combined to reduce the extent of the check. The control checks in sub-para a. and b. below need only be carried out on air tests. For a normal flight, it is sufficient to check that all controls are set to AUTO and then to carry out a functional check of spoiler, tailplane and rudder in conjunction with the groundcrew.

a. Raise the guard on the AJAX switch and select EMERGY. Ensure that the attention-getter flashes and that the amber AJAX warning on the CWP is lit. Check the pitch controls for full and free movement and ensure that the force required has increased. Select RESET (hold for 3 to 4 seconds), then AUTO and close the guard. Ensure that the AJAX warning is extinguished. Recheck the controls and confirm that the force required has returned to normal.

b. Select LO on the RUDDER SENS switch. Ensure that diagonals followed by the small triangle show on the indicator. Operate the rudder over the full range. Operate the rudder trim over the full range and return to neutral. With LO still selected, select MAX on the DIFF T/P switch (when the switch-guard is raised it carries the switch to MAX). Ensure that the DIFF T/P blue light comes on, that the attention-getter flashes, that the red DIFF warning on the CWP is lit, and that the RUDDER SENS indication changes to the large triangle. Return the RUDDER SENS switch to AUTO and move the DIFF

T/P switch to EMERGY. Ensure that the DIFF T/P blue light is extinguished, that the DIFF warning remains lit (the warning may flicker), and that the RUDDER SENS indicator continues to show the large triangle. Cancel the attention-getter, then operate the roll control over the full range. Check that there is no roll deflection of the tailplane. Return the DIFF T/P switch to NORMAL. Ensure that the DIFF warning goes out and that full tailplane differential has returned.

Note: To guard the switch in NORMAL, MAX must first be selected: the guard then closes round the switch and moves it to NORMAL. If the switch is in NORMAL first, closing the guard moves it to EMERGY.

51. *Autostabilisers.* If required, confirm all control surfaces respond to aircraft rocking. Post-mod 703, operate the RUDDER TEST switch to LEFT and RIGHT in turn and confirm with the groundcrew that the rudder moves with each selection. Leave the switch in the central (locked) position.

Before Take-Off Checks

52. Check rudder trim and roll trim at neutral and pitch trim set as required.

53. Check autostabs engaged in all three axes (STAB caption out). Confirm that the DIFF T/P switch is guarded with the toggle in NORMAL, and that the AJAX and RUDDER SENS switches are both in AUTO and guarded, with the RUDDER SENS indicator showing a large triangle.

After Take-Off Checks

54. When the landing gear locks up, check that the RUDDER SENS indicator shows a small triangle (low range).

During Flight

55. Under normal flight conditions, there should be no need to operate any control switches other than those of the trims. However, if training procedures require AJAX, DIFF T/P or RUDDER SENS to be operated, the correct flight conditions for doing so must prevail and, subsequently, a specific check must be made for normal switch selections before departing on other exercises.

Note 1: Under normal circumstances MAX DIFF T/P must not be selected above 200 knots; otherwise lateral oversensitivity will result, and full lateral stick movement will produce excessive roll rates.

Note 2: Rudder HI range must not be selected above 300 knots.

Landing and Shut-Down Checks

56. When the landing gear extends, check that the RUDDER SENS indicator shows the large triangle. After landing, set the AJAX switch to EMERGY to isolate the normal motor. On shut-down, confirm that the autostab switches have moved to OFF.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

57. Indications and actions relating to system malfunction are listed in Table 2 overleaf. Autostabiliser failures are covered in Part 3.

Table 2 — Flight Control System Malfunctions

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
DASHPOT FAILURE			
Stick forces inappropriate to rate of stick movement	Reduce airspeed, carry out low speed handling check	Use pitch trim to aid control on the approach	Break-out forces may be greater as airspeed reduces
DIFF TAILPLANE MALFUNCTION			
Audio alarms. Attention-getter flashes. DIFF caption on CWP	Cancel warning. DIFF T/P switch to EMERGY (4 seconds) then NORMAL	If no reset, trip then reset the AJAX circuit breaker. If normal operation fails to return and warning persists, select DIFF T/P switch and AJAX switch to EMERGY (AJAX caption on CWP)	Tailplane differential is inoperative with switch in EMERGY. Select MAX below 200 knots for the landing. Avoid rapid rolling with the DIFF warning on. With diff tailplane inoperative, fly a wider circuit than normal (especially in strong crosswinds) to avoid large spoiler demands in the final turn below 200 kt
AJAX FAILURE			
Attention-getter flashes. AJAX caption on CWP	Cancel warning. AJAX switch to RESET for 4 seconds, then to AUTO	If warning cancels, normal operation has returned. If warning persists reselect RESET. Trip then reset AJAX c/b. If warning persists, select AJAX switch to EMERGY	In EMERGY, pitch feel remains constant and the AJAX warning remains on
Stick forces seem inappropriate to speed—no warnings on CWP	AJAX switch to EMERGY	—	If feel forces seem to light for airspeed, take care not to over-control in pitch, particularly when approaching manoeuvre limits. In EMERGY, pitch feel remains constant and the AJAX warning remains off
RUDDER GEARING MALFUNCTIONS			
a. Indication fails to change when landing gear locks up	Select RUDDER SENS switch to LO. Check that small triangle appears in the indicator	—	If gear fails to change avoid large rudder inputs at high airspeed. Select HI before landing
b. Indication fails to change when landing gear unlocks	Select RUDDER SENS switch to HI. Check that large triangle appears in the indicator. If not select DIFF T/P switch to MAX below 200 knots	—	Selecting DIFF T/P to MAX bypasses RUDDER SENS switch. If still no gear change, avoid landings in crosswinds (max 15 knots). Rudder travel will be limited

continued

Table 2 — *continued*

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
TRIM MALFUNCTIONS			
a. Normal pitch trim fails to operate	Check the PITCH TRIM NORM circuit breaker. Select PITCH TRIM guard to EMERGY. Use emergency trim switch	—	—
b. Pitch trim runaway	Trim in opposite direction. Select PITCH TRIM to EMERGY	Trip PITCH TRIM NORM circuit breaker. Use emergency trim switch for remainder of flight	Runaway may be intermittent
c. Rudder or roll trim fails to operate	Check YAW or ROLL circuit breaker as appropriate	—	—
d. Rudder or roll trim runaway	Select opposite trim and trip the appropriate YAW or ROLL circuit breaker	—	Do not reset the circuit breaker. Runaway may be intermittent
AUTOSTAB FAILURE			
STAB caption on CWP (yaw stab channel out), ◀ hardover or random control movement ▶	In safe flight conditions, operate cut-out and check all channels disengaged.	◀ When control is regained, at a safe altitude reselect serviceable channels as required. ▶ If dutch roll occurs, select DIFF T/P to EMERGY to reduce oscillations. Select NORMAL in descent or at low altitude	Spine deflection compensation inoperative. With yaw channel failure do not exceed minus 2 to +4 g. With pitch channel failure avoid over-control at high speed at low altitude

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PART 1

CHAPTER 7 — OTHER AIRCRAFT CONTROLS

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SLATS, FLAPS AND AIRBRAKES

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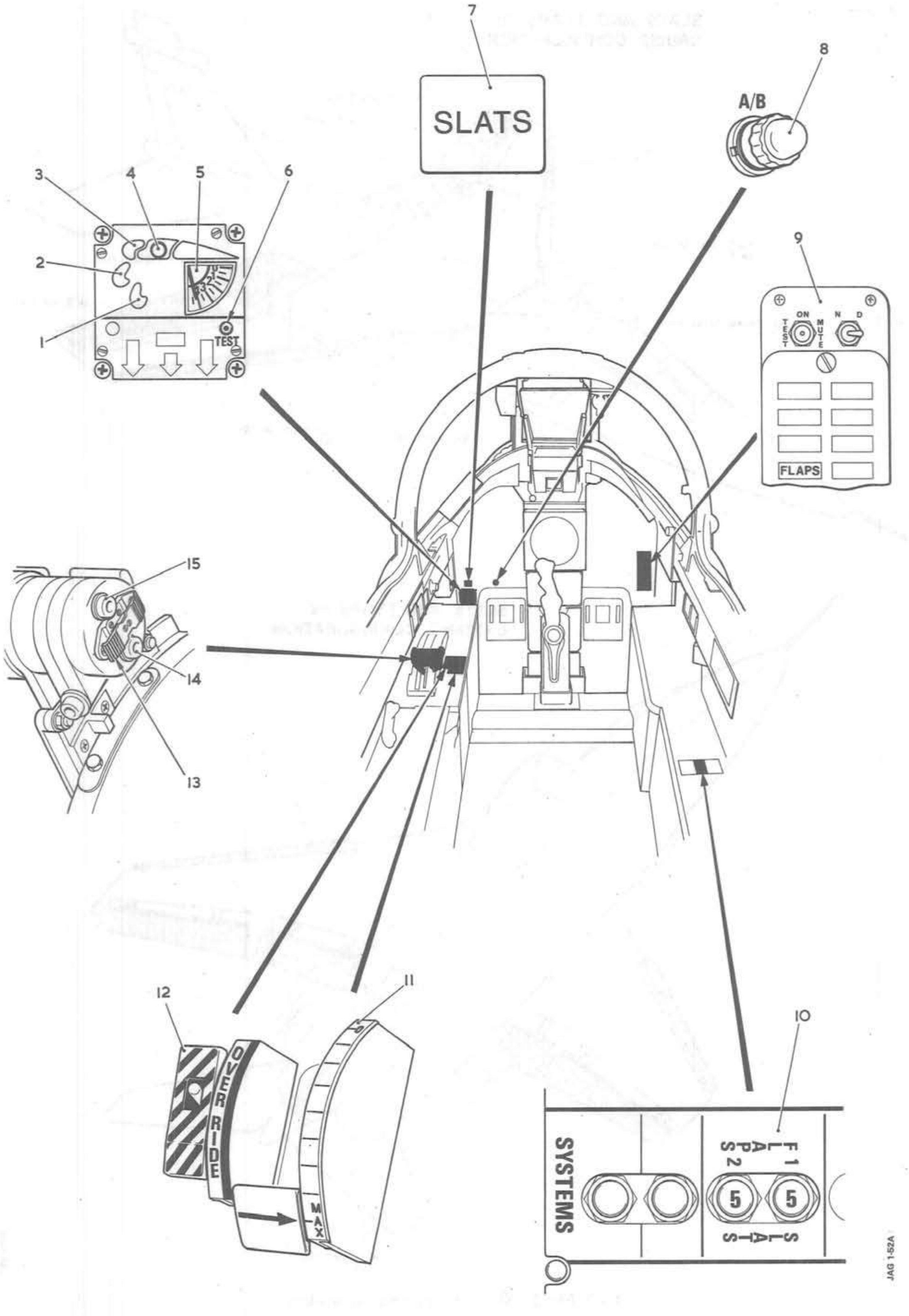
SLATS, FLAPS AND AIRBRAKES

CONTROLS AND INDICATORS

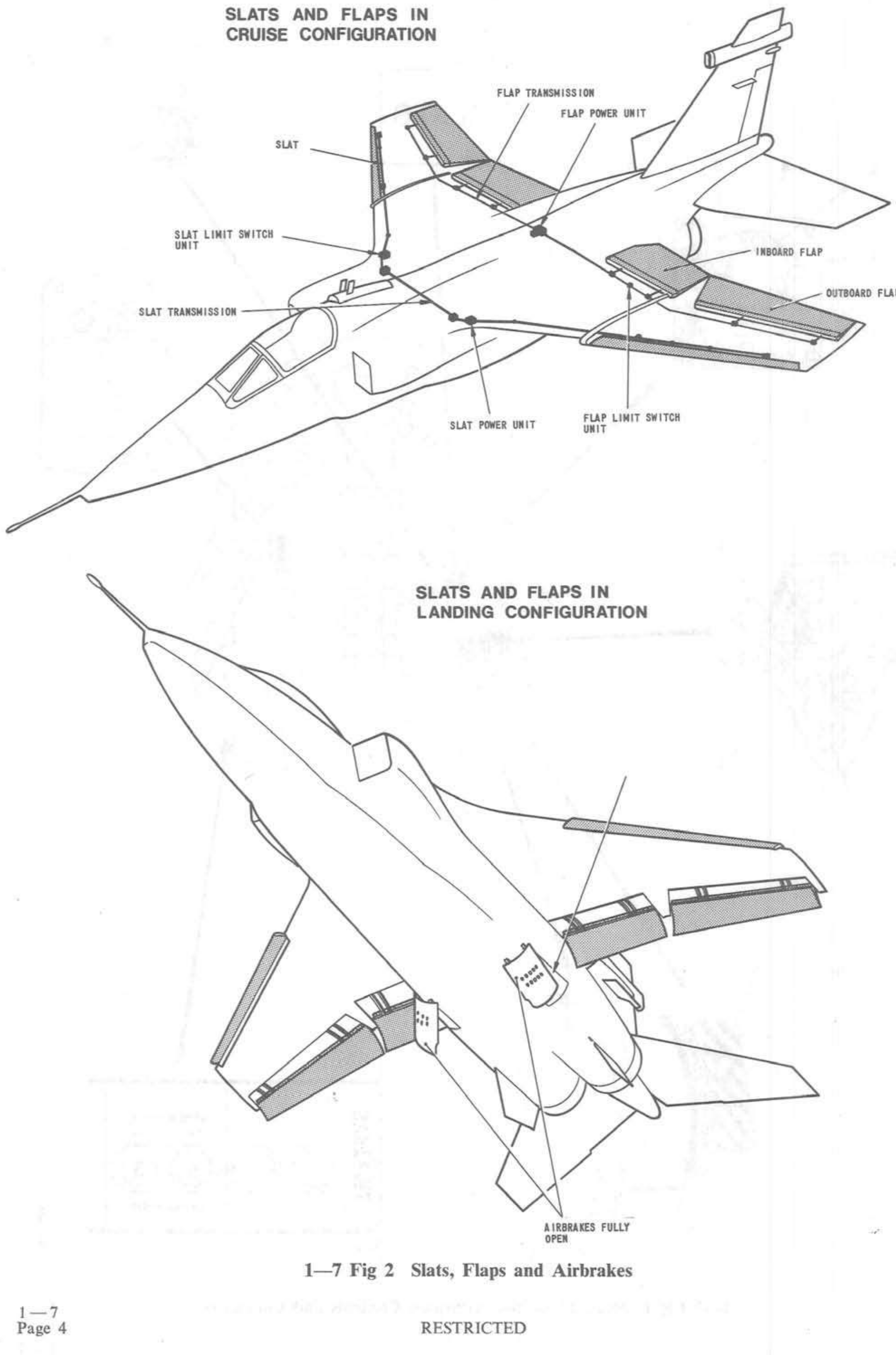
1. Details concerning the control and indicators shown in Fig 1 are listed in Table 1.

Table 1 — Slats, Flaps and Airbrakes Controls and Indicators

Item No	*Item*	*Location*	*Markings*	*Remarks*
1 to 3	Slat indicator lights	Configuration indicator on left main instrument panel	—	Blue lights Refer to Fig 3
4	Flap indicator light	Configuration indicator on left main instrument panel	—	Amber light Refer to Fig 3
5	Flap angle indicator	Configuration indicator on left main instrument panel	0 to 4	0 to 45° in 5° increments
6	Indicator lights test button	Configuration indicator on left main instrument panel	TEST	Press to test slat, flap and landing gear lights
7	Auto 'combat' slats button	Left main instrument panel	SLATS	Illuminated orange button, light on when system in manual mode
8	Airbrakes unlocked light	Left main instrument panel	A/B	Amber light, on when airbrakes not locked in
9	Flaps down warning ⧓	CWP	FLAPS	Red caption
10	Slat and flap circuit breakers	Right console, rear	FLAPS—SLATS 1, 2	5A
11	Flap selector	Left console	0 to MAX	In increments of five degrees
12	Slat override switch	Left console	OVERRIDE	Black/yellow striped guard
13	Airbrake switch	Right throttle handle	—	3-position rocker switch: Aft — out Neutral — locked Fwd — in
14, 15	'Combat' slats buttons	Right throttle handle	—	Lower — slats out 9° Upper — slats in



1—7 Fig 1 Slats, Flaps and Airbrakes Controls and Indicators



1—7 Fig 2 Slats, Flaps and Airbrakes

DESCRIPTION OF THE SYSTEMS

General

2. The lift augmenting devices consist of three-quarter span leading-edge slats and full span double-slotted Fowler flaps. The inboard and outboard flaps extend to different angles, the inboard angle always being greater. Aerodynamic braking is by means of conventional airbrakes (refer to Fig 2).

3. The flaps can be extended to any one of nine settings between 0 and 42 degrees. These values refer to the inboard flap angles, the equivalent outboard flap angles are 0 and 25 degrees. The flap selector operates in increments of five degrees. The slats extend to either of two configurations only; a 'combat' setting of nine degrees, or a maximum lift setting of 23 degrees which automatically accompanies any flap extension.

4. The airbrakes comprise two perforated panels arranged one either side to the rear of the main landing gear; when closed they overlap the engine bay doors. The engine starter air generator exhausts through the left airbrake well, therefore the airbrakes must always be open during engine starts.

5. All three services are driven hydraulically and controlled electrically. Electrical power is derived from the 28V DC emergency busbar. The slat and flap control and indicator circuits are protected by two circuit breakers on the right console.

Slat and Flap Systems

6. *General.* The mechanical operation of the slats and flap systems is identical; both sets of surfaces run out on tracks and are driven by screw-jack actuators on a torsion shaft drive from an electro-hydraulic power unit. The transmissions are located as shown on Fig 2, one power unit per system serving the components in both wings. Though separately operated, the slats and flaps are controlled by a common electrical system arranged so that the flaps cannot normally be extended without the slats first being fully extended; the flaps are retracted fully before slat retraction to the combat position. An override is provided for flap extension in the event AL5, 1 of slat failure. ~~Post-mod 537~~, a red FLAPS caption on the CWP lights up when the flaps are extended more than 8·5 degrees and the airspeed is above 260 ± 5 knots.

7. *Power Units.* Each power unit has paired hydraulic motors powered separately by No 1 and No 2 hydraulic systems to ensure continuing operation in the event of failure of either system. While at rest, the drive shafts are locked by a spring-loaded brake on each unit; the brake is released as pressure is applied to either motor. From the motors the drive is taken via a clutch which, in the event of overloading, de-clutches and mechanically locks the system to prevent asymmetric extension; in these circumstances microswitches operate to isolate hydraulic power from the motors.

8. *Slat and Flap Indication* (*Fig* 3). Slat position is indicated by three blue lights on the configuration indication panel. When the slats are fully retracted the lights are out: when slat is extended the upper light comes on, together with the centre ('combat' slat) or lower (full slat) light, depending on the amount of slat extension. An amber light on the indication panel comes on when the flaps are in any position other than fully retracted. Actual flap angle is indicated by a pointer which moves over a scale graduated in five degree increments from 0 to 45. The amber and blue lights are tested by pressing the TEST button on the indication panel.

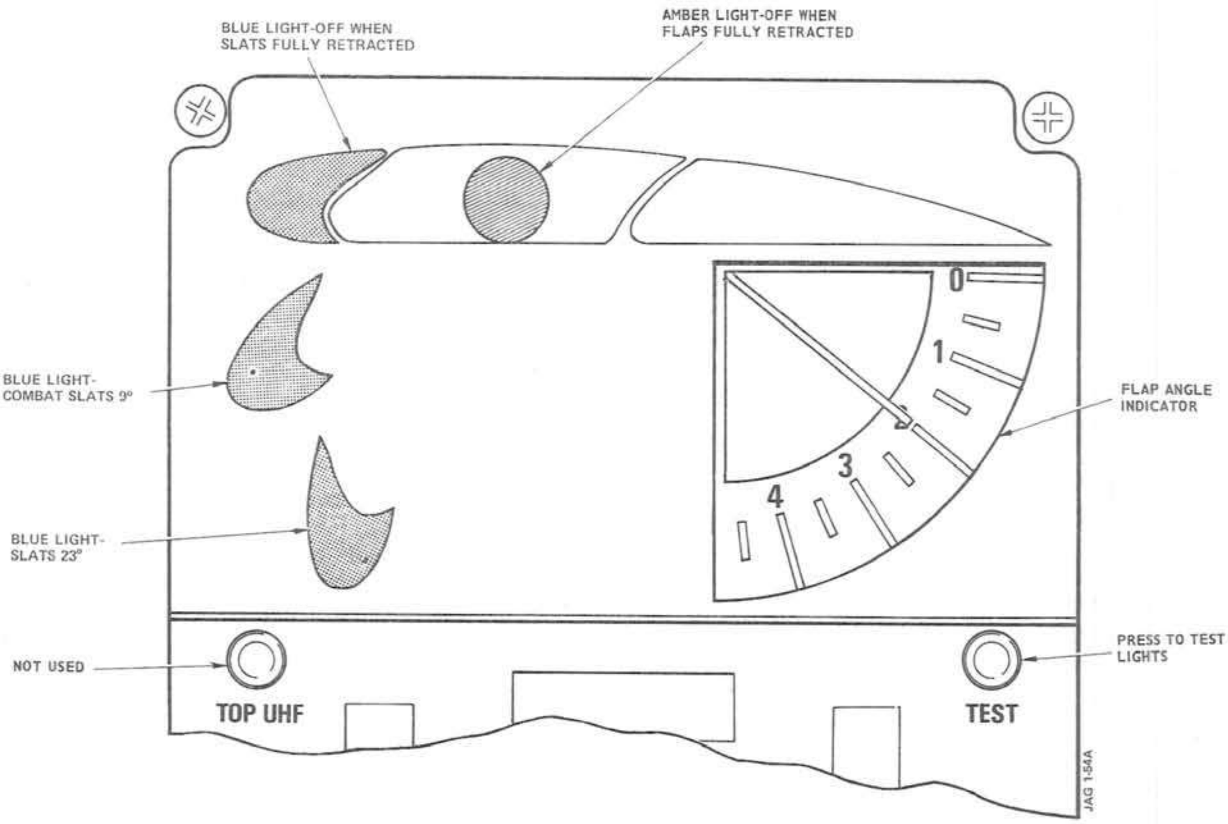
9. *'Combat' Slats.* Provided that the flaps are retracted, 'combat' slats may be selected in and out as follows:

a. *Manual Selection.* 'Combat' slats are manually selected in and out by the upper and lower buttons on the right throttle. Pre-STI 245, slat selections are inhibited at airspeeds above 500 knots by an airspeed switch. A second airspeed switch, set at 520 knots, also inhibits out selections in the event of failure of the 500 knots switch. Post-STI 245, a single airspeed switch inhibits manual selection above 580 knots.

b. *Automatic Selection.*

(1) 'Combat' slats may be selected to cycle automatically with changes of incidence. The automatic mode is selected by pressing the SLATS button; the integral light goes out as the button is pressed and remains out to confirm engagement. The automatic mode is disengaged by pressing either throttle button; the SLATS button light comes on whenever the automatic mode is disengaged. The integral light is tested by the CWP TEST/ON/MUTE switch.

(2) With autoslat selected, 'combat' slats are controlled automatically by the incidence probe, to extend as incidence increases through 5° and to retract as incidence decreases through 4°. If a flaps selection is made, the automatic mode remains engaged but 'combat' slat selections are overridden until the flaps are retracted. Pre-STI 245, the incidence probe is isolated by the airspeed switch which automatically retracts the slats, if extended, at 500 knots and although the automatic mode remains engaged, both automatic and manual 'combat' slat extension is inhibited until airspeed is reduced. Post-



1—7 Fig 3 Slat and Flap Position Indication Panel

STI 245, the airspeed inhibition is delayed until 580 knots is reached.

(3) Pre-STI 245, in the event of failure of the 500 knots airspeed switch, the second airspeed switch operates at 520 knots to disengage the automatic mode and the system reverts to the manual mode: the light comes on in the SLATS button and, until speed reduces below 520 knots, the manual 'extend' button is isolated. In this case the slats, if extended, must be retracted manually. If the 500 knots airspeed switch has functioned correctly, the 520 knots switch has no effect. Post-STI 245, there is a single airspeed switch set at 580 knots; there is no second switch as in pre-STI 245 aircraft.

10. *Slat Override.* Normally, when flaps are selected down, the slats must first run out to the fully extended setting of 23° before the flaps extend. In the event of slat extension failure, operation of the OVERRIDE switch bypasses the slat limit microswitches and connects the electrical supply direct to the flap circuit. This switch provides for flap operation only.

Airbrakes

11. The airbrakes are powered by the No 2 hydraulic system. They are controlled, via a throttle-mounted rocker switch, by a solenoid-operated selector valve in the hydraulic supply which directs

pressure to the appropriate sides of the airbrake rams: when the airbrakes have reached a selected setting the switch should always be returned to neutral. When fully in, the airbrakes are locked mechanically; the lock is released as extension pressure is applied. As either lock releases, an integral limit microswitch is operated and switches on the A/B light. With the rocker switch at neutral and the airbrakes partially or fully out, both solenoids of the selector valve are energised by a circuit through the limit microswitches and the rams are locked hydraulically. As the airbrakes fully retract and lock, the A/B light goes out.

12. The airbrakes control circuit is routed via the engine starter air GENERATION master switch which must be OFF for the airbrakes to operate. A microswitch at the hinge point of the left airbrake renders the air generator START button inoperative when the airbrakes are closed. During in-flight cycling of the airbrakes, a signal from a potentiometer, operated by the right airbrake, is introduced to the autostabilisation system to counteract automatically any pitch moment change; if the autostab is not operating, a manual trim adjustment is necessary (refer to para 20).

NORMAL USE OR MANAGEMENT

Pre-Start Check

13. During the external and internal inspections, confirm that the airbrake ground safety locks and the clip guarding the airbrake switch are each removed. With electrical power on, the A/B light will be on if the airbrakes are unlocked. Ensure that the airbrakes are fully open (manually if necessary). Check that the FLAP and SLAT circuit breakers are set, that the slat OVERRIDE switch is normal and guarded, and that the flap selector is zero.

14. The slat and flap position lights are extinguished when all surfaces are retracted; check the lights using the TEST button on the configuration indicator. With electrical power off, the SLATS button is in manual mode with its integral light out; the light comes on as power is applied. Press the SLATS button; check that it holds in and that the integral light goes out. Press the upper combat slats button on the right throttle; check that the SLATS button releases and that the integral light comes on.

After Start Check

15. Check flaps up. Select 'combat' slats in on the upper throttle button.

16. Select the slat OVERRIDE switch ON and select 5° flap; check that the flap lowers to 5° with no slat. Select the slat OVERRIDE switch OFF. Select 20° flap for take-off: check that the slats extend to 23° and the flaps lower to 20°.

17. Set the air generator master switch OFF and select the airbrakes in, checking that the A/B light goes out.

18. If the engine start has been normal with no excessive heating of the air generator, the airbrakes may be retracted as convenient. If, however, cooling is necessary due to abortive starts or high ambient temperatures, the airbrakes must be left extended until the pre-take-off checks. During taxying, the airbrakes must not be selected 'out' while turning as there is a risk that the high hydraulic supply demand will cause the nosewheel steering to disengage.

Before and After Take-Off Checks

19. During the pre-take-off checks, confirm that the airbrakes are selected in and that the A/B light is out. Confirm that the flaps/slats are at 20/23°. Press the SLATS button to engage auto-slats and confirm that the integral light goes out. After take-off when the flaps are retracted, the slats (if in manual mode) must be retracted from the 'combat' position by pressing the upper throttle button until all the slat lights are out.

In Flight

20. The airbrakes may be fully or partially extended as desired. A nose-up trim change accompanies airbrake extension and vice versa; re-trimming is only necessary if the autostab is disengaged. 'Combat' slats may be cycled as desired using the throttle buttons or, alternatively, auto slats may be selected.

Landing and Shut-Down

21. When landing flap is selected, check that the slats first fully extend. When the landing roll is completed, retract the flaps and slats. The airbrakes must be extended before shutting down the engines; they must not be extended whilst taxying as this depletes the pressure required for nosewheel steering. The flaps may be lowered fully in dispersal, if required.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

22. Indications and actions relating to system malfunctions are listed in Table 2.

Table 2 — Slats, Flaps and Airbrakes System Malfunctions

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
SLATS MALFUNCTIONS			
'Combat' slats fail to operate	Check circuit breakers	—	—
FLAPS FAILURES			
a. Flaps fail to extend	Check SLAT and FLAP circuit breakers. Select combat slat. Select MAX flaps and when required angle is reached, move selector to that angle	If fault persists, select zero flap then slat OVERRIDE and 20° flap	Without slats, landing flap should be restricted to 20°. Use normal incidence on the approach. For flapless landings, approach speeds at 10° incidence are 50 knots higher than normal. Where possible, do not exceed maximum tyre rotation speed or maximum braking speeds. Do not stream the chute until below 185 knots IAS. Consider lowering the hook after touchdown
b. Flaps fail to retract Flap travel light remains on	Check SLAT and FLAP circuit breakers	Reselect MAX then zero flap. When the retracting flap reaches the required angle, move selector to that angle	—
◀c. Uncommanded flap/slat movement	Trip SLAT and FLAP circuit breakers. Observe flap speed limitation	Set flap selector as near as possible to existing flap position	It may be necessary to reset the circuit breakers to change the flap setting and the subsequent action is desirable in case the fault has cleared ▶
AIRBRAKES MALFUNCTIONS			
a. Airbrakes fail to extend	Check starter air GENERATOR master switch to OFF. Check No 2 hydraulic pressure	Reselect airbrakes out	—
b. Airbrakes fail to retract	Reselect airbrakes in repeatedly	If airbrakes still fail to retract, set airbrake priority switch to OVERRIDE (T2) and reselect. If fault persists, set air generator master switch to ON	If fault lies in relay system, valve solenoids de-energise to release hydraulic lock and allow airflow to close airbrakes

Landing Gear, Brake Parachute and Arrester Hook — *overleaf*

LANDING GEAR, BRAKE PARA CHUTE AND ARRESTER HOOK

CONTROLS AND INDICATORS

23. Details concerning the controls and indicators shown in Fig 4 are listed in Table 3.

DESCRIPTION OF THE SYSTEMS

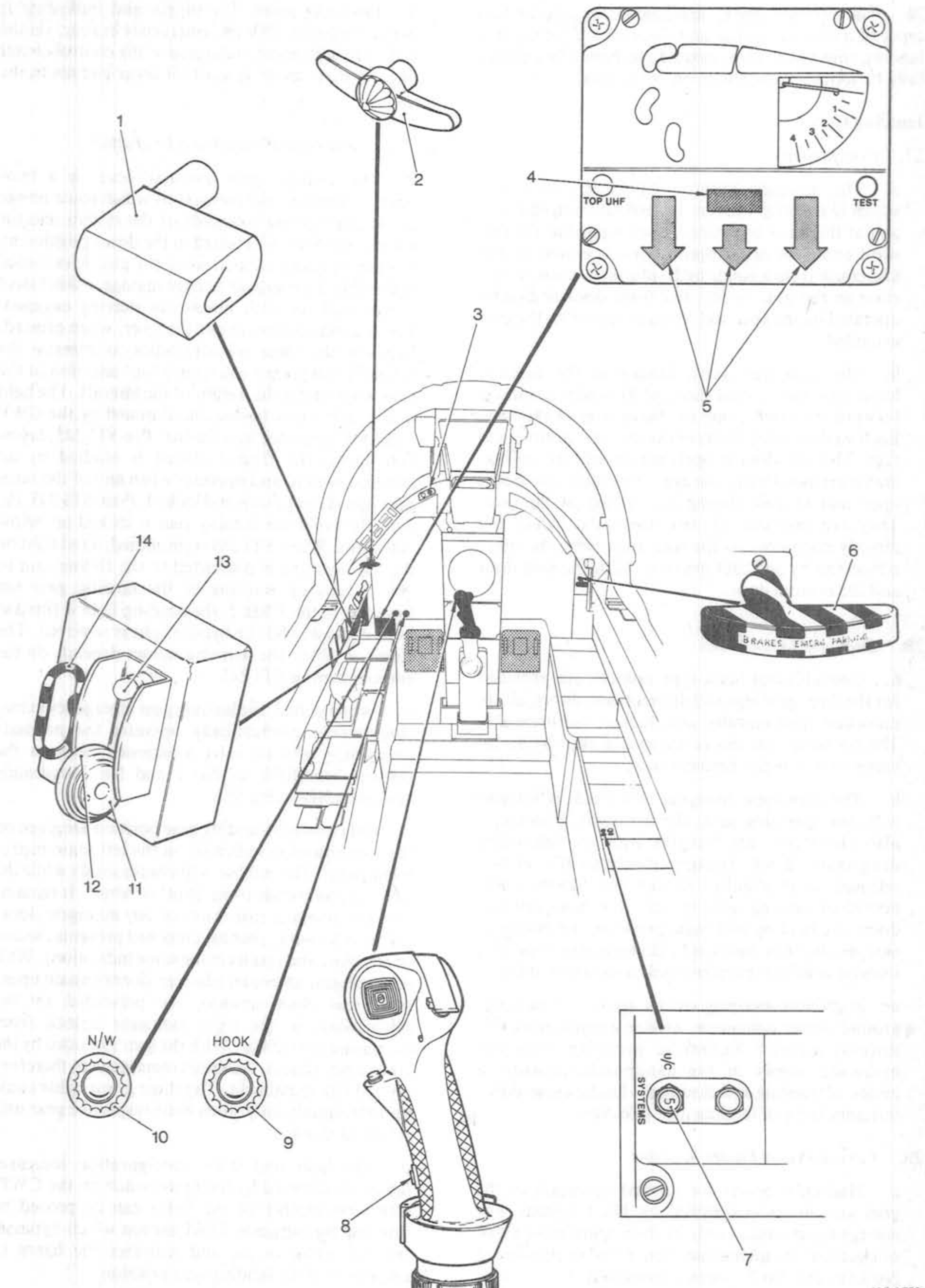
General

24. Consisting of a single-wheeled nosegear unit and twin-wheeled maingear units, the landing gear (refer to Fig 5) is a hydraulically-operated trailing arm type, with low-pressure tubeless tyres, designed to enable the aircraft to operate from PSP or rolled earth airstrips. The nosewheel steering system is hydraulically-operated and includes components to counteract shimmy and provide self-centring. Hydraulically-operated disc brakes are employed on all four mainwheels; the system incorporates anti-skid.

25. The ribbon-type brake parachute is housed in a container immediately forward of the tailcone. Its operation is entirely mechanical.

Table 3 — Landing Gear, Brake Parachute and Arrester Hook Controls and Indicators

Item No	*Item*	*Location*	*Markings*	*Remarks*
1	Arrester hook handle	Under left canopy sill	Hook symbol	Brisk pull to lower hook
2	Brake parachute handle	Left coaming	Parachute symbol	Brisk pull to stream parachute. Push in to jettison
3	Head-up landing gear flasher	Left coaming	—	As Item 12
4	Landing gear door indicator	Configuration indicator on left main instrument panel	—	Red bar, lit when doors are not locked shut
5	Landing gear indicators	Configuration indicator on left main instrument panel	—	Green arrows, lit when respective gear is locked down
6	Wheelbrakes emergency and parking handle	Right instrument panel extension	BRAKES—EMERGENCY/PARKING (Black/yellow stripe)	Pull out and rotate to lock Fully in—Normal brakes plus automatic emergency brakes Mid position—Emergency brakes Fully out—Parking
7	Landing gear control circuit breaker	Right console, rear	U/C	5A
8	Nosewheel steering button	Control column handgrip	—	—
9	Arrester hook warning light	Left main instrument panel	HOOK	Red warning light Press-to-test filament
10	Nosewheel steering light	Left main instrument panel	N/W	Amber light. Press-to-test filament
11	Landing gear normal selector	Left main instrument panel extension	—	Solenoid locked in 'down' position with aircraft on ground
12	Landing gear flasher	Landing gear normal selector	—	Red light, flashes when a gear downlock microswitch not made and, pre-STI 245 IAS is below 160 kt, or post STI 245, speed is below 200 kt and gear is locked up
13	Landing gear emergency retraction button	Above landing gear normal selector	—	Press button and select 'up' normally
14	Landing gear emergency extension handle	Adjacent to landing gear normal selector	Black/yellow striped	Pull to select emergency extension system



1 – 7 Fig 4 Landing Gear Controls and Indicators

26. The arrester hook, designed to engage certain types of airfield arresting gear, is provided for use in a landing emergency. It is released mechanically and can only be retracted externally on the ground.

Landing Gear

27. *Components*

a. The nosegear retracts rearwards into a well which is sealed at the rear by two side-hinged doors and at the front by a single door hinged at the forward end. The side-hinged doors, operated by rod and crank from a single hydraulic jack, open and re-close as the gear cycles; the front door is directly operated by the gear and remains open with the gear extended.

b. The maingear units, hinged to the fuselage lower structure, rotate through 90° whilst retracting forward into wells, one on either side of the keel. Each well is sealed by three doors: side, bottom and rear. The rear door is operated directly by, and remains extended with, the gear. The other two doors open and re-close during the cycling of the gear. They are operated by two hydraulic jacks, one directly connected to the side door only, the other connected by rod and crank to both the side door and the bottom door.

28. *Gear and Door Locks*

a. Conventional hook-type uplocks are provided for the three gear legs and the maingear doors; all are unlocked hydraulically and locked mechanically. The nosegear rear doors are locked shut by an integral lock in their common jack.

b. The claw-type nosegear downlock is integral with the operating jack; the maingear downlocks, also claw-type, are integral with the telescopic dragstruts. Each engages mechanically and is released hydraulically. During the 'doors open' period of landing gear cycling, the nosegear rear doors are held by hydraulic pressure, the maingear side and bottom doors are held by a claw-type lock integral with the operating jack common to both.

c. A ground servicing switch above the electrical ground power connector, used in conjunction with normal aircraft hydraulic pressure, external hydraulic supply or the handpump, provides a means of opening and closing the landing gear doors independently of landing gear selection.

29. *Landing Gear Power Supplies*

a. Hydraulic power for normal operation of the gear and doors is supplied by No 1 system. For emergency extension only of these units in the event of electrical circuit malfunction or loss of pressure in No 1 system, No 2 system is employed.

b. Electrical power for supply and indication is derived from the 28V DC emergency busbar, via the U/C circuit breaker in the case of the control circuit and via fuses in the case of all other circuits in the system.

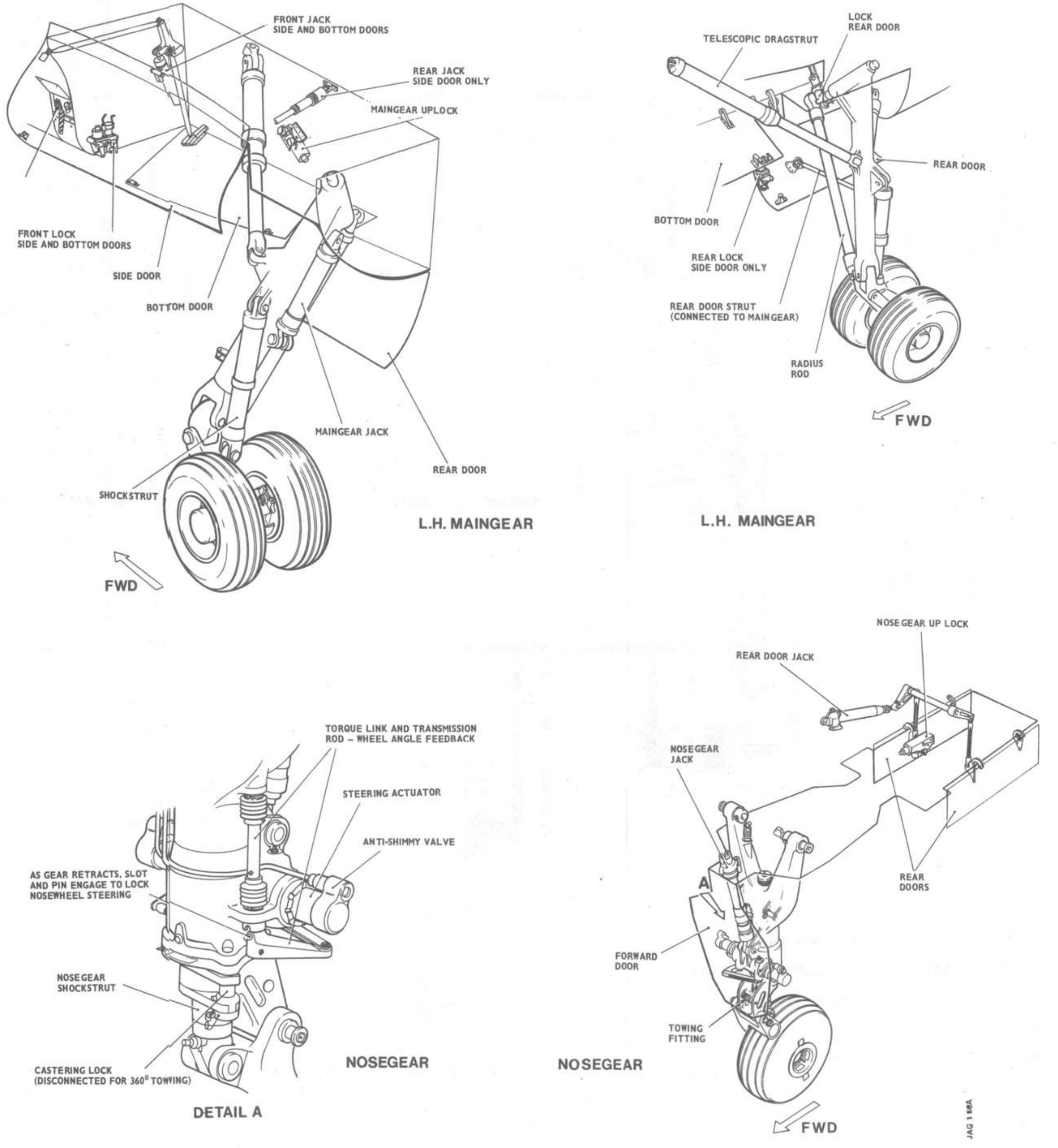
30. *Landing Gear Control and Indication*

a. The landing gear 'normal' lever is a two-position selector, the contacts of which route power to the appropriate solenoids of the system selector valves. The lever is retained in the down position by a solenoid-operated lock when the gear is extended with either the nosegear or right maingear shockstrut compressed, or with nosewheel steering engaged. The override button above the lever, when pressed, bypasses the three microswitches to energise the solenoid and permit emergency 'up' selection of the gear while under the weight of the aircraft. The light in the lever knob (tested and dimmed by the CWP facility) is operated by a flasher. Pre-STI 245, below 160 knots, the flasher circuit is readied by an airspeed switch, and operates when any of the three gear legs are not down and locked. Post-STI 245, the light flashes if the landing gear is locked up below 200 knots. When STI 243 is embodied, a red light on the left coaming is connected to the flasher unit to give a head-up warning of the landing gear not lowered. In the T Mk 2, the head-up light is fitted in both cockpits and the handle light is removed. The speed at which the warning occurs depends on the embodiment of STI 245.

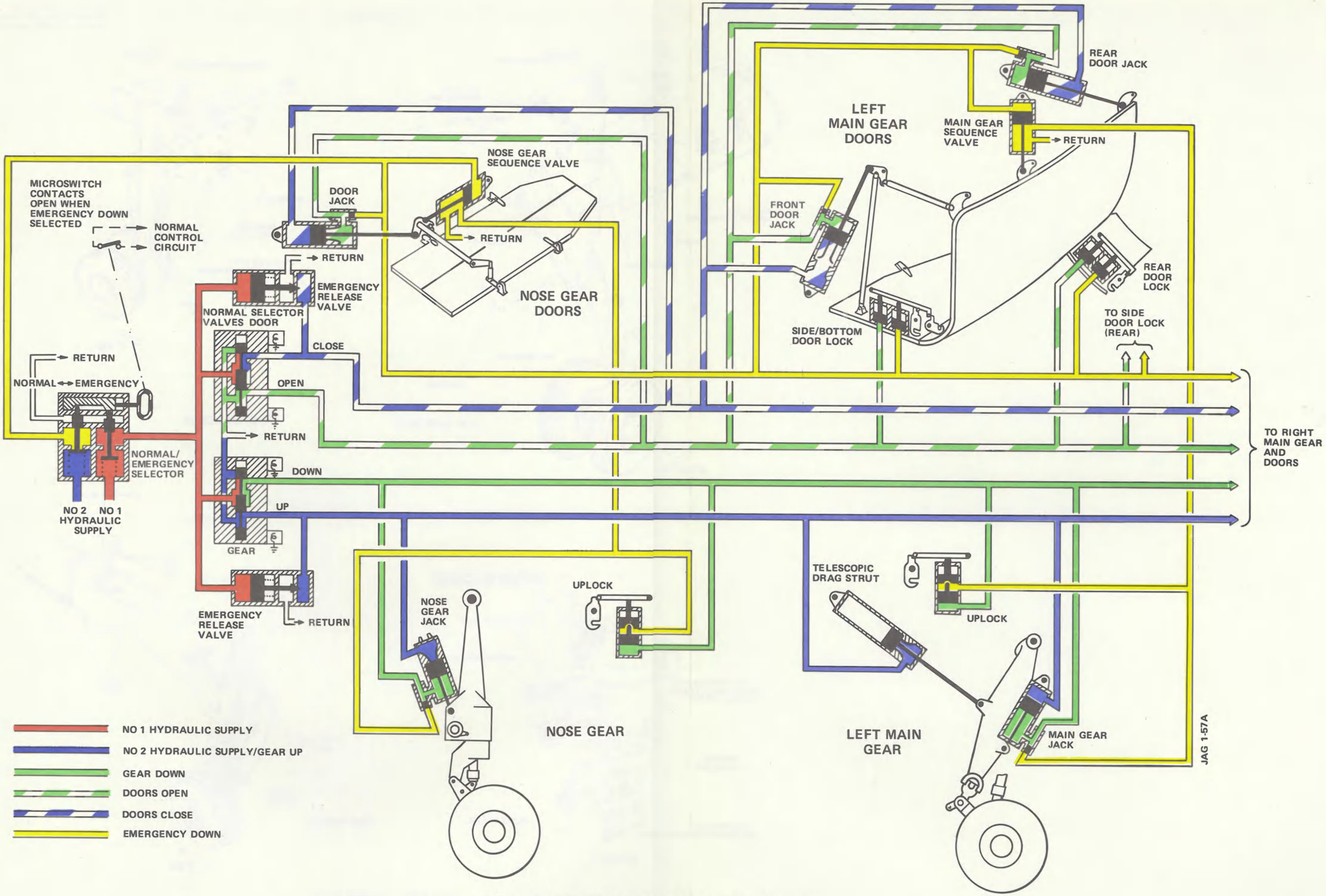
b. When pulled, the landing gear emergency extension handle mechanically operates the normal/emergency selector valve positioned between the delivery manifolds of No 1 and No 2 hydraulic systems (refer to Fig 6).

c. Indications of landing gear position are given on the configuration indicator on the left main instrument panel. The red bar is lit continuously while the doors are in transit from 'shut' to 'shut'. It remains lit if the nosegear rear doors or any maingear doors fail to lock shut (a gear leg unlocked prevents closure of all doors and results in the same indication). With the maingear extended (the rear doors remain open) both rear door uplocks are prevented by the microswitch in the right maingear uplock from energising the red bar. With the gear extended by the emergency system, the doors remain open; therefore the red bar remains lit. The three green lights come on individually only when their respective gear unit is locked down.

d. The gear and door configuration indicator lights are dimmed by the D/N switch on the CWP. The serviceability of the lights can be proved by pressing the adjacent TEST button which bypasses the indicating circuit and activates the lights irrespective of the landing gear position.



1—7 Fig 5 Landing Gear



1—7 Fig 6 Landing Gear Hydraulic System — Schematic

e. A white light is mounted facing forward on the nosewheel door of T Mk 2 aircraft. The light comes on to provide a visual check externally when the nosewheel leg is down and locked.

31. *Landing Gear Operation*

a. Normal operation of the system (refer to Fig 6) is controlled by the solenoid-operated selector valves which, when energised, admit No 1 hydraulic system pressure to the appropriate delivery circuit. A tapping between the gear 'up' and wheelbrake control valve pressurises the brakes automatically during gear retraction.

b. The electrical control circuit between the normal selector and the selector valve solenoids is routed through microswitches (operated by the moving components) so that the gear cannot cycle until the doors open fully, and the doors cannot close until the gear is locked up or down.

c. At the 'down' side of each hydraulic jack, a shuttle valve admits normal or emergency hydraulic supply, depending on which is selected. Both supplies are also delivered to the hook-type uplocks which incorporate dual unlocking pistons, one fed by each hydraulic supply. With the normal/emergency valve in the emergency extension position, No 1 system delivery to the solenoid valves is shut off and the emergency lowering system is directly pressurised by the No 2 system. A microswitch in the normal/emergency valve is simultaneously operated when emergency extension is selected, and the normal control circuit to the solenoid valves is de-energised.

d. Emergency extension pressure first unlocks and opens the doors. In turn the doors mechanically actuate sequence valves in the pressure line. At 'doors open' these valves admit pressure both to the gear uplocks and the 'down' side of the gear jacks. In this instance the doors do not close following gear extension.

e. When the left maingear locks up, power is applied to the airframe fatigue meter (g-recorder). Other systems routed via the landing gear microswitches are included under the relevant system descriptions.

Nosewheel Steering

32. The steering system is powered by the No 2 hydraulic system and is controlled by a fuse-protected circuit on the 28V DC emergency busbar. Directional control is by means of the rudder pedals. The facility is selected by a button on the control column which engages or disengages the system via a wafer-type 'step' switch. The N/W light is on when the system is engaged.

Note 1: The EHP pressure output is not sufficient to operate the nosewheel steering.

Note 2: On GR1 aircraft in the reconnaissance role, the nosewheel steering button is also used to operate the F95 cameras (refer to Aircrew Manual Book 2).

33. When the button on the control column is pressed, a ratchet moves the wiper in the 'step' switch to a live terminal. Provided hydraulic pressure is sufficient and the nosewheel shock strut is compressed, the button is held in, the steering coupler engages and pressure is routed to a steering controller. Although the system may be pressurised, mechanical engagement can only take place when the relative angle between nosewheel and rudder pedals is less than 7 degrees. With the system engaged, maximum nosewheel deflection is 55 degrees left or right.

34. Movement of the rudder pedals is transmitted by the steering coupler to a steering controller which directs hydraulic pressure to the appropriate side of an actuator which, via a rack and pinion, turns the nosewheel in the required direction. When nosewheel deflection reaches the demanded value, a mechanical feedback linkage restores the steering controller to a neutral setting. Accumulator pressure in conjunction with a restrictor valve at each end of the actuator serves to counteract shimmy and provides self-centring when the steering system is disengaged.

35. When the control column button is again pressed, or the shock strut extends, the ratchet moves the 'step' switch wiper to a neutral terminal, hydraulic supply is cut off to disengage steering and the N/W light goes out. Accumulator pressure centralises the nosewheel.

36. If hydraulic pressure reduces to below about 150 bar, the steering coupler will not engage to transmit steering commands. If, however, the system fails to engage because of 'step' switch malfunction, the engage button may be held pressed to bypass the 'step' switch and engage nosewheel steering.

37. *Paragraph not used.*

Wheelbrakes and Anti-Skid

38. Hydraulic disc-type brakes are provided at all four mainwheels. Each wheelbrake unit has eight hydraulically-operated pistons, four for normal braking (No 1 circuit) and four for emergency braking (No 2 circuit). Three modes of braking are available, depending on the setting of the black and yellow striped BRAKES—EMERGENCY/PARKING handle, as follows:

a. *Normal Braking (handle fully in).* Differential, anti-skid braking is obtained by pressing the toe end of each rudder pedal. This applies progressively increasing pressure from No 1 circuit, via anti-skid units, to the four 'normal braking' pistons of each wheelbrake unit on the associated side. If No 1 circuit pressure reduces, normal braking is automatically supplemented by emergency braking from No 2 circuit and the brake accumulator to the remaining four pistons of each wheelbrake unit, to retain the total braking capacity. The emergency braking element does not include anti-skid.

b. *Emergency Braking (handle pulled and rotated at mid-position).* Differential variable braking is applied by the toe pedals, using No 2 circuit or brake accumulator pressure. No 1 circuit is isolated. There is no anti-skid facility. A fully charged brakes accumulator provides sufficient pressure for approximately eight normal brake applications.

c. *Parking (handle pulled fully and rotated).* Equal pressure from No 2 circuit or the brakes accumulator is applied to the four 'emergency brakes' pistons at each wheel.

39. The anti-skid system is a tacho-generator type consisting of a wheel-driven speed sensor and a solenoid-operated dump valve for each wheel, plus two control boxes, one for the outboard wheels and one for the inboard. The system is powered from the 28V DC emergency bus via two fuses, one to each control box: the circuits are isolated when the landing gear is retracted. With the gear down, the dump valves are energised to the 'pressure dump' position until the landing gear shock struts are compressed on touchdown; the wheel sensors assume control as the wheels spin up.

40. The circuit is so designed that speed sensor spin-up overrides a failure of the shock strut microswitch: additionally, if a dump valve remains open for more than approximately two seconds, a fail-safe circuit isolates the associated control box resulting in loss of anti-skid control at the related pair of wheels. The anti-skid system is automatically isolated at speeds below 20 knots to ensure positive brake control during low speed manoeuvring and parking.

Brake Parachute

41. The brake parachute (refer to Fig 7) is in a container forward of the tailcone and is attached to the aircraft by a release mechanism. The jaws of the release mechanism are held shut by two separate locks, a main lock operated by the cockpit handle and a safety lock operated by the tailcone; in flight the main lock is open and the safety lock closed. The tailcone acts as a parachute extractor and is retained by two hooks.

42. When the handle is pulled the tailcone is released to extract the parachute. Simultaneously the state of the two release mechanism locks is reversed, the main lock being closed by the handle and the safety lock by the tailcone; the release mechanism jaws therefore remain closed. The parachute is jettisoned by pushing the handle fully home; this re-opens the main lock and allows the release mechanism jaws to open to release the parachute.

43. Should the parachute stream spontaneously in flight the safety lock is opened by the tailcone and the release mechanism operates (the main lock remains open) to jettison the parachute immediately.

43A. The brake parachute handle is fitted with a safety latch which, when in the latched position, prevents movement of the handle and thus, accidental self-deployment of the parachute. Prior to streaming the brake parachute, the safety latch is operated clear of the latched position allowing the handle to be pulled.

WARNING: If the safety latch is not correctly engaged in the handle it is possible for the handle to move and for the brake parachute to stream. This can be extremely hazardous in flight because the brake parachute, having been streamed normally, does not self release as in para 43. Therfore, the safety latch must normally be engaged during all stages of flight.

Arrester Hook

44. The arrester hook (refer to Fig 8) and its shoe are mounted on a steel arm connected to the aircraft by a hinge pin which permits lateral and vertical movement. The hook is held in position by a lock; the lock is cable-operated by the hook control handle in the cockpit. A spring-loaded actuator forces the hook down and maintains the load during ground contact. A microswitch on the lock mechanism energises the HOOK warning light when the hook is released. The hook should only be extended when the aircraft is on the ground. After extension the hook can only be retracted by the groundcrew. A safety pin is installed and must be removed before flight.

NORMAL USE OR MANAGEMENT

Pre-Flight

45. On the aircraft exterior, ground safety pins or

locks to be removed are installed at the hook, the ground servicing landing gear door switch, the maingear doors (two each), the nosegear doors, the nosegear jack, and the maingear dragstruts. In the cockpit, pins on the security cord are installed in the landing gear selector and hook handle. The pin locking the ground servicing doors switch must not be removed until after the door locks are removed; the switch must then be set to the 'flight' position (down) and the cover flap fastened. Ensure that the brake parachute handle latches, required to be fitted in accordance with current SOP, are fully engaged.

46. With power on the aircraft, the three landing gear indicator greens are lit and, if the gear doors are open, the red also is lit until they close; the N/W and HOOK lights are out. Check that the hook and brake parachute handles are fully in and the chute handle safety latch is in position. Apply the parking brake; handle fully out and rotated. Pressures are confirmed during checks of the hydraulic system.

Engine Starting

47. No 1 hydraulic system supplies the door jacks and, if the doors are open with the ground locks removed and the ground servicing doors switch in the 'flight' position, the doors close when No 1 engine comes up to idle speed during the start. If No 2 engine is started first, the PTU pressurises No 1 system and also closes the doors if the No 1 system HYD BY-PASS switch is at AUTO or ON: therefore, it is important to check that all personnel are clear, during starting.

Before Taxying

48. Nosewheel steering is engaged by pressing the control column switch, and by moving the rudder

Intentionally Blank

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Before Taxying

48. Nosewheel steering is engaged by pressing the control column switch, and by moving the rudder pedals until forces indicate the system is engaged. Check that the parking brake handle is fully home; check the brakes and steering as the aircraft moves off.

Take-Off

49. At the line-up, with maximum dry power applied, the wheelbrakes will hold. Nosewheel steering automatically disengages at rotation and the N/W light goes out. When the right shock strut extends as the aircraft unsticks, the gear selector solenoid is energised and 'up' can be selected. The indicator red bar is lit while the landing gear doors cycle, and all greens go out as the legs start to move. When the aircraft unsticks, the anti-skid dump valves open, then close momentarily as the gear unlocks, providing automatic braking as the gear retracts. Refer to Part 2, Chapter 1 for landing gear limitations.

Note: If moderate rudder is being applied at rotation, the nosewheel may follow and prevent disengagement of steering which, in turn, will prevent the gear 'up' selection until the rudder is centralised after unstick.

Landing

50. Pre-STI 245, if the airspeed is less than 160 knots, the landing gear flasher operates until the gear locks down. Post-STI 245, the flasher operates if the landing gear is locked up and speed is below 200 knots. The three indicator greens come on when the gear locks down, and the red door indicator goes out when the doors re-close and lock.

51. Nosewheel steering should be selected only after all three wheels are rolling. Also at this stage, during a normal landing, the brake parachute may be streamed by a brisk pull on the handle.

52. Although the anti-skid system prevents the brakes coming on until after touchdown, toe pressure must not be prematurely applied. Excessive braking pressures will not necessarily result in a shorter landing roll due to frequent cycling of the anti-skid system and a consequent reduction in braking effect.

53. At the end of the landing, release the brake parachute by pushing the control handle fully home.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Continuous or Early Green Light

54. A sticking microswitch operating rocker or a defective microswitch can cause a landing gear green light to be maintained throughout the landing gear cycle, up and down. It is also possible that vibration of the rocker or microswitch could bring on a green light during the lowering cycle before a leg is fully locked down.

55. Normally, the main landing gear legs lock down before the nosewheel. If a continuous or early green indication signal occurs in the nose leg microswitch circuit, the hydraulic pressure to the 'down' side of the jacks is removed by the sequence value before the nose leg mechanical downlocks engage, on receipt of the 'three greens' signal. The hydraulic lock holds the nose leg close to the fully down position but, because the mechanical lock is not engaged, the leg collapses after touchdown.

56. It is also possible for a main landing gear light to be on continuously or to come on early. In this case, because the nosewheel is normally the last

to lock down, all mechanical locks would probably be engaged before the removal of hydraulic pressure. However, should the other two legs lock down before the affected main leg, a similar situation to that detailed in para 55 would arise.

57. If a green light remains on throughout landing gear retraction, the gear retraction sequence is unaffected and the wheels will lock up normally. The sortie may be continued in this condition but as a precaution, a visual check of landing gear retraction should be made before accelerating above the limiting speed.

58. When positioning for landing with a continuous landing gear green light, lower the gear normally and then pull the gear emergency extension handle. The second action overrides the normal lowering system, opens the landing gear doors, locks down the gear and maintains a constant positive pressure to the 'down' side of the jacks. Similarly, if a green light occurs early in the gear lowering cycle, operate the emergency extension handle to ensure all wheels are locked down. The landing gear red indicator remains on after operation of the emergency extension handle. After landing, have the ground locks inserted before taxying.

Other Failures — Indications and Actions

59. Indications and actions relating to other malfunctions in the landing gear related systems are listed in Table 4.

Table 4 — Landing Gear, Brake Parachute and Arrester Hook System Malfunctions

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
LANDING GEAR — INDICATOR FAILURE			
Gear and door indicator lights not lit	Press TEST button. If lights fail to come on, set D/N switch on CWP to opposite setting and repeat test	—	If the TEST button fails to energise lights, a fault in indicator circuit is likely. Flasher does not operate if gear locked down
LANDING GEAR —'UP' SELECTION MALFUNCTIONS			
a. Gear selector cannot be raised after take-off	If N/W light on, centralise rudder pedals. If fault persists, disengage steering and reselect 'up' when N/W light is out	If N/W steering will not disengage, or is not the cause, *do not use the emergency retraction button;* leave the gear extended	—
b. Gear selected 'up' but green(s) remain lit with or without HYD 1 warning or door red warning	Return selector to 'down'. Check c/b and reset if tripped, then reselect gear up	If c/b not tripped, leave landing gear down	—
c. Gear selected 'up' but door indicator remains lit	Select airbrakes out then in	If warning persists, return selector to 'down'. Check greens lit. Leave gear extended	—

(continued)

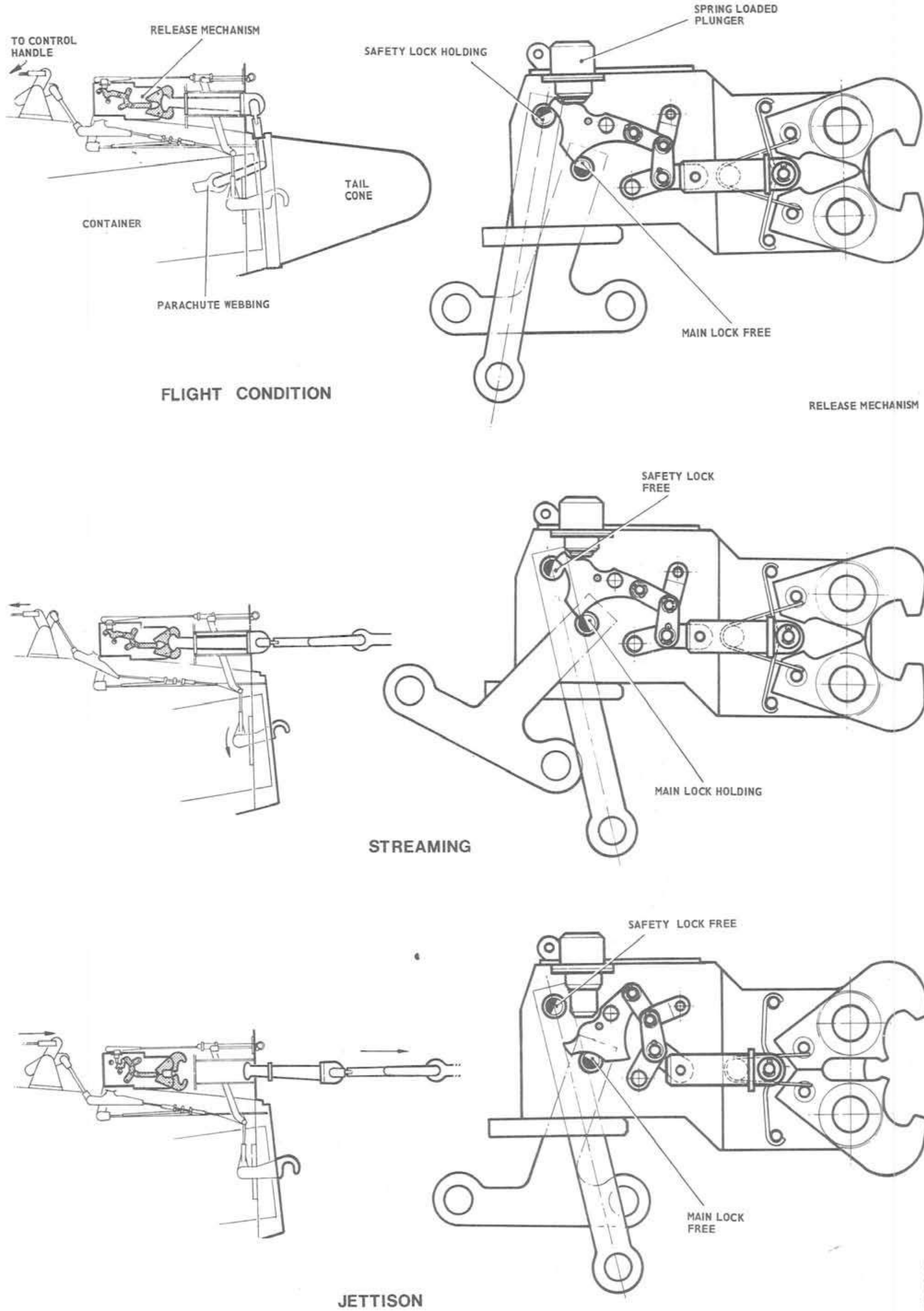
Table 4 — *continued*

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
LANDING GEAR — 'DOWN' SELECTION MALFUNCTIONS			
a. The red and all three greens fail to come on OR b. The red only comes on OR c. The red and only one or two greens come on (the red remains on)	Check No 1 system services pressure. If zero, carry out hydraulic failure drill. *Do not* cycle gear at this stage, leave 'down' selected. Check UC c/b and flasher operation. With or without a HYD 1 warning, pull landing gear emergency extension handle and, if necessary, apply g, yaw and roll while increasing air-speed. If still unsuccessful push in emergency extension handle	Recycle the landing gear using the normal controls. If fault persists, repeat the complete procedure	Do not land with one main leg not locked down. Do not retract the landing gear once it is down and locked. Unless both main gear legs are locked down, do not land; abandon the aircraft
d. The red comes on then goes out in the correct order, but one of the greens fails to light The flasher does not operate. On T2 aircraft, light on nosewheel door on	Operate the TEST button	If the test brings on the green and flasher operates, the gear is down and locked Confirm by pulling landing gear emergency handle (red then comes on and stays on)	The door indicator proves that the cycle is complete. The probable cause is a failed microswitch contact
NOSEWHEEL STEERING MALFUNCTIONS			
a. Steering engages but fails to hold in	Press and hold the steering button	—	A failed 'step' switch is likely. Do not taxy if steering fails
b. Steering fails to disengage after take-off (the gear cannot be retracted)	Pulse the steering button	—	If steering remains engaged, a faulty 'step' switch or solenoid valve is likely. If steering disengages, a faulty nosegear microswitch is likely
c. Steering fails to engage after landing	Ensure rudder central and attempt a further engagement	Keep straight using rudder and differential braking. Stream brake parachute if required; jettison chute if swing develops	Do not taxy the aircraft

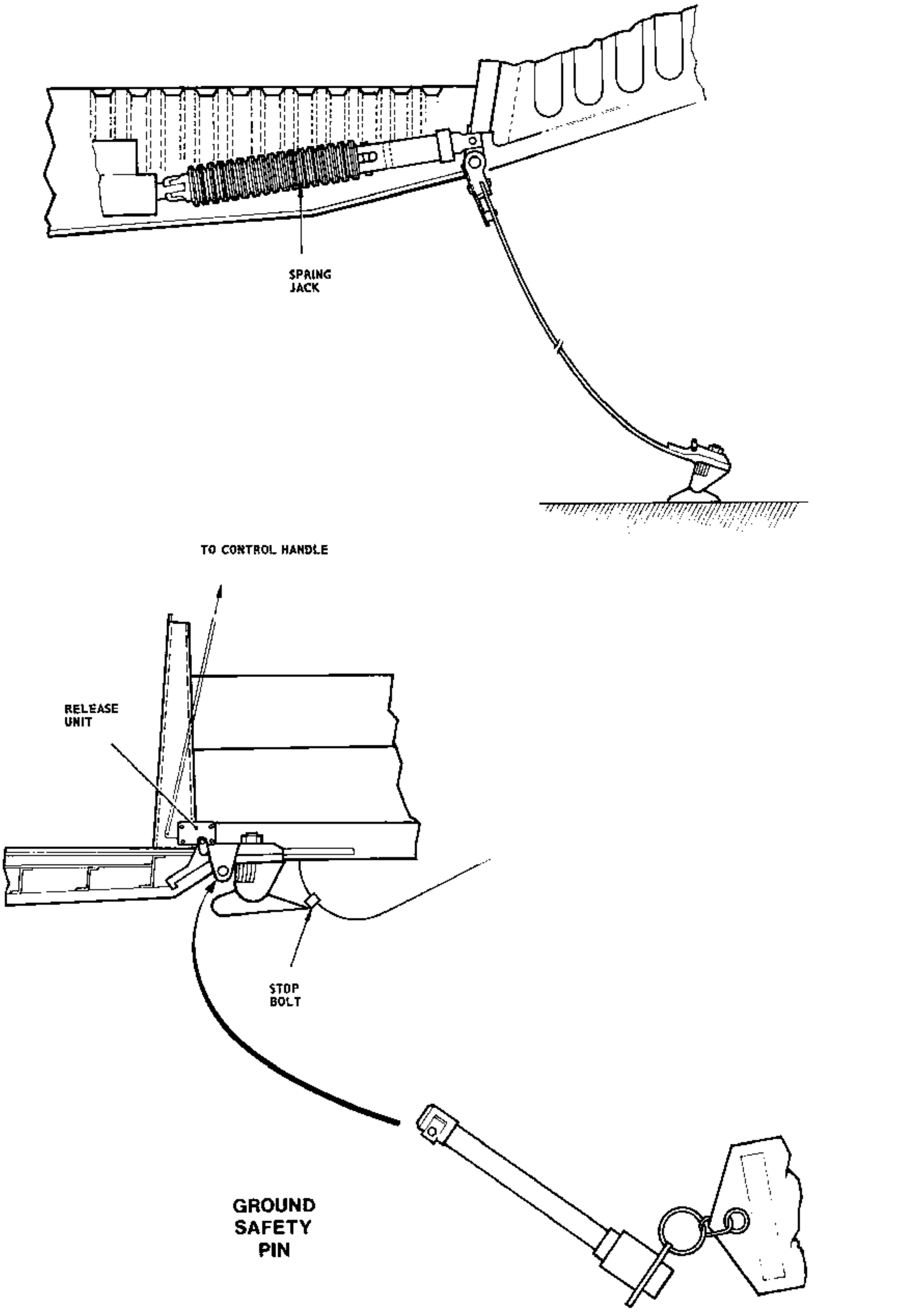
(continued)

Table 4 — *continued*

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
WHEELBRAKES FAILURE			
When brakes applied, one or both fail to operate	Pull brake handle to mid-position and lock	Recommence braking (no anti-skid)	With pressure normal, auto emergency would be precluded. With no hydraulic system pressure, accumulator pressure will provide approximately 8 normal brake applications. No anti-skid
BRAKE PARACHUTE MALFUNCTIONS			
No deceleration, or deceleration rate below normal, when handle pulled	Apply maximum braking technique. Consider lowering hook	—	—
ARRESTER HOOK FAILURES			
a. HOOK light fails to come on (hook has not dropped)	Push the hook handle fully home. Repeat selection **WARNING:** Keep all ground personnel clear of hook area	—	—
b. HOOK light comes on in flight	—	Land upwind of threshold cable	—



1—7 Fig 7 Brake Parachute



1 – 7 Fig 8 Arrester Hook

PART 1

CHAPTER 8 — AIR CONDITIONING AND PRESSURISATION

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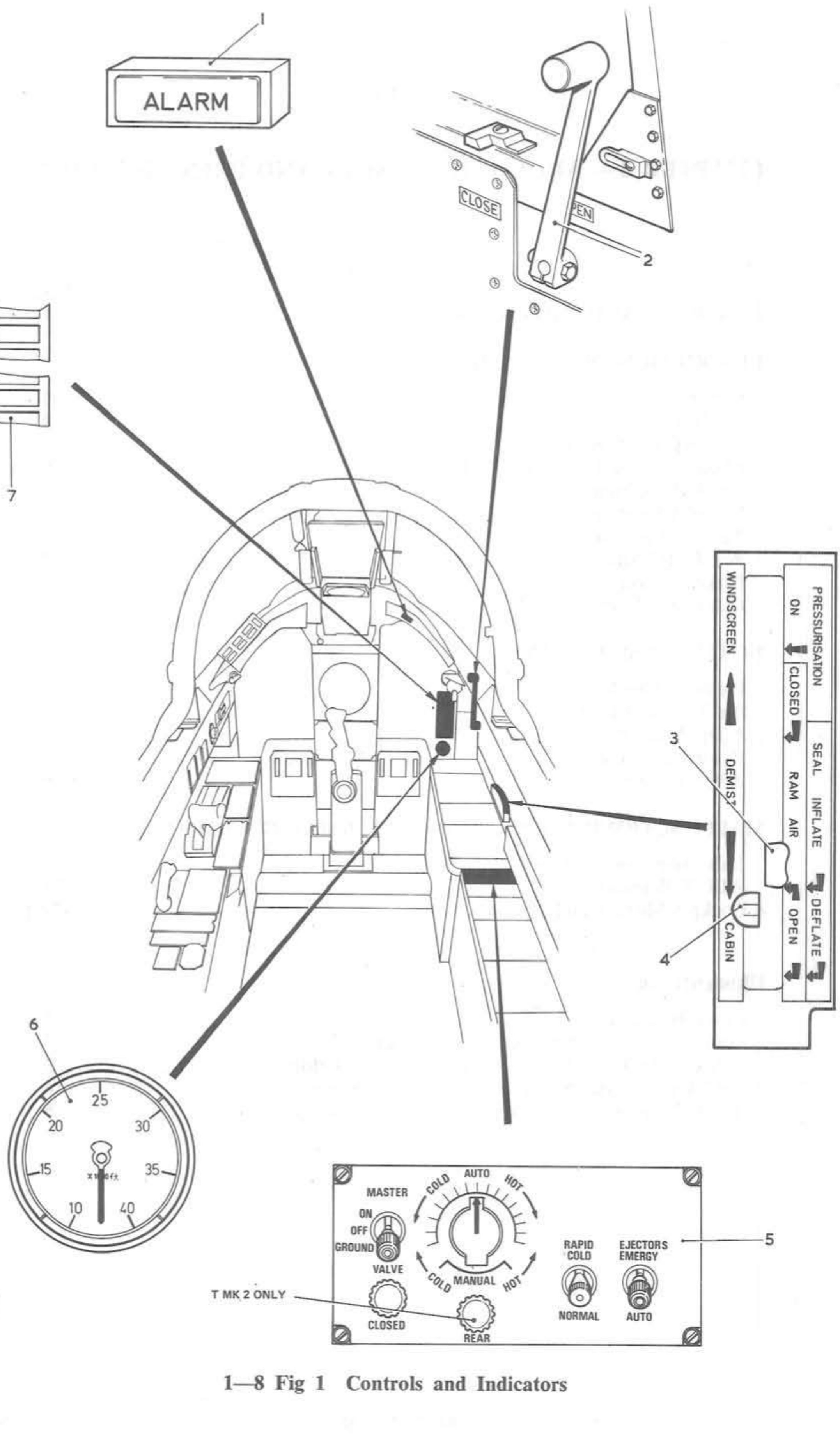


1—8 Fig 1 Controls and Indicators

CONTROLS AND INDICATORS

1. Details concerning the controls and indicators shown on Fig 1 are listed in Table 1.

Table 1 — Controls and Indicators

Item No	*Item*	*Location*	*Marking*	*Remarks*
1	Attention-getter	Right coaming	ALARM	Flashing red
2	Canopy locking handle	Right sill	—	—
3	Cabin air lever	Right console	Refer to Fig 1	—
4	Demisting control	Right console	DEMIST—WINDSCREEN/CABIN	—
5	Air conditioning control panel	Right console	Refer to Fig 1	—
6	Cabin altimeter	Main instrument panel—lower right	× 1,000 ft	5,000 ft graduations up to 40,000 ft
7	Cabin low pressure or canopy locking lever not fully forward warning	Centralised warning panel	C/PR $\bowtie$	Red warning plus audio alarm (see WARNING below)
	Air supply overheat warning		AIR T	Amber warning

WARNING: Irrespective of canopy position, movement of the canopy locking handle to SHUT extinguishes the C/PR warning, and allows canopy seal inflation.

DESCRIPTION OF THE SYSTEM

General

2. Air tapped from the final stage of the HP compressor of each engine is fed into a common duct, cooled, and fed to the canopy seal, cockpit interior and the front and rear equipment bays. Pressurisation is obtained by regulating the discharge to atmosphere of cockpit air. With the cockpit unpressurised, ram air can be fed into the cockpit for ventilation purposes.

Air Supply

3. Air from each engine passes via a non-return valve into a common duct (see Fig 2 or 3). The air flows successively through a primary heat exchanger, a main pressure regulating valve, an air conditioning unit comprising a cold air unit and a secondary heat exchanger, and a water extractor. When warmer air is required, the air conditioning unit and the secondary heat exchanger can be bypassed. Tappings in the duct supply the primary heat exchanger ejector, canopy seal inflation and the secondary heat exchanger ejector. The duct also includes temperature control sensors.

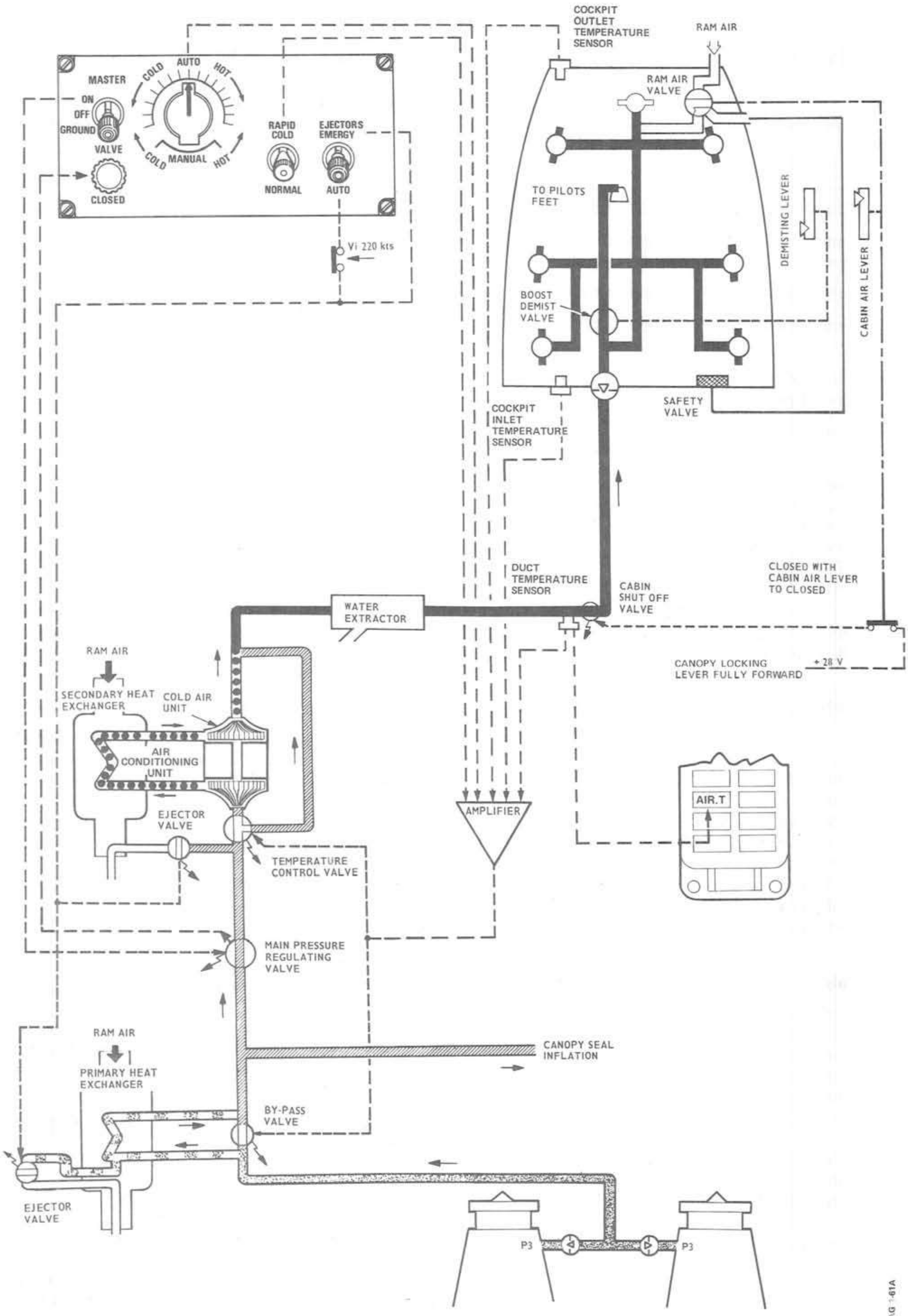
Primary Heat Exchanger

4. The primary heat exchanger provides initial cooling of the hot air from the engines. The air is diverted past the unit by a bypass valve positioned by the temperature control system to give hotter air when required. Cooling air through the matrix is ram air flow, augmented at low speeds or when on the ground by an ejector which induces an increased airflow through the primary heat exchanger. The ejector shut-off valve is controlled by the air conditioning MASTER switch and the EJECTORS—EMERGY/AUTO switch on the air conditioning control panel in conjunction with an airspeed switch; with the MASTER switch ON and the EJECTORS switch set to AUTO the ejectors shut-off valve is open below 220 knots $\bowtie$ and closed above this speed. Should the airspeed switch fail open, selecting the EJECTORS switch to EMERGY allows the ejectors to be operated.

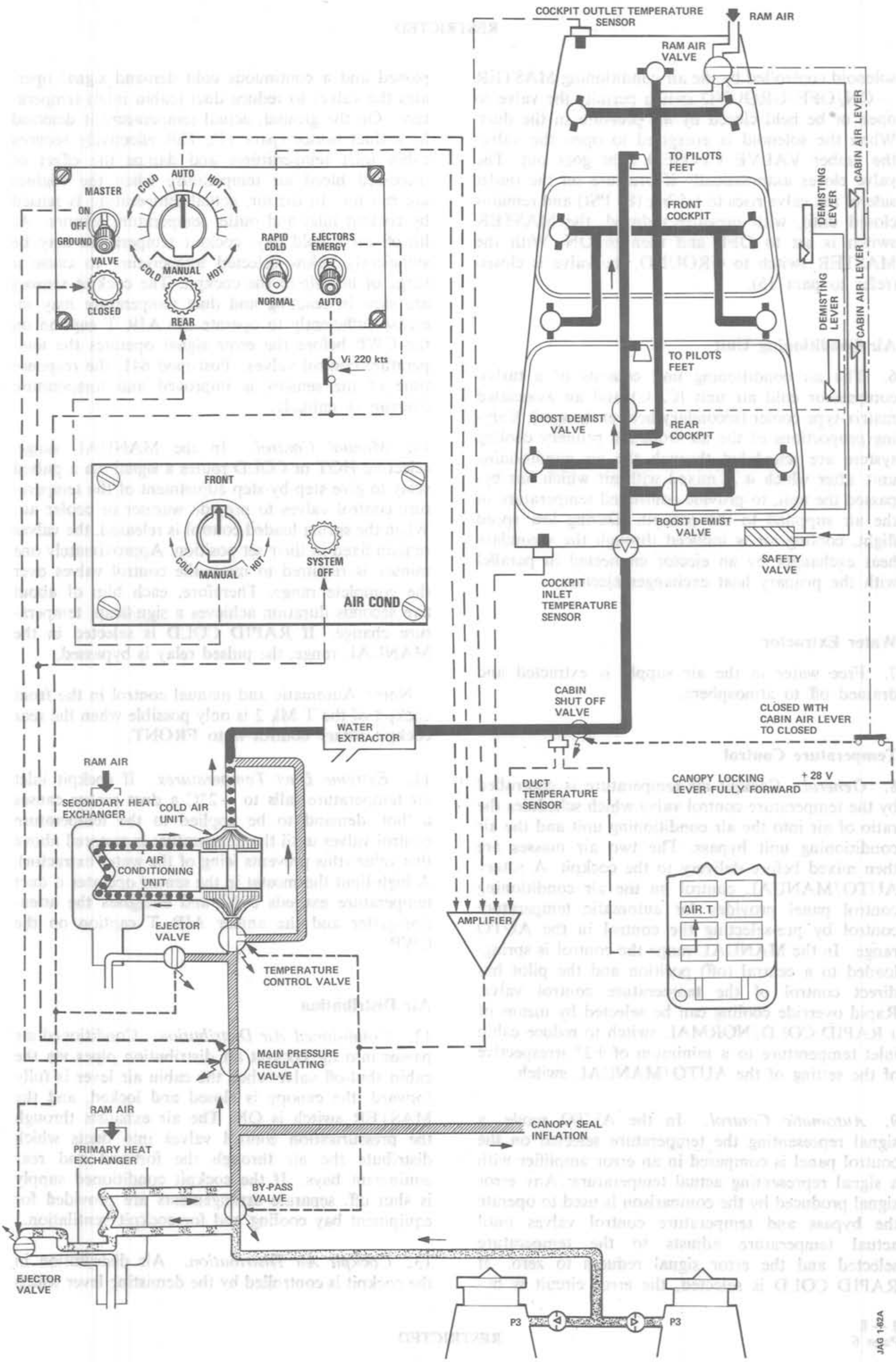
Note: EMERGY should not be selected above 220 knots.

Main Pressure Regulating Valve

5. The valve combines the functions of a pressure regulator and an on/off valve. A valve-operating



1—8 Fig 2 GR1 Air Conditioning Supply and Distribution



1—8 Fig 3 T Mk 2 Air Conditioning Supply and Distribution solenoid controlled by the air conditioning MASTER —ON/OFF/GROUND switch permits the valve to open or be held closed by air pressure in the duct. When the solenoid is energised to open the valve, the amber VALVE CLOSED light goes out. The valve closes automatically if pressure on the outlet side of the valve rises to 5·5 bar (80 PSI) and remains closed until, with pressure reduced, the MASTER switch is set to OFF and then to ON. With the MASTER switch to GROUND, the valve is closed (refer to para 15).

Air Conditioning Unit

6. The air conditioning unit consists of a turbo-compressor cold air unit (CAU) and an associated matrix-type cooler (secondary heat exchanger). Varying proportions of the air from the primary cooling system are scheduled through the air conditioning unit, after which it is mixed with air which has bypassed the unit, to provide controlled temperature of the air supplied to the cockpit. During low speed flight, cooling air is induced through the secondary heat exchanger by an ejector connected in parallel with the primary heat exchanger ejector.

Water Extractor

7. Free water in the air supply is extracted and drained off to atmosphere.

Temperature Control

8. *General.* Cockpit air temperature is controlled by the temperature control valve which schedules the ratio of air into the air conditioning unit and the air conditioning unit bypass. The two air masses are then mixed before delivery to the cockpit. A rotary AUTO/MANUAL control on the air conditioning control panel provides for automatic temperature control by pre-selecting the control in the AUTO range. In the MANUAL range the control is spring-loaded to a central (off) position and the pilot has direct control of the temperature control valve. Rapid override cooling can be selected by means of a RAPID COLD/NORMAL switch to reduce cabin inlet temperature to a minimum of +2° irrespective of the setting of the AUTO/MANUAL switch.

9. *Automatic Control.* In the AUTO mode, a signal representing the temperature selected on the control panel is compared in an error amplifier with a signal representing actual temperature. Any error signal produced by the comparison is used to operate the bypass and temperature control valves until actual temperature adjusts to the temperature selected and the error signal reduces to zero. If RAPID COLD is selected, the error circuit is bypassed and a continuous cold demand signal operates the valves to reduce duct (cabin inlet) temperature. On the ground, actual temperature is detected by a duct sensor (para 11). This effectively reduces cabin inlet temperatures and damps the effect of increased bleed air temperature when the engines are run up. In the air, actual temperature is sensed by cockpit inlet and outlet temperature sensors. At lift-off on a cold day, cockpit temperature may be sufficiently below selected temperature to cause a surge of hot air to the cockpit. The cockpit sensors are slow in reacting and duct temperature may increase sufficiently to operate the AIR T caption on the CWP before the error signal operates the temperature control valves. Post-mod 641, the response time of the sensors is improved and temperature overrun is unlikely.

10. *Manual Control.* In the MANUAL range, selecting HOT or COLD routes a signal via a pulsed relay to give step-by-step adjustment of the temperature control valves to provide warmer or cooler air. When the spring-loaded control is released, the valves remain fixed in their set position. Approximately one minute is required to move the control valves over the complete range. Therefore, each blip of about five seconds duration achieves a significant temperature change. If RAPID COLD is selected in the MANUAL range, the pulsed relay is bypassed.

Note: Automatic and manual control in the front cockpit of the T Mk 2 is only possible when the rear cockpit rotary control is to FRONT.

11. *Extreme Duct Temperatures.* If cockpit inlet air temperature falls to +2°C a duct sensor causes a 'hot' demand to be applied to the temperature control valves until the temperature is restored above this value (this prevents icing of the water extractor). A high-limit thermostat in the sensor operates if duct temperature exceeds 80°C and energises the attention-getter and the amber AIR T caption on the CWP.

Air Distribution

12. *Conditioned Air Distribution.* Conditioned air passes into the cockpit air distribution pipes via the cabin shut-off valve when the cabin air lever is fully forward, the canopy is closed and locked, and the MASTER switch is ON. The air exhausts through the pressurisation control valves into ducts which distribute the air through the forward and rear equipment bays. If the cockpit conditioned supply is shut off, separate arrangements are provided for equipment bay cooling and for cockpit ventilation.

13. *Cockpit Air Distribution.* Air distribution in the cockpit is controlled by the demisting lever which

changes the setting of the boost demist valve(s) as follows:

Fully back (CABIN)—Flow to the pilot's feet and flow to the windscreen and canopy (front cockpit canopy only on T Mk 2).

Fully forward (WINDSCREEN) — Full flow to the transparencies (including rear cockpit on T Mk 2), *no* flow to the pilot's feet.

Ram air from the forward facing intake can be fed into the distribution ducting via a valve controlled by the cabin air lever. The valve is open when the lever is set to RAM AIR OPEN and, at the same time, the safety valve is opened to obtain air circulation. When RAM AIR OPEN is selected, cabin pressurisation is de-selected: it is also possible to deflate the canopy seal with ram air selected. Ram air ventilation must not be selected at speeds above 400 knots. From physiological considerations, unpressurised flight with oxygen must be limited to 25,000 feet with up to 10 minutes between 25,000 and 30,000 feet.

14. *Equipment Bay Distribution.* With the cabin air lever fully forward, air exhausts from the cockpit into the front and rear equipment bays and is distributed through the bays for cooling purposes. When the lever is not fully forward or the canopy is unlocked, the cabin shut-off valve is closed and conditioned air tapped upstream of the cabin shut-off valve is routed direct to the equipment bays via individual bypass valves (Fig 4/5). A thermostat in each equipment bay air outlet operates if the temperature reaches 57° ±3°C and opens both bypass valves to promote rapid cooling irrespective of other conditioning demands; the thermostats reset, closing the valves, at 42° ±3°C.

15. *Equipment Bay Ground Cooling.* An alternative facility is provided to cool equipment located in the forward equipment bay, and the rear equipment bay. This facility should be used whenever the electrical systems are operated without the engines running, or when the use of conditioned air from the engines is unacceptable (eg AIR T caption, or during take-off when the 2 to 5% loss of thrust due to use of compressor air is undesirable). On the GR1 it consists of a 'cooling' door and two AC powered fans on the right side of the fuselage nose for the forward equipment bay. On the T Mk 2, a 'cooling' door and fan are provided on the right side of the fuselage nose for the forward bay and a cooling fan and associated shut-off valves to the rear of the left ammunition bay for the rear equipment bay. With the MASTER switch on the air conditioning panel set to GROUND the engine air supply is shut off and ambient air is drawn through into the bay(s) by by the fans and ducted to the equipment. The GROUND position should not be selected unless the aircraft is below 25,000 feet and speed is below 400 knots: above this speed, adequate cooling cannot be guaranteed and, on the GR1, the laser cooling door may be damaged.

15A. *Laser Ventilation (GR1 only).* The Laser head is installed in a separate compartment in the aircraft nose and the compartment is provided with two separate automatic ventilating systems.

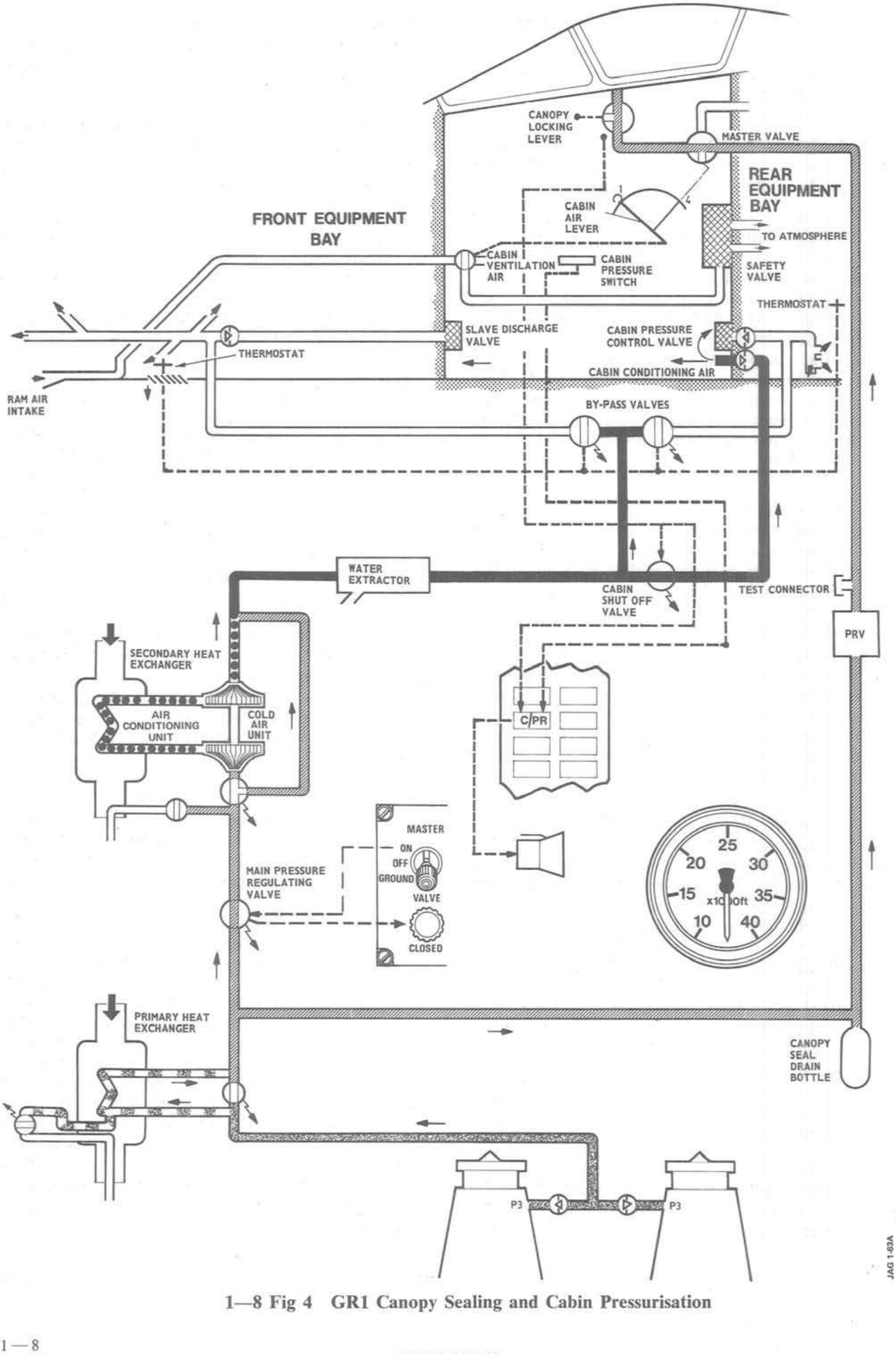
a. *Equipment Cooling.* The Laser head is cooled by air from the slave discharge valve when the air conditioning master switch is to ON or by air from an AC powered fan which draws ambient air through a cooling door on the left side of the fuselage nose when the air conditioning master switch is to GROUND. The air exhausts into the front equipment bay.

b. *Laser Compartment Ventilation.* This system recirculates the air in the compartment by means of an AC powered fan when the Laser Mode switch is to TS or LR. The fan draws air through a heat exchanger and feeds it past a heater element and over the Laser window to ensure demisting. The heater is switched on and off by a thermostat (35±3°C) located at the heat exchanger inlet. If compartment temperature rises to 45±3°C a thermostat opens a valve to direct air from the cockpit air supply through the heat exchanger matrix to cool the Laser compartment air. If the temperature of the air close to the Laser window rises to 60±3°C (eg due to skin friction heating) the heater is switched off irrespective of compartment air temperature. Should the fan fail, a fourth thermostat switches off the heater to protect the duct and its lagging from overheating.

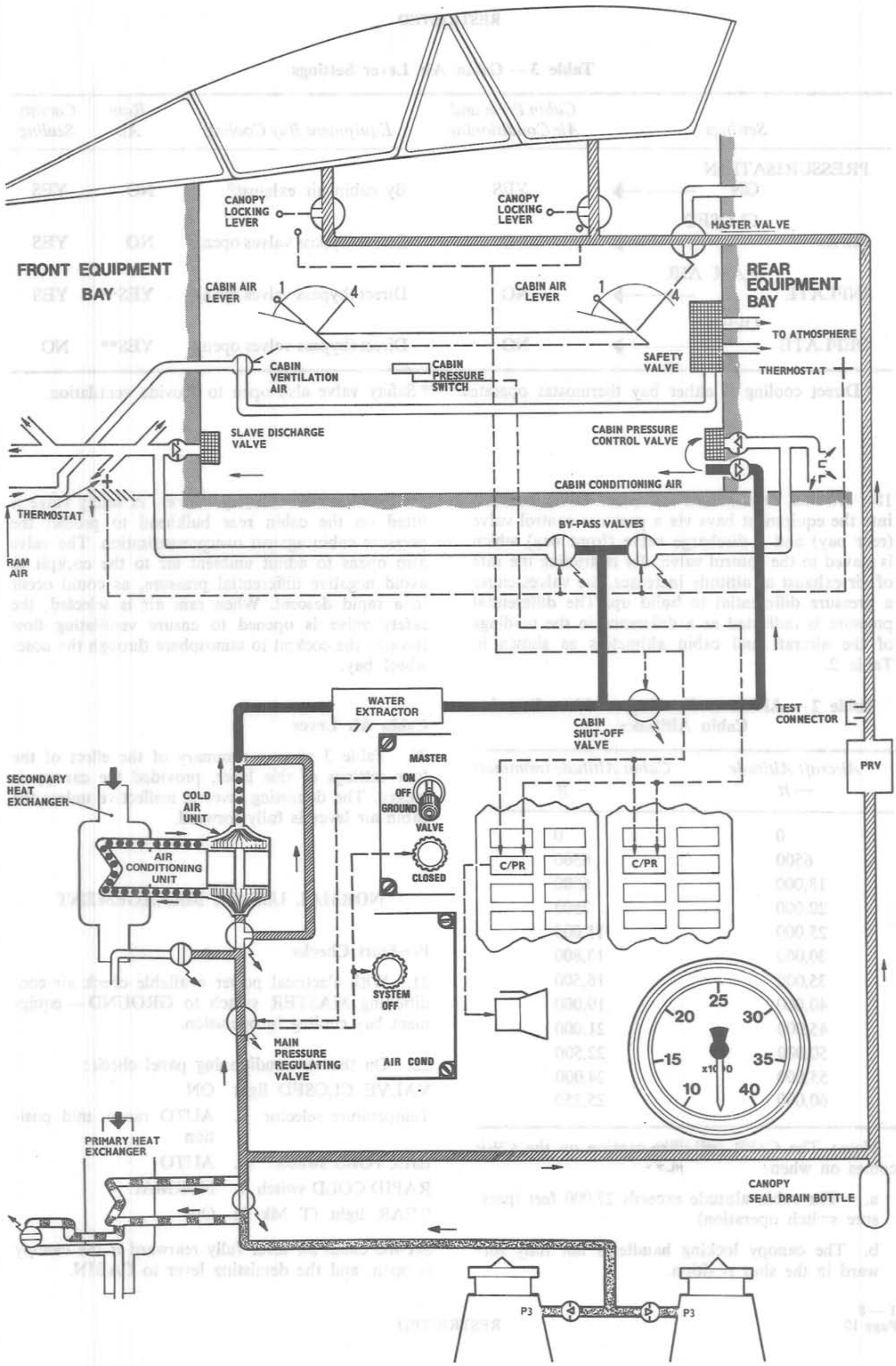
Pressurisation (Fig 4 and 5)

16. *General.* With the canopy sealed, the cabin is automatically pressurised to a value related to aircraft altitude, by restricting the release of conditioning air into the equipment bays.

17. *Canopy Sealing.* The canopy seal cannot be inflated unless the canopy locking lever is fully forward; the final movement of the handle sets the canopy seal on/off valve to the 'on' position. Air tapped from the supply duct between the primary heat exchanger and the main pressure regulating valve passes through a pressure reducing valve to a valve connected to the cabin air lever. When the lever is fully back, the sealing air supply is shut off and the seal is vented to atmosphere. With the lever at any other setting, the valve routes the air supply to the canopy seal on/off valve and if the canopy locking handle is forward, the seal inflates. The canopy seal is deflated by moving the cabin air lever fully back or by unlocking the canopy (see also Chapter 12).



1—8 Fig 4 GR1 Canopy Sealing and Cabin Pressurisation



1—8 Fig 5 T Mk 2 Canopy Sealing and Cabin Pressurisation

Table 3 — Cabin Air Lever Settings

Settings	*Cabin Press and Air Conditioning*	*Equipment Bay Cooling*	*Ram Air*	*Canopy Sealing*
PRESSURISATION ON ⟶	YES	By cabin air exhaust*	NO	YES
CLOSED SEAL ⟶	NO	Direct (bypass valves open)	NO	YES
RAM AIR INFLATE ⟶	NO	Direct (bypass valves open)	YES**	YES
OPEN DEFLATE ⟶	NO	Direct (bypass valves open)	YES**	NO

* Direct cooling if either bay thermostat operates. ** Safety valve also open to provide ventilation.

18. *Normal Pressurisation Control.* Air exhausts into the equipment bays via a pressure control valve (rear bay) and a discharge valve (front bay) which is slaved to the control valve. By restricting the rate of air exhaust as altitude increases, the valves cause a pressure differential to build up. The differential pressure is indicated as a difference in the readings of the aircraft and cabin altimeters as shown in Table 2.

Table 2 — Altimeter Readings — Aircraft and Cabin Altitudes

Aircraft Altitude — ft	*Cabin Altitude (nominal) — ft*
0	0
6500	6500
18,000	6500
20,000	7500
25,000	11,000
30,000	13,800
35,000	16,500
40,000	19,000
45,000	21,000
50,000	22,500
55,000	24,000
60,000	25,250

Note: The C/PR ~~(PRESS)~~ caption on the CWP comes on when: ALS.

a. The cabin altitude exceeds 27,000 feet (pressure switch operation).

b. The canopy locking handle is not fully forward in the shut position.

19. *Pressurisation Safety Valve.* A safety valve is fitted on the cabin rear bulkhead to protect the pressure cabin against overpressurisation. The valve also opens to admit ambient air to the cockpit to avoid negative differential pressure, as could occur in a rapid descent. When ram air is selected, the safety valve is opened to ensure ventilating flow through the cockpit to atmosphere through the nosewheel bay.

Cabin Air Lever

20. Table 3 gives a summary of the effect of the four settings of this lever, provided the canopy is locked. The demisting lever is ineffective unless the cabin air lever is fully forward.

NORMAL USE OR MANAGEMENT

Pre-Start Checks

21. With electrical power available check air conditioning MASTER switch to GROUND — equipment bay cooling in operation.

22. On the air conditioning panel check:

VALVE CLOSED light	ON
Temperature selector ...	AUTO range, mid position
EJECTORS switch ...	AUTO
RAPID COLD switch ...	NORMAL
REAR light (T Mk 2)	Out

Set the cabin air lever fully rearward if the canopy is open, and the demisting lever to CABIN.

Pre-Taxying Checks

23. Close and lock the canopy, if required, check C/PR caption on CWP goes out. Check MASTER switch GROUND and cabin air lever fully forward. Check VALVE CLOSED light on.

Note: If the canopy is secured on the strut, the cabin air lever should remain in the DEFLATE position. The C/PR caption remains on unless the canopy locking handle is moved fully forward.

After Take-Off Checks

24. After take-off set the air conditioning MASTER switch to ON and check that the VALVE CLOSED light is out. Check cabin air lever fully forward and that pressure differential builds up on schedule.

Before Landing

25. Below 6500 feet check that cabin differential pressure is approximately zero. If a single-engine landing is to be carried out, set the air conditioning MASTER switch to GROUND.

After Landing

26. Set the air conditioning MASTER switch to GROUND. Before unlocking the canopy set the cabin air lever to the fully back position.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

27. Indications and actions in the event of system malfunctioning are listed in Table 4.

AIR T Warnings

28. In certain circumstances it is possible for the automatic temperature control system to demand such a high cabin inlet temperature that an AIR T warning is generated. This is most likely to occur when the ejectors are on at high altitude and when warming up a cold cabin. In these cases airspeed should be increased to above the ejector operating speed. If an AIR T warning occurs when the cabin air lever is fully forward and the cabin inlet air flow is of normal volume and temperature, the warning is spurious.

Cockpit Misting and Fogging

29. Misting is the condensation on cockpit surfaces: fogging occurs when free water droplets are suspended in the air. In conditions where both the temperature and water vapour content are high, severe fogging can be experienced below 1000 feet when the dewpoint at ground level exceeds +16°C (+20°C post-mod 891/STI Jaguar 114). Selection of ram air only aggravates the problem and reducing engine power can also increase the amount of fog.

30. If cockpit misting or fogging occurs in flight, climb to safety height, raising the visor and wiping the HDD attitude indicator/HUD if necessary, then:

If misting

Temperature control ... MANUAL, HOT
Demist control ... ... WINDSCREEN

If fogging

Cabin air lever ... ... RAM AIR CLOSED (until fog clears)
Temperature control ... MANUAL, HOT
Cabin air lever ... ... Forward

If visual flight or reference to the HDD attitude indicator or HUD is impossible and aircraft safety is at immediate risk, the canopy should be jettisoned.

Table 4 — Malfunctioning or Use in Abnormal Conditions

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
LOSS OF PRESSURISATION			
Attention-getter flashes and audio warning C/PR caption on CWP	Confirm air conditioning MASTER switch ON and VALVE CLOSED light out. Check canopy correctly locked and cabin air lever fully forward	Check cabin altitude:	
		1. If cabin altitude below 27,000 feet, land as soon as practicable avoiding violent manoeuvres and high speeds	1. Canopy locking may be faulty
		2. If cabin altitude above 27,000 feet descend to below 25,000 feet	2. If no air entering cockpit from air conditioning system refer to 'Loss of Cockpit Conditioning'

(continued)

Table 4 — *continued*

Indicating	*Immediate Action*	*Subsequent Action*	*Considerations*
LOSS OF COCKPIT CONDITIONING			
No air entering cockpit from conditioning system. VALVE CLOSED light may be on (and SYSTEM OFF light—T2 rear cockpit)	Check MASTER switch ON and cabin air lever fully forward	If VALVE CLOSED light on, select MASTER switch to OFF and then ON. If fault persists, reduce altitude to below 25,000 feet then select MASTER switch to GROUND (below 400 kt)	Below 400 knots ram air ventilation may be used if required
TEMPERATURE CONTROL FAILURE			
Cabin temperature control unstable or not responding to selection	Confirm rear cockpit controller to FRONT (T Mk 2). Select temperature control to MANUAL	Use short blips of control to HOT or COLD as required. If fault remains below 25,000 feet, set MASTER switch to GROUND. If still no control on T Mk 2, attempt control from rear cockpit	Below 400 knots, ram air ventilation may be used if required
EXCESSIVE CABIN INLET TEMPERATURE			
Attention-getter flashes. AIR T caption on CWP lit. Note: If cabin air lever fully forward and cockpit air flow of normal volume and temperature, warning is spurious.	◀ Cancel warning. If above 220 knots set temperature control to AUTO COLD	If the fault persists select RAPID COLD. If the fault still persists set temperature control to MANUAL and apply short blips of control in the COLD direction. If condition still persists descend to below 25,000 feet and select MASTER switch to GROUND (below 400 kt)	Below 400 knots, ram air ventilation may be used if required ▶◀
	If below 220 knots select EJECTORS to EMERGY	Carry out the 'above 220 knots procedure ▶	
FUMES IN THE COCKPIT			
Fumes in the cockpit	Adjust mask and select 100% oxygen. Descend below 25,000 feet	If fumes appear to come from the air conditioning outlet, select cabin air lever to RAM AIR CLOSED ◀ If associated with an AIRT caption, reduce speed below 400 knots and set the MASTER switch to GROUND ▶	Below 400 knots use ram air ventilation if required

PART 1

CHAPTER 9 — FLIGHT INSTRUMENTS

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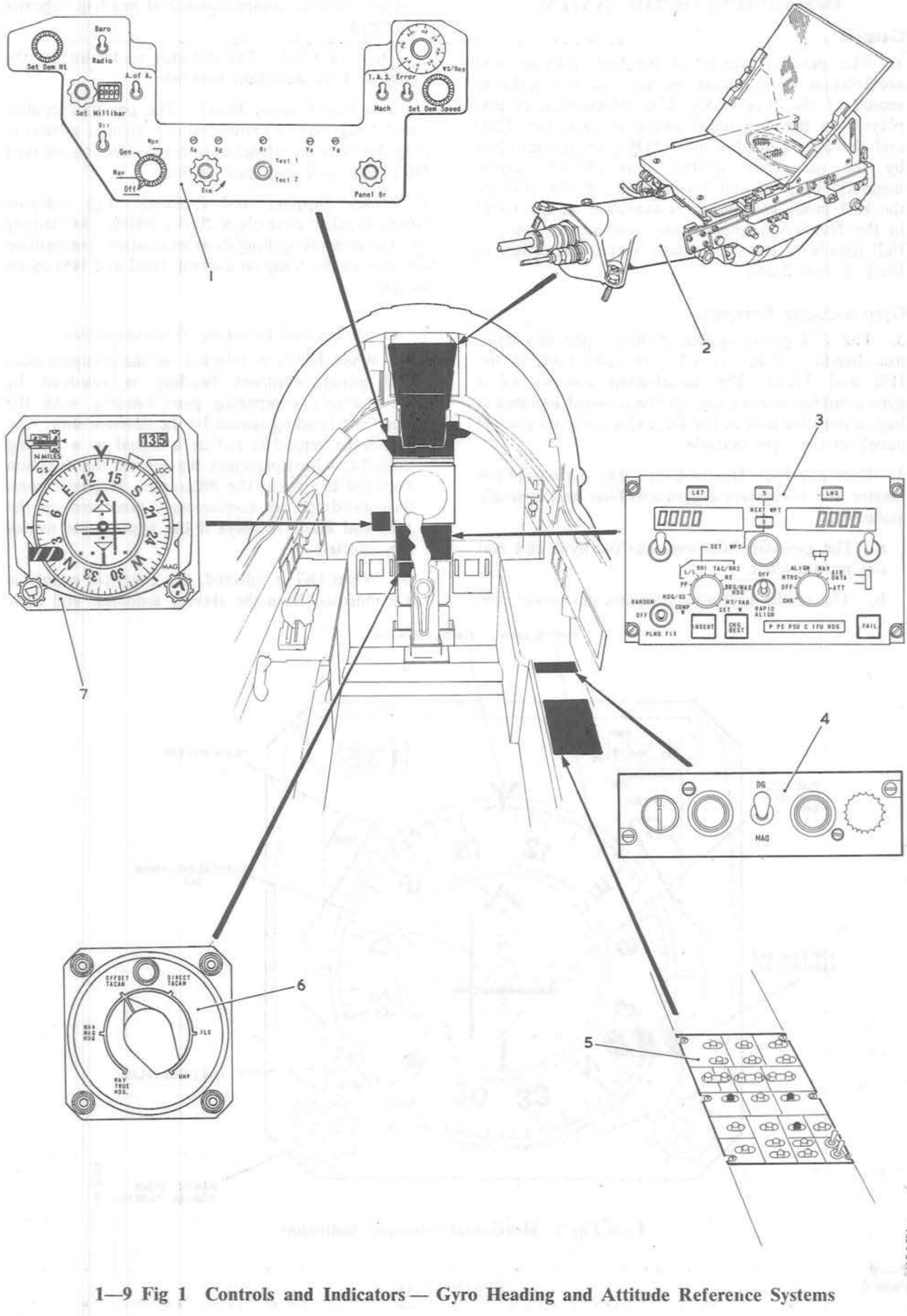
GYRO HEADING AND ATTITUDE REFERENCE SYSTEMS

CONTROLS AND INDICATORS

1. Details concerning the controls and indicators shown in Fig 1 are listed in Table 1.

Table 1 — Gyro Heading and Attitude Reference Systems, Controls and Indicators

Item No	*Item*	*Location*	*Marking*	*Remarks*
1	Pilot's control panel	Centre coaming	—	—
2	Pilot's display unit	Above centre coaming	—	—
3	Navigation control unit	Centre console	—	—
4	Compass control panel	Right console	—	—
5	5A circuit breaker 5A circuit breaker 7·5A circuit breaker	Circuit breaker panel on the right console	HUD COMPASS PLATFORM HTRS	5A, AC 5A, AC 7·5A, AC
6	HSI mode switch	Centre console	—	—
7	Horizontal situation indicator	Instrument panel	—	Aircraft heading, bearing and range indicator



1—9 Fig 1 Controls and Indicators — Gyro Heading and Attitude Reference Systems

DESCRIPTION OF THE SYSTEM

General

2. The primary source of heading, attitude and acceleration information is the inertial velocity sensor of the NavWASS. The information is displayed on the horizontal situation indicator (HSI) and the pilot's display unit (PDU) when controlled by the navigation control unit (NCU). Gyro-magnetic heading can be selected on the HSI by the HSI mode switch and is available on the HUD in the NavWASS general and reversionary modes. Full details of the Nav/Attack system are given in Book 2, Part 2 and 3.

Gyro-magnetic Compass

3. The C2J gyro-magnetic compass provides compass heading or directional gyro indications to the HSI and HUD. The installation consists of a gyro-amplifier master unit in the forward equipment bay, a detector unit in the fin and a compass control panel on the right console.

4. *Gyro-amplifier Master Unit.* The gyro-amplifier master unit comprises a gyro-amplifier and a cradle assembly.

a. The gyro-amplifier contains the gyro unit and slaving amplifier.

b. The cradle assembly contains the power converter, remote compensator and heading repeater systems.

5. *Detector Unit.* The detector unit contains the magnetic field detection network.

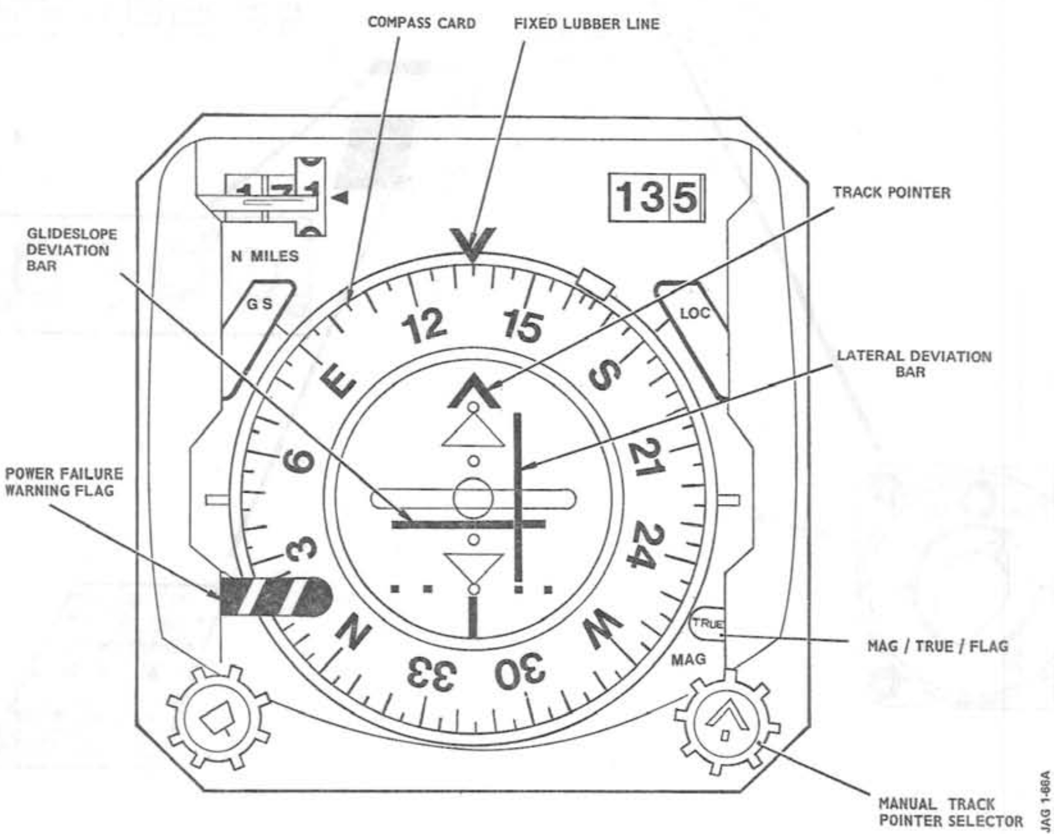
6. *Compass Control Panel.* The compass control panel comprises an annunciator, a manual synchronising knob, a mode selector control switch marked DG/MAG and two panel lights.

7. *Power Supplies and Lighting.* The compass circuit breaker controls a 200V, 400Hz, AC supply and the integral lighting dimmer controls the lighting supplies to the compass control panel and HSI mode switch.

8. *Operation and Compass Synchronisation.*

a. When MAG is selected on the compass control panel, compass heading is resolved by continuously comparing gyro heading with the magnetic heading sensed by the detector unit. Any difference sensed is fed as a signal to a slaving amplifier which precesses the gyro in the direction required to correct the difference. Magnetic compass headings are continuously presented on the HSI and HUD displays if the appropriate modes are selected.

b. When DG is selected, the electrical supply is disconnected from the slaving amplifier and con-



1—9 Fig 2 Horizontal Situation Indicator sequently no comparison and correction is made, so the system is provided with directional gyro indications only.

Note: With DG selected, the gyro precesses and readings should be compared periodically with the standby compass.

c. With MAG selected, the system synchronises automatically but it does so slowly. Rapid synchronisation is achieved by rotating the synchronising knob in the direction indicated by the annunciator pointer. The pointer is central when the compass system is synchronised.

Horizontal Situation Indicator (HSI)

9. The heading repeater system provides heading information to the compass card of the HSI (Fig 2) and to the pilot's display unit of the HUD.

10. A detailed description of the complete HSI presentation is given in the Aircrew Manual Book 2.

NORMAL USE OR MANAGEMENT

Nav/Attack System

11. Details concerning operation and indicator sequences are contained in Book 2, Part 3.

Gyro-magnetic Compass

12. *Preliminaries.*

a. Check that the COMPASS and HUD circuit breakers are set.

b. Select GEN mode on the pilot's HUD control panel.

c. Select DIRECT TACAN on the HSI mode switch.

13. *MAG Mode.*

a. Select MAG mode on the compass control panel DG/MAG switch.

b. Check the annunciator and synchronise as necessary.

c. Compare the compass readings on the HSI and HUD with the standby compass indication and ensure readings are within ± 5 degrees. (This check is carried out with the canopy closed.)

d. To compare the compass heading with NavWASS magnetic heading, the inertial platform alignment and HSI magnetic mode selection procedures must be carried out. Refer to Book 2, Part 3.

Note: Compass accuracy during straight and level flight is ± 3 degrees but is subject to large turning errors; the pilot should not attempt to adjust the instrument to remove these transient errors. Gyro limitations are 85 degrees in pitch and roll. In the unlikely event of the gyro toppling it is re-erected automatically by the internal levelling circuits. This can take up to 6 minutes. During re-erection the aircraft should be flown straight and level.

14. *DG Mode.* During flight, should the directional gyro display be required, the following switch position must be selected:

a. Compass control panel — DG/MAG selector to DG.

b. HSI mode selector — to DIRECT TACAN, ILS or UHF.

c. Pilot's HUD control panel — selector switch to GEN.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

15. Indications and actions relating to system malfunctions are given in Table 2.

Table 2 — Gyro Heading and Attitude Reference Systems Malfunctions

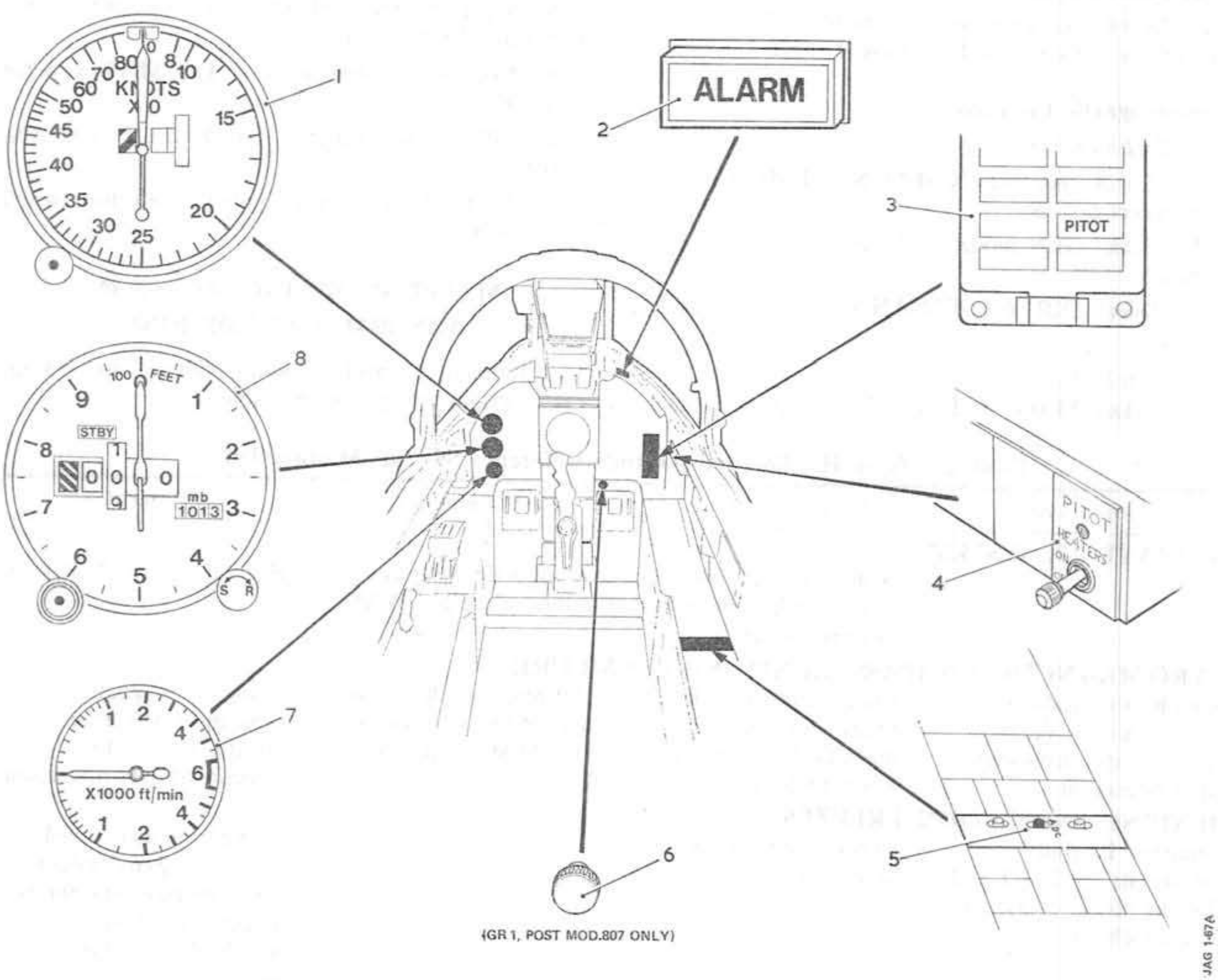
Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
NAV/ATTACK SYSTEM			
	Automatic reversion to gyro magnetic compass heading takes place should failure of the NavWASS heading occur.		Refer to Book 2, Part 3
GYRO-MAGNETIC COMPASS MONITORING FAILURE			
Annunciator indications remain central during turns or synchronising knob operation	Check compass circuit breaker and ensure that the DG/MAG switch is set to MAG	If circuit breaker is set and MAG selected, set DG/MAG switch to DG	Compass magnetic heading monitoring failure. Revert to directional gyro operation
HEADING INDICATION FREEZES			
Compass heading indications on HUD and HSI do not alter during heading change	Check compass circuit breaker is set	—	Possible power supply failure or gyro failure. The compass system is inoperative. Use NavWASS or standby compass

PITOT-STATIC SYSTEM
CONTROLS AND INDICATORS

16. Details concerning the controls and indicators shown in Fig 3 are listed in Table 3. Pitot probes and static vents are shown on Fig 4.

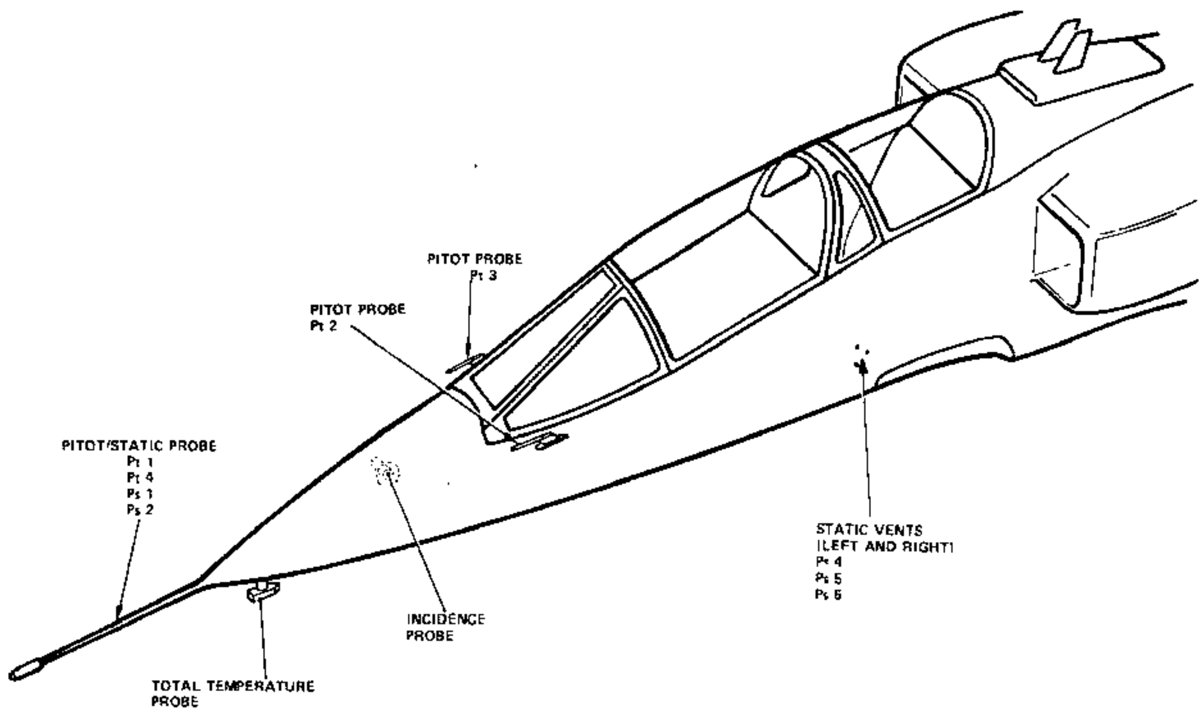
Table 3 — Pitot-Static System Controls and Indicators

Item No	*Item*	*Location*	*Marking*	*Remarks*
1	Combined speed indicator (CSI)	Instrument panel	—	—
2	Attention-getter	Right coaming	ALARM	Flashing red
3	Pitot warning lamp	CWP	PITOT	Amber caption
4	Pitot heaters switch	Right sill	PITOT HEATERS—ON/OFF	—
5	Circuit breaker	Circuit breaker panel	ADC	—
6	Static supply changeover control	Instrument panel	—	Push-pull control
7	Vertical speed indicator (VSI)	Instrument panel	—	—
8	Altimeter	Instrument panel	—	—

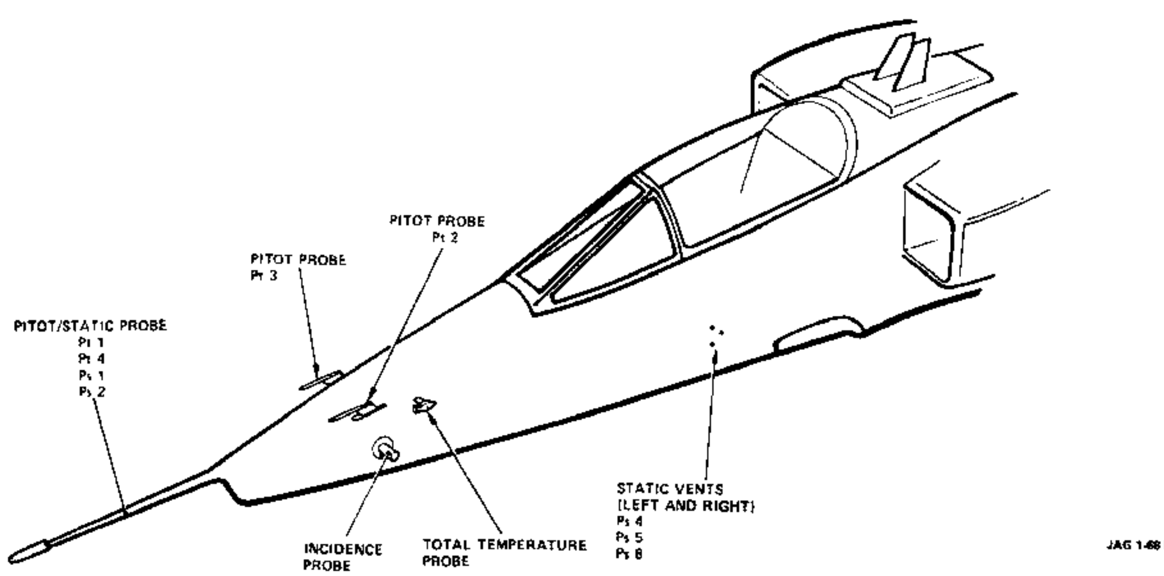


1—9 Fig 3 Controls and Indicators — Pitot/Static System

T 2



GR 1



1—9 Fig 4 Probe and Vent Locations

DESCRIPTION OF THE SYSTEM

General

17. The pitot and static pressures are sensed by probes and vents on the forward fuselage. The pitot-static and pitot probes are heated electrically. The system supplies pitot-static information to the flight instruments and to other equipment shown in Fig 5 (GR1): Fig 6 (T Mk 2).

Pitot-Static Pressure Supplies

18. Pitot and static pressures are utilised as shown in Fig 5 and 6. Post-mod 807 (GR1 only) a normal (in)/emergency (out) control is fitted below the right instrument panel to enable the pilot to select an alternative static source for the altimeter (standby mode) and VSI, thereby retaining basic flight instruments in the event of nose pitot-static probe failure.

Probe Heating

19. The pitot probe and pitot-static probe heating elements are supplied from the emergency DC busbar and are controlled by the PITOT HEATERS switch. The same switch controls a relay which, when energised, routes a supply from the No 1 AC busbar to the total temperature probe and a further DC supply to the angle of attack probe heater elements. Failure of any of the pitot probe heaters causes the attention-getter to operate and the PITOT caption to appear on the CWP. There is no warning of failure of the incidence or total temperature probe heaters.

Air Data System

20. The air data computer (ADC) supplies air data signals to the altimeter, CSI, IFF transponder, and Nav/Attack systems as shown on Fig 5 (GR1) and Fig 6 (T Mk 2). The air data signals are derived from the pitot pressure, static pressure, and air temperature inputs. Air data outputs comprise baro-height, indicated airspeed (IAS), true airspeed (TAS) and mach number.

21. *Air Data Computer.* The ADC is in the nose of the aircraft. It is a transducer-computer system consisting of the following principal modules:

An altitude transducer which converts static pressure into a baro-height electrical signal.

An airspeed transducer which operates on the same principle as the altitude transducer but produces an equivalent IAS electrical signal derived from pitot and static pressures.

A computing and output module which by mechanical resolution produces a mach number output.

In addition, a combination of the mach number and air temperature compensation is used to compute a TAS output. An altitude encoder is fitted within the unit and provides altitude code signals to the IFF transponder.

Altimeter

22. The Mk 29A altimeter is calibrated from 0 to 60,000 feet and indicates the ADC baro-height output (reset mode), derived from the Ps 2 source, or on reversion to the standby mode, baro-height output from a capsule in the altimeter fed from Ps 1 (or Ps 6 on GR1). In the standby mode, a vibrator is automatically switched on to reduce the effects of static friction. The standby mode can be selected manually or is selected automatically by an integral monitor in the event of:

(a) Primary power failure.

(b) Servo amplifier failure.

(c) Servo motor failure.

(d) Detection circuit failure.

(e) A pressure difference equivalent to about 4000 feet at sea level between ADC output and Mk 29A altimeter static input. This value increases rapidly with increase in aircraft altitude.

22A. The instrument comprises the following:

a. A barometric pressure setting knob and barometric pressure setting indicator graduated in millibars.

b. Altitude indicators consisting of digit drums for tens of thousands, thousands and hundreds of feet and a pointer traversing the dial which is graduated at 50 foot intervals.

c. An S/R control knob for selecting the standby (S) or reset (R) ADC mode.

d. A STBY flag which appears following reversion to standby mode.

e. A hatched black on white display which appears on the tens of thousands of feet drum for altitudes less than 10,000 feet.

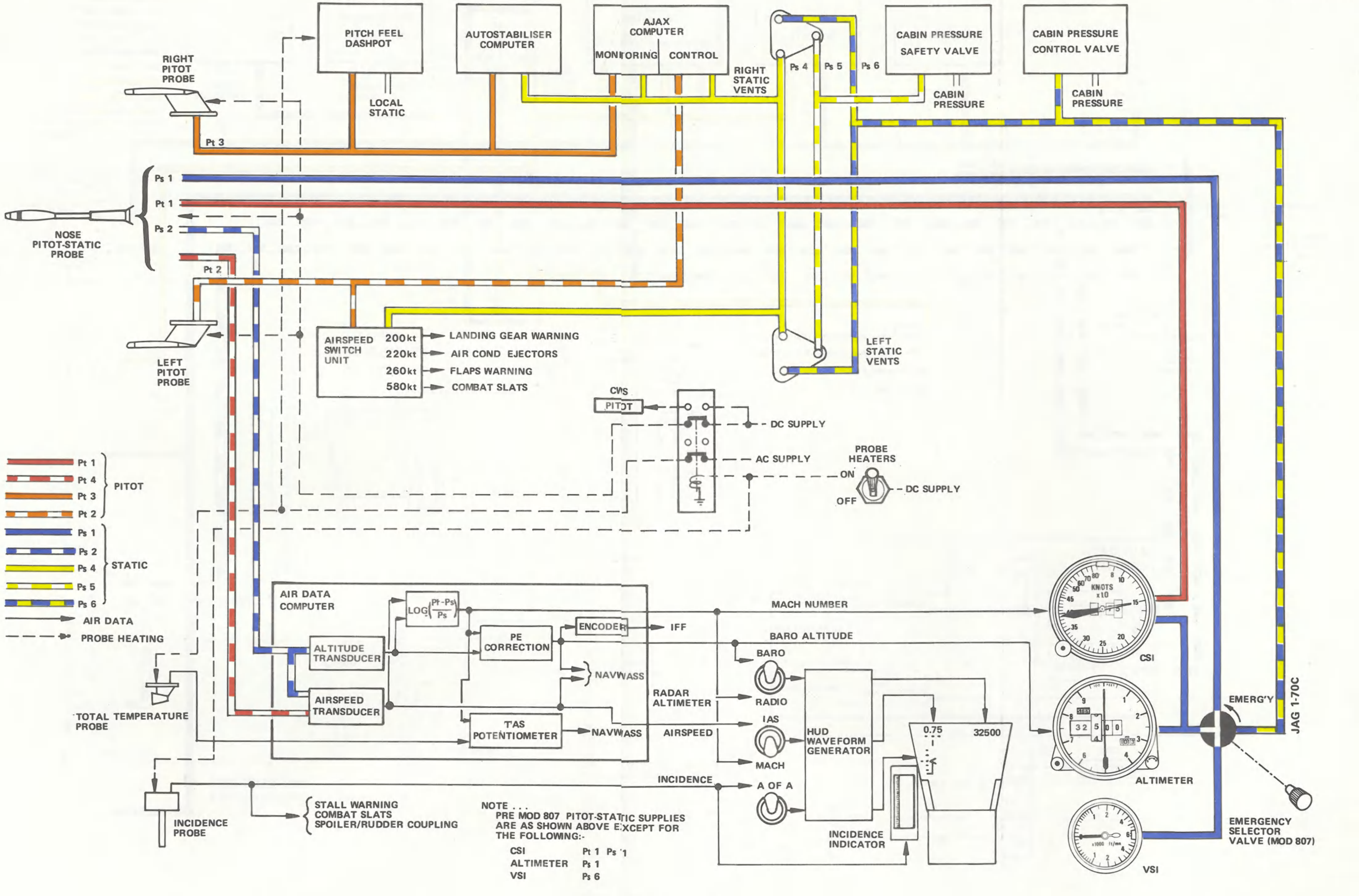
f. A hatched white on red display appears on the same drum for negative altitudes.

Vertical Speed Indicator

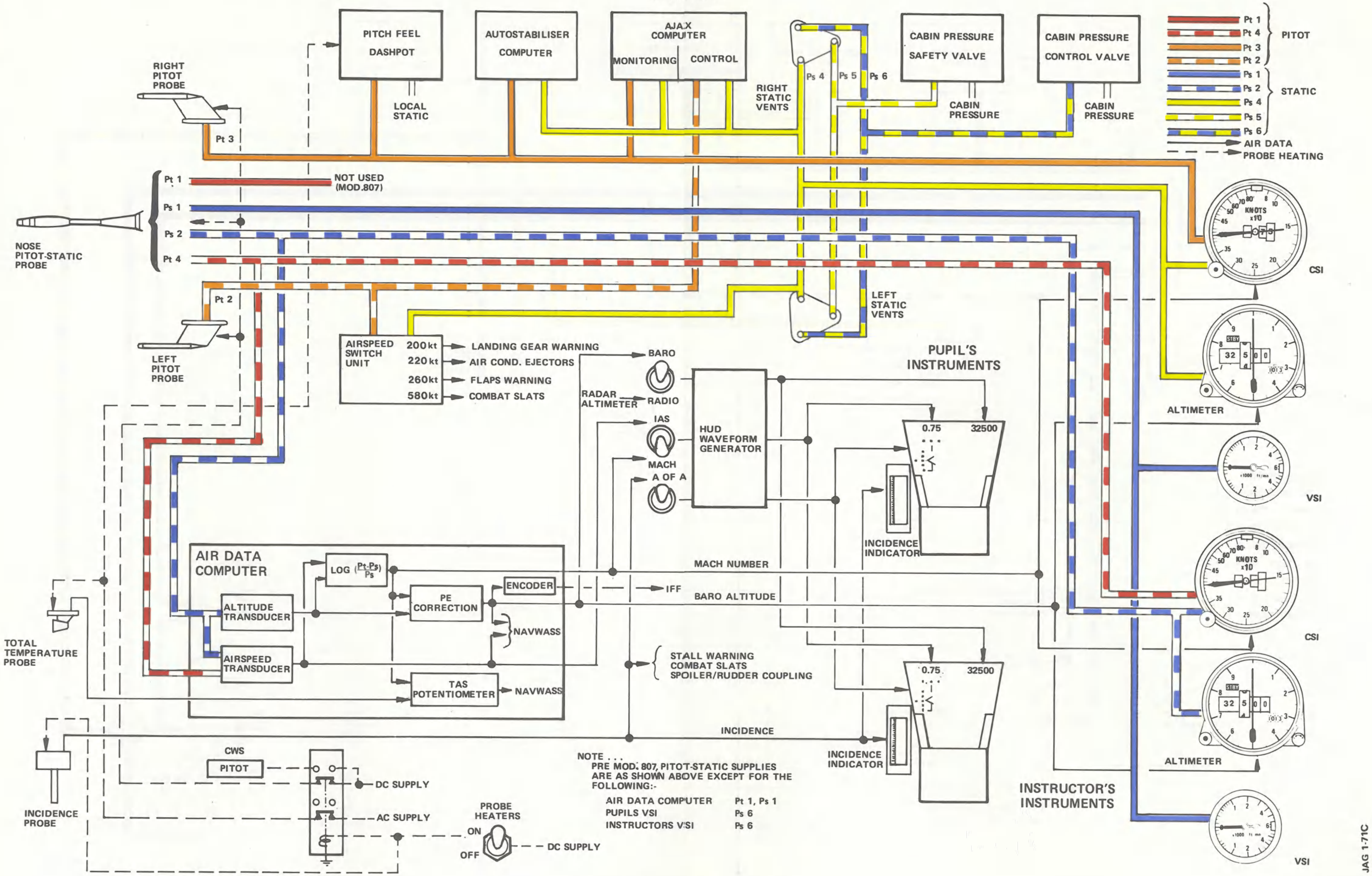
23. The VSI is on the main instrument panel. It is supplied with static pressure and the calibrated range is from 0 to ± 6000 feet per minute. The graduated scale is non-linear and more open near zero.

Combined Speed Indicator

24. The CSI consists of a capsule-driven airspeed indicator together with a servo-driven machmeter. Indicated airspeed is derived from pitot and static pressures (para 18) and indicated by a pointer on a



1 – 9 Fig 5 GR1 Pitot/Static System
◀*Combat slat switching amended*▶



1 – 9 Fig 6 T Mk 2 Pitot/Static System

◀*Combat slat switching amended*▶

dial graduated from 80 to 800 knots. A movable index can be set to any required airspeed by an index control knob. A mach number (M) signal is supplied from the ADC and presented on a three drum digital counter which has an indication range from 0·5 to 2·97M. Power failure warning is provided by a hatched red and black shutter which covers the units drum. A separate black shutter covers the tenths and hundredths drum below 0·5M.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

25. *Static Supply Changeover Control.* During the internal checks, ensure control is in the normal (in) setting.

26. *Pitot Heaters.* Before take-off, set the PITOT HEATERS switch to ON and check that the PITOT caption on the CWP goes out.

27. *Altimeter.* Carry out the following checks:

a. Ensure the air data computer (ADC) circuit breaker is set.

b. Set the barometric setting scale to QFE and switch to R. Check the altimeter reading.

c. Check the altimeter indications in the reset and standby modes and ensure the readings agree.

d. Check that the HUD circuit breaker is set and select the HUD mode selector switch to GEN.

e. Select the BARO/RADIO switch to BARO and set the QFE on the barometric indicator on the pilot's control panel.

f. Check that the height indications of the HUD and altimeter agree when reset mode is selected. Use the altimeter in the standby mode.

Note: During flight, and particularly prior to an instrument descent, compare the indications of HUD baro-height and the HDD altimeter in the reset and standby modes.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

28. Indications and actions relating to the system malfunctions are given in Table 4.

Table 4 — Pitot-Static System Malfunctions

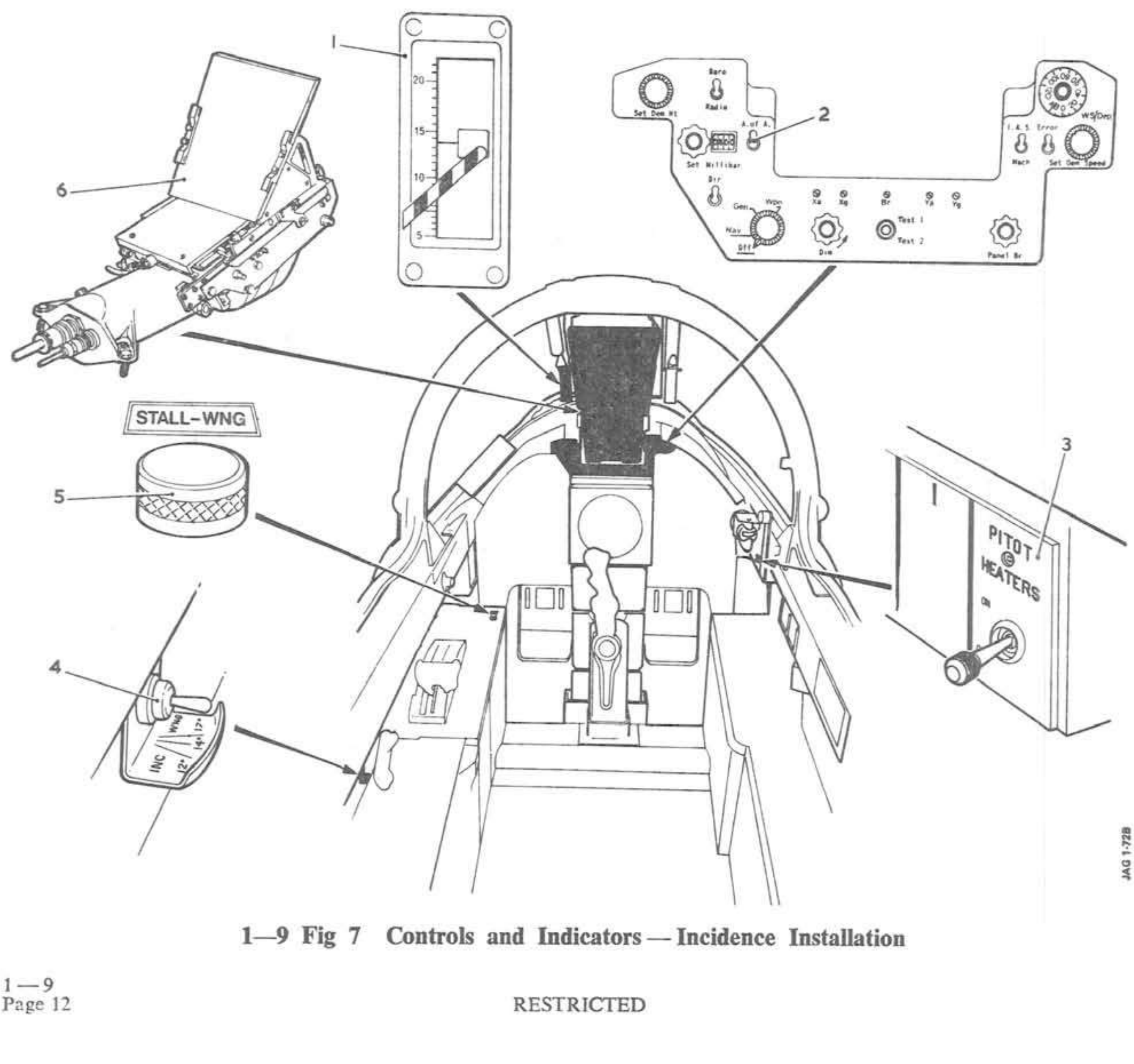
Indications	*Immediate Action*	*Considerations*
ALTIMETER FAILURES		
The STBY warning flag does not clear when control knob is to R (reset)	Check that the ADC circuit breaker is set	Possible altimeter power failure or altimeter servo system failure
CSI FAILURE		
Power failure warning flag appears over mach counters	Check the ADC circuit breaker is set	If the ADC circuit breaker is set and the ADC mach output satisfactory (verify on HUD) mach system feed to CSI failure has occurred and only IAS indication is available
NOSE PITOT-STATIC PROBE FAULT		
Pitot-static instrument malfunction	*GR*1 *only, post-mod* 807 Pull out static supply changeover control. Set altimeter to S	Loss of or damage to nose probe. Control provides alternative static source
PITOT HEATERS FAILURE		
PITOT caption on CWP: attention-getter flashes	Check PITOT HEATERS switch set to ON	Possible pitot heaters supply or heater failure

INCIDENCE INSTALLATION
CONTROLS AND INDICATORS

29. Details concerning the controls and indicators shown in Fig 7 are listed in Table 5.

Table 5 — Incidence Installation Controls and Indicators

Item No	*Item*	*Location*	*Marking*	*Remarks*
1	Incidence indicator	Windscreen support — left	—	Combined angle/light indicator
2	Pilot's control panel	Main instrument panel — centre	Switch marked A of A	—
3	Pitot heating switch	Sill above right console	PITOT HEATERS — ON/OFF	—
4	Stall warning incidence selector switch	Sill above left console	INC WNG—12°/14°/17°	—
5	Stall warning switch, indicator (mod 792)	Left console—forward	STALL — WNG	Combined lamp and push/pull switch
6	Pilot's display unit	Above centre coaming	—	—



1—9 Fig 7 Controls and Indicators — Incidence Installation

DESCRIPTION OF THE SYSTEM

General

30. Knowledge of incidence angles during flight allows precise control throughout the flight envelope and provides warning of an approaching stall during the landing phases and during combat at high altitudes.

Incidence Installation

31. *Incidence Probe.* The incidence probe consists essentially of a tube which projects horizontally from the nose (Fig 4). The tube is free to rotate. Slots are cut along the length of the tube and the dynamic pressures sensed via these slots are applied to either side of a vane which is attached to the tube (Fig 8). The vane moves to equalise these pressures and is thus aligned with the air flow direction. The angular deviation between the aerodynamic axis of the probe fixed relative to the aircraft axis and the relative airflow direction, is transmitted by two potentiometers, one feeding the HUD and the other feeding the incidence indicator, the auto 'combat' slat system, the spoiler/rudder coupling system and the stall warning tone generator. Probe heating is controlled by the PITOT HEATERS switch. There is no indication on the failure warning panel of probe heating failure.

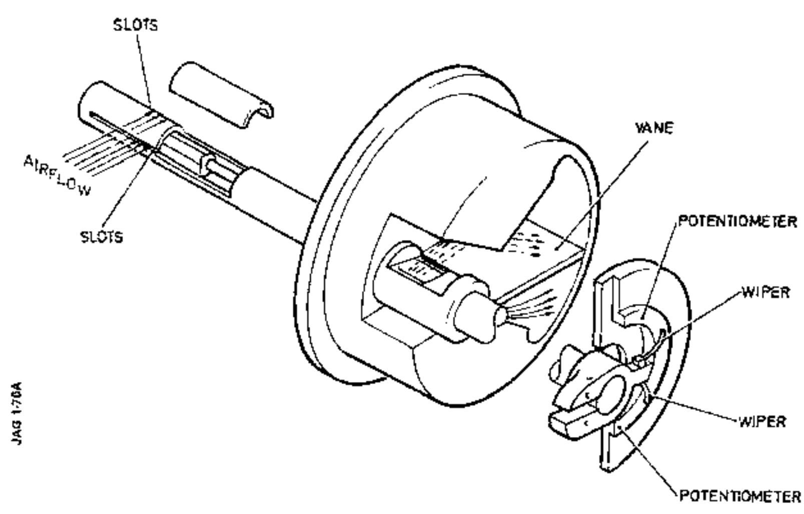
32. *Incidence Indicator.* The instrument is connected to the incidence probe potentiometer. It consists of a case with a tape having a white band. The end of the white band, which is the datum for reading the instrument, moves in front of a vertical scale graduated in degrees. A window let into the tape passes successively in front of four coloured indicator lights which correspond to the following incidence values:

blue	7·5 to 10·5 degrees
green	10·5 to 13·5 degrees
amber	13·5 to 16·5 degrees
red	16·5 to 22 degrees

The centre of the window corresponds to the edge of the white band, and the height of the window spans 3 degrees incidence. The lights are controlled by the dimmer above the indicator. The instrument also contains a damping device to filter out rapid variations of small amplitude (±0·7 degree approximately) caused by turbulence; in contrast, for large variations (a change of load factor for example) the instrument is automatically undamped to avoid any lag in the indications. A red and black hatched flag appears across the dial in the event of a power supply failure or if the servo circuit fails.

Note: The flag may appear at incidence angles below 2 degrees.

33. *Stall Warning Tone Generator* (*Post-mod* 792). A stall warning tone generator, interfaced with the incidence system, provides an audio warning tone via the CCS. The tone generator emits a low frequency warbling tone at a nominal 14 degrees incidence, the tone frequency increasing as incidence is increased until, at a nominal 17 degrees incidence, the tone volume is also increased. The tone thresholds are scheduled with rate-of-change of incidence, being progressively advanced as rate-of-change of ◀ incidence is increased. When SRIM 3975 is embodied, the warning range values are 12° and 15° ▶



1—9 Fig 8 Incidence Probe

respectively to relate to recce pod limitations. The tone generator can be switched off by pulling up on the STALL-WNG switch. An amber light, integral with the switch, comes on when the switch is pulled: brightness of the light is adjusted by rotating its cap.

33A. *Stall Warning Tone Generator* (*Post-mod* 919). A stall warning tone generator, interfaced with the incidence system, provides an audio tone via the CCS. A 3-position INC WNG (incidence warning) switch enables the incidence at which the warning is to be triggered, to be set to 12°, 14° or 17°; the selector is only operative when flap selection is less than 20°. With flap set to 20° or more, the warning occurs at 17° incidence irrespective of switch selection. The warning can occur up to 3° before the nominal preset incidence depending on the rate of increase of incidence. The tone generator can be switched off by pulling up on the STALL WNG switch. An amber light, integral with the STALL WNG switch, comes on when the switch is pulled; brightness of the light is adjusted by rotating its cap.

34. *Incidence Displays* (*HUD*). The HUD is connected to one incidence probe potentiometer via the HUD waveform generator. Incidence indications are shown on the pilot's display unit when the A of A toggle switch on the pilot's control panel is set to ON. For further details on the HUD incidence display refer to Book 2, Part 2.

35. *Electrical Supplies.* The electrical supply for probe heating is from No 1 AC busbar and system operation supply is from the emergency DC busbar. An additional reference supply to the HUD incidence output potentiometer is derived from the waveform generator.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

36. During the external inspection, remove the rubber sleeve which is provided to cover the probe tube when the aircraft is on the ground and check the condition of the probe. Check the correct operation of the indicator scale and the dimmer controls. Leave the probe in mid-position. During the internal checks, test the STALL-WNG light by pulling the switch. Press the switch to restore system operation and check light goes out. Set the INC WNG switch to the required setting.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Incidence Indication Malfunction

37. If the failure warning flag appears on the incidence indicator, check the indication on the HUD. If there is no indication, the system is inoperative and the CSI should be used for the remainder of the flight.

Note: Post-mod 805, the incidence gauge reads 1° to 1½° lower than the HUD incidence indicator during an increase in incidence. Pre-mod 805, incidence gauge lags of up to 6° are possible at high rates of pitch.

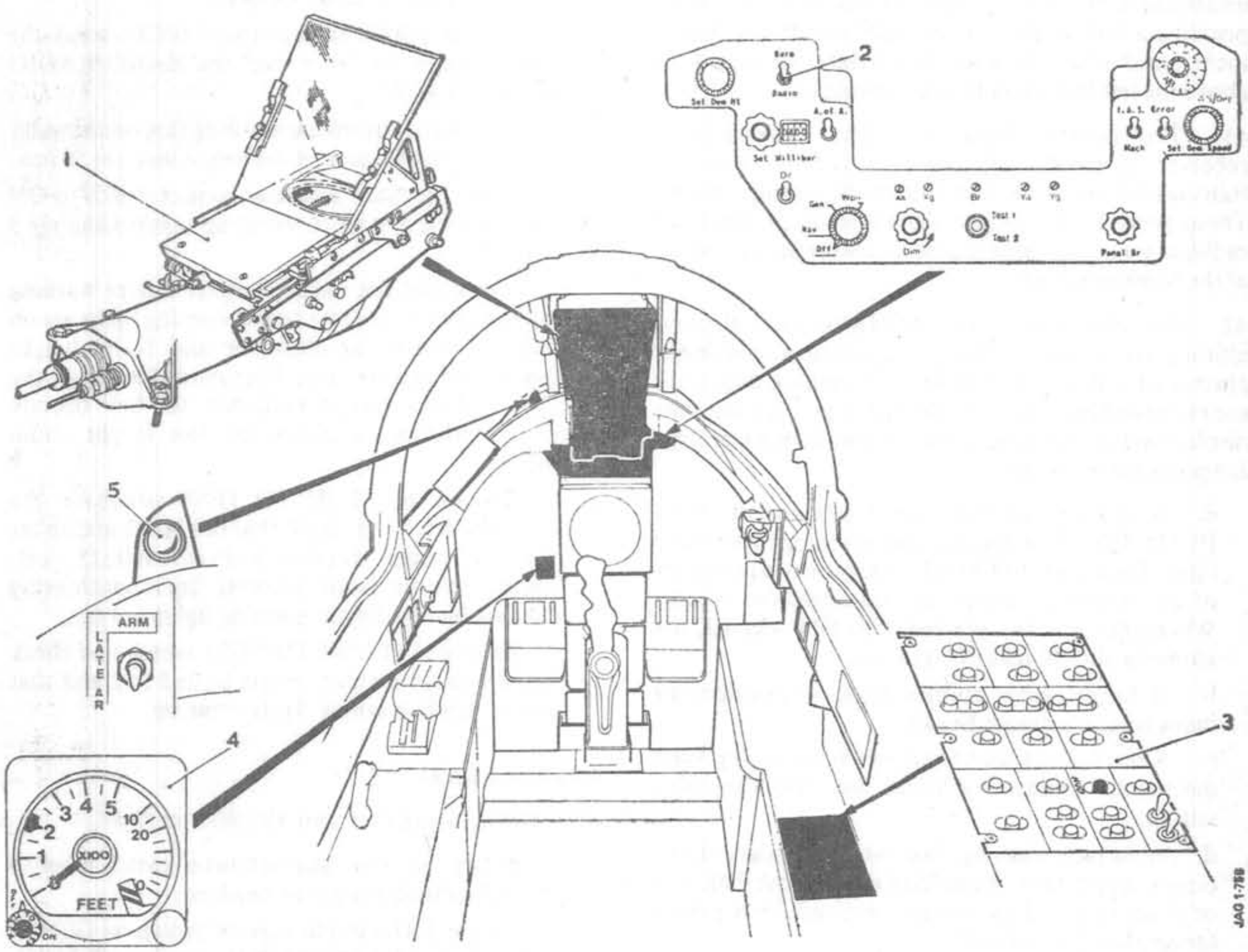
RADAR ALTIMETER SYSTEM

CONTROLS AND INDICATORS

38. Details concerning the controls and indicators shown in Fig 9 are listed in Table 6.

Table 6—Radar Altimeter System Controls and Indicators

Item No	*Item*	*Location*	*Marking*	*Remarks*
1	Pilot's display unit	Above centre coaming	—	—
2	Pilot's control panel	Centre coaming	BARO/RADIO	—
3	Circuit breaker	Circuit breaker panel	HUD	5A
4	Radar altimeter	Left instrument panel	—	—
5	Low height warning light	Left instrument panel coaming	—	Amber light



1—9 Fig 9 Controls and Indicators—Radar Altimeter System

DESCRIPTION OF THE SYSTEM

General

39. The radar altimeter system derives aircraft height data from the leading edge reflection principles of a pulsed radar system. This information is displayed by the radar altimeter indicator and the head up display. The presentation indicates the aircraft's height above the flight path terrain. To obtain valid displays, the roll and pitch angles must be limited to ±60° over good reflective surfaces such as sea. For terrain with poorer reflectivity, such as sandy surfaces, lower manoeuvre angles may be necessary to maintain valid signals.

Note: If height lock is lost as a result of manoeuvres in excess of ±60°, head up and head down displays of radar height may not be reliable after lock is gained.

System Equipment

40. The radar altimeter (ARI 23232) system consists of a transmitter/receiver in the forward equipment bay, transmitter and receiver aerial units flush with the underside of the aircraft nose, an indicator unit incorporating a low height warning light on the left instrument panel and a repeater low height warning light above the left instrument panel coaming.

41. *Transmitter/Receiver.* The transmitter/receiver assembly contains the radio frequency transmission reception and altitude measuring circuits. These produce the height signals resolved from the radiated pulses of the transmitted and reflected signals at the receiver aerials.

42. *Indicator Unit.* The indicator unit displays altitude by a single pointer traversing a non-linear graduated scale of 0 to 5000 feet. The scale graduations are expanded between 0 to 500 feet to provide accurate displays at low altitudes. Controls and failure warnings are provided as follows:

a. A two-position ON/OFF rotary switch with a PUSH TO TEST facility and an integral warning light. The PUSH TO TEST facility provides a check of all except the aerial and transmission circuits. When the switch is pressed with ON selected, the altimeter should read 100±15 feet.

b. A height index control knob to position the index to give a datum height.

c. A red light in the switch which comes on when the pointer indicates a height less than the index setting.

d. A failure warning flag which appears if the power supply fails, the pointer reads above 5000 feet or if no reflected signals are received for a period longer than 0·3 second.

42A. *Low Height Warning Light.* When mod 955 is embodied, an amber warning light is fitted above the left instrument panel coaming. The light is wired in parallel with the indicator unit light and its brightness is adjusted by rotating its cap.

42B. *Low Height Audio Warning.* Post-mod 1098, audio warning is provided when the aircraft descends below the height index set on the radar altimeter, providing the STALL-WNG switch is in the operate position (down).

43. *Power Supplies and Lighting Controls.* The ON/OFF switch controls the supply of 115V, single-phase 400 Hz from No 1 AC busbar.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

44. With a power supply available check the radar altimeter as follows:

a. Set the HUD circuit breaker.

b. On the pilot's control panel (PCP) select the mode selector to NAV and the BARO/RADIO switch to RADIO.

c. Check that the failure warning flag on the radar altimeter is visible and set the height index to 50 feet.

d. Select the radar altimeter control switch to ON and allow the system to warm up (approximately 3 minutes).

e. Check that the radar altimeter failure warning flag has cleared, the low height warning lights are on and that the radar altimeter and HUD height displays indicate 0±5 feet. Post-mod 1098, move the STALL-WNG switch/indicator to the operate (down) position to check the low height audio warning.

f. Operate the PUSH TO TEST switch on the radar altimeter and check that the HUD and radar altimeter height displays indicate 100±15 feet. Confirm that the failure warning flag is not showing and that the low height warning lights are out.

g. Release the PUSH TO TEST switch and check that the height display reverts to 0±5 feet and that the low height warning lights come on.

In-Flight Checks

45. Before using the radar altimeter in flight:

a. Check that the radar altimeter switch is set to ON and set height index as required.

b. Set the HUD mode selector switch to GEN or NAV and the BARO/RADIO switch to RADIO.

c. Check that the aircraft height above flight path terrain is displayed on the HUD and radar altimeter.

d. Post-mod 1098, set the STALL-WNG switch/indicator to the operate position (light out) if low height audio warning is required.

Note: The low height audio warning system is to be treated as an advisory aid and never used as a primary means of height keeping.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

46. Indications and actions relating to system malfunctions are given in Table 7.

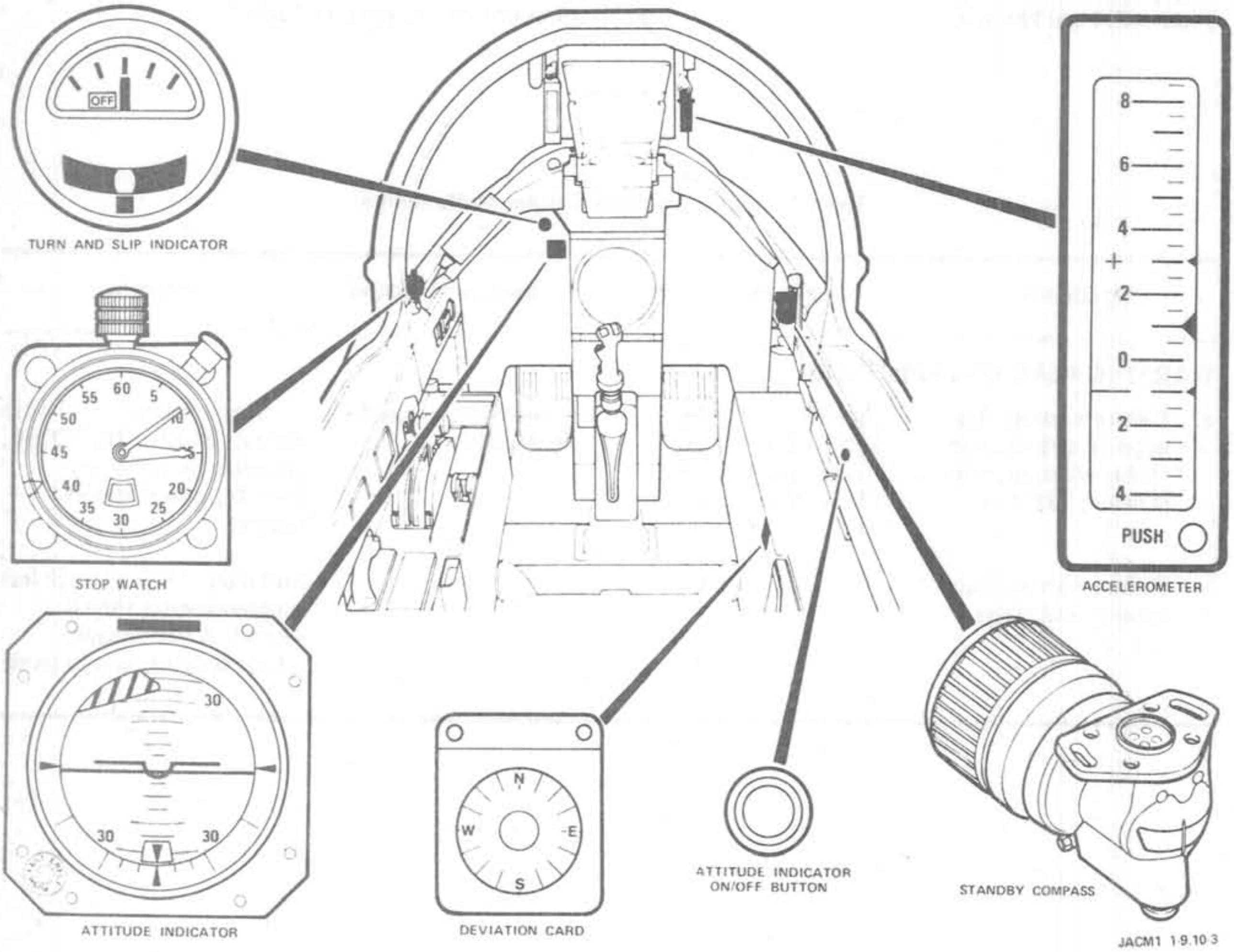
Table 7—Radar Altimeter System Malfunctions

Indications	*Immediate Actions*	*Subsequent Actions*	*Remarks*
WARNING FLAG ON INDICATOR			
a. Failure warning flag appears and remains visible when aircraft is below 5000 feet	Operate the PUSH TO TEST knob; check failure flag disappears. Check circuit breaker set	If flag remains visible switch OFF	If flag remains visible during PUSH TO TEST, system is inoperative (possible power supply failure)
b. Failure warning flag appears and clears	—	—	Momentary loss of track has occured greater than 0·3 second. Automatically regained during search mode

STANDBY AND MISCELLANEOUS INSTRUMENTS

CONTROLS AND INDICATORS

47. Details concerning the controls and indicators are shown in Fig 10.



1—9 Fig 10 Controls and Indicators—Standby and Miscellaneous Instruments

(Mod 1014 embodied)

DESCRIPTION OF THE SYSTEMS

Attitude Indicator

48. *General.* The attitude indicator (Fig 11) is an electrically driven gyroscopic instrument which provides continuous indication of aircraft attitude in pitch and roll. The natural horizon is represented by the division of a sphere into sectors, blue (above horizon) and black (below horizon). The aircraft is represented by a green coloured aircraft symbol fixed to the centre of the instrument glass. The pitch scale is graduated in 5° steps and shown as white marks in both sectors. The roll pointer traverses a scale graduated in 10° steps up to 30° then in two 30° steps to 90°. The instrument has full freedom in roll but is pitch limited to 82° nose-up (but see Note) and 73° nose down (+3° – 0°).

Note: When a later model of instrument, identified by a green rectangle on the bezel, is fitted, the nose-up limit is increased to 91°.

49. *Electrical Supplies.* The power supply is 115V, single-phase 400 Hz from the essential instrument AC busbar. A red and black striped flag appears at the top left of the instrument whenever power is off. The instrument takes its power from the static inverter after total AC failure and therefore operates automatically when the battery is switched on before normal AC power is available. A push-pull ATT IND button is fitted above the centre of the right console post-mod 1014. This enables the instrument to be isolated during servicing, thus reducing ground running time. An integral amber light indicates when the switch is open.

Note: In the T Mk 2, the rear cockpit attitude indicator is not wired through the static inverter.

49A. *Lighting at Night.* When attitude indicator FH 14 is fitted the following warning applies:

WARNING: In night conditions it may not be possible to distinguish between the blue and black portions of the attitude indicator sphere using red cockpit lighting alone. Ensure that the UV lighting is switched on and operating before flight at night.

Modification action replaces attitude indicator FH 14 with attitude indicator FH 31. The latter has a light blue upper half, eliminating the problem of distinguishing between the blue and black portions of the sphere under red light alone.

50. *Fast Erection.* A fast erection button at the bottom left of the instrument can be used to erect the gyro after starting if required, or in the air if the gyro has toppled.

Note: The fast erection button must only be used when the aircraft is straight and level.

Standby Compass

51. The standby compass is a magnetic compass providing compass heading to ±2° of aircraft magnetic heading. Aircraft heading is displayed on a compass card graduated in 10° steps which moves against a lubberline. An internal lamp controlled by an adjacent dimmer provides scale lighting. A deviation card is provided. For limitations as to use and factors which affect the validity of readings, refer to Parts 2A and 2B.

Turn-and-Slip Indicator

52. The turn-and-slip indicator is a miniaturised unit having a pointer which indicates the direction and rate of turn and a ball which indicates slip or skid. The rate scale is graduated to represent rate ½, 1 or 2 turns. The gyro is supplied with 115V from No 2 AC busbar and is energised whenever the busbar is live.

Accelerometer

53. The accelerometer provides a vertical display over a range of minus 4 to +9 g. The main pointer (yellow) indicates the instantaneous value and sign of the acceleration component. Two pointers (white), indicate the maximum positive and negative values attained. A resetting button is provided which, when pressed in 1g conditions, brings the white pointers into coincidence with the main pointer. An integral light is controlled by a dimmer above the incidence indicator.

Stopwatch

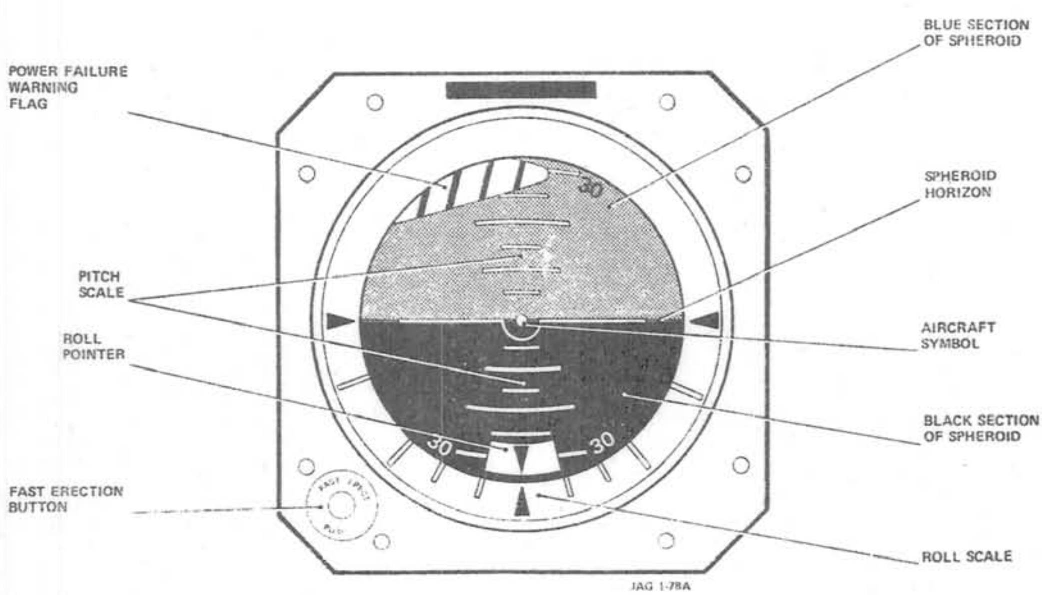
54. The stopwatch records the elapsed time up to 12 hours as follows:

a. A 'seconds' hand sweeps the dial which is numbered in steps of 5 from 0 to 60.

b. A large 'minutes' hand (0 to 60).

c. A window in the bottom of the dial indicates hours elapsed (0 to 12 hours).

55. A knob on the top of the watch controls the rewind and stop/start mechanism. A pushbutton on the side of the watch is used to reset the hands and hours indicator. An index marker on the outer bezel around the



1—9 Fig 11 Attitude Indicator

dial can be adjusted by rotating the bezel. Lighting is provided via the dimmer above the incidence indicator.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

56. *Attitude Indicator.* Check that the power failure warning flag clears and if necessary operate the fast erection button.

Note: The fast erection button must not be operated until 40 seconds after switching on.

57. *Standby Compass.* Carry out a comparison check with the gyro-magnetic compass and the Nav/Attack system. Check lighting dimmer operation.

58. *Turn-and-Slip Indicator.* Ensure that the OFF flag clears and check the operation of the instrument during taxying.

59. *Accelerometer.* Before take-off reset the pointers to + 1g. Adjust lighting as required.

60. *Stopwatch.* Carry out rewind and reset operations and check operation of start/stop button.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Attitude Indicator Failure

61. If the power failure warning flag appears, check that AC supplies are available (fuel gauges operating). If power is available and the indicator is inoperative, the HUD should be used for attitude reference.

Turn-and-Slip Indicator Failure

62. If the OFF flag appears and the AC No 2 busbar is live, the turn indications are unusable but the slip ball is not affected.

PART 1

CHAPTER 10—COMMUNICATIONS EQUIPMENT

Contents

COMMUNICATIONS INSTALLATION

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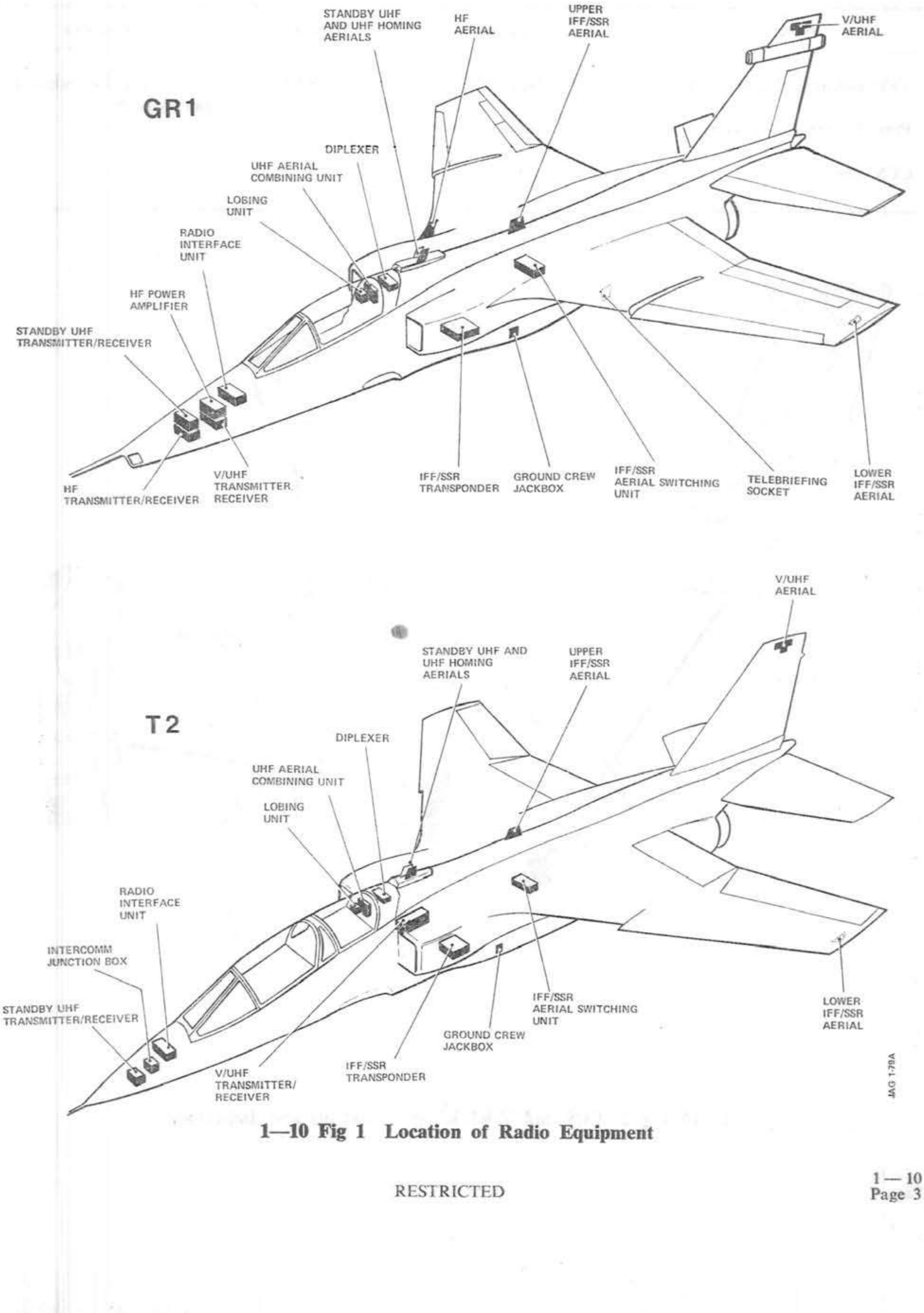
COMMUNICATIONS INSTALLATION

General

1. The aircraft communications installation comprises main VHF/UHF, standby UHF, and IFF/SSR transponder systems and on the GR1, includes HF and a telebriefing facility. Centralised control of the installation is provided via a communication control system and, on the GR1, voice monitoring is by a voice recorder unit.



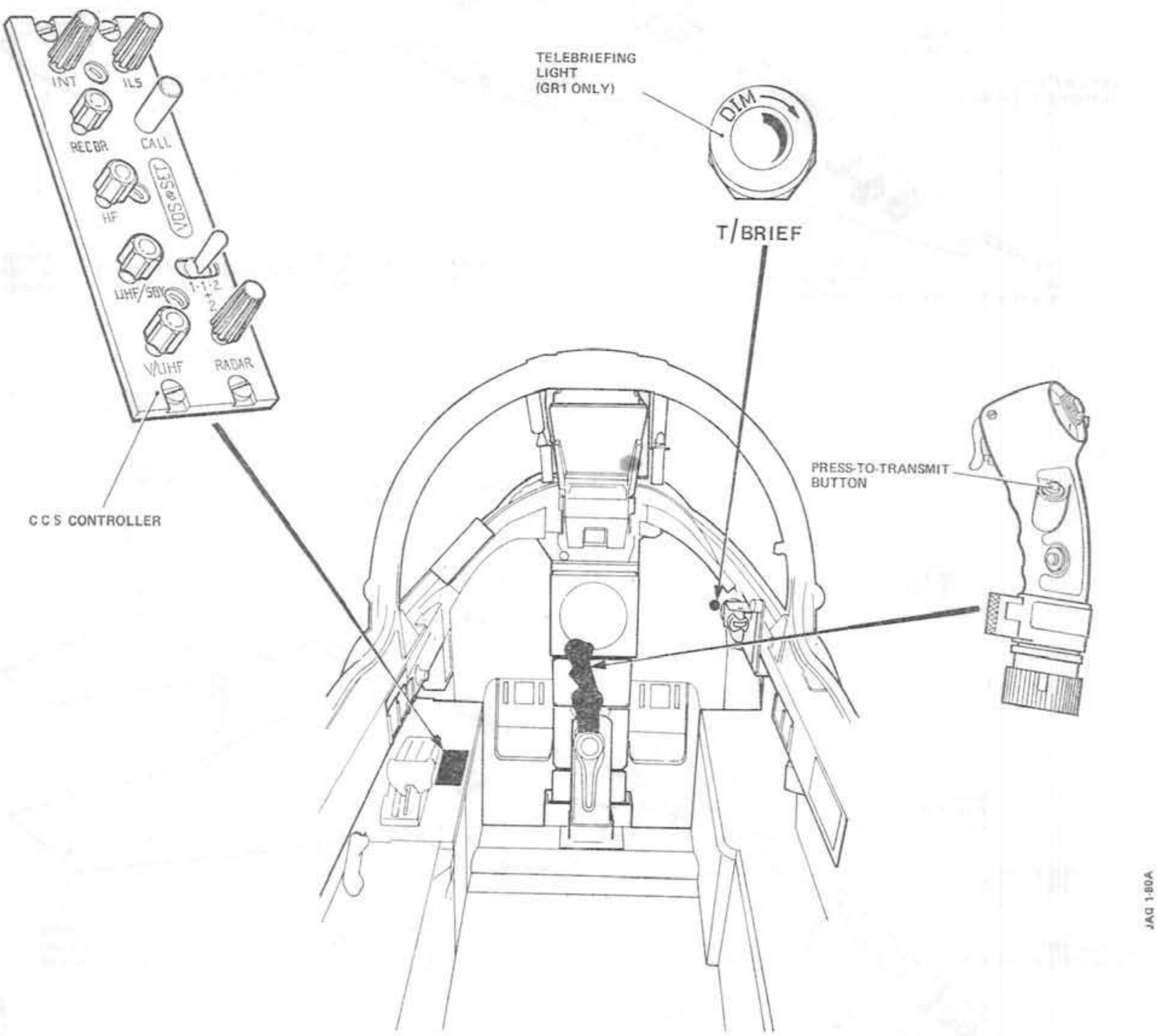
1—10 Fig 1 Location of Radio Equipment

COMMUNICATION CONTROL SYSTEM AND TELEBRIEFING CONTROLS AND INDICATORS

2. Details concerning the controls and indicators shown in Fig 2 are listed in Table 1.

Table 1 — CCS and Telebriefing — Controls and Indicators

Item	*Location*	*Marking*	*Remarks*
Telebriefing light. GR1 only	Right instrument panel	T/BRIEF	Press light for telebriefing transmission
Press-to-transmit button	Control column handgrip	—	—
CCS controller	Left console	—	—



1—10 Fig 2 CCS and Telebriefing — Controls and Indicators

DESCRIPTION OF THE SYSTEM

General

3. The communication control system (CCS) provides centralised control of the aircraft's communication, intercommunication, voice recording and audio warning systems. It provides the following facilities:

a. Modulation and keying selection of three transmitters: the VHF/UHF, standby UHF and HF (GR1 only).

b. Volume-adjustable intercommunication between:

(1) GR1—Cockpit and groundcrew, and between cockpit and operations ground controller during telebrief operation.

(2) T Mk 2—Cockpit and groundcrew, and between front and rear cockpits.

c. Volume adjustment of receiver output signals from the following:

(1) VHF/UHF communication channels.

(2) Standby communication channels.

(3) HF communication channels (GR1 only)

(4) ILS localiser receiver.

(5) Passive warning receiver (GR1 only).

d. Connection of the ILS marker, Tacan receiver and aircraft centralised warning audio signals to the pilot's telephones.

e. Connection of the press-to-transmit button(s) into the CCS circuit and the telebriefing press-to-talk button to the telebriefing installation.

f. On T Mk 2, muting of VHF and UHF reception by means of two switches in the rear cockpit.

CCS Controller

4. *Selector Buttons.* Four buttons, which combine selection and volume control functions, are provided (see Fig 2). Pressing a button selects the associated facility. Rotation of a button, whether pressed or not, adjusts the level of the associated audio signal received in the telephones. The selector buttons provide the following functions:

a. V/UHF—selects the transmit capability on the VHF/UHF system.

b. UHF/SBY—selects the transmit capability on the standby UHF system.

c. HF—selects the transmit capability on the HF system (GR1 only).

d. RECDR—selects recording of all received signals (GR1 only). This selection is not required to record the pilot's voice only (refer to para 72).

Note 1: The three buttons, marked V/UHF, UHF/SBY and HF on the CCS controller are mechanically interlinked. To select any desired combination of these facilities the appropriate buttons must be pressed simultaneously. Pressing any one of these buttons automatically releases any previously selected button.

Note 2: Selection of either communication system on the front cockpit CCS controller, on the T Mk 2, provides modulation, keying and reception facilities for the selected system in both cockpits.

5. *INT Volume Control.* The INT volume control adjusts the audio level of the groundcrew intercommunication signals to the pilot's telephones, receiver sidetone and signals to the voice-operated switch of the voice recorder.

6. 1/1 + 2/2 *Selector Switch.* The selector switch is a 3-position switch which selects either or both of the CCS microphone/telephone audio amplifiers. The amplifiers provide individual amplification of the microphone and telephone signals and are normally operated in parallel (position 1 + 2). In the event of failure of one amplifier channel the system continues to function on the remaining channel.

7. *RADAR (GR1 only) and ILS Volume Controls.* The RADAR and ILS volume controls adjust the level of the passive warning receiver and ILS localiser receiver output signals.

Note: The levels of audio signal from the ILS marker receiver and the failure warning system are preset and cannot be adjusted. The volume of the Tacan audio signal is adjusted at the Tacan controller.

8. *Panel Lamps.* The CCS panel is illuminated by three red panel lamps controlled via the integral lighting dimmer on the left console.

9. *VOS SET and CALL Switches.* The VOS SET and CALL switches are not used and are both inoperative on the GR1. On the T Mk 2, the CALL switch enables the front crew member to call the rear crew member even if the VOL control on the rear CCS panel is turned to a low setting.

Associated Controls

10. *Press-to-Transmit Button.* Operation of the press-to-transmit button on the control column handgrip connects the microphone to the selected transmitter (para 4). On the GR1, when the button is pressed, the passive warning receiver is inhibited (refer to Book 2).

11. *Telebriefing Control (GR1 only).* The telebriefing control (T/BRIEF) consists of a combined spring-loaded button and amber indicator light on the right instrument panel. Indicator light intensity is controlled by rotating the rim of the light unit; clockwise to DIM.

CCS Amplifier and Junction Box Installation

12. The audio amplifier system in the CCS controller provides for individual amplification of the microphone and telephone signals. The amplifier circuits are duplicated and controlled by the 1/1 + 2/2 selector switch. In normal conditions the amplifiers are operated in parallel (position 1 + 2) so that in the event of failure in one amplifier channel it is possible to continue to operate the system on the other channel. Individual amplifier channels can be used by selecting to either position 1 or 2 if required.

13. Intercommunication facilities are provided through the following:

a. The CCS junction box provides the various interconnection and matching facilities between the CCS controller, groundcrew jack box and other associated systems. The unit is in the forward equipment bay.

b. The groundcrew jack box provides intercommunication facilities between the groundcrew and pilot. It incorporates a groundcrew microphone amplifier, and headset connection facility. The unit is located in the left side of the centre fuselage.

Telebriefing Installation (GR1 only)

14. The telebriefing installation is connected to the telebriefing centre via the external telebriefing plug in the left wheel bay. When the ground cable is connected the following indications and functions are provided:

a. The T/BRIEF light comes on, indicating that the system is operational in the receive mode. Telebriefing transmission to the telebriefing centre is effected by using the spring-loaded T/BRIEF light as a press-to-transmit button.

b. Automatic inhibition of all radio transmissions occurs; however, when STI/Jag/320 has been incorporated, normal radio transmissions may be made.

c. Whilst transmitting on telebrief, groundcrew intercommunication is completely inhibited.

d. Recorder monitoring of telebriefing signals is available providing the recorder unit is switched ON.

Electrical Supplies

15. Electrical supplies to the CCS and telebriefing are obtained from the 28V DC emergency busbar.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

16. Carry out the following procedures on the CCS installation:

a. Set all volume controls of the associated communication systems to their mid positions.

b. With the headset connected, re-adjust the INT volume control for comfortable sidetone level.

c. Set the 1/1 + 2/2 amplifier selection switch to position 1 and check that the sidetone is audible. Repeat with selector switch in position 2.

d. Set selector switch to position 1 + 2.

e. Select the required communication facilities.

In Flight

17. Turning down the INT volume greatly reduces cockpit noise.

MALFUNCTION OR USE IN ABNORMAL CONDITIONS

CCS Mic/tel Amplifier Failure

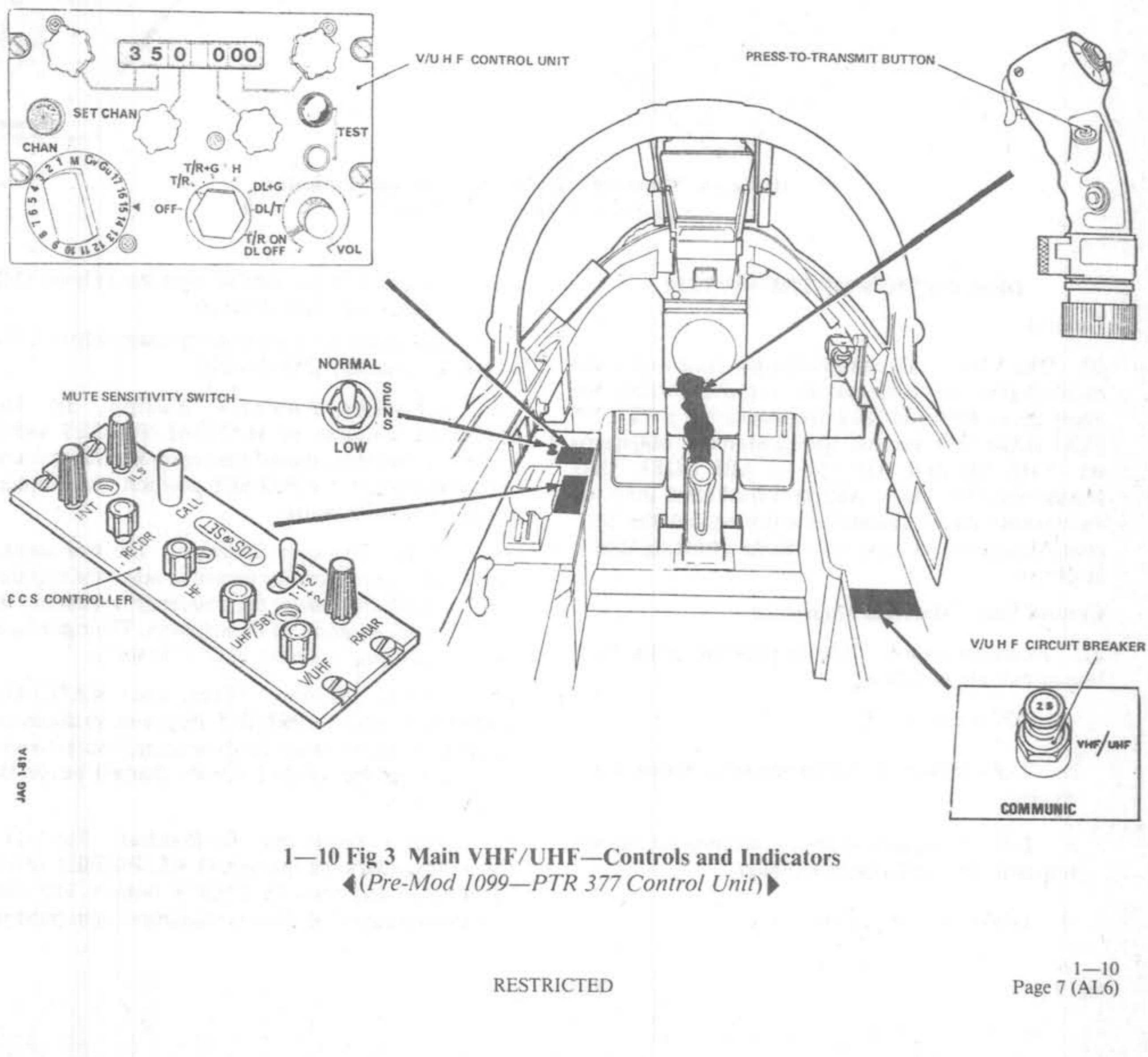
18. With 1 + 2 selected on the CCS controller selector switch, failure of one amplifier can cause interference and oscillations. Select 1 or 2 as appropriate to isolate the faulty amplifier.

MAIN VHF/UHF CONTROLS AND INDICATORS

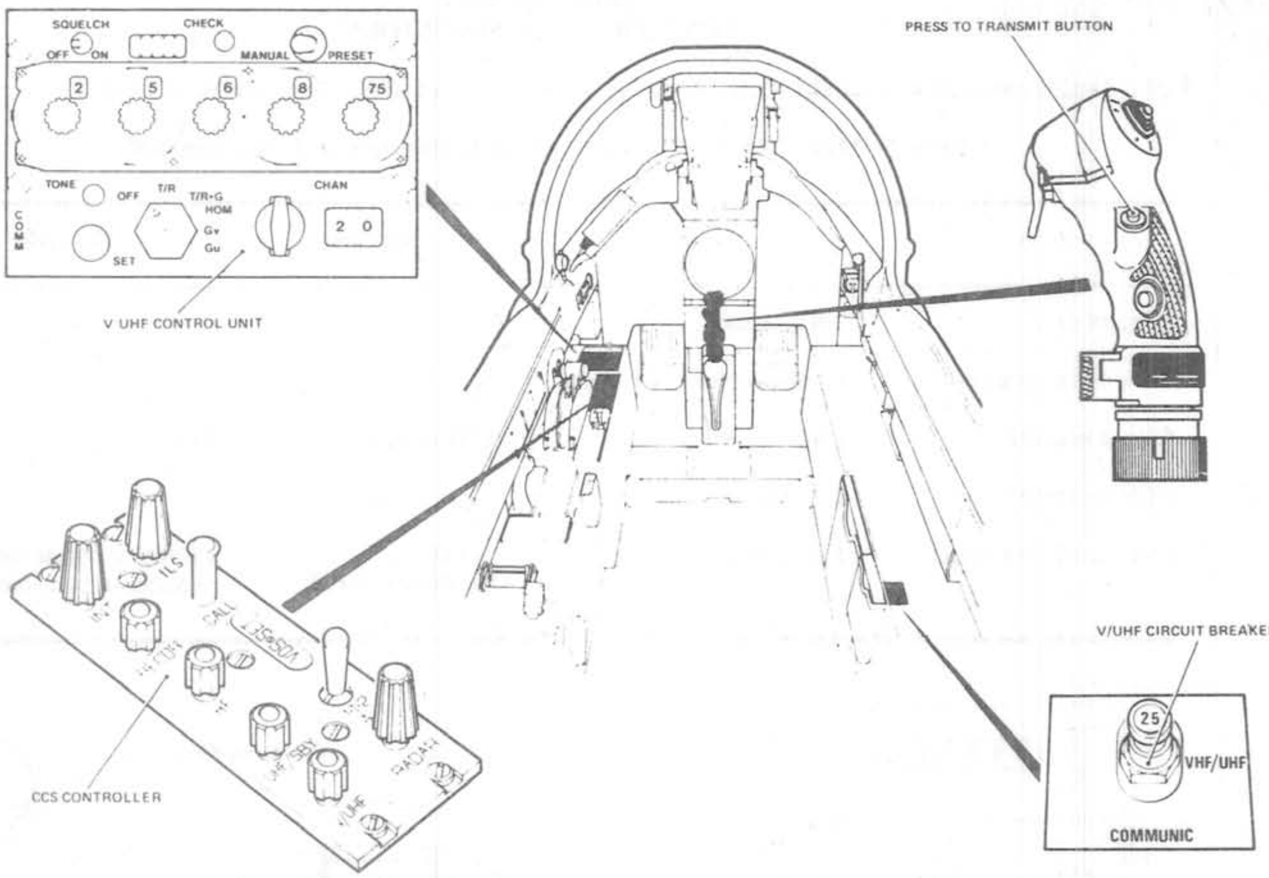
19. Details concerning the controls and indicators shown in Fig 3 and Fig 3A are listed in Table 2.

Table 2—Main VHF/UHF Controls and Indicators (pre-and post-mod 1099)

Item	*Location*	*Marking*	*Remarks*
Control unit	Left console	—	—
Press-to-transmit button	Control column handgrip	—	—
Circuit breaker	Circuit breaker panel	VHF/UHF	25A
CCS controller	Left console	—	—
Mute sensitivity switch	Left console	SENS—NORMAL/LOW	2-position toggle switch (redundant post-mod 1099)



1—10 Fig 3 Main VHF/UHF—Controls and Indicators
(Pre-Mod 1099—PTR 377 Control Unit)



1—10 Fig 3A Main VHF/UHF—Controls and Indicators
(*Post-mod 1099 Control Unit*)

DESCRIPTION OF THE SYSTEM

General

20. The VHF/UHF communication system provides multi-channel air-to-air and air-to-ground voice communication. Pre-mod 1099 the installation is PTR 377 (ARI 18220/3); post-mod 1099 a Marconi/Magnavox set (VHF Marconi AD 120 — ARI 23288, UHF Magnavox ARC 164 — ARI 23315) is fitted. Both sets incorporate guard channel monitoring but the Marconi/Magnavox set does not include a homing facility at present.

Control Unit - Marconi/Magnavox

21. *Function Switch.* The six positions of the function switch are as follows:

a. OFF—power off.

b. T/R—power on; equipment set to transmit and receive.

c. T/R + G—guard receivers switched on; normal transmit/receive facilities retained.

d. HOM—not at present in use.

e. Gv—transmitter-receiver operates only on VHF guard frequency (121·5 MHz).

f. Gu—transmitter-receiver operates only on UHF guard frequency (243·0 MHz).

22. *MANUAL/PRESET Switch.* In the MANUAL position the MANUAL/PRESET switch selects the manually dialled frequency for transmission and reception; in the PRESET position the indicated pre-set channel is in use.

23. *Manual Frequency Selection.* The five manual frequency selectors can be turned to select the required VHF or UHF frequency; the frequency is shown in the five windows adjacent to the selectors. The right-hand knob selects tens and units in 25 kHz steps.

24. *CHAN Selector.* When the MANUAL/PRESET switch is to PRESET, 20 pre-set channels are available by turning the CHAN selector. There is a window showing the selected pre-set channel beside the CHAN selector.

25. *CHECK Button and LED Readout.* To check a pre-set frequency, set the MANUAL/PRESET switch to PRESET and press the CHECK button. The LED display then shows the pre-set frequency corresponding

to the channel selected at the CHAN selector. To check a guard frequency, select Gv or Gu at the function switch and press the CHECK button. The LED display should read either 121·5 or 243·0 as appropriate.

26. *SET Channel Button.* The SET button is used for inserting frequencies into the pre-set channels as follows:

a. Set MANUAL/PRESET switch to PRESET and select T/R on the function switch.

b. Rotate CHAN selector to display channel to be changed.

c. Using manual frequency selector knobs, dial the pre-set frequency required.

d. Press and release SET button; the dialled frequency is now pre-set.

e. Press CHECK button and ensure LED readout shows correct frequency.

27. *SQUELCH Switch.* The SQUELCH switch has two positions marked OFF and ON. Selecting ON reduces receiver background noise.

28. *TONE Pushbutton.* When the spring-loaded TONE pushbutton is pressed, an audio tone is transmitted on the manual frequency or pre-set channel in use independently of the press-to-transmit button.

Control Unit—PTR 377

28A. *Function Switch.* Only the first four positions are used, these being:

a. OFF—power off.

b. T/R—power on: equipment set to transmit and receive.

c. T/R + G—guard receivers switched on: normal transmit/receive facilities retained.

d. H—as for T/R + G, homing added.

28B. *CHAN Selector.* The CHAN selector is a 20-position rotary selector switch which provides the following selections:

a. 1 to 17—seventeen pre-set channel selections.

b. Gu—transmitter-receiver operates only on UHF guard frequency (243·0 MHz).

c. Gv—transmitter-receiver operates only on VHF guard frequency (121·5 MHz).

d. M—manual tuning of the transmitter-receiver.

28C. *Manual Frequency Selection.* With the channel selector to M, four control knobs provide manual selection of frequency (which is displayed on a six-digit indicator) as follows:

a. Upper left hand knob selects hundreds and tens MHz.

b. Lower left hand knob selects units MHz.

c. Lower right hand knob selects hundreds kHz.

d. Upper right hand knob selects tens and units kHz.

28D. *VOL Control.* The volume control, marked VOL, adjusts the level of the receiver audio signals, as does rotation of the V/UHF pushbutton on the CCS controller.

28E. *SET CHAN Button.* The SET CHAN button is used for setting up the pre-set channel frequencies. To insert a frequency into a numbered channel carry out the following:

a. Select T/R and set CHAN selector to the channel which requires setting up.

b. Using manual frequency selecting knobs, set pre-set frequency required.

c. Turn SET CHAN button clockwise and press fully in.

d. Release SET CHAN button. The selected frequency is now pre-set.

28F. *TEST Button.* The TEST button and associated lamp, when used in conjunction with the function switch, provide inbuilt test facilities in the VHF/UHF communication system. To carry out the tests set the VHF/UHF circuit breaker, select V/UHF on the CCS controller (adjusted to mid volume) and proceed as follows:

a. *Receiver:* Select T/R and press the TEST button. Check that a continuous moderate pitch (780 Hz) tone is audible.

b. *Transmitter:* With T/R selected, press the TEST and press-to-transmit buttons simultaneously. Check that the continuous tone is audible.

c. *Control Unit:* Manually select the frequency 350.0 MHz; press the TEST button. Check that the TEST lamp lights and the continuous tone is audible.

d. *Homer:* Set the function switch to H and press the TEST button. The homing indication on the horizontal situation indicator (HSI) shows full deflection left.

e. *Guard Receivers:* Set the function switch to DL + G and the CHAN switch to M. Manually tune to a VHF or UHF frequency which is more than 10 MHz from the appropriate guard frequency and press the TEST button. Check that the tone signal is audible.

Associated Controls (Marconi/Magnavox and PTR 377)

29. *V/UHF Button.* The CCS controller V/UHF button is pressed down to enable the pilot's microphone to be connected to the transmitter via the press-to-transmit button and is turned to adjust the receiver audio level.

Note: There is no volume control on the Marconi/Magnavox control unit.

30. *Press-to-Transmit Button*. The press-to-transmit button is on the control column handgrip.

WARNING: The press-to-transmit button must not be operated whilst changing channels as this action could result is serious damage to the transmitter-receiver.

31. *VHF/UHF Circuit Breaker*. The VHF/UHF circuit breaker on the right console controls the 28V DC supply from the emergency busbar.

32. *Mute Sensitivity Switch*. The mute sensitivity switch on the left console is redundant post-mod 1099. Pre-mod 1099 it eliminates unwanted signals and interference. The 2-position toggle switch is set to NORMAL for long-range operation but this may give unwanted noise at short ranges: LOW is selected for short-range operation and a quieter environment.

Transmitter-Receiver (Marconi/Magnavox and PTR 377)

33. The post-mod 1099 transmitter-receiver unit operates in the VHF frequency band 118.00 to 135.975 MHz and in the UHF frequency band 225.00 to 399.975 MHz. It is therefore possible to select 720 VHF or 7000 UHF channels at 25 kHz intervals. Pre-mod 1099, the PTR 377 transmitter-receiver operates in the VHF frequency band 100.00 to 156.00 MHz and the UHF frequency band 225.00 to 399.90 MHz. It is possible to select 1120 VHF channels or 3500 UHF channels at 50 kHz intervals.

34. The guard receiver is capable of simultaneous reception on the VHF and UHF emergency frequencies both pre- and post-mod 1099. When the function switch is set at T/R + G (and H pre-mod 1099), constant monitoring on both guard channels is maintained in addition to the selected channel or manually set frequency.

35. Pre-mod 1099 when the function switch is set to H, the UHF receiver also provides a UHF azimuth homing facility. Visual homing indications are displayed on the HSI and the HUD when the appropriate mode is selected on the HSI mode selector and the HUD control panel. (For details of the HSI and HUD controls refer to Aircrew Manual Book 2.) Normal communication remains available during the homer mode operation. Post-mod 1099 there is no homing facility.

Note: During normal communication in the homer mode (pre-mode 1099) a faint buzz is audible owing to the homer demodulator operation.

36. A combined UHF/VHF aerial is situated on top of the fin. For pre-mod 1099 homing facilities there are two UHF homing aerials behind the cockpit canopy. The UHF homing aerials are also used for the standby set.

Electrical Supplies and Lighting

37. Electrical power supplies are obtained from the emergency DC busbar; a 25A circuit breaker marked VHF/UHF on the right console controls power to the main system. Pre-mod 1099 a 5A fuse supplies the homer aerial switching supply.

38. Control panel lighting is adjusted by the INT LIGHT dimmer on the left console. Pre-mod 1099 the brilliance of the test light is controlled by the CWP N/D dimmer control.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks (Marconi/Magnavox)

39. With power applied to the emergency DC busbar and the VHF/UHF circuit breaker set:

a. Rotate the V/UHF knob on the CCS controller to a mid position and press down.

b. Set the function switch to T/R. Allow 30 seconds for the installation to warm up.

Note: Optimum sensitivity may not be obtained for a further 90 seconds.

c. Select Gv and Gu in turn on the function switch, pressing CHECK button and checking LED readout to ensure the correct guard frequencies are set.

d. Select T/R or T/R + G. Select PRESET and the required channel or MANUAL and dial the required frequency. Then carry out a two-way communication check, adjusting the V/UHF knob on the CCS controller for a comfortable receiver audio level.

Pre-Flight Checks (PTR 377)

39A. With power applied to the emergency DC busbar and the VHF/UHF circuit breaker set:

a. Rotate the V/UHF knob on the CCS controller to a mid position and press down.

b. Set the function switch to T/R and adjust the VOL control to max (to ensure test tone audible). Allow 30 seconds for the installation to warm up.

Note: Optimum sensitivity may take a further 90 seconds.

c. With the CHAN selector at M, set the manual frequency knobs to indicate 350.0 MHz. Press the TEST button and check that the test lamp lights and a continuous (780 Hz) tone is audible.

d. With the T/R selected, press TEST and press-to-transmit buttons simultaneously. Check that the continuous tone is audible.

e. Adjust VOL control to a mid position and the CHAN selector to the required channel; then carry out a two-way communication check, adjusting the V/UHF knob on the CCS controller for a comfortable audio level.

MALFUNCTIONS OR USE IN ABNORMAL CONDITIONS

Indications and Actions

40. The indications and actions relating to system malfunctions are listed in Table 3.

Table 3—Main VHF/UHF Malfunctions

Indications	*Immediate Actions*	*Subsequent Actions*	*Considerations*
V/UHF COMMUNICATIONS FAILURE			
Microphone failure	Post-mod 1099, use TONE pushbutton to transmit during speechless recovery	—	—
Transmitter failure	Check V/UHF button on CCS controller is pressed down.	Post-mod 1099, if press-to-transmit button has failed, use TONE pushbutton during no-voice recovery	—
No reception or transmission	Check VHF/UHF circuit breaker is set. On T Mk 2 check rear cockpit NORM/SBY switch to NORM. Check volume control on CCS is turned up	If normal operation not regained, use standby set; switch OFF main set and deselect V/UHF button on CCS controller. If standby set also fails, ground-to-air reception possible on ILS localiser frequency	Selecting UHF/SBY on CCS controller automatically deselects the V/UHF button
CONTINUOUS TRANSMISSION			
Jammed press-to-transmit button causing continuous transmission	Deselect all radio services on CCS controller	—	Reception now possible on all communications equipment switched on
		To transmit, press down the appropriate equipment selector button on the CCS controller	

Note: Pre-mod 1099, an apparent fault can occur if power is applied to or removed from the emergency DC busbar with the main VHF/UHF set switched on. Care must be taken to ensure that the mode switch is to OFF *before* the busbar is energised or de-energised. Failure to do so may result in non-functioning of the TEST switch and lamp and may also cause incorrect frequency selection. If such symptoms occur, set the mode switch to OFF and then back to the required mode *or* carry out a manual channel change and then revert to the required channel.

Intentionally Blank

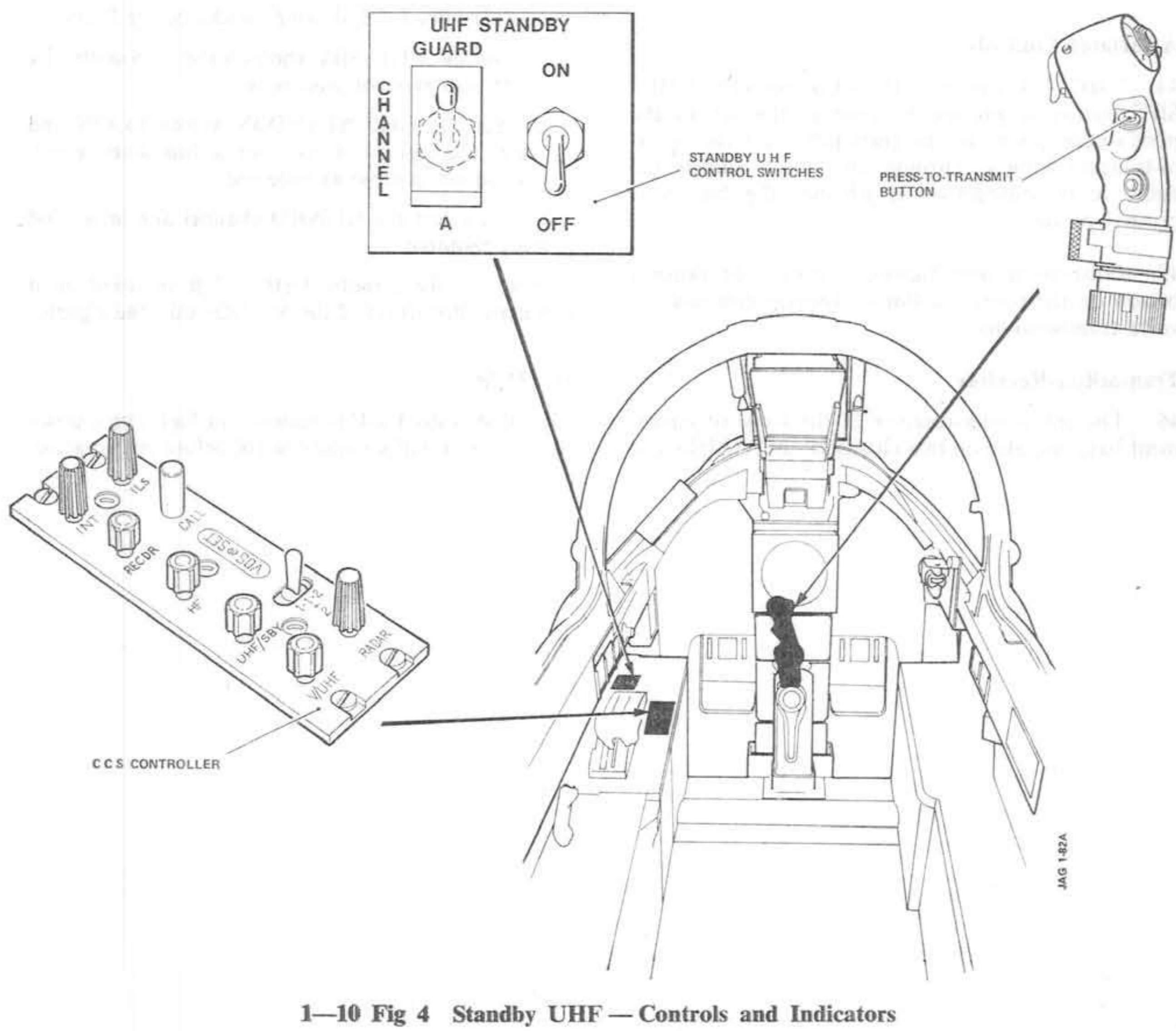
STANDBY UHF

CONTROLS AND INDICATORS

41. Details concerning the controls and indicators shown in Fig 4 are listed in Table 4.

Table 4 — Standby UHF Controls and Indicators

Item	*Location*	*Marking*	*Remarks*
Control switches	Left console	ON/OFF GUARD/A	Power supply control Channel selection
Press-to-transmit button	Control column handgrip	—	—
CCS controller	Left console	UHF/SBY	—



1—10 Fig 4 Standby UHF — Controls and Indicators

DESCRIPTION OF THE SYSTEM

General

42. Standby communications are provided by a 2-channel UHF transmitter-receiver (ARI 23159).

Control Switches

43. Two toggle switches on the left console marked UHF STANDBY, ON/OFF and CHANNEL—GUARD/A provide the following functions:

a. The ON/OFF switch connects the power supply to the standby UHF transmitter-receiver.

b. The GUARD/A channel switch selects either the GUARD (243·0 MHz) frequency which is the normal guarded position, or the A channel frequency; the latter is primarily used during system tests and provides an additional channel for emergency communications.

Associated Controls

44. *UHF/SBY Button.* The CCS controller UHF/SBY button is pressed to connect the set to the pilot's microphone to the transmitter via the press-to-transmit button. Turning the button adjusts the audio level irrespective of whether the button is pressed or not.

45. *Press-to-transmit Button.* The press-to-transmit button on the control column handgrip controls the voice transmissions.

Transmitter-Receiver

46. The transmitter-receiver in the forward equipment bay, operates on two channels: 243·0 MHz and an additional frequency within 1 MHz of the distress frequency. It is connected to the combined UHF homing aerials via an aerial combining unit.

47. Expected communication range is approximately optical line of sight up to a maximum of 100 NM.

Electrical Supplies

48. The standby UHF transmitter-receiver is supplied from the 28V, DC emergency busbar.

49. Lighting of the control switches is by the amber floodlighting of the left console controlled by the CONSOLES dimmer on the right console.

NORMAL USE OR MANAGEMENT

Pre-flight Checks

50. Carry out the following checks before flight:

a. Set the UHF/SBY knob on the CCS controller to its mid position and press.

b. Set the UHF STANDBY switch to ON and select channel A. Carry out a functional check and adjust volume as required.

c. Re-select the GUARD channel and switch off until required.

Note: If the standby UHF is left switched on it can cause distortion of the V/UHF sidetone signals.

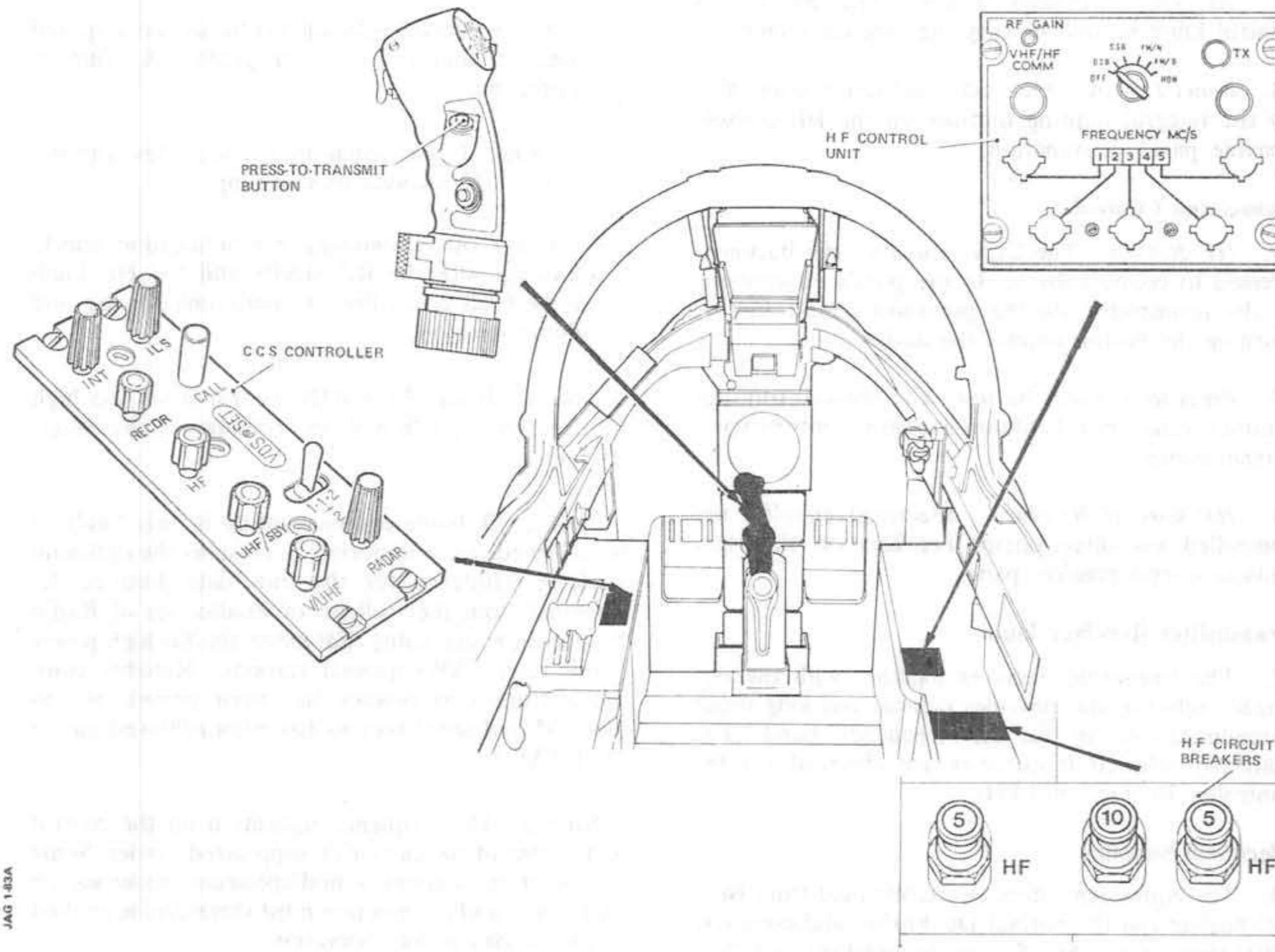
In Flight

51. If standby UHF is required in flight, turn down the CCS V/UHF volume control before transmitting.

HF INSTALLATION (GR1 ONLY)

CONTROLS AND INDICATORS

52. Details concerning the controls and indicators are shown in Fig 5.



1—10 Fig 5 HF Installation — Controls and Indicators

DESCRIPTION OF THE SYSTEM

General

53. The HF communication system (ARI 23181/3) operates in the double sideband (DSB) and upper sideband (USB) modes and is amplitude modulated. It comprises the following:

a. A controller on the right console.

b. A transmitter-receiver, power amplifier and a frequency selector, all in the forward equipment bay.

c. A notch type aerial in the leading edge of the right mainplane root, together with matching and coupling units.

HF Controller

54. *Function Switch.* Only the first three positions are used:

a. OFF — power off position.

b. DSB — power on and the equipment set to receive in the double sideband mode.

c. SSB — as above but for single sideband operation (USB only).

55. *Manual Frequency Selection.* Frequency is selected by five manual frequency selection knobs associated with the five-digit indicator. The indicator gives a direct reading in MHz of the manually selected frequency.

56. *TX Indicator Lamp.* The green lamp is on when the tuning cycle of the transmitter-receiver is completed. The light intensity is controlled by the D/N dimmer switch on the centralised warning panel.

57. *RF GAIN Control Knob.* The RF GAIN control knob is used to vary the receiver volume.

58. *Panel Lamps.* Two red panel lamps controlled by the integral lighting dimmer on the left console provide panel illumination.

Associated Controls

59. *HF Button.* The CCS controller HF button is pressed to connect the set to the pilot's microphone to the transmitter via the press-to-transmit button. Turning the button adjusts the audio level.

60. *Press-to-transmit Button.* The press-to-transmit button on the control column handgrip controls voice transmissions.

61. *HF Circuit Breakers.* Electrical supplies are controlled via three circuit breakers on the right console circuit breaker panel.

Transmitter-Receiver Unit

62. The transmitter-receiver together with the frequency selector unit provides tactical and long range communications in the HF frequency band. The manually selected frequencies are obtained via the controller in steps of 1 kHz.

Electrical Supplies

63. The equipment supplies are obtained from No 1 AC busbar and the normal DC busbar and comprise 200V three-phase AC (5A circuit breaker) and 28V. DC (5A and 10A circuit breakers).

NORMAL USE OR MANAGEMENT

Pre-flight Checks

64. Carry out the pre-flight checks as follows:

a. Set the HF circuit breakers (3).

b. Set HF knob on CCS controller to the mid position and press.

c. HF controller, select as follows:

(1) Function switch to SSB or DSB.

(2) RF GAIN control knob to approximately the mid volume position.

(3) Frequency selector knobs to the required channel and wait for the green TX lamp to come on.

Note: From switch on, the set takes approximately 30 seconds to warm up.

d. Carry out a two-way communication check, adjusting both the RF GAIN and the HF knob on the CCS controller to approximately the mid volume position.

Note 1: If the RF GAIN control is set too high the received signals will be accompanied by excessive noise.

Note 2: Reliable communication is only likely to be achieved if the frequency is close to the optimum working frequency for the time/date/distance determined from the Bulletin of Predictions of Radio Propagation, and using SSB mode against high power (more than 5 kW) ground stations. Reliable communications performance has been proven out to 600 NM and some success has been achieved out to 1500 NM.

Note 3: The frequency indication on the control unit is that of the carrier or suppressed carrier. Some ground stations quote a mid-spectrum frequency on SSB mode, and a correction must therefore be applied to ensure compatible operation.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

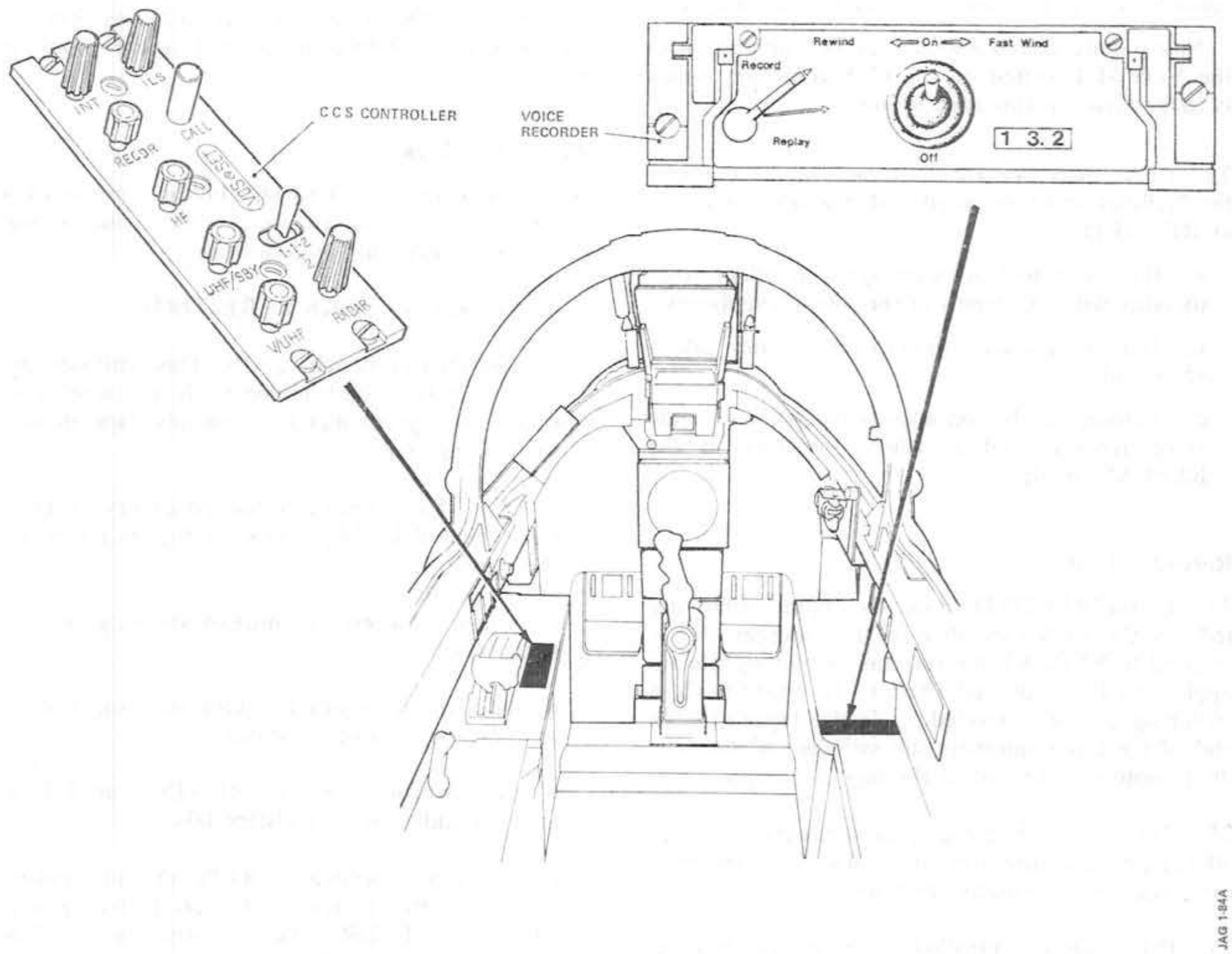
Indications and Actions

65. If the HF installation fails to operate, check all switch selections and the HF circuit breakers. If the equipment remains inoperative, set the function switch to OFF.

VOICE RECORDER (GR1 ONLY)

CONTROLS AND INDICATORS

66. Details concerning the controls and indicators are shown in Fig 6.



1—10 Fig 6 Voice Recorder — Controls and Indicators

DESCRIPTION OF THE SYSTEM

General

67. The voice recorder mounted on the right console is a cassette tape recorder. It provides audio recording and playback of the pilot's radio transmission and reception.

Recorder Control Panel

68. *Selector Switch.* A 2-position rotary selector switch provides selection of the RECORD or REPLAY modes, when the control switch is set to ON.

Note 1: In the RECORD mode, the tape drive motor runs at normal speed only when the voice-operated switch is activated.

Note 2: In the REPLAY mode, the tape drive motor runs continuously at normal speed.

69. *Control Switch.* A 4-position toggle switch provides selection of the ON/OFF, REWIND and FAST WIND functions.

70. *Tape Used Indicator.* The tape used indicator is a 3-digit Veeder counter. It provides a digital count from zero to 999, beyond which it reverts to zero, and recommences the counting.

Associated Controls

71. *Voice-Operated Switch.* This automatically energises the recording circuit when a valid (above a preset level) audio signal is received from the pilot or an external transmitter. When the audio signal ceases the recorder continues to run for seven seconds before the recording circuit is de-energised.

Note: This switch should not be confused with the VOS SET switch on the CCS controller which is inoperative on this installation.

72. *CCS Controller RECDR button.* This selects the facilities to be recorded with the selector switch at RECORD:

a. Button pressed; monitoring of the pilot's voice together with all signals at the pilot's telephones.

b. Button released; monitoring of the pilot's voice only.

c. Turning the button adjusts the volume of the voice recorder output when operating in the REPLAY mode.

Recorder Unit

73. In the RECORD mode the input signals are fed via the CCS controller to the recorder. When selected to REPLAY the recorder output signals are applied to the pilot's telephones. In either mode a switching circuit (activated by leader tapes at each end of the tape) automatically switches off the tape drive motors if the end of the tape is reached.

74. The type C60 recording tape cassette provides 30 minutes recording time per track. The tape indicator registers 880 digits per track.

75. Panel light is controlled via the integral lighting dimmer.

Electrical Supplies

76. The recorder unit operates from the 28V, DC normal busbar.

NORMAL USE OR MANAGEMENT

Insertion of Cassette

77. Carry out the following procedure:

a. Set the control switch to OFF, unlock the recorder handle and withdraw the recorder from casing.

b. Insert the cassette and select REWIND. When fully rewound the tape drive motor will stop.

c. Re-select OFF and temporarily release the cassette. Tape position indicator should reset to zero.

d. Refit the recorder in its casing and lock in position.

Note: A mechanical interlock prevents removal of the cassette unless the control switch is set to OFF.

Pre-flight Checks

78. Check that the RECDR button on the CCS controller is de-selected (pilot's voice monitoring only), and carry out the following:

a. Set selector switch to RECORD.

b. Set control switch to ON. This activates the voice-operated switch momentarily and tape drive occurs for approximately 7 seconds (tape indicator reading 004).

Note: This eliminates the possibility of false starts caused by blank tape at the beginning of the spool.

c. Carry out a test recording by speaking into the microphone.

d. Set the control switch to OFF and note reading on the tape position indicator.

e. Set control switch to REWIND until tape position indicator re-registers 004.

f. Set selector switch to REPLAY and control switch to ON. Listen to the test recording and adjust the RECDR volume control on the CCS controller as required.

g. Set control switch to OFF and selector switch to RECORD on completion of pre-flight checks.

Note: When a replay is required, note the reading on the tape position indicator before rewinding. After listening to the replay select FAST WIND and return tape to the position previously noted. Otherwise, obliteration of the previously recorded information will occur.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

79. The indications and actions relating to system malfunctions are listed in Table 5.

Table 5 — Voice Recorder — Malfunctions

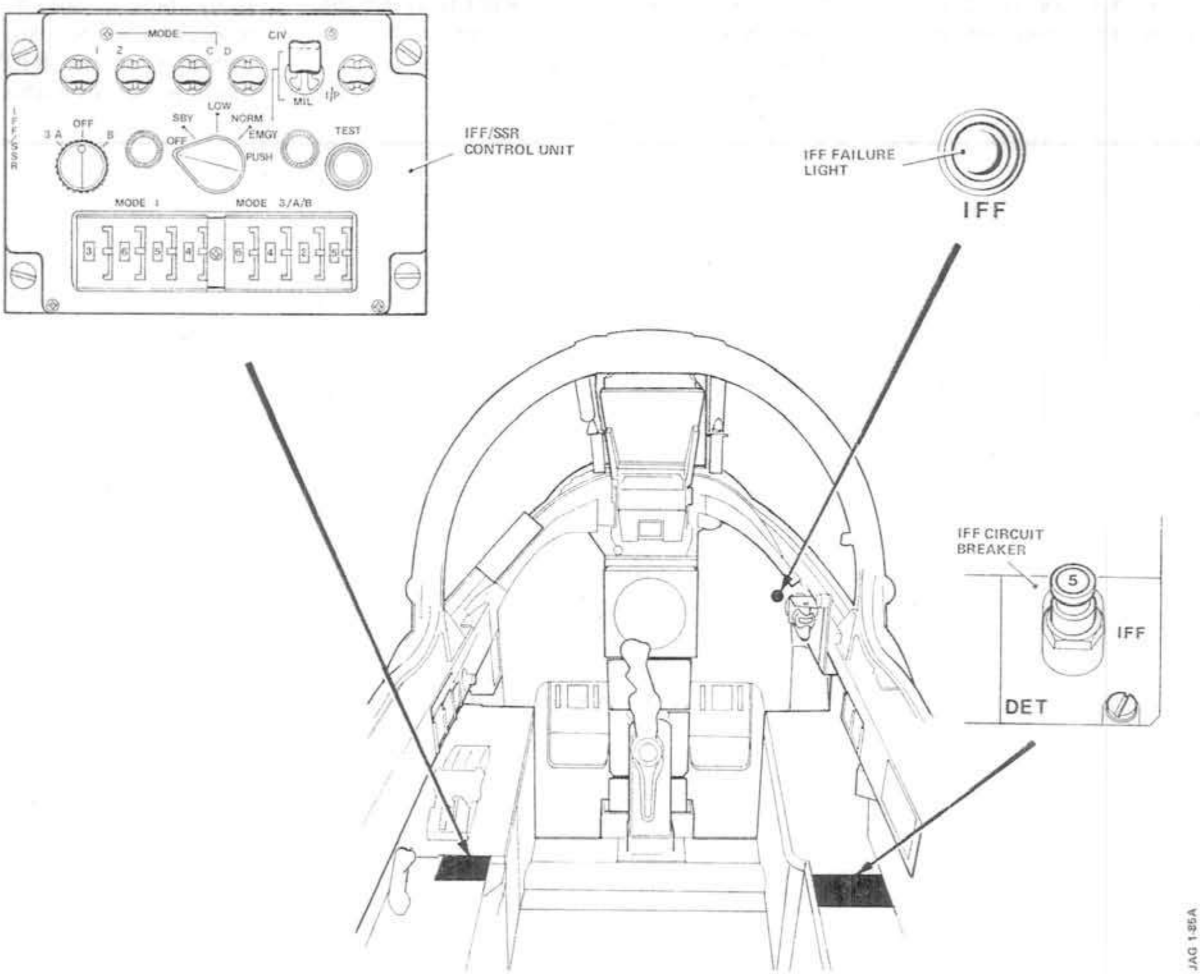
Item	*Immediate Action*	*Subsequent Action*	*Considerations*
TAPE DRIVE FAILURE			
Tape indicator remains stationary during operation	Withdraw the recorder from its casing and check if the tape continues to be driven	Refit recorder into casing	If the tape is driven, the recorder can be used but operation in the REPLAY mode is not advisable

IFF/SSR overleaf

IFF/SSR INSTALLATION

CONTROLS AND INDICATORS

80. Details concerning the controls and indicators are shown in Fig 7.



1—10 Fig 7 IFF/SSR — Controls and Indicators

DESCRIPTION OF THE SYSTEM

General

81. The IFF/SSR system transmits identification pulse signals in reply to interrogation signals received from a ground radar station. In addition, it provides a coded pulse transmission of aircraft altitude derived from the air data computer. The installation consists of a control unit, transponder, two aerial units and a warning lamp.

Control Unit

82. *Function Switch.* This is a 5-position rotary selector switch which controls transponder operation as follows:

a. OFF — power off.

b. SBY — power on but transponder replies inhibited. Transponder in a standby condition.

c. LOW — transponder fully operational, but with reduced receiver sensitivity. Only responsive to very strong signals.

d. NORM — transponder fully operational on all selected modes.

e. EMGY — as in NORM but in addition an emergency reply is given for each interrogation on modes 1, 2 and 3/A or B.

Note: To select EMGY push in the function switch and turn.

83. *Mode Control.* Mode control is obtained through five separate mode switches consisting of four 2-position toggle switches and a 3-position rotary switch. The toggle switches marked MODE—1, 2, C and D and the rotary mode switch marked 3A/OFF/B provide the following functions:

a. MODE 1 — the coded reply is manually selected.

b. MODE 2 — the selected coded reply is preset at the transponder prior to flight.

c. MODE C — is used to transmit height information supplied to the transponder by the air data computer in reply to the mode C interrogations.

d. MODE D — not used on this installation.

e. Rotary mode switch — selects OFF and modes 3A or B as required. The coded reply is set manually.

84. *MODE 1 Manual Code Selector.* Is a 4-digit selector (up to 7777) used to set up a specified coded reply to mode 1 interrogations, as instructed by ground control.

85. *MODE 3/A/B Manual Code Selector.* Is a 4-digit selector as in para 84 but provides a coded reply to either mode 3/A or mode B interrogations. The mode reply depends on the mode selected on the rotary mode switch.

86. *CIVIL/MIL Switch.* A 2-position toggle switch providing selection of either civil or military replies in an emergency.

Note: This switch is only operational when the function switch is set to EMGY.

87. *IP Switch.* This is a 2-position toggle switch spring-loaded to its inoperative position and controls the transmission of the I/P (identification of position) pulse. Operation of the switch produces a civil mode reply to interrogations on modes 2, 3A, B or D. A military I/P reply is given for a mode 1 interrogation.

88. *TEST Button and Indicator Light.* Pressing the combined TEST button and indicator light injects a simulated interrogation signal into the receiver. The green indicator light comes on if the transmitter reply is correct, thereby proving the equipment (but not the aerial circuits).

89. *Panel Lamps.* Two red lamps controlled by the integral lighting dimmer (left console) provide the panel lighting.

Associated Controls and Indicators

90. *IFF Failure Light.* An amber press-to-test light which comes on whenever power is applied to the transponder and the transmitter is unable to transmit a satisfactory reply due to:

a. The equipment being switched off.

b. Insufficient warm-up time.

c. Low power output of a transmitted pulse.

d. Failure of the aerial circuits.

Note: If, during the warm-up period, the equipment receives an interrogation signal to which it is normally capable of replying (the appropriate code selected) the light flashes to indicate that the interrogation is recognised but low output power prohibits a satisfactory reply.

91. *Circuit Breaker.* The IFF circuit breaker, on the right console circuit breaker panel, connects the DC supply to the warning light and the self-test light.

92. *Ejection Seat IFF Emergency Switch.* Operated by a lanyard on ejection, bypasses the IFF controller function switch and selects automatic transponder operation in the emergency mode. If, on ejection, the controller function switch is to OFF, the IFF takes 25 seconds to warm up.

Transponder System

93. The transponder contains the receiver and transmitter units.

94. The receiver decodes the incoming interrogation signals to ascertain the mode. A coded reply when set up on the control unit for the appropriate interrogation mode triggers the transmitter. This generates the selected pulse code for transmission back to the ground interrogating station.

95. Two IFF aerials (operating on the 1000 MHz band) are on the top of the spine and under the tip of the left mainplane respectively. These provide all round cover for reception of the IFF beacon interrogations and automatically transmitted replies. An aerial switching unit automatically connects the transponder alternately to the two aerials.

Electrical Supplies

96. Power is supplied from the 28V DC busbar and 115V essential AC busbar.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

97. Carry out the following pre-flight checks:

a. Check IFF emergency switch on bulkhead behind the ejection seat by ensuring that the switch is pushed down and connected to the ejection seat by the distress signal lanyard.

b. Set IFF circuit breaker.

c. Set function switch to NORM and allow 1 minute for the system to warm up.

Note: Warning light will be on during the warm-up period.

d. Press the TEST button and check that the test light comes on. Release the TEST button, check that the light goes out within 10 seconds. The warning light should remain out during these checks

e. Unless otherwise instructed by the controlling authority, reset function switch to SBY. Check that warning light remains out.

f. Set CIVIL/MIL switch, all mode control switches and mode selector switches as instructed.

Warning System Check

98. Check the warning system as follows:

a. Set function switch to SBY.

b. Press TEST button; in this condition the transponder is inhibited, representing a fault condition.

c. Check that IFF failure light flashes and TEST light remains out.

d. Release TEST button.

Note: Under certain conditions the IFF failure light can come on to give false indications of failure:

1. With the IFF circuit breaker set and the function switch at OFF, the light is on.

2. When operating the function switch from OFF to SBY during the initial 50-second delay period the light is on (when switching from OFF to EMGY this delay is overridden).

3. If the TEST button is pressed and released too quickly the light may come on.

4. If any of the mode control switches are selected with the function switch at SBY the light flashes at 1 second intervals if interrogated on a selected mode. This flashing ceases when LOW or NORM is selected.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

99. The indications and actions relating to system malfunctions are listed in Table 6.

Table 6 — IFF/SSR Installation — Malfunctions

Indication	*Immediate Action*	*Subsequent Action*	*Remarks*
IFF light on	Check switch-on and warm-up correct	—	If light remains equipment is unserviceable
Ground control report no IFF response — failure light out	Check IFF circuit breaker and correct code set. Select NORM and press TEST button	—	If warning light comes on equipment is unserviceable (even if green light obtained)

INSTRUMENT LANDING SYSTEM (ILS) (ARI 18227/1)

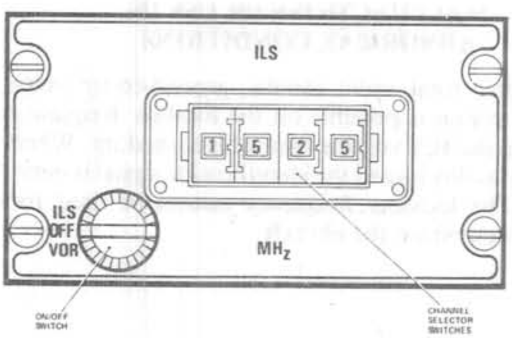
(Issued at AL6)

CONTROLS AND INDICATORS

100. Illustrations of the ILS controller and the Horizontal Situation Indicator (HSI) are shown at Fig 8 and Fig 9. These, and the associated controls, are listed in Table 7.

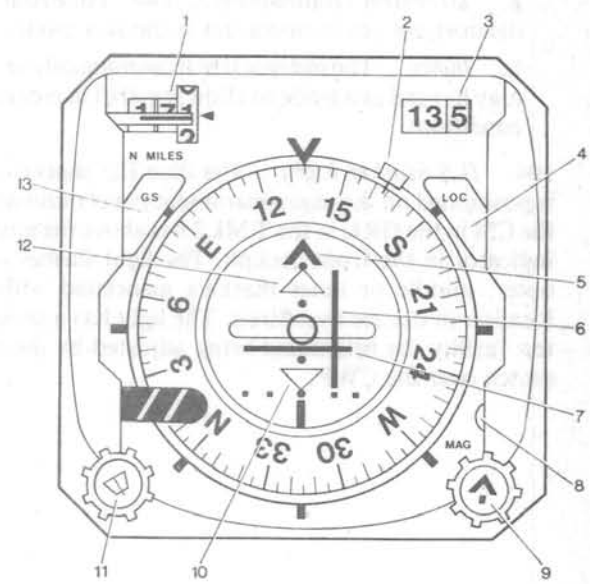
Table 7—ILS Controls and Indications

Item	*Location*	*Marking*	*Remarks*
ILS Controller	Left console (right console, front cockpit of T Mk 2)	—	On/off and frequency control
HSI	Main instrument panel	—	—
HSI Mode Switch	Centre panel below NCU	—	6-position switch
ILS Marker Light	Main instrument panel	ILS MARKER	Blue light
CCS Controller	Left console	—	—



1 RANGE COUNTER
2 INDEX
3 TRACK COUNTER
4 LOC FLAG
5 TRACK POINTER
6 LATERAL DEVIATION BAR
7 GLIDESLOPE DEVIATION BAR
8 MAG/TRUE FLAG
9 MANUAL TRACK SELECTOR
10 FROM FLAG
11 INDEX SETTING CONTROL
12 TO FLAG
13 GLIDESLOPE FLAG

1—10 Fig 8 ILS Controller



1—10 Fig 9 Horizontal Situation Indicator

DESCRIPTION OF THE SYSTEM

ILS Controller

101. The ILS controller has the following controls:

a. *ILS/OFF/VOR Switch.* The system is switched on and off by selecting the ILS/OFF/VOR switch to ILS or OFF. The VOR position is not used.

b. *Channel Selector Switches.* Three thumbwheel selector switches select and display the localiser frequency within the range 108.0 to 111.95 MHz in 50 kHz steps. Setting the appropriate localiser frequency automatically tunes the paired glidepath frequency for the glidepath receiver.

Associated Equipment

102. *HSI Mode Switch.* In order to obtain ILS indications on the HSI, the HSI mode switch is selected to the ILS position.

103. *HSI.* In the ILS mode the HSI has the following functions:

a. *Track Pointer and Counter.* The track pointer and counter, when set to the magnetic heading of the runway in use, validate the indications from the lateral deviation bar. The pointer and counter are set by adjusting the manual track selector knob on the HSI.

b. *Lateral Deviation Bar.* When the localiser flag is not in view, the lateral deviation bar indicates aircraft displacement from the runway extended centreline in the horizontal plane.

c. *Glideslope Deviation Bar.* Providing the glideslope flag is retracted, the glideslope deviation bar indicates the aircraft's relationship to the correct glidepath.

d. *Range Indication.* With ILS selected at the HSI mode switch and the Tacan selected to T/R, the range counter displays ranges to the position inserted into the NAVWASS off-set computer (TAC/BR2 store). If no off-set has been inserted, the range shown is to the Tacan beacon selected, not to the touchdown point.

e. *Localiser and Glideslope Flags.* If either the localiser or glideslope flag is visible, the associated azimuth or glidepath information is not valid. The flags are marked LOC and GS respectively.

f. *True/Mag Flag.* The True/Mag flag indicates MAG in the ILS mode.

g. *To/From Indications.* The To/From indicators are not in operation in the ILS mode.

h. *Index.* The index is free to be manually set and may be used as a guide to allow for drift in crosswind conditions.

104. *ILS Marker Light.* The blue ILS marker light is positioned on the main instrument panel outboard of the CSI in the GR1; in the T Mk 2 it is above the attitude indicator in the front cockpit. The light flashes when outer, middle or inner markers associated with the localiser in use are overflown. The light has a press-to-test facility, its brightness being adjusted by the N/D switch over the CWP.

105. *CCS Controller.* The volume control on the CCS controller, marked ILS, adjusts the level of the ILS identification signal to the headphones. The level of audio signals from marker beacons cannot be controlled.

Power Supplies

106. The ILS system takes 28V DC from the normal busbars in the GR1 and T Mk 2. A separate 28V DC source is used to check the ILS marker light filament when the press-to-test facility is used to allow the check to be made without switching on the ILS.

NORMAL USE OR MANAGEMENT

107. Set the correct frequency at the ILS controller and turn the ILS/OFF/VOR switch to ILS. Set the HSI mode switch to ILS and the track pointer and counter to the magnetic heading of the runway in use. Check the identification signal is correct by adjusting the ILS volume on the CCS controller. If accurate ranges are to be displayed in the range indicator, the NAVWASS TAC/BR2 store should have the off-set difference between the Tacan beacon position and the runway touchdown point inserted. The ILS system is then ready for use.

MALFUNCTIONS OR USE IN ABNORMAL CONDITIONS

108. After total radio failure, ground-to-air voice communication is possible on the localiser frequency providing the ILS volume control is turned up. When the voice facility is used the identification signal is interrupted. The localiser frequency cannot be used for transmissions from the aircraft.

PART 1

CHAPTER 11 — COCKPIT EQUIPMENT

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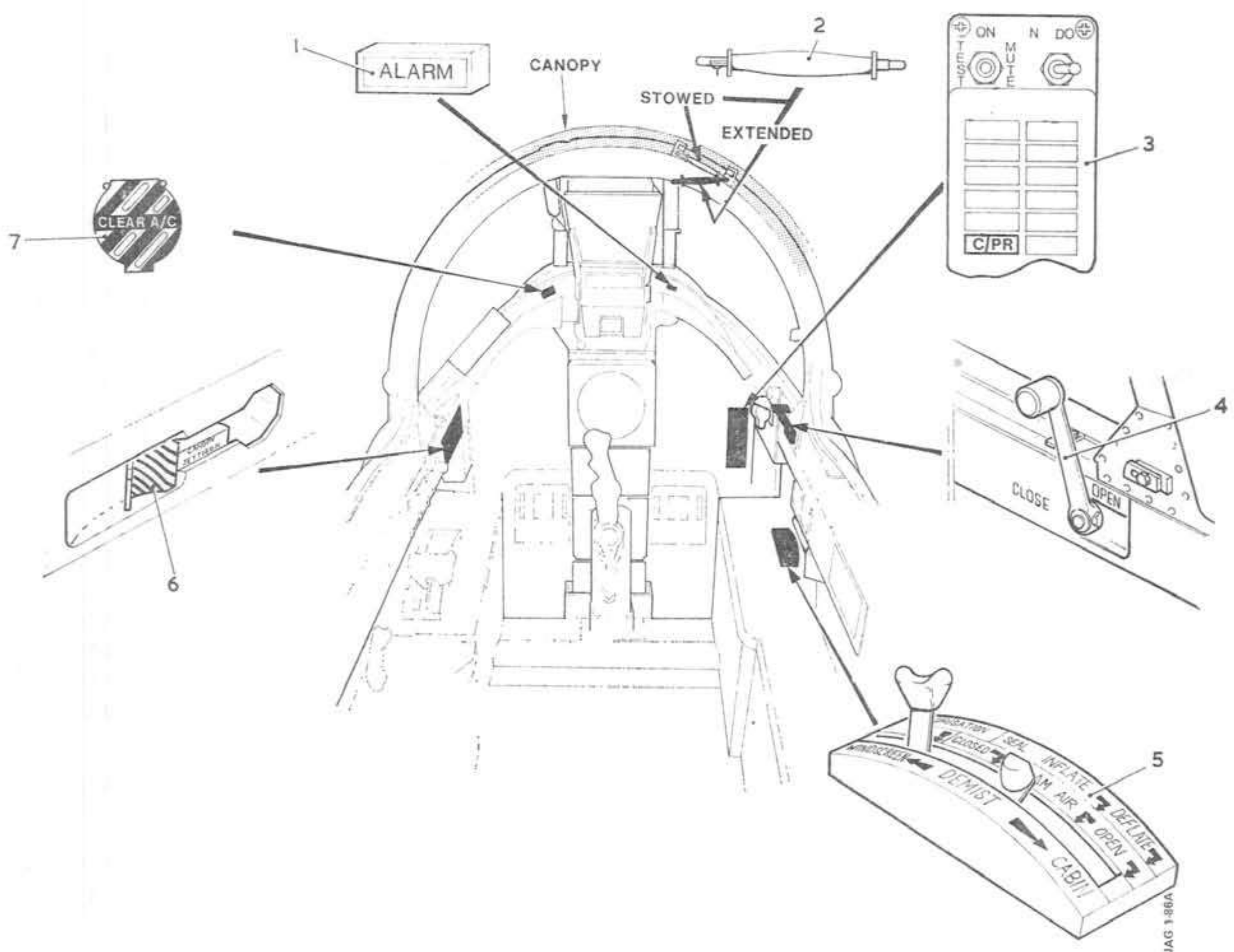
CANOPY

CONTROLS AND INDICATORS

1. Details concerning the controls and indicators shown in Fig 1 are listed in Table 1.

Table 1 — Canopy and External Stores Jettison Controls and Indicators

Item No	*Item*	*Location*	*Marking*	*Remarks*
1	Attention-getter	Right coaming	ALARM	Flashes red
2	Canopy strut	Forward canopy frame	—	—
3	Pressurisation failure and canopy locking handle not forward warning	Centralised warning panel	C/PR ~~(PRESS pre-mod 466)~~ AL5.	Red plus audio warning
4	Canopy locking handle	Right sill	OPEN — CLOSE	—
5	Canopy seal control	Right console	SEAL — INFLATE/ DEFLATE	—
6	Canopy jettison handle	Left sill	CANOPY JETTISON	—
7	External stores jettison button	Left coaming	CLEAR A/C	—



1—11 Fig 1 Canopy and External Stores Jettison, Controls and Indicators

DESCRIPTION OF THE SYSTEM

General

2. The transparent canopy, mounted in a light metal frame and hinged at the rear, is manually opened and closed and can be locked in the fully open or fully closed position from inside and outside the cockpit. It can also be secured in the partially open position by engaging a strut on the canopy frame with a spigot on the right arch of the windscreen. It is advisable to have the canopy shut or on the strut for starting. When taxying with the canopy on the strut, the wind speed plus taxy speed is not to exceed 40 knots. The canopy must not be fully opened whilst taxying.

Locking/Unlocking, Sealing and Jettison

3. *Locking/Unlocking.* The locking and unlocking mechanism is actuated by either of the canopy handles. (The canopy jettison system also actuates the unlocking mechanism.) The internal handle (Fig 1) and the flush fitting external handle (on the fuselage below the windscreen) operate as follows:

a. *Canopy 'Shut' Selected* (canopy held closed). Two forward locking hooks engage the underside of the canopy frame and the canopy seal valve operates to allow canopy seal inflation, when the cabin air lever is fully forward.

b. *Canopy 'Open' Selected.* Canopy seal valve operates to deflate the canopy seal and the locking hooks are disengaged.

WARNING: Irrespective of canopy position, movement of the canopy locking lever handle to the shut position extinguishes the C/PR caption on the CWP and allows canopy seal inflation.

4. *Sealing.* Canopy sealing is achieved by means of an inflatable rubber seal between the fuselage and the canopy. Charge air is tapped from the air conditioning supply, upstream of the main pressure regulating valve, and passes through a non-return valve and pressure reducing valve to a master valve, controlled by the cabin air lever, which vents the air supply to atmosphere when the lever is fully back. From the master valve, air is routed to the seal via a valve controlled by the associated canopy locking handle: if air is available the seal inflates whenever the locking lever is fully forward.

5. *Jettison.* The canopy is jettisoned from inside the cockpit by using the canopy jettison handle or the ejection seat firing handle. Jettison from outside the cockpit is by breaking the transparent panels on either the left or the right front fuselage and pulling the exposed jettison D-ring. When canopy jettison is initiated the following occurs:

a. The sear is withdrawn from the canopy jettison gun which fires.

b. The resultant gases are piped to release the canopy locking hooks and to fire the cartridges in the canopy jettison jacks. The canopy is lifted by a piston rod attached to the jettison jacks.

c. The canopy rises, is disconnected from the compensating mechanism and is ejected clear of the cockpit.

Note: The ejection seat is designed to eject through the canopy if the canopy fails to jettison.

NORMAL USE OR MANAGEMENT

Canopy Operation from Inside the Cockpit

6. *To Open the Canopy*

a. Move the cabin air lever fully aft to DEFLATE.

b. Pull the canopy locking handle to its central position (slightly aft of the vertical): the canopy unlocks and lifts.

c. Push the canopy upwards until it locks.

7. *To Shut the Canopy*

a. Unlock the canopy by taking the weight of the canopy with the left hand and pulling the locking handle fully to the rear with the right hand. The handle is spring-loaded from the rear to the central position.

b. Using the canopy handle, pull the canopy down to its bottom position.

c. Lock the canopy by pushing the locking handle fully forward. Check that the yellow stripes on both sides of the canopy arch and windscreen frame are aligned, that the red strip at the top of the windscreen frame is not visible, and that the C/PR ~~(PRESS)~~ caption on the CWP goes out.

d. Set the pressurisation control to SEAL — INFLATE.

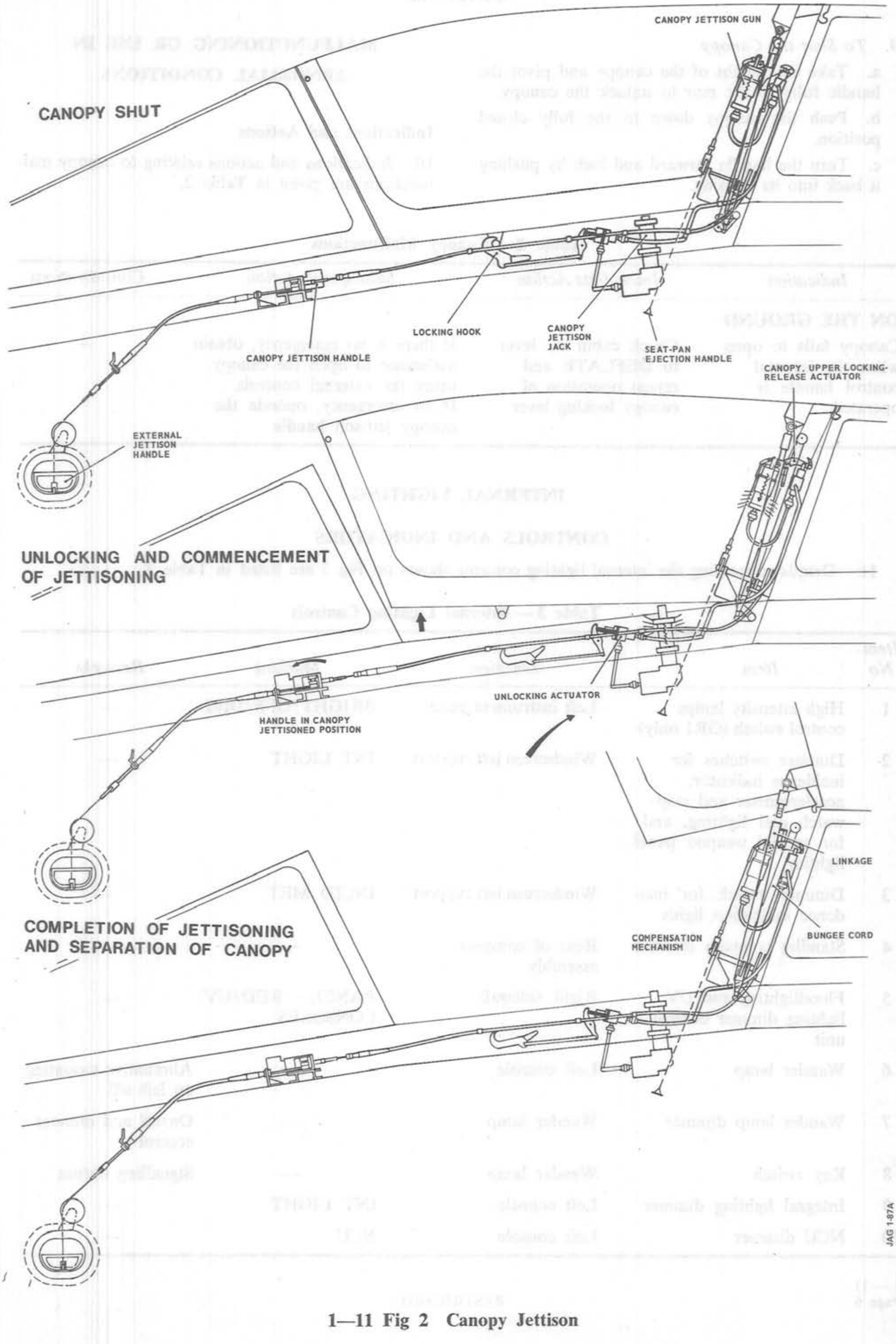
Note: If a part open position of the canopy is required, carry out the initial opening or closing operations and secure the canopy in the intermediate position with the canopy stay rod. Always stow the canopy stay rod before closing the canopy as there is a risk of it striking the HUD sight glass.

Canopy Operation from Outside the Cockpit

8. *To Open the Canopy*

a. Press the grooved end at the rear of the external handle. With the handle freed, pivot it to the rear to unlock the canopy.

b. Push the canopy to the top position until it locks.



1—11 Fig 2 Canopy Jettison

9. *To Shut the Canopy*

a. Take the weight of the canopy and pivot the handle fully to the rear to unlock the canopy.

b. Push the canopy down to the fully closed position.

c. Turn the handle forward and lock by pushing it back into its housing.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

10. Indications and actions relating to canopy malfunctions are given in Table 2.

Table 2 — Canopy Malfunctions

Indication	*Immediate Action*	*Subsequent Action*	*Considerations*
ON THE GROUND			
Canopy fails to open when the internal control handle is operated	Check cabin air lever to DEFLATE and repeat operation of canopy locking lever	If there is no emergency, obtain assistance to open the canopy using the external controls. If an emergency, operate the canopy jettison handle	—

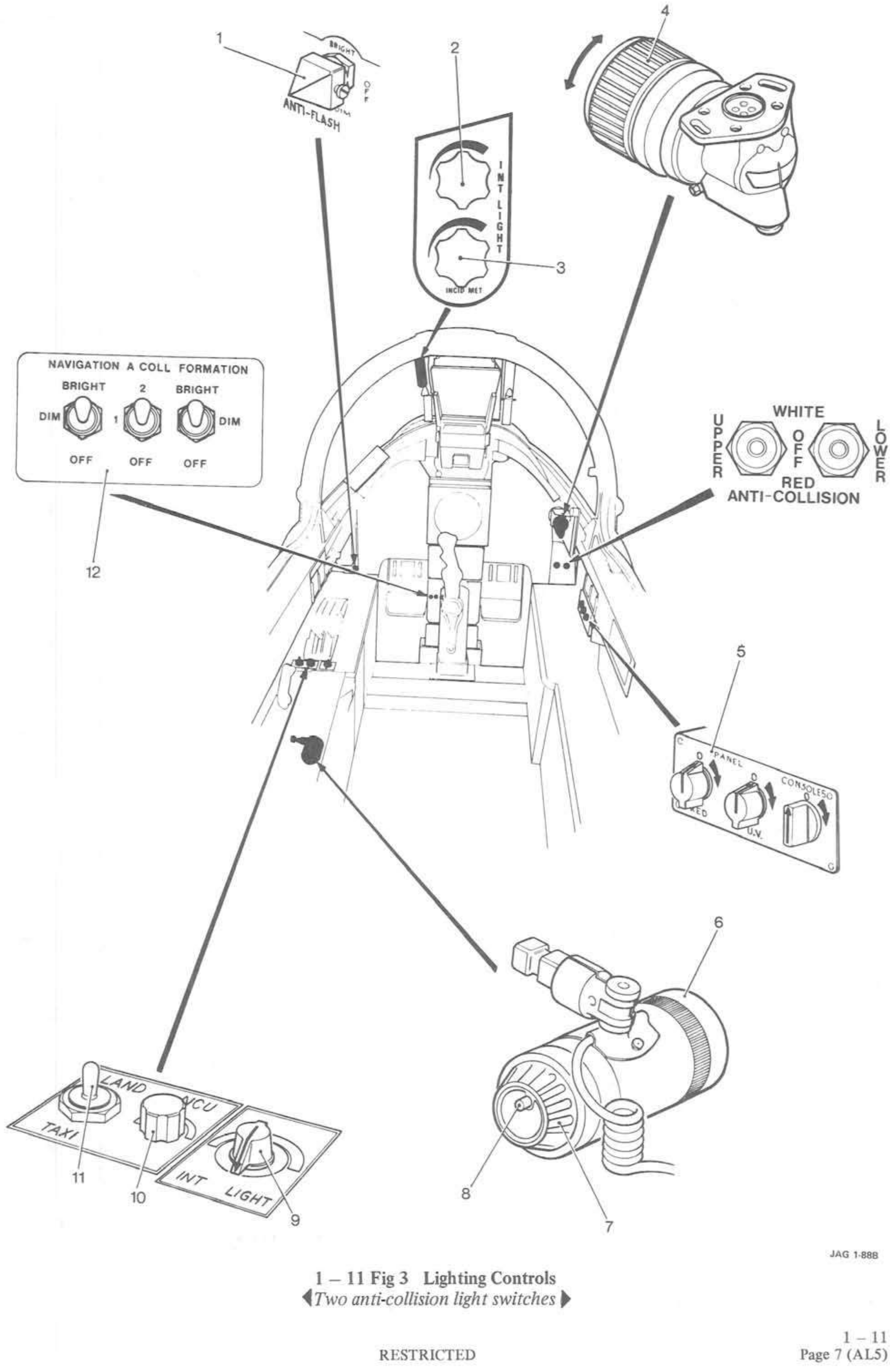
INTERNAL LIGHTING

CONTROLS AND INDICATORS

11. Details concerning the internal lighting controls shown on Fig 3 are listed in Table 3.

Table 3 — Internal Lighting Controls

Item No	*Item*	*Location*	*Marking*	*Remarks*
1	High intensity lamps control switch (GR1 only)	Left instrument panel	BRIGHT/OFF/DIM	—
2	Dimmer switches for incidence indicator, accelerometer and stop-watch dial lighting, and for special weapon panel lighting	Windscreen left support	INT LIGHT	—
3	Dimmer switch for incidence indication lights	Windscreen left support	INCID MET	—
4	Standby compass dimmer	Rear of compass assembly	—	—
5	Floodlighting and UV lighting dimmer control unit	Right sidewall	PANEL — RED/UV: CONSOLES	—
6	Wander lamp	Left console	—	Alternative mounting on left sill
7	Wander lamp dimmer	Wander lamp	—	On/off and dimmer control
8	Key switch	Wander lamp	—	Signalling button
9	Integral lighting dimmer	Left console	INT LIGHT	—
10	NCU dimmer	Left console	NCU	—



1 – 11 Fig 3 Lighting Controls
◀*Two anti-collision light switches*▶

DESCRIPTION OF THE SYSTEM

Internal Lighting System

12. The internal lighting system comprises:

a. Red floodlighting and ultra-violet lighting of the instrument panels and amber floodlighting of the consoles.

b. High intensity floodlighting (GR1 only).

c. Panel integral lighting and additional lighting.

d. Wander lamp.

Floodlighting

13. The main instrument panel floodlighting is provided by two double-tube lamp units fitted under the left and right instrument panel shrouds, each having one red and one ultra-violet lamp tube. The tubes are controlled independently by PANEL dimmer switches marked RED and UV respectively.

14. Console lighting is provided by one amber tube unit above the left console and two amber tube units on the right console. Brightness is controlled by a dimmer marked CONSOLES.

15. In normal conditions the lamps are supplied from the 115V, 400 Hz, AC normal supply. Should the normal AC supply fail, the supply is maintained by an automatically-switched static inverter.

High Intensity Lighting (GR1 only)

16. Two high intensity floodlamps are fitted under the left and right coamings and provide lighting of the essential instruments. Light intensity is controlled by the BRIGHT/OFF/DIM switch on the left side panel: the BRIGHT setting provides an anti-dazzle facility. Electrical supplies are obtained from the 28V, DC emergency busbar.

Panel Integral and Additional Lighting

17. The integral lighting system provides lighting for the control panels on the left and right consoles. Lighting, in addition to the high intensity lighting (GR1) and floodlighting, is controlled via the INT LIGHT dimmer, NCU dimmer, Pilot's Control Panel (PCP) dimmer, standby compass dimmer and miscellaneous instruments dimmer controls.

18. The INT LIGHT dimmer controls the lighting on the following control panels:

a. VHF/UHF, CCS, IFF, ILS controllers.

b. Compass, Tacan, air conditioning, HF (GR1) and voice recorder (GR1) controllers on the right console, WCP, fuze control or reconnaissance control (GR1) and c/b panels.

c. Electrical control panel on right wall, PCP and HSI mode switch.

19. Additional lighting dimmers control the following:

a. NCU digital indicators and failure warnings, WAMS and PMD.

b. The HUD system lighting (via the PCP dimmer).

c. The standby compass lighting.

d. The incidence indication integral lights (via the INCID MET dimmer).

e. The incidence indicator, stopwatch and accelerometer dial lighting and the special weapon control panel (GR1) (via the INT LIGHT dimmer on the left windscreen support).

20. Electrical supplies to the dimmers are as follows:

a. 28V, DC from the normal DC busbar to the panel integral lighting, NCU and PCP lighting.

b. 28V, DC from the emergency DC busbar to the standby compass and angle of attack indication lights

c. 5V, AC via a transformer from the 115V, AC busbar to the accelerometer, angle of attack indicator and stopwatch dial lighting.

Warning Lights and Centralised Warning Panel Lighting

21. Refer to Chapter 2.

Wander Lamp

22. Additional cockpit lighting is provided by a wander lamp stowed at the rear of the left console. The lamp is connected to the emergency DC busbar via a coiled extension lead and incorporates the following:

a. A two-part knurled control: the front part a filter selector (red or white) and beam width adjuster, and the rear portion a dimmer on/off switch.

b. A signalling facility controlled by a key switch at the rear of the knurled dimmer.

Note: The wander lamp may be clipped on to the left sill of the cockpit to provide supplementary lighting for the instrument panel.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

23. During the check of the angle of attack system indication lights, adjust the light intensity as required

24. Before a night flight, check that all lighting systems are serviceable and adjust the light intensity as required.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

25. Indications and actions relating to malfunctions are listed in **Table 4.**

Table 4 — Internal Lighting Malfunctions

Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
FLOODLIGHTING			
Supply failure occurs	—	—	Automatic emergency supply is obtained via 28V, DC emergency busbar
HIGH INTENSITY LIGHTING (GR1)			
Supply failure	Switch off	Use wander lamp	No standby supply is available for the high intensity lamps
INTEGRAL LIGHTING			
Control panel lighting failure	Switch off	Use wander lamp	Attach to fitting on cockpit left sill

EXTERNAL LIGHTING

CONTROLS AND INDICATORS

26. The external lighting controls are shown in Fig 3 (items 11 and 12).

DESCRIPTION OF THE SYSTEM

Navigation Lights

27. The navigation lights are on the leading edge of the wing tips and the upper trailing edge of the fin. They are controlled via the NAVIGATION — BRIGHT/DIM/OFF switch on the centre console and supplied from the 28V, DC emergency busbar.

Anti-Collision Lights

28. Two anti-collision lights are fitted, one on the spine and one on the underside of the rear fuselage. Pre-STI 197/198 they are controlled by the 3-position A-COLL — 2/1/OFF switch on the centre console and supplied from the 28V, DC normal busbar. Position 1 switches on the lower light only: position 2 switches on both lights. Post STI 197/198 the lights are controlled individually by switches on the right instrument panel.

Formation Lights

29. Two white formation lights are fitted, one on each wing above the outboard edge of the flap. They are controlled by the 3-position FORMATION — BRIGHT/DIM/OFF switch ⧓ on the centre console and supplied from the 28V, DC normal busbar: with the switch central the lights are dimmed.

Landing and Taxying Lamps

30. A landing lamp and taxying lamp, on the right and left of the nose landing gear door respectively, are controlled by the LAND/OFF/TAXI switch on the left console. The electrical supplies, which are from the 28V, DC normal busbar, are interrupted when the nose landing gear is not in the locked down position. The landing lamp should not be used continuously for more than 3 minutes.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

31. Before a night flight, carry out a check of all the external lights.

Note: The landing and taxying lamps can only be checked if power is available from a ground supply or aircraft AC generators.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

32. Indications and actions relating to malfunctions are listed in Table 5.

Table 5 — External Lighting Malfunctions

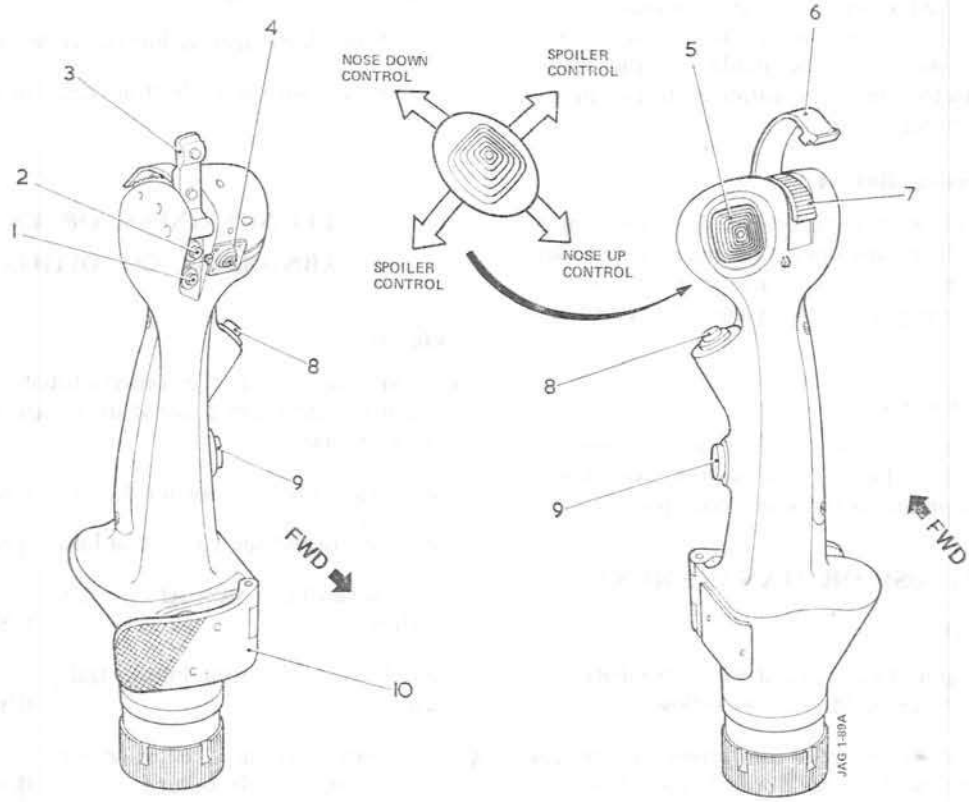
Indications	*Immediate Action*	*Subsequent Action*	*Considerations*
LANDING LAMP FAILURE			
Prior to landing the landing lamp does not operate	Check the position of the nosewheel landing gear	If the landing gear is locked down, use the taxying lamp	—
TAXYING LAMP FAILURE			
Taxying lamp does not operate	Use the landing lamp	—	3 minute limit

CONTROL COLUMN HANDGRIP CONTROLS AND INDICATORS

33. Details concerning the handgrip controls shown in Fig 4 are listed in Table 6.

Table 6 — Control Column Handgrip Controls

	Item No	*Item*	*Remarks*
	1	Guns firing button	Normally operated by firing trigger
AL6	2	Pilot's display recorder button/~~recce pod sensor switch (pre-mod 896)~~	Normally operated by firing trigger
	3	Firing trigger	Two modes: Safe — recorder only Firing — guns and recorder
	4	Firing trigger safety catch	Slide catch inserts stop between firing trigger and guns firing button
	5	Pitch and roll trim switch	Spring-centred 5-position switch
	6	Fire commit button guard	Hinged flap
	7	Fire commit button	Milled, spring-loaded to off
	8	Press-to-transmit button	—
AL6	9	Nosewheel steering button/ F95 camera run switch ~~(post-mod 896)~~	Press-to-engage; press-to-disengage
	10	Autostabilisation cut-out	Press to disengage autostabilisation



1—11 Fig 4 Control Column Handgrip

DESCRIPTION OF THE SYSTEM

General

34. The control column handgrip is a combined centralised control unit providing the following control functions:

a. Pitch and roll trim control.

b. Weapon release, gun firing, recce pod and camera recording control.

c. Nosewheel steering selection.

d. Autostabiliser disconnect control.

e. R/T transmit facility.

Pitch and Roll Trim Switch

35. The tailplane (pitch) and spoiler (trim) control is a 5-position switch spring-loaded to the centre. The switch selector moves in a cross-shaped guide and activates any one of four microswitches. The switch positions, away from the centre, and associated functions are as follows:

a. Forward — nose-down trim is applied.

b. Back — nose-up trim is applied.

c. Right or left — the appropriate roll trim is applied.

Firing Trigger Control Switches

36. The firing trigger controls the pilot's display recorder and guns firing circuit buttons. It has two operating positions:

a. *'Safe'*. The trigger safety catch is engaged by pushing the safety catch towards the trigger. This allows the trigger when pulled, to operate the pilot's display recorder button but not the guns firing button.

b. *'Guns Ready'*. The trigger safety catch is released by sliding the catch away from the trigger. This allows the trigger when pulled to operate both the pilot's display recorder and guns firing buttons.

Fire Commit Button

37. The fire commit button is guarded by a safety cover which, in the safe (stowed) position, prevents inadvertent operation of the button. With the safety cover raised, operation of the button energises the selected conventional or special weapons release circuit.

Press-to-Transmit Button

38. The press-to-transmit button provides overall control of radio transmissions. With the button pressed transmissions can be made via the transmitter unit selected on the communications control system (CCS) panel.

Nosewheel Steering Button

39. The nosewheel steering button provides control of the nosewheel steering via an electrical distributor. Operation of the button activates the step switch which in turn engages or disengages the nosewheel steering.

Autostabiliser Cut-out

40. The autostabiliser cut-out is a rapid disengagement switch. Operation of the switch disconnects the electrical supplies to the servo-controls.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

41. The pre-flight checks called for in the FRC are detailed in the Aircrew Manual as follows:

a. Pilot's display recorder and trigger controls (refer to Aircrew Manual Book 2, Part 8, Chapter 9).

b. Pitch/roll trim switch and autostabiliser cut-out (refer to Chapter 6).

c. Nosewheel steering button (refer to Chapter 7).

d. Press-to-transmit button (refer to Chapter 10).

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

References

42. Malfunctions in the controls fitted to the control column handgrip are covered in the associated chapters as follows:

a. Pitch/roll trim switch failure	Chapter 6
b. Autostabiliser cut-out failure	Chapter 6
c. Nosewheel steering button failure	Chapter 7
d. Press-to-transmit button failure	Chapter 10
e. Pilot's display recorder or guns firing circuit failure ...	Book 2, Part 8, Chapter 9

EXTERNAL STORES JETTISON

CONTROLS AND INDICATORS

Control Button

43. The external stores jettison button is on the cockpit left coaming under a striped guard labelled CLEAR A/C.

DESCRIPTION OF THE SYSTEM

General

44. The jettison button enables the emergency release of all external stores. Except for the tandem bomb carriers, if fitted, all stores are jettisoned with their carriers. Electrical supply is obtained from the 28 V, DC emergency busbar *but only when the master armament switch is set to LIVE.*

NORMAL USE OR MANAGEMENT

Jettison

45. To jettison external stores:

a. Set the master armament switch (left console rear) to LIVE.

b. Raise the guard and press the CLEAR A/C button.

Note: Jettisoning is total. No selection is possible when using the CLEAR A/C button. (Refer to Book 2, Part 8.)

PART 1

CHAPTER 12 — PILOT EQUIPMENT AND ASSOCIATED SYSTEMS

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WARNING: The aircraft assisted escape system is a potential source of danger and inadvertent operation can cause fatal injuries. Five safety pins are fitted to make the system safe. On completion of a landing and before departing from the aircraft, the pilot must ensure that the ejection seat and canopy are left in the 'Safe for Parking' condition, that is, safety pins fitted in the seat firing handle sear, the canopy jettison firing unit sear, the rocket initiator and the manual separation handle. In the 'Safe for Servicing' condition the remaining pin is fitted in the main gun sear.

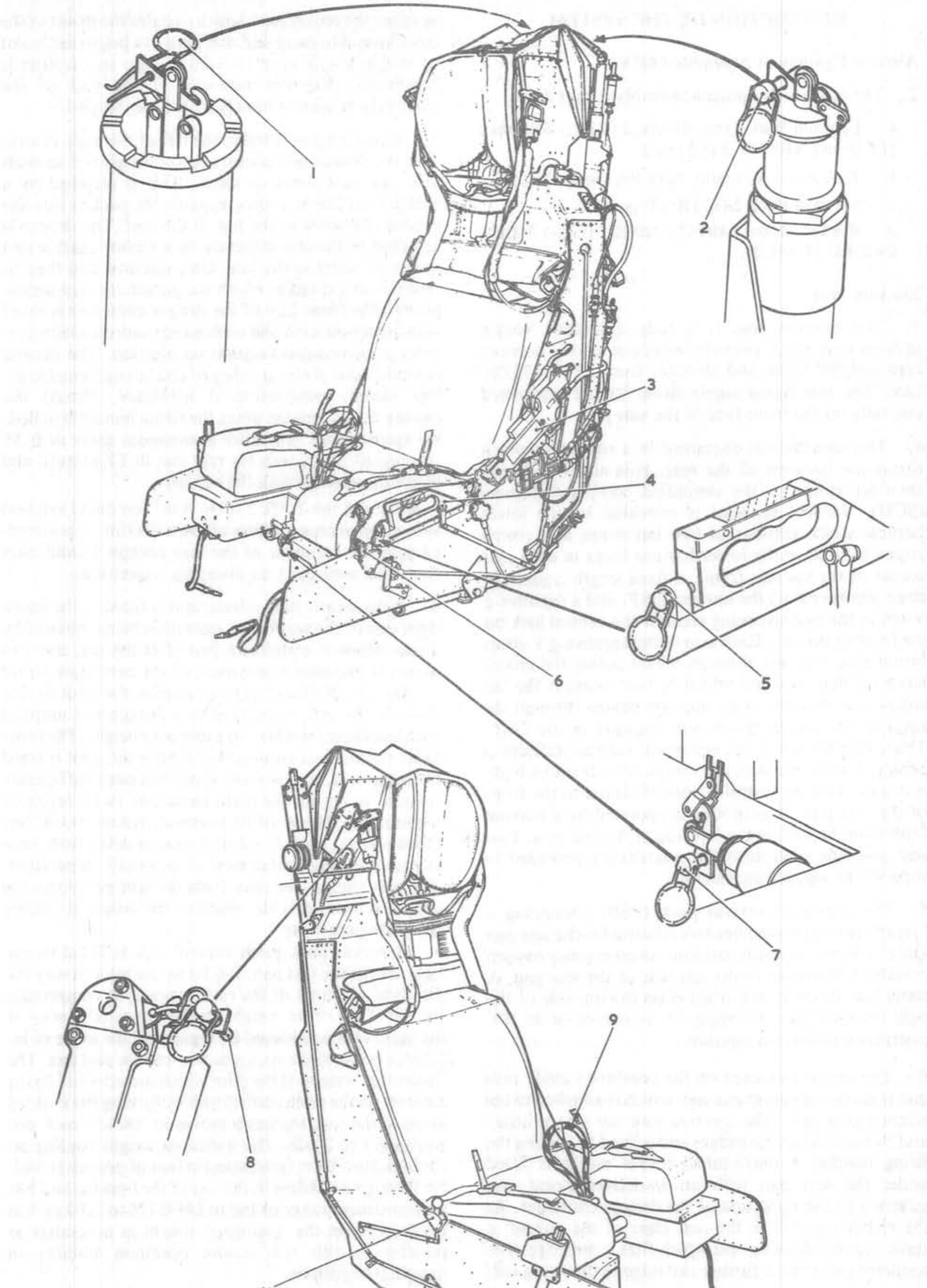
EJECTION SEAT TYPE 9B Mk 2

EJECTION SEAT CONTROLS AND INDICATORS

1. Details concerning the controls and indicators shown on Fig 1 are listed in Table 1.

Table 1 — Ejection Seat Controls and Indicators

Item No	*Item*	*Location*	*Remarks*
1	Main gun safety pin	Main gun sear	—
2	Canopy jettison gun safety pin	Canopy jettison gun sear	—
3	Personal equipment connector (PEC)	Left side of seat	Connects oxygen (main and emergency) anti-g suit supplies and radio
4	Manual separation handle	Left side of seat pan	Yellow/black striped handle. Thumb catch must be pressed before handle can be pulled up
5	Manual separation handle safety pin	Manual separation handle	—
6	Leg restraint line release lever	Left side of seat pan (forward)	Pull back to release lines
7	Seat firing handle safety pin	Seat firing handle sear	—
8	Rocket initiator safety pin	Rocket initiator (top right of seat)	—
9	Seat firing handle	Centre of forward face of seat pan	Yellow/black striped handle
10	Pitch control unit	Right side (forward) of seat pan	Adjusts the direction of thrust of rocket motor by setting 'boarding weight' of pilot in window on top of unit
11	Harness go-forward lever	Right side (rear) of seat pan	Move to rear and release to mid-position — 'Unlock' position. Move fully forward—'Locked' position



1—12 Fig 1 Ejection Seat Equipped

DESCRIPTION OF THE SYSTEM

Aircrew Equipment Assembly (AEA)

2. The aircrew equipment assembly comprises:

a. Ejection Seat Type 9B Mk 2 (GR1), 9B1 Mk2 (T2 front), 9B2 Mk 2 (T2 rear).

b. Parachute Assembly 5038 PA (Back-type 61).

c. Survival Pack 2832 DP (Type ZJ).

d. Rocket Motor MBEU 2820 RU (GR1) MBEU 2902 RU (T Mk 2).

Ejection Seat

3. The ejection seat is a fully automatic rocket assisted unit which provides escape at speeds between zero and 600 knots and altitudes from zero to 50,000 feet. The seat has a single firing handle positioned centrally on the front face of the seat pan.

4. The parachute is contained in a rigid case which forms the backrest of the seat. It is attached to the shoulder straps of the simplified combined harness (SCH). Vertical restraint is provided by the lower harness which consists of two lap straps and crotch straps secured to the lower harness locks in each rear corner of the the seat frame, a fixed length negative-g strap incorporating the harness QRF, and a negative-g V-strap, the two last being secured at a central lock on the front of the seat. Each arm of the negative-g V-strap terminates in a ring through which passes the crotch strap on that side and which in turn engages the lap strap. The shoulder strap lugs are passed through the rings in the crotch straps and engaged in the QRF. Thus, with the lap straps tightened, vertical restraint is achieved whilst the shoulder straps provide upper body restraint. Two leg restraint lines are fitted to the front of the seat pan. A guillotine is operated by a manual separation handle on the left side of the seat pan. Two seat pan side extensions (leg guards) are provided to support the legs during ejection.

5. The personal survival pack (PSP) containing a liferaft and survival equipment is housed in the seat pan and also serves as a seat cushion. An emergency oxygen cylinder is mounted to the left rear of the seat pan. A static line attached to a bracket on the top side of the right beam on the seat triggers the operation of the IFF emergency coding on ejection.

6. The seat is mounted on the combined guide rails and telescopic ejection gun unit which is attached to the aircraft structure. The ejection gun has one primary and two secondary cartridges and is fired by pulling the firing handle. A multi-tubed rocket motor is fitted under the seat pan with an associated firing unit attached to the right side of the drogue container. As the ejection gun fires the seat clear of the aircraft a static line withdraws a sear which fires a cartridge. The resultant gases fire a further cartridge in the firing unit to ignite the rocket pack which sustains the thrust of the ejection gun to carry seat and pilot to a height sufficient to enable a safe ejection even in zero speed/altitude conditions. Ejection veleocity at the end of the gunstroke is approximately 65 feet per second.

7. A drogue gun fitted to the left of the main beams, fires the drogue gun piston approximately 0·5 seconds after the seat starts to move. This is attached by a withdrawal line to a drogue assembly packed into the drogue container at the top of the seat. The drogue is attached to the seat structure by a scissor shackle and serves to stabilise the seat after ejection and then to retard it to a speed at which the parachute may deploy safely. The front face of the drogue container is fitted with an upholstered and contoured headrest which provides positive head location on ejection. The drogue container side plates are shaped and strengthened to effect canopy penetration if necessary. Should the canopy fail to jettison when the firing handle is pulled, the ejection gun fires after a minimum delay of 0·35 seconds (0·25 seconds for rear seat in T2 aircraft) and ejects the seat through the canopy.

Note: On the T Mk 2 there is no command ejection system; each pilot initiates his own ejection. It is intended that the occupant of the rear cockpit should eject first. The seats eject on diverging trajectories.

8. A barostatic time-release unit is fitted to the upper right side of the seat beam, operation being initiated by a sear which is withdrawn just after the seat starts to move. It prevents deployment of the parachute above 10,000 feet (3048 metres) and enables the pilot to ride down in the seat, controlled by a drogue and supplied with emergency oxygen, to a tolerable height. The time-delay mechanism ensures that before the pilot is freed from the seat, the forward speed has been sufficiently reduced to permit the main parachute to be deployed without any danger of its bursting. Below 10,000 feet (3048 metres) there is a 2±0·1 second delay from time release unit sear withdrawal to automatic seperation. The unit releases the pilot from the seat and opens the drogue scissors shackle, enabling the drogue to deploy the main parachute.

9. A rocket pack pitch control unit is fitted to the right side of the seat pan. It is set by the pilot to vary the direction of thrust of the rocket motor to compensate for the effect of his weight on the centre of gravity of the seat. This is achieved by regulating the angle of incidence between the rocket motor and the seat pan. The 'boarding' weight of the pilot which includes full flying kit is set on the pitch control unit by turning the knurled knob at the top; the knob moves in 'clicks', each one equivalent to 2½lb. The indicated weight reading on the indicator drum (graduated in tens of pounds) is visible through a window in the top of the housing and has an adjustment range of 165 to 245 lb (75 to 110 kg). It is essential to set the 'boarding' weight as accurately as possible as this will ensure optimum stability in marginal conditions.

10. The seat is adjusted vertically by an electrically operated actuator with a 5-inch stroke, which is controlled by a three-position switch on the left console. The seat pan moves relative to the headrest and accommodates different body lengths. The switch is spring-loaded to the central OFF position.

11. The PSP is connected to the parachute harness by two-quick release side connectors, but the PSP lowering line is connected to the life preserver by a similar connector. Releasing either side connector after separation allows the survival pack to detach and hang 15 feet below the body on the lowering line.

WARNING: The QRF must not be operated during parachute descent. The PSP is lowered by operating *either* side connector. It is recommended that the right side connector is used for PSP lowering to preclude possible confusion between the side connector and PSP lowering line connector on the left.

12. A harness power retraction unit is fitted in the upper part of the back of the seat pan and an associated harness go-forward control lever is on the lower right side of the seat pan. The retraction unit ensures that irrespective of either the pilot's position when ejection is initiated or the setting of the go-forward control lever, he is bought back to the correct position for ejection before the seat moves and g-forces are applied. It also provides (by use of an inertia clutch), automatic restraint for excessive forward and transverse g-forces. The unit comprises two inertia reels (mounted on opposite ends of a common shaft) on which the shoulder straps of the seat harness are wound using a torsion spring, a piston driving a rack-and-pinion mechanism, a ratchet and pawl device, a clutch mechanism and a gas pipe connection from the seat pan firing unit. The system functions as follows:

a. With the harness go-forward control lever fully forward the inertia reels wind back the shoulder straps under the influence of the torsion spring. The ratchet and pawl device prevents the shoulder straps from being wound forward.

b. If the go-forward control lever is moved fully back it returns to a gated mid-setting. This lifts the pawl free from the ratchet and the shoulder straps can be wound in and out freely against a slight spring tension. The pawl is tripped back into action automatically to prevent forward movement of the shoulders caused by horizontal deceleration (crash landing), vertical acceleration (ejection), or manually, by returning the lever to the fully forward position.

c. On initiation of ejection, the gas pressure from the ejection gun firing unit is applied to and activates the rack-and-pinion mechanism. This action rotates the common shaft and the shoulder straps are wound in on the inertia reels, forcing the shoulders back into a good ejection position.

13. A leg restraint system is provided which ensures that the pilot's legs are automatically drawn back and kept close to the seat during ejection to prevent injury caused by flailing. Two restraint lines (one for each leg) are routed from a position slightly right and left of the seat pan centre line, around the front of each leg and pass through two 'D' rings of each of the leg garters fitted below the knee before going into a taper plug assembly on the inside of the side extensions of the seat pan. The lines are attached to the aircraft structure by a fitting incorporating a shear rivet and pass through snubbing units on the front of the seat pan which allow the lines to be drawn downwards but not upwards. The lines can be adjusted to give sufficient movement for application of full rudder. A leg restraint line manual release lever is on the outside of the left side extension of the seat pan. On separation, the lines are released by automatic operation of the harness release mechanism or by use of the manual separation handle.

14. A Personal Equipment Connector (PEC) is on the left side of the seat pan and enables main oxygen, emergency oxygen, mic-tel and the anti-g suit to be connected or disconnected in one action. It comprises three components:

a. A 'man portion' which is attached to the flying clothing and released from the seat by operation of the harness release mechanism or by pulling the handle lanyard.

b. A 'seat portion' bolted to the left side of the seat pan and connected to the emergency oxygen supply.

c. An 'aircraft portion' which connects all services to the seat. Incorporated in the aircraft portion are the main oxygen ON/OFF selector, the anti-g on/off selector and the anti-g test button.

On ejection, personal supplies are disconnected at a disconnect on the aircraft bulkhead; the 'man-portion' is separated from the seat portion when the harness release mechanism operates. Dust covers are provided for both the 'man' and 'seat' portions of the PEC.

Ejection Sequence (Fig 2)

15. When the firing handle is pulled, the sear is withdrawn from the ejection gun firing unit in the centre of the seat pan. This action fires a cartridge, the resultant gases being piped into the harness power retraction unit and directly to the piston unit operating the sear withdrawal shaft which is connected by linkages to the canopy jettison unit and ejection gun firing unit. The canopy jettisons immediately and the harness straps are wound in, ensuring that the pilot assumes the correct ejection posture: the feet should be left on the rudder pedals as drawing them back could lead to injury.

16. After a minimum delay of 0·25/0·35 seconds the primary cartridge fires, initiating upward movement of the seat. As the seat rises, the drogue gun sear and time

release firing unit sear are withdrawn by trip rods, the emergency oxygen is tripped on, personal supplies are disconnected and the leg restraint lines tighten to draw back the pilot's legs against the front of the seat pan. When the legs are secure the restraint lines separate from the aircraft by shearing rivets at the floor brackets. The IFF is switched on in the emergency mode.

17. As the seat leaves the aircraft, the rocket firing unit static line withdraws a sear to ignite the rocket pack to supplement the upward thrust of the ejection gun. The drogue gun fires 0·55±0·10 second after drogue gun sear withdrawal, ejecting a piston which deploys the drogue to stabilise the seat.

18. Removal of the sear from the barostatic time-release firing units arms the barostatic time-release mechanism. When the seat, attached to the drogues, has descended to 10,000 feet the barostat removes an obstruction to the gear train of the time-release mechanism allowing it to operate. If ejection takes place below 10,000 feet, the time release mechanism starts to run immediately the sear is withdrawn from the unit.

19. After 2·0±0·10 seconds the harness release plunger drops allowing the scissor shackle to open thus freeing the drogues. At the same time the plunger strikes the harness release lever releasing the upper and lower harness locks, the negative-g restraint straps, the leg restraint lines and the 'man portion' of the PEC; the pilot being held in the seat by the sticker straps. The drogues, now freed from the scissor shackle first withdraw the parachute withdrawal line from the guillotine unit and then the parachute from its pack.

20. The parachute when deployed lifts the pilot from the seat pulling the sticker straps from their clips. This arrangement ensures that there is no possibility of collision between the seat and the pilot after separation.

Note: The firing handle remains attached to the seat and must therefore be released prior to separation.

Manual Separation

21. A guillotine unit is fitted to the seat to reduce the number of actions required to effect manual separation. In the unlikely event of failure of the automatic system, manual separation can be initiated by operation of the handle on the left side of the seat pan; the handle incorporates a thumb catch which must be pressed before the handle can be pulled up. The handle is connected by linkages to the harness release mechanism and to the sear of the guillotine breech unit. It is essential that the handle is pulled fully up to ensure disengagement of the harness locks. The breech unit located on the left lower rear of the seat pan, houses a firing unit and cartridge. A safety pin is placed in the breech unit sear during servicing.

22. When the handle is pulled, the upper and lower harness locks, leg restraint lines, negative-g restraint straps and the 'man portion' of the PEC are released and the guillotine breech unit sear is withdrawn to fire the cartridge. The gases produced are piped to the guillotine unit which serves the parachute withdrawal line where it passes under the yellow gate, freeing it from the drogue assembly. The pilot is now free to push himself clear of the seat. When clear, the main parachute ripcord handle (on the left lift web of the main parachute harness) ▶◀ is pulled to deploy the parachute.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

23. If the T Mk 2 is to be flown solo, ensure that when the rear cockpit is checked, the seat safety pins are fitted: the seat apron must also be fitted. Check the front seat installation as follows:

a. Ensure that the seat pan firing handle is securely linked to the initiating sear and the handle safety pin is fitted.

b. Ensure that the leg restraint lines are secured to the floor brackets.

c. Check security of the shoulder straps, lap straps, crotch straps and negative-g straps. Ensure that the sticker straps are in their clips. Ensure the PSP connections to the lap straps are made. Check that the PSP single-handed release strap is underneath the parachute harness seat pad and is routed inside the sticker strap and is secured at the associated quick-release connector on the parachute harness.

d. Check that the static rod is connected to the barostatic time-release unit.

e. Ensure that the black portion on the end flap of the gas pipe from the rocket initiator lines up with the body of the unit. Check that the rocket firing unit static line is secured to the time-release unit trip rod and the trip rod to the beam. Remove and stow the initiator pin.

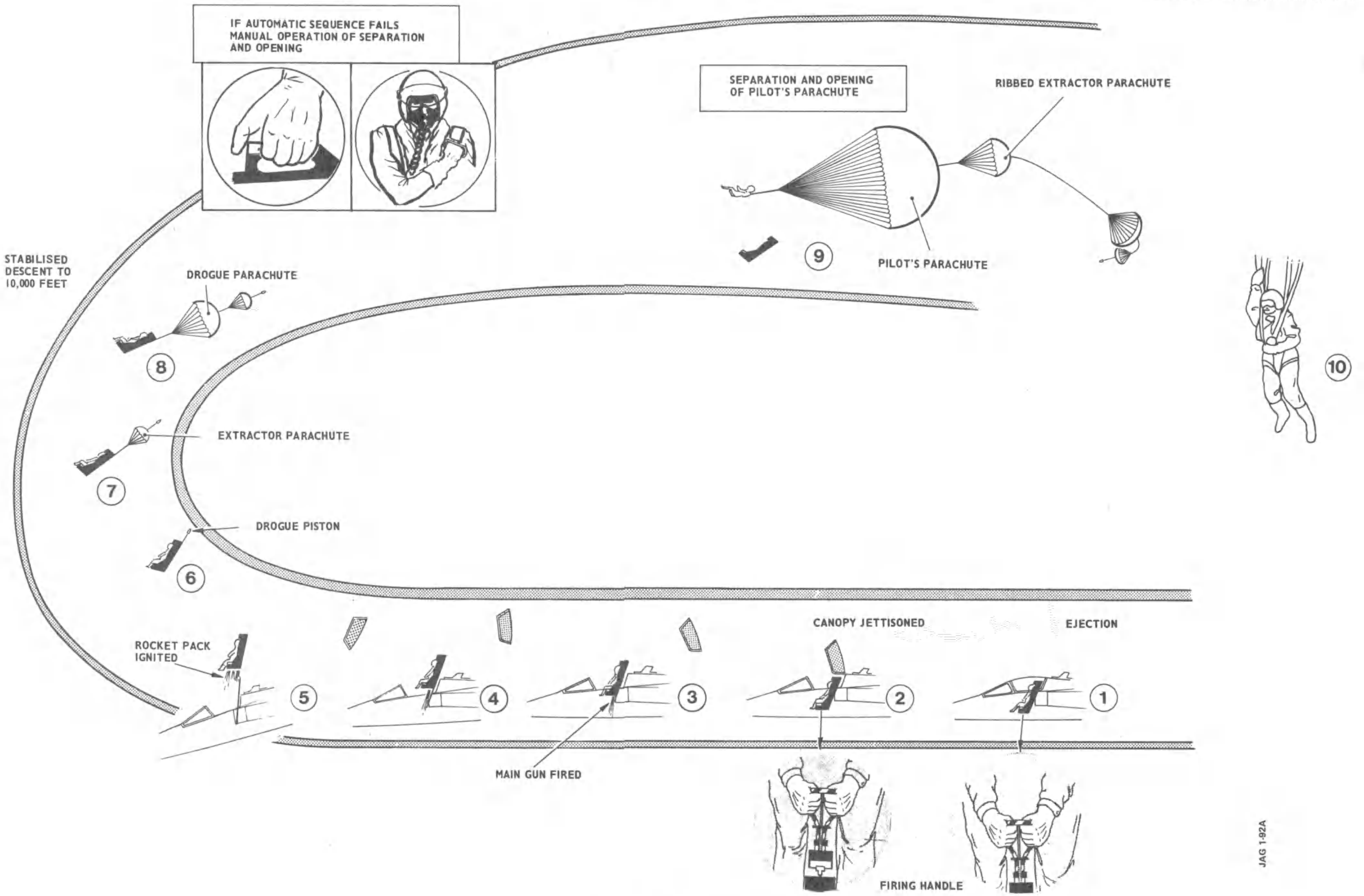
f. Ensure that the IFF emergency switch is fully down and the lanyard connected.

g. Ensure that the scissor shackle is closed and flat, drogue shackle attached.

h. Ensure that the firing linkage is correctly connected to the ejection gun sear and that the safety pin has been removed and stowed.

i. Ensure that the firing linkage is correctly connected to the canopy jettison firing unit and that the safety pin is removed and stowed.

j. Ensure that the seat is correctly locked to the ejection gun, ie the top latch indicator spigot (inner plunger) is level with or slightly protruding above the



1—12 Fig 2 Ejection Sequence

end of the latch plunger and that the plunger is level with or slightly below the housing face.

k. Ensure that the drogue withdrawal line is correctly routed and that the safety ties to the drogue closure pin and shackle are intact.

l. Check that the drogue gun trip rod is secured to the cross beam.

m. Ensure that the parachute withdrawal line is correctly connected and routed down the headrest pad through the guillotine, and that the two safety ties in the headrest channel are intact. Also check that the acorn connecting the drogue side of the withdrawl line with the parachute side and stowed in the headrest pad tunnel is correctly connected.

n. Ensure that the parachute alignment ring safety tie is intact.

o. Check that the oxygen/electrical breakaway connector static line is connected to the bracket at the top of the main beam and that the 'seat' and 'aircraft' portions are correctly mated and safety-wired. Confirm that the restraint cable from the seat is connected to the 'seat' portion. Check that the emergency oxygen bottle is full, that the operating ring is not pulled and that the quick-release connection to the oxygen trip lever is secure.

p. Check that the manual separation handle is down, pin in position.

q. Set 'boarding weight' in the rocket pack pitch control unit.

r. Check that the face of the QRF is at the locked setting (yellow marks uppermost).

Strapping-In

24. When seated, strap in using the following sequence:

a. Ensure that the oxygen and anti-g are turned off at the PEC. Remove and stow the PEC dust cover.

b. Remove the cover from the 'man portion' of the PEC, insert the forward end first and press down with a hingeing motion until it locks into place.

c. Adjust seat height as required.

d. Pass the leg restraint line from the left snubber unit around the front of the left leg passing it through the garter D-rings and plug the taper plug end into the socket on the inside of the left side seat extension (leg guard). Similarly route the right line through the right leg garter D-rings and plug the taper plug into the socket on the inside of the right side seat extension (leg guard).

e. Connect the survival pack lowering line to the quick-release connector on the life preserver, routeing the line outside the left leg.

Note: If the connection is short extend the strap attached to the life preserver. Do not attempt to extend the lowering line by pulling as this is tied to the survival pack.

f. Bring down the shoulder straps, releasing the Velcro fasteners with a sharp tug. If the straps are too short, extend them by lifting the metal tab on each adjustment buckle.

g. Bring the left crotch strap up inside the left thigh and pass it through the left lap strap D-ring from below, checking that the PEC supplies are outside and the PSP lowering line is under the lap strap. Bring up the QRF ensuring that the negative-g strap does not foul the seat firing handle and fold the left crotch strap end inboard towards the QRF. Pass the lug of the left shoulder strap down through the crotch strap loop. Rotate the face of the QRF (yellow line towards dots) and insert the left shoulder strap lug into the left QRF slot, ensuring that it locks into position; allow the QRF face to return to the normal locked position. Re-check that the lap strap is routed over the PSP lowering line and under the PEC supplies.

h. Pull the oxygen tube and mic-tel lead through the restraint flap on the life preserver to minimise the surplus between the flap and the PSP.

i. Bring the right crotch strap up inside the right thigh and pass it through the right lap strap D-ring from below. Pass the lug of the right shoulder strap down through the crotch strap loop and lock it into the QRF as for the left shoulder strap.

j. Fully tighten the lap straps, ensuring that the QRF remains central on the body. Roll up the free ends of the lap straps and secure with the Velcro flaps.

k. Ensure that the harness go-forward lever is in the locked (forward) setting. Tighten the shoulder straps ensuring that they are clear of the lobes and beaded handle of the life preserver. Ensure the groundcrew pull any slack through the shoulder D-link buckles.

l. Unlock the harness go-forward lever (back and release to centre). Lean forward and ensure that the harness is free. Return the lever forward to re-engage the lock and confirm forward restraint. Lean back fully and check that the harness reels in on the ratchet and locks. Retighten the shoulder harness if necessary and tuck excess shoulder strap ends under the harness.

m. Don protective helmet and connect oxygen hose to man-mounted regulator. Feed mic-tel cable assembly behind 70 psi oxygen hose and up left hand side (as worn) of man-mounted oxygen regulator, the connector and lead being secured behind the oxygen regulator. Pass mic-tel lead from the helmet over right shoulder and connect male and female portions together. Turn on oxygen and anti-g and test.

n. Remove and stow the seat pan firing handle safety pin and the manual separation lever safety pin. Ensure the safety pins are in the stowage.

Leaving the Aircraft After Landing.

25. Proceed as follows:

a. When the aircraft has been parked, fit the safety pin to the seat pan firing handle. Turn off the oxygen and anti-g at the PEC.

b. Release the harness by rotating and then pressing the face of the QRF. Free the shoulder straps from the QRF and return the face of the fitting to the locked setting. Slip the crotch straps from the lap strap D-rings and lay the straps clear.

c. Using the left hand, press the plungers on the PSP lowering line connector to release the lowering line, and at the same time release the 'man' portion of the PEC by pulling the lanyard which is connected to the PSP lowering line connector.

d. Operate the leg restraining cords release lever to release the cords.

e. Fit dust covers to the 'man' and 'seat' portions of the PEC.

f. Make the aircraft 'safe for parking'.

Abandoning the Aircraft in Flight

26. If it becomes necessary to abandon the aircraft in flight:

a. Reduce to 250 knots and fly straight and level or climb (if possible).

b. Grasp the seat firing handle and pull it upwards to its full extent. This action operates the harness retraction unit, jettisons the canopy and ejects the seat (the firing handle remains attached to the seat and must therefore be released prior to separation).

c. When the parachute has developed and the seat has fallen away, release the PSP by operating either of the side PSP connectors (**not the QRF**, right side connector preferable), leaving the lowering line attached to the life preserver (full extent approximately 15 feet).

d. As soon as safely down, turn and press the QRF face to free the occupant from the parachute. If in water, trace the PSP lowering line to the operating handle of the CO_2 cylinder, pulling the handle to inflate the liferaft.

Action After Crash Landing

27. Use the following procedure to vacate the aircraft after crash landing:

a. If time permits, fit the seat firing handle safety pin.

b. With the right hand, rotate and press the QRF face, at the same time using the left hand to operate the leg restraining cord lever. Then with the right hand pull both cords through the D-rings.

c. Using the left hand, press the plungers on the PSP lowering line connector to release the lowering line and, at the same time, release the 'man' portion of the PEC by pulling on the lanyard connected to the PSP lowering line attachment strap.

d. Vacate the aircraft.

Ditching

28. Eject from the aircraft rather than attempt a ditching.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Failure to Eject

29. If the seat fails to eject after pulling the firing handle, carry out the following procedure:

a. If the canopy has not jettisoned, operate the canopy jettison handle (pull out and push forward).

b. Operate the manual sparation handle on the left side of the seat by pressing the thumb-catch and pulling the handle upwards to its full extent.

c. After the guillotine fires push free of the seat and bale out.

d. Pull the parachute ripcord handle attached to the left lift web of the parachute harness.

Note: Emergency oxygen is not available.

Failure of Auto-Separation

30. If the auto-separation fails to operate carry out the following procedure:

a. Operate the manual separation handle by pressing the thumb-catch and pulling the handle upwards to its full extent.

b. Push free of the seat and when clear pull the parachute ripcord handle attached to the left lift web of the parachute harness.

OXYGEN SYSTEM

OXYGEN SYSTEM CONTROLS AND INDICATORS

31. Details concerning the controls and indicators shown on Fig 3 are listed in Table 2. Fig 3 shows the Type 417A Mk 1 regulator; the Type 317A Mk 1 regulator is at Fig 3A.

DESCRIPTION OF THE SYSTEM

General

32. The aircraft has two oxygen systems, a main system and an emergency system which supply oxygen via a personal equipment connector (PEC) and a man-mounted regulator to the pilot's oxygen mask. An oxygen on/off switch is mounted on the 'seat' portion of the PEC.

33. Oxygen for the main system is stored in liquid form and passed through an evaporator system which turns it into gas. Oxygen at medium pressure is then

Table 2—Oxygen System—Controls and Indicators

Item No	Item	Location	Marking	Remarks
1	Oxygen failure warning caption	Centralised warning panel	OXY	Red warning activates audio alarm and attention-getter when oxygen pressure falls below 30 PSI (2 bar)
2	LOX contents indicator	Right side panel	LOX—T	Graduated in quarters. Press-to-test button. Magnetic black/white indicator (black when energised)
3	Emergency oxygen contents gauge	Top of emergency oxygen bottle at left rear of the seat	REFIL, 1800 } Red line; FULL, 2500 } Black line	Normal operating pressure 1800 PSI (124 bar)
4	Oxygen on/off switch	Personal equipment connector (aircraft portion)	—	Supply is on when switch is fully forward
5	Emergency oxygen supply selector	Left side of seat forward of PEC	Yellow/black striped ring	Pull to operate
6	Changeover switch	Miniaturised regulator —forward face	MAIN—STANDBY	Changes from MAIN to STANDBY regulator on selection (both regulators contained in the miniature assembly)
7	Air dilution snap-over lever	Miniaturised regulator —top right	100%/AIRMIX	Selects air/oxygen mixture or 100% oxygen as required
8	Press-to-test button	Miniaturised regulator —top left	—	Used to check for mask leaks and integrity of connections

piped through an ejection seat/aircraft quick-release coupling. The main oxygen supply is also used for the anti-g system. The system is illustrated on Fig 4 (GR1) and Fig 5 (T Mk 2).

Main Oxygen System

34. *Liquid Oxygen Package Unit.* The unit comprises a 17·6 pint (10 litre) capacity liquid oxygen container and an associated evaporator and stabilising system housed in a sealed compartment on the right side of the nose fuselage.

35. *System Pressure.* The system operates on all pressures between 50 and 110 PSI (approximately 3 and 8 bar) but a valve regulates the working pressure to 75 PSI (5·17 bar). A relief valve operates if the pressure exceeds 115 PSI (approximately 8 bar) and if the valve fails a bursting disc in the LOX container blows out. An OXY red warning caption on the CWP accompanied by an audio alarm and the flashing attention-getter indicates that the oxygen pressure is below 30 PSI (2 bar).

36. *Contents Indication.* The contents of the LOX container are indicated on a gauge in the bottom right hand corner of the instrument panel. The gauge indications are 0, ¼, ½, ¾ and 4/4. A test button marked T is at the bottom centre of the gauge: when the button is pressed, the pointer moves to zero, swings back to indicate the contents and then returns to zero until the button is released to restore correct contents indication. A magnetic indicator, also on the gauge, shows alternately black and white during normal breathing, ie black when there is no oxygen flow and white when oxygen is flowing. A second contents gauge is fitted externally on the right front fuselage.

MINISTRY OF DEFENCE

June 1979

JAGUAR GR MK 1 AND T MK 2 AIRCRAFT
AIRCREW MANUAL - BOOK 1

ADVANCE INFORMATION LEAFLET 2/79

Insert this leaflet in AP 101B-3101&2-15A to face Part 1, Chapter 12, Page 10

Aircrew NBC equipment is being brought into use as specified by user Commands. Fitting and instruction on use will be carried out by aeromedical training units. The equipment includes the Aircrew Respirator NBC No 5 MK1. This AIL gives brief details of the AR5, its use on the ground and in the air, and the normal and emergency operating procedures. The air /gas supply system to the AR5 as described is an interim measure: action is in hand to modify the aircraft to provide a system which imposes a lower demand on the oxygen supply.

General

1. The AR5 is illustrated at Fig 1. As shown, it comprises two compartments, the mask and the hood. The edge of the mask seals to the wearer's face and the hood seals around his neck. Air or oxygen gas supplies, are fed to each compartment from a manifold mounted on the wearer's life preserver. The hose connection to the mask is by means of an anti-drowning connection which can be quickly released to provide an air inlet at the mask in an emergency. The hood outlet can be closed to prevent ingress of water. Gas supply into the manifold when outside the aircraft is from a Portable Ventilator NBC Mk1, the hose of which is connected to the manifold air inlet. In the aircraft, the wearer connects the PEC to feed aircraft oxygen into the manifold and disconnects the air inlet from the portable ventilator and connects it to the hose of an NBC filter canister, also attached to the life preserver. It is important to ensure a continuous supply of air or oxygen through the hood otherwise misting of the optical area of the hood will occur within a few seconds. Oxygen can only flow into the hood when the EMERGENCY DEMIST control is selected open.

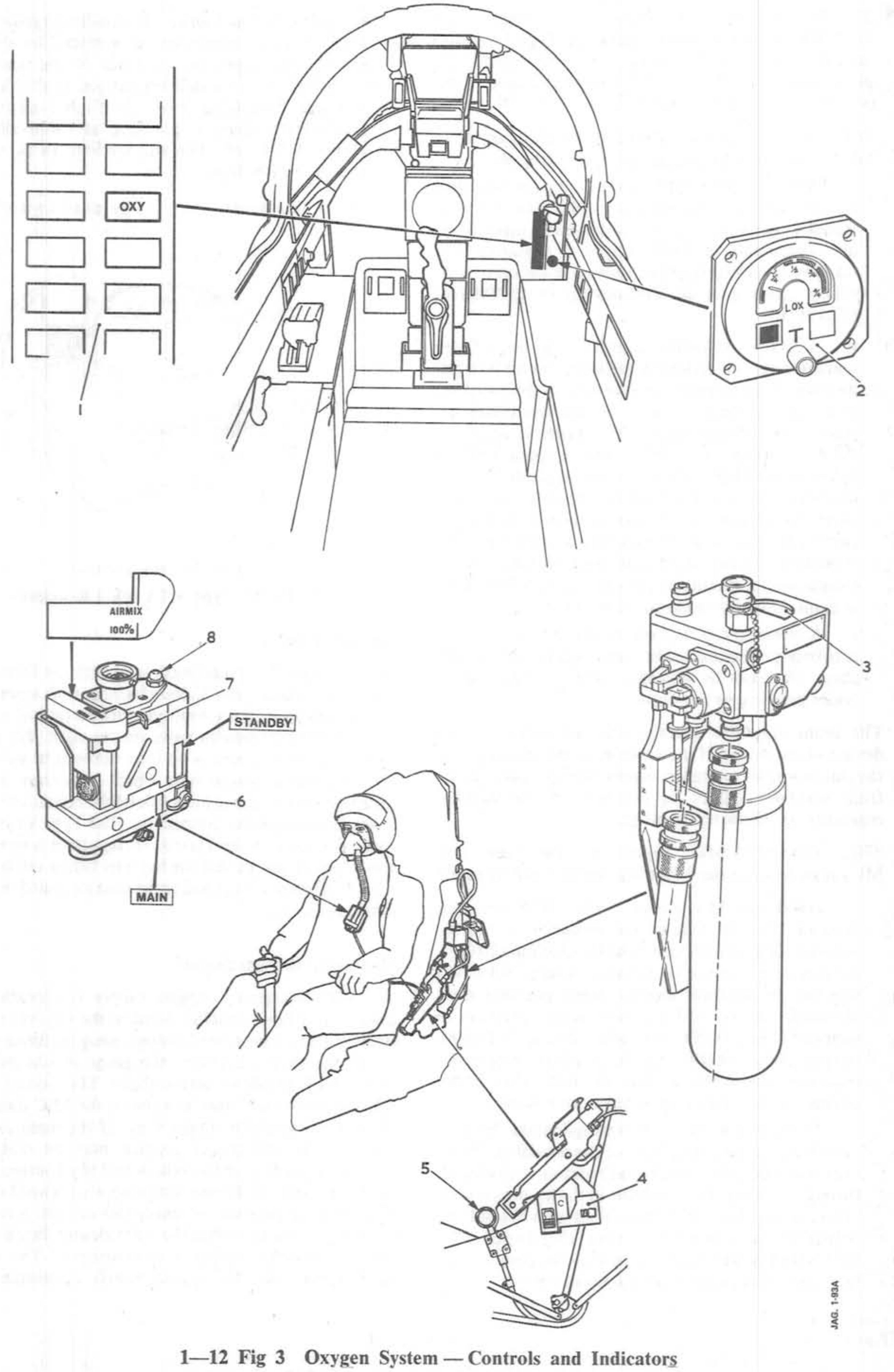
Oxygen Consumption

2. Since oxygen flow into the respirator is continuous, the rate of LOX consumption is increased considerably above the normal rate. Comparative values in a T2 aircraft are:

Aircraft Altitude (feet)	Both pilots using Mk 417A regulator - airmix	One pilot using respirator / One pilot using Mk 417A -
0	2.2 litres/hour	4.2 litres/hour
10,000	1.8 litres/hour	3.4 litres/hour
25,000	1.3 litres/hour	2.9 litres/hour

The above assumes that both anti-g suits are inflated once per minute throughout flight.

3. In the worst case, a full LOX supply will be consumed in two hours and therefore the LOX system must be replenished before every flight in which the respirator is to be used. If the normal oxygen supply fails, the emergency supply can be selected, but because of the increased consumption, will only last for 3 to 4 minutes, after which the optical area of the hood will rapidly mist over.



1—12 Fig 3 Oxygen System — Controls and Indicators

(Type 417A Mk 1 Regulator shown)

37. *Pressure Dem and Regulators.* Either a type 417A Mk 1 regulator and V2 mask or a Type 317A Mk1 regulator with a V1 mask may be used. The mask/regulator fits are not interchangeable. Both regulators are miniaturised and man-mounted.

37A. *Type 417A Mk 1 Regulator.* The Type 417A Mk 1 regulator is provided with three controls:

a. A MAIN/STANDBY lever on the forward face of the regulator for selecting either the main or standby regulator. The main regulator supplies an air/oxygen mix or 100% oxygen as required. The standby regulator supplies 100% oxygen only, with safety pressure at all altitudes up to 40,000 feet (12,196 m).

b. A 100%/AIRMIX lever on the top of the regulator; in the AIRMIX position, an air/oxygen mixture of appropriate proportions is delivered up to a cabin altitude of about 30,000 feet (9146 m). Above this altitude only 100% oxygen is supplied. With the lever at 100%, pure oxygen only is delivered at a slight safety pressure at all altitudes. If the cabin becomes filled with smoke or fumes, 100% should be selected. Safety pressure is delivered above cabin altitudes of approximately 15,000 feet with AIRMIX selected. Both main and standby oxygen regulators automatically provide pressure breathing at cabin altitudes in excess of 40,000 feet.

c. A press-to-test button at the top left of the regulator provides a facility for checking the oxygen mask for leaks by allowing oxygen to be passed under pressure to the mask.

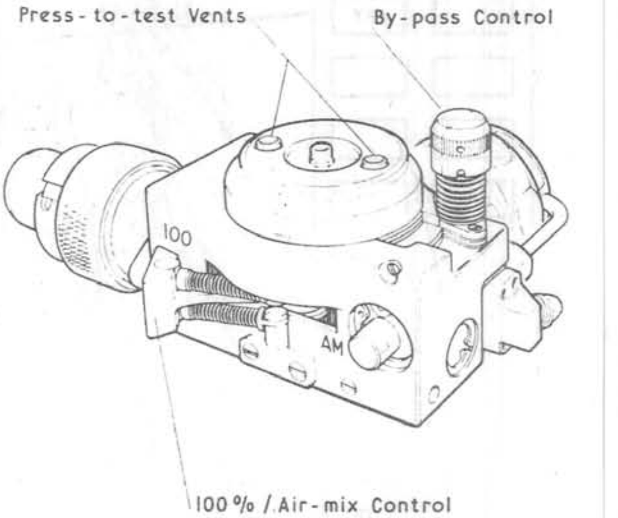
The main regulator incorporates an anti-drowning device which shuts off the air-inlet to the regulator via the dilution port whenever supply inlet pressure to the main regulator ceases (ie selection of the standby regulator or following ejection).

37B. *Type 317A Mk 1 Regulator.* The Type 317A Mk 1 regulator has the following controls and features:

a. *100%/Air-Mix Lever.* The 100%/air-mix lever on the right side of the regulator (as worn), marked 100 and AM, controls the selection of 100% oxygen or a mixture of air and oxygen. With 100 selected the regulator supplies safety pressure at all altitudes. In the AM position safety pressure is supplied above 18,000 feet cabin altitude and 100% oxygen above 34,000 feet. As a safety feature the regulator closes the air-mix air inlet after either oxygen supply failure or immersion in water.

b. *By-Pass Control.* A spring-loaded by-pass valve is mounted on the front of the regulator. Pressing down the milled knob and rotating it clockwise through 60° locks the regulator in the by-pass mode, allowing an alternative flow of oxygen should the regulator malfunction. Unlike the Type 417A STANDBY mode, selecting by-pass supplies a constant flow of oxygen without aneroid control.

c. *Press-to-Test Vents.* The ability to ground test mask fit and connections is provided by the two press-to-test vents on the front of the regulator. Covering the vents delivers oxygen to the mask at pressure-breathing level. In flight, automatic pressure breathing is provided at cabin altitudes above 39,000 feet. The altitude limit of the equipment is 50,000 feet.



1—12 Fig 3A Type 317A Mk 1 Regulator

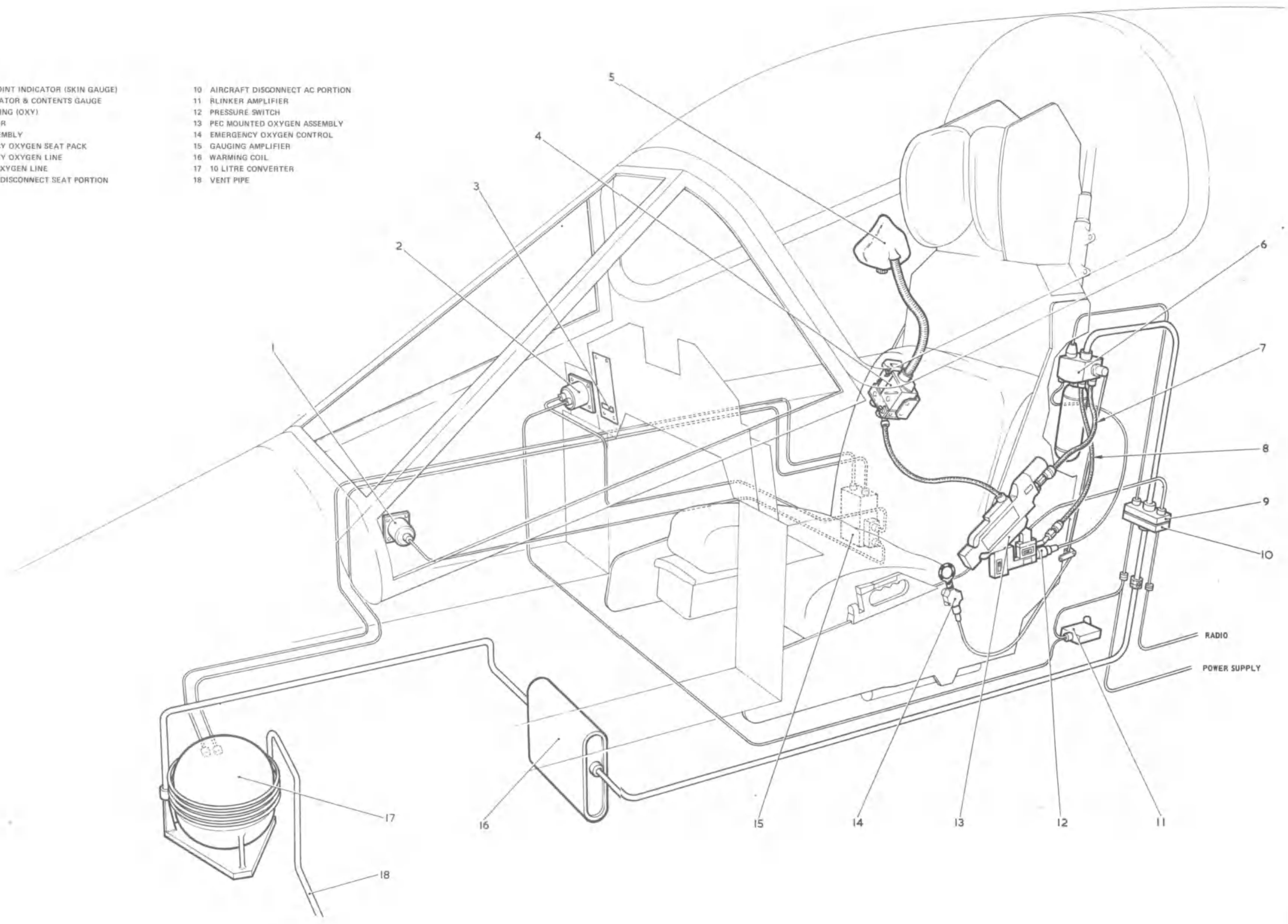
Oxygen Masks

38. The Type V2 oxygen mask used with the Type 417A regulator incorporates a chain harness with a pressure-breathing toggle, a microphone with an on/off switch, and an anti-suffocation valve on the right side of the mask facepiece. There is no inlet non-return valve but the hose has a central tube which runs from the expiratory valve to the control side of the regulator via the mask/hose regulator connection. The Type V1 oxygen mask for use with the Type 317A regulator is similar to the V2 mask except that the bayonet fitting on the hose is of a different design and there is an ice guard over the inspiratory valve.

Emergency Oxygen System

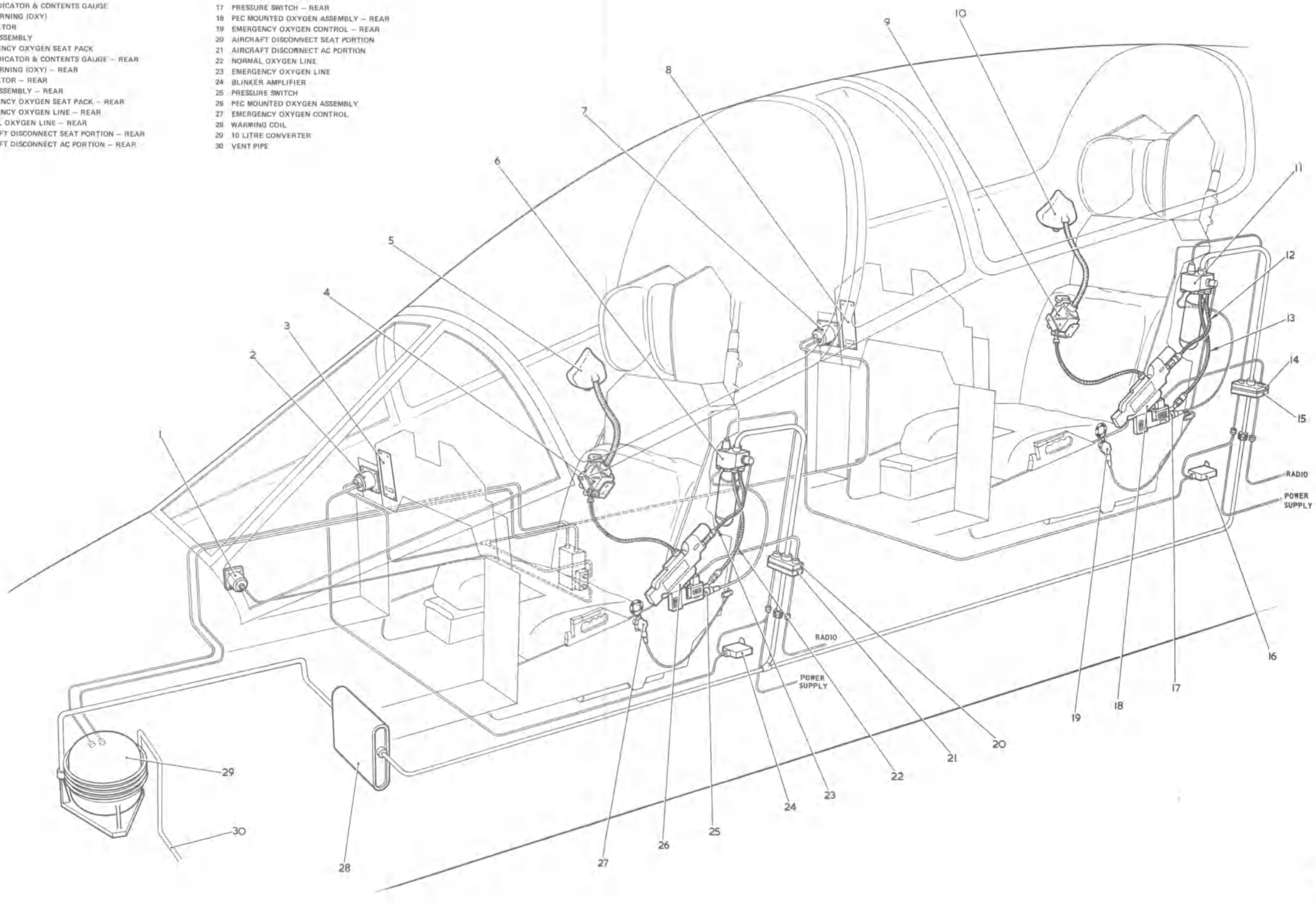
39. The emergency oxygen supply is contained in gaseous form in a cylinder fitted to the left rear of the ejection seat. A pressure/contents gauge is fitted to the top of the oxygen cylinder; the gauge should indicate 1800/FULL or above before flight. The oxygen feeds into the rear of the 'seat' portion of the PEC then into the oxygen regulator supply hose. If the main oxygen system fails, emergency oxygen may be manually selected by pulling up the yellow and black striped ring on the left side of the seat immediately forward of the PEC. During ejection the emergency oxygen is switched on automatically when the seat rides up the rails and the main oxygen supply is disconnected. The emergency supply lasts for approximately 10 minutes and

1 FILLING POINT INDICATOR (SKIN GAUGE)
2 LOX INDICATOR & CONTENTS GAUGE
3 CWP WARNING (OXY)
4 REGULATOR
5 MASK ASSEMBLY
6 EMERGENCY OXYGEN SEAT PACK
7 EMERGENCY OXYGEN LINE
8 NORMAL OXYGEN LINE
9 AIRCRAFT DISCONNECT SEAT PORTION
10 AIRCRAFT DISCONNECT AC PORTION
11 RLINKER AMPLIFIER
12 PRESSURE SWITCH
13 PEC MOUNTED OXYGEN ASSEMBLY
14 EMERGENCY OXYGEN CONTROL
15 GAUGING AMPLIFIER
16 WARMING COIL
17 10 LITRE CONVERTER
18 VENT PIPE



1—12 Fig 4 GR1 Oxygen Supplies and Distribution

1 FILLING POINT INDICATOR (SKIN GAUGE)
2 LOX INDICATOR & CONTENTS GAUGE
3 CWP WARNING (OXY)
4 REGUALTOR
5 MASK ASSEMBLY
6 EMERGENCY OXYGEN SEAT PACK
7 LOX INDICATOR & CONTENTS GAUGE – REAR
8 CWP WARNING (OXY) – REAR
9 REGUALTOR – REAR
10 MASK ASSEMBLY – REAR
11 EMERGENCY OXYGEN SEAT PACK – REAR
12 EMERGENCY OXYGEN LINE – REAR
13 NORMAL OXYGEN LINE – REAR
14 AIRCRAFT DISCONNECT SEAT PORTION – REAR
15 AIRCRAFT DISCONNECT AC PORTION – REAR
16 BLINKER AMPLIFIER – REAR
17 PRESSURE SWITCH – REAR
18 PEC MOUNTED OXYGEN ASSEMBLY – REAR
19 EMERGENCY OXYGEN CONTROL – REAR
20 AIRCRAFT DISCONNECT SEAT PORTION
21 AIRCRAFT DISCONNECT AC PORTION
22 NORMAL OXYGEN LINE
23 EMERGENCY OXYGEN LINE
24 BLINKER AMPLIFIER
25 PRESSURE SWITCH
26 PEC MOUNTED OXYGEN ASSEMBLY
27 EMERGENCY OXYGEN CONTROL
28 WARMING COIL
29 10 LITRE CONVERTER
30 VENT PIPE



1—12 Fig 5 T Mk 2 Oxygen Supplies and Distribution

flows at a pressure of 50 PSI (3·4 bar) through the PEC to the regulator.

40. When the pilot separates from the seat after ejection, the separation of the 'man' and 'seat' portions of the PEC breaks the emergency supply.

41. Oxygen from the emergency system is prevented from flowing while the main oxygen supply pressure is greater than the 50 to 58 PSI of the emergency system. Thus to select emergency supply with an intact main supply, the main supply must be switched off. A shuttle valve in the PEC prevents oxygen from the main system being vented to atmosphere when the 'man portion' of the PEC is disconnected with the main oxygen switch on the oxygen being vented to the emergency system when the main switch is off and the emergency supply is flowing.

NORMAL USE OR MANAGEMENT

External Checks

42. Check the contents indication on the gauge on the right side of the front fuselage (minimum of ½).

Pre—Flight Checks

43. Check the oxygen system as follows:

a. Before connecting the PEC, select AIRMIX or AM on the regulator, don mask and connect mask hose to the regulator. Breathe in and note high resistance (operation of anti-suffocation valve, ie air inlet orifice in regulator is closed).

b. Check that the oxygen contents gauge agrees with the reading of the external gauge.

c. With electrical supplies available, check that the PEC is connected and that the oxygen switch on the PEC is fully forward (on).

d. Press the LOX contents gauge test button and check that the pointer rotates to zero, swings back and then returns to zero. Release the button and check the pointer returns to its original position.

e. Check that the OXY warning caption on the CWP is not lit.

f. Check oxygen mask fit and hose connections to the regulator. Set the air dilution lever to 100%.

g. Check that no undue resistance is felt to either normal or deep breathing and that the magnetic indicator conforms to the breathing cycle.

h. Lift the mask from the face and check for continuous flow (safety pressure) and flow blinker white.

◀i. Using the press-to-test button on the Type 417A regulator or after covering the press-to-test vents on the Type 317A regulator carry out the following actions:

(1) Rotate the toggle on the oxygen mask harness to the down position.

(2) Press the test button or cover the vents and check pressure builds up in the mask.

(3) Holding breath check no leaks are present and magnetic indicator shows black continuously. Then take 3 to 4 breaths to ensure pressure is maintained.

(4) Release test button or uncover vents and return toggle to normal position.

j. Set the air dilution level to AIRMIX or AM checking that the magnetic indicator continues to annunciate and that no resistance to breathing is felt.

k. Set MAIN/STANDBY lever to STANDBY or press in and rotate by-pass control and check no resistance to either normal or deep breathing and magnetic indicator conforms to breathing cycle. Lift mask from face and check for continuous flow (magnetic indicator white).

Note: Following the selection of the standby regulator or by-pass facility a continuous flow of oxygen lasting approximately 5 seconds occurs and may be felt in the mask.

l. Re-select the changeover lever to MAIN or de-select by-pass and ensure AIRMIX or AM is selected. ▶

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Indications and Actions

44. The indications and actions in the event of system failure are listed in Table 3.

Table 3—Oxygen System Malfunctions—Types 317A and 417A Regulators

Indications	*Immediate Actions*	*Subsequent Actions*	*Considerations*
SUSPECTED HYPOXIA			
Symptoms of oxygen lack	Check PEC connection and mask fit, mask hose to regulator connections, main oxygen switch ON and oxygen content	1. Pull emergency oxygen ring 2. Initiate immediate max rate descent to cabin altitude of 10,000 feet 3. Select STANDBY regulator or by-pass	Approximately 10 minutes oxygen available on emergency
MASK OVERPRESSURISATION			
Difficulty in breathing out	1. Check cabin altitude below 38,000 feet 2. Select regulator to STANDBY or by-pass	1. If cabin altitude above 10,000 feet and difficulty persists, ease mask off the face when breathing out and descend to a cabin altitude of 10,000 feet or below. MI should operate with breathing 2. Monitor oxygen contents	—
CONTAMINATION			
Suspected oxygen contamination	Pull emergency oxygen ring	Set main oxygen supply on PEC to off. Descend to a cockpit altitude of 10,000 feet or below	Approximately 10 minutes oxygen available

RESTRICTED FLOW

Indications: OXY warning on CWP

or

MI continuous white or black

or

Difficulty in breathing in

Actions: Carry out the following analysis and actions:
Select 100% oxygen
Check PEC connection, supply ON, mask fit and connections

- Breathing normal
  - Continue sortie
    Monitor contents
- Breathing restricted
  - MI black or intermittent
    - Select STANDBY regulator or by-pass
      - MI normal
        Continue sortie
        Monitor contents
      - MI still black and breathing restricted
        - Pull emergency oxygen ring
          Select AIRMIX
          Descend to cabin altitude of 10,000 feet
  - MI white or OXY warning on CWP
    - Pull emergency oxygen ring. On Type 317A regulator select by-pass and AIRMIX. Descend to cabin altitude of 10,000 feet

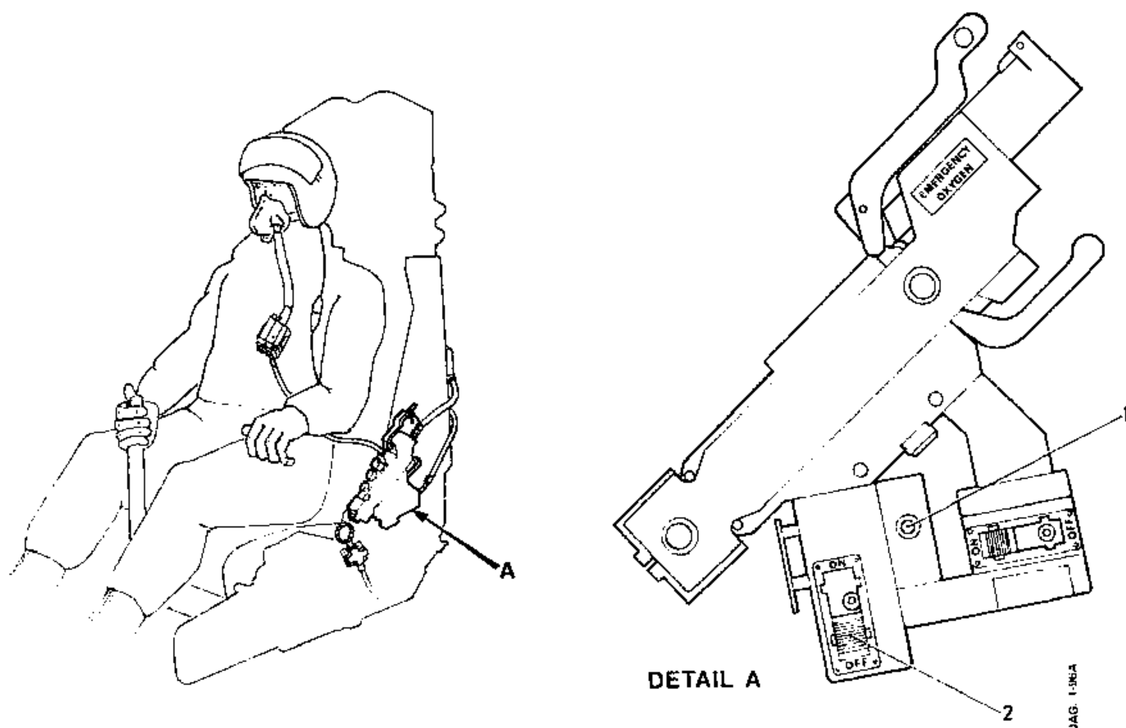
ANTI-G SYSTEM

ANTI-G SYSTEM CONTROLS AND INDICATORS

45. The details concerning the controls and indicators shown in Fig 6 are listed in Table 4.

Table 4 — Anti-g System Controls and Indicators

Item No	*Item*	*Location*	*Marking*	*Remarks*
1	Anti-g press-to-test button	Aircraft portion of PEC	·	Used to test suit connection and integrity of supply system
2	Anti-g on/off switch	Aircraft portion of PEC	ON/OFF	Moved fully upwards to connect supply



1—12 Fig 6 Anti-g System Controls and Indicators

DESCRIPTION OF THE SYSTEM

General

46. The anti-g system is supplied from the aircraft normal oxygen system. Supply is via the anti-g switch on the aircraft portion of the PEC which must be on for the system to function. The anti-g system will not function from the emergency oxygen supply.

47. A miniaturised anti-g valve controls the pressure of oxygen admitted via the PEC to the pilot's anti-g suit, which inflates when positive accelerations are applied. The pressure admitted varies linearly with the severity of the g force applied. A safety valve limits the maximum pressure to 10·5 PSI.

48. The anti-g ON/OFF switch should only be selected ON when anti-g garments are worn and connected, otherwise oxygen will be discharged into the cockpit during high g manoeuvres. During normal operation the oxygen from the garment is vented to the cabin through the anti-g dump valve as acceleration decreases.

Note: It is important to ensure that the anti-g switch has gone all the way to the fully 'on' or fully 'off' position since it is possible for it to be left in the mid-position.

Anti-g Test

49. An anti-g test button is incorporated in the aircraft portion of the PEC. Provided the main oxygen supplies and anti-g valve switches are on, the integrity of the suit connections and the system supply can be checked. When the test button is pressed pressure should be felt in the suit.

NORMAL USE OR MANAGEMENT

Pre-flight Checks

50. Before flight, test the anti-g system as follows:

a. Connect the PEC and switch on the main oxygen system.

b. Switch on anti-g shut-off valve (fully up).

c. Press the test button on the PEC to check the integrity of the suit connections and system supply. Check that pressure builds up in the suit and releases when the button is released.

MALFUNCTIONING OR USE IN ABNORMAL CONDITIONS

Anti-g Valve Failure

51. Should the anti-g valve fail in flight, causing a build-up of pressure in the system, select the anti-g switch to 'off' to vent the pressure to atmosphere and deflate the suit.

PART 2A

GR MK 1

LIMITATIONS

List of Chapters

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ENGINE LIMITATIONS	2
PERMITTED CONFIGURATIONS AND ASSOCIATED CARRIAGE LIMITATIONS	3
MISCELLANEOUS LIMITATIONS	4
SYSTEMS LIMITATIONS	5

PART 2A—GR 1 LIMITATIONS

CHAPTER 1—AIRFRAME AND FLYING LIMITATIONS

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Approach Limitations	30

The limitations given in this Part are taken from the MOD (AFD) Release Document, Stage 2, AL15. The Release Document must be consulted to ascertain the latest release standard.

General

1. The Jaguar GR Mk 1 is a single seat tactical support aircraft released for use by day and night over land and sea subject to the limitations given in this Part, and in the MOD (AFD) Release Document.

2. *Definition of Limitations.* Certain limitations are given at two levels, these are:

a. *Normal Limits.* These values may be *reached* as often as the pilot's task requires, without undue risk, and may be exceeded occasionally by a small margin without untoward consequences. The pilot should not deliberately aim to exceed the quoted Normal Limits. Unless otherwise stated, the limitations given are Normal Limits.

b. *Never Exceed Limits.* In some cases a second and higher limit is quoted in addition to the Normal Limit. This represents the full Design Flight Envelope case or the highest figure for which all aspects have been investigated in flight and ground tests. These limits are *never* to be exceeded because consequential effects beyond these levels are either hazardous or unknown.

Flight Envelope

3. *Altitude.* The aircraft is cleared for operation up to 45,000 feet AMSL.

4. *Temperature.* The aircraft is cleared for operation at ground air temperatures in the range minus 15°C to +40°C subject to the following conditions and limitations:

a. If the aircraft is exposed to ground air temperatures below minus 15°C for a period of more than one hour, a time allowance must be made for the aircraft to warm up after temperature rises to above minus 15°C. Considerations resulting from operation down to minus 15°C are included in Part 3, Chapter 10.

b. When the ground air temperature exceeds +25°C, the dew point temperature must not exceed +16°C (+20°C on aircraft fitted with mod 891 or STI/Jaguar/114). If this limit is exceeded, severe fogging and misting may occur in the cockpit, sufficient to obscure the instruments, when cockpit conditioning is selected on.

c. When the ground air temperature exceeds +30°C in conditions of strong solar radiation, the canopy and windscreen must be shaded, otherwise temperatures may become excessive even with the canopy open, and equipment could be damaged.

5. *Speed.*

a. *Clean Aircraft With or Without Pylons*

Normal limit ...	The greater of 0·95M/575 kt up to a maximum of 1·3M

Never Exceed limit	Up to 20,000 ft: The greater of 1·0M/625kt up to a maximum of 1·25M Above 20,000 ft: The greater of 1·25M/600kt up to a maximum of 1·4M

b. *Aircraft With External Stores (Including Asymmetric Stores).* Unless an overriding limitation is imposed by individual stores or aircraft mod state, the speed limitations are:

Normal limit ...	0·9M
Never Exceed limit	0·95M

Airspeed Limitations

6. *Flaps.* The flaps are cleared for use for take-off and landing, and for up to an average of seven additional cycles during each flight, subject to the following speed limitations:

Flap Angle	*Maximum Speed (kt)*
5° or 10°	280
15° or 20°	260
25° or 30°	240
35° or 40°	220

7. *Combat Slats.* For manoeuvres at speeds below 500 knots, slats are to be at the combat setting for incidences greater than 5°. Speed limitations depend on aircraft modification state and are given below.

Mod State	*Speed Limit*
Pre- and post-mod 762 Pre-mod 843 Pre-mod 872 Pre-mod 972	*Auto*: the lower of 450 knots/ 0·95M *Manual*: the lower of 500 knots/ 0·95M (pre-mod 762) the lower of 550 knots/ 0·95M (post mod 762) Max speed for slat selection 500 knots Slat selection above 450 knots must be made in nominal 1g flight
Post-mod 762 Post-mod 843 Post-mod 872 Post-mod 972	*Auto*: 0·95M. Auto retract at 500 knots *Manual*: 0·95M. Selection above 500 knots prevented by speed switch

Mod State	*Speed Limit*
Post-mod 762 Post-mod 843 Post-mod 872 Post-mod 972	*Auto*: the lower of 580 knots/ 0·95M. Auto retract at 580 knots *Manual*: 0·95M. Selection above 580 knots prevented by speed switch

◀Note: Mod 972 = STI 245

8. *Airbrakes.* The airbrakes are cleared for use throughout the full aircraft speed range, except that, pre-mod 716 with 1200 litre tanks on the inboard pylons, speed for airbrake extension is limited to 0·9M. Simultaneous extension of airbrakes and cancellation of reheat is to be avoided at speeds above 500 knots.

9. *Landing Gear.* The landing gear limiting speeds are:

Landing Gear Position	*Maximum Speed (kt)*
On selecting up or down	230 in 1g flight 220 with normal acceleration 0 to +3g
Unlocked:	
a. After take-off	250
b. All other times	220
Locked down	250

Maximum Weight and Centre of Gravity

10. *Weight*

a. *Take-Off Weight.*

Maximum take-off weight (pre-mod 921)	15,130 kg
Maximum take-off weight (post-mod 921)	15,700 kg

Note 1: See Chapter 4 for tyre limitations.

Note 2: At aircraft weights above 15,000 kg, lateral accelerations are to be minimised with gentle taxy manoeuvres only.

Note 3: Maximum reheat power is to be used for all take-offs.

b. *Landing Weights.*

Maximum normal landing weight	9600 kg
Maximum overload landing weight	13,600 kg

Note: At any weight above 9,600 kg a low rate of descent at touchdown is to be achieved.

11. *Centre of Gravity.* The Mean Aerodynamic Chord (MAC) is 3·235 metres in length, and its leading edge is 6·747 metres aft of aircraft datum. The position of the centre of gravity is stated as a percentage of MAC aft of the leading edge of the MAC.

a. *Limits.* The centre of gravity is to be maintained within the limits in the MOD (AFD) Release Document at D10.

b. *Flap Settings for Landing With Forward CG Positions.*

Flap settings for landing with forward CG positions are shown below. The flap angles are the maximum which can be used for standard approaches carried out at 13° incidence.

% MAC	*Flap Angle*
13	10°
14	20°
17	30°
20	40°

Incidence

12. *Clean Aircraft With Symmetric Stores or Asymmetric Lepus.* Incidence limits depend on configuration as given in the MOD (AFD) Release Document at D10.

13. *Aircraft With Centreline Fuel Tank or Reconnaissance Pod (pre-mod 803 only).* On aircraft not embodying mod 803, control problems may be encountered at incidence angles above 12°. Refer to Part 3, Chapter 2, para 41.

14. *Aircraft With Heavy Asymmetric Stores.* Limitations for aircraft in heavy asymmetric stores configurations are intended only for emergency use in the event of a failure or unintentional asymmetric release. In general, manoeuvres in these configurations should be kept as gentle as possible and the asymmetric stores released or jettisoned as soon as circumstances permit. The aircraft in these configurations is incidence limited. The incidence limits given below are not to be exceeded as large spoiler angles would be required to maintain roll attitude and the sideslip angle would approach the structural limit.

Speed—knots	*Incidence*
350	10°
400	9°
450	8°
500	7°
550	6°

15. *With Flaps Extended.* When flaps are extended to 20° or more with the landing gear up or down, the incidence limits are:

Clean aircraft and aircraft with symmetric stores or asymmetric Lepus ... ... 17°

Aircraft with asymmetric heavy stores ... 15°

Note: 'Heavy stores' refers to BL 755 and 1000 lb bombs.

Normal-Acceleration Limitations

Note: Under certain flight conditions, the limits in para 16 and 17 are not achievable due to adverse handling characteristics (see para 20).

16. *Clean Aircraft With or Without Pylons.* For the clean aircraft with landing gear and flaps retracted, the normal-acceleration limits for symmetric manoeuvres involving negligible rate of roll and negligible roll acceleration) are given in Table 1.

17. *Aircraft With External Stores*

a. *Aircraft With Symmetric Stores or Asymmetric Lepus.* Unless an overriding limitation is given in the MOD (AFD) Release, the normal-acceleration limits are:

Normal limits: minus 1·0 to +5·25g or +6g

Never Exceed limits: 2·0 to +6·0g or +7g

The configurations and conditions for the +6g and +7g limits are given in the MOD (AFD) Release Document at D10.

Table 1—Normal-Acceleration Limits (clean, with or without pylons)

Mach No/Speed	*Aircraft Weight (kg)*	*Normal Limits*	*Never Exceed Limits*
Up to 0·95	Up to 10,300	−2g to +7·25g	−3g to +8g
	Above 10,300	−2g to +6·75g	−3g to +7·5g
Above 0·95	All	−2g to +4·5g	−3g to +5g
Exception Above 500 kt, below 5000 ft	All	−2g to +5·5g	−3g to +6g

b. *Aircraft With Heavy Asymmetric Stores.* Aircraft with heavy asymmetric stores configurations are incidence limited (refer to para 14).

18. *All Configurations*

a. Acceleration limits applicable to rolling manoeuvres are given in para 24.

b. With flaps or landing gear down, the acceleration limits are 0 to +3g. If the landing gear is to be selected at 230 knots, the normal-acceleration must be +1·0g.

19. *Sustained Negative g.* The aircraft is cleared for sustained negative g, including inverted flight, subject to the following limitations:

a. The N1 and N2 fuel warning lights must not be on prior to the manoeuvre.

b. The elapsed time under negative g is not to exceed:

(1) 15 seconds in dry power

(2) 7·5 seconds in reheat with Mk 102 engines

(3) 6 seconds in reheat with Mk 104 engines

Incidence and Manoeuvre Limitations

20. *Pitching Manoeuvres.* The incidence during pitching manoeuvres is not to be increased beyond that point at which any of the following limitations is reached:

a. The incidence limitations given in para 13 to 15, and in Chapter 3.

b. The normal acceleration (g) limits given in para 16 to 19.

c. The onset of wing rock or wing drop.

d. The onset of heavy buffet.

e. The onset of 'yaw off' (a rapid increase of lateral g sideslip).

f. Stick force per increment of normal acceleration tending to zero: this may occur above 0·88M at greater than 6° incidence.

Slats are to be at the combat setting for incidences greater than 5° at speeds below 500 knots.

21. *Manoeuvring With Heavy Asymmetric Stores.* The speed and incidence limitations are given in para 5b and 14 respectively. Associated handling information is given in Part 3, Chapter 6.

22. *Ground Attack Dives.* Ground attack dives are permitted up to 30° dive angle, provided that minimum recovery heights are calculated from Table 2. Column 2 of the table gives the minimum height loss achievable with the pertaining handling limitations and Column 3 gives the normal ground avoidance criteria allowance. No allowance has been made for debris zone. Column 4 (the sum of columns 2 and 3) represents the recommended minimum height for initiation of dive

Table 2—Ground Attack Dive Recovery

Column 1	*Column* 2			*Column* 3	*Column* 4		
	Height Loss (ft)				*Break-off Height AGL*		
	Configurations				*Configurations*		
Dive Angle	Pre-mod 803—without C/L tank or recce pod; Post-mod 803—all configurations		Pre-mod 803 with C/L tank or recce pod	Ground Avoidance Safety Height	Pre-mod 803—without C/L tank or recce pod; Post-mod 803—all configurations		Pre-mod 803 with C/L tank or recce pod
	UP to 450 kt	*Above 450 kt*	*All Speeds*		*UP to 450 kt*	*Above 450 kt*	*All Speeds*
Up to 10°	Normal Criteria				Normal Criteria		
15°	550	650	650	350	900	1000	1000
20°	800	1000	1000	500	1300	1500	1500
25°	1100	1400	1400	600	1700	2000	2000
30°	1400	1800	1800	700	2100	2500	2500
35°	1650	2150	2150	850	2500	3000	3000

Table 3—Rapid Rolling Limitations

Rolling Case	Roll Entry Limits				
	Speed Range	*Altitude Limit —feet*	*Incidence*	*Normal-accel*	*Max change of bank angle*
1	0·9M to lower of 1·2M/600 kt	36,000	NA	+1·0 to +2·0g	180°
2	250 kt to 0·9M	30,000	10° NA	+0·5 to +4·5g +1·0g	180° 360°
3	250 kt to 0·9M	30,000	10° NA	+1·0 to +4·0g +1·0g	180° 360°
4	250 kt to 0·9M	30,000	10°	+1·0 to +4·0g	180°
5	250 kt to 550 kt/0·9M	30,000	10° NA	+1·0 to +4·0g +1·0g	180° 360°
6	250 kt to 550 kt/0·9M	30,000	10°	+1·0 to +4·0g	180°
7	250 kt to 530 kt/0·9M	30,000	10°	+1·0 to +4·0g	180°
8	250 kt to 550 kt/0·9M	30,000	8°	+1·0 +3·0g	180°

recovery. Users are advised to choose a dive angle 5° greater than the planned attack condition in order to allow for variations in dive angle estimation.

23. *Ground Attack Dive Recovery*. Table 2 assumes that ground attack dive recoveries are made by pulling rapidly to the normal-acceleration limit, or to the ground attack recovery incidence limit (MOD (AFD) Release at D10), whichever is reached first. In the case of an unintentional asymmetric release, and assuming that the pilot is able to transfer to the appropriate lower incidence limitations, the break-off heights given at column 4 of Table 2 remain adequate, but the safety margins are reduced.

Note: In configurations with a normal-acceleration limit of +6g (Normal Limit), attempts to pull to +6g below 0·75M may be inhibited by yaw-off or wing rock as incidence increases, particularly at higher weights.

24. *Rolling Manoeuvres*.

a. *Gentle Rolling*. Outside the envelope given in Table 3—Rapid Rolling Limitations—gentle rolling manoeuvres only are permitted; ie, high roll rates are to be avoided. The need to moderate roll rate becomes progressively more important as the symmetric g boundary is approached, *particularly under low or negative g conditions* where it is possible to induce excessive rates of roll with a risk of encountering autorotation.

b. *Rapid Rolling*. Rapid rolling (ie the use of coarse lateral control with large roll attitude changes) is permitted only within the limitations given in Table 3.

Note 1: The relavent rolling case to be used with a particular configuration is shown in the MOD (AFD) Release at D10.

Note 2: Limitations in Cases 1 and 2 for the clean aircraft are applicable at weights below 10,300 kg below 0·9M and below 9200 kg at speeds above 0·9M. When the clean aircraft exceeds the above weights, rolling is restricted to gentle manoeuvres only.

Note 3: The incidence limits in the table may, in certain configurations and at high mach numbers, be further limited by aircraft handling factors, eg wing rock. These handling boundaries are not to be exceeded.

Note 4: Rapid rolling is not permitted when more than one third lateral stick travel is needed to maintain lateral trim.

Note 5: Application of rudder during a rapid roll is to be avoided.

Note 6: Forward or aft movement of the control column during a rapid roll through angles greater than 100° is to be avoided.

Note 7: Autostabilisers are to be engaged for rapid rolling.

Note 8: Airbrakes are to be IN during rapid rolling.

Note 9: Rapid rolling with asymmetric heavy stores is not permitted.

25. *Formation Flying*. The aircraft is cleared for close formation flying. Line astern formation is permitted in dry power, provided vertical separation between adjacent aircraft is greater than 15 feet.

26. *Stalling and Spinning*. The aircraft is not cleared for deliberate stalling or spinning.

27. *Loft and Toss Bombing Recovery Manoeuvres.* The following minimum heights should be observed for starting a *full* 'roll and pull' manoeuvre (135° bank angle, 12° incidence) following a loft or toss bombing attack:

Climb Angle (degrees)	*Minimum Height AGL (ft)*
15	2300
20	2050
25	1750
30	1500

Flight in Icing Conditions

28. There is a continuously-operated engine anti-icing system but there is no airframe ice protection. Conditions likely to cause icing are to be avoided where possible.

Flight in Rain

29. The aircraft is cleared to fly in rain, provided rain repellant paste RR 990 has been applied to the windscreen.

Approach Limitations

30. *Visual Approaches*. The nominal approach incidence is not to exceed 13°.

31. *Visual Committal Height*. The decision to overshoot from a single engined approach using PTR is to be made above 100 feet AGL with not more than 20° flap lowered. The incidence should not be allowed to exceed 10° since at incidences above this value the rate of climb deteriorates rapidly.

Note: If an engine fails during any normal approach after 40° has been lowered, any attempt to overshoot will involve a height loss of between 500 and 1000 feet.

32. *Instrument Approach Limitations*. The Aircraft Approach Limitations (AAL), using a 2·5° to 3° glideslope and not more than 13° nominal approach incidence, are given below for approaches using Precision Approach Radar (PAR), Surveillance Radar Approach (SRA) or Instrument Landing System/HDD HSI (Raw ILS):

	PAR	*SRA*	*Raw ILS*
True height (GR1 & T2)	200	250	250
Indicated Heights:			
HUD (GR1 & T2)	180	230	230
GR1 HDD Altimeter:			
Reset or Standby	180	230	230
Standby and emergency source	400	450	450
T2 HDD Altimeter:			
Front			
Reset	180	230	230
Standby	400	450	450
Rear			
Reset or Standby	180	230	230

Note 1: ILS approaches should be monitored by PAR or SRA wherever possible.

Note 2: Approaches may be made using the HUD providing continual cross-reference is made to the HDD altitude and air data (or pressure) instruments. In particular, Decision Height (DH) actions are to be initiated by reference to the HDD altimeter.

Note 3: The above figures ILS refer to in-line localisers. For offset localisers, an increment of 20 feet for Raw ILS should be added.

Note 4: For approaches using a 3·5° glideslope, 60 feet should be added to the AAL given above.

PART 2A—GR 1 LIMITATIONS

CHAPTER 2—ENGINE LIMITATIONS

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Engine Operating Limitations

1. The Adour Mk 102 and 104 are cleared for operation subject to the following limitations:

Power Condition	*% HP RPM (NH)*		*TGT°C—Cockpit Gauge*			*Time Limit*
	Mk 102	*Mk* 104	*Mk* 102		*Mk* 104	*Per Flight*
During starting and relighting	—	—	550	(Note 1)	◀600▶	—
Minimum idle	57	(See Note 2)		450		Unrestricted
Maximum continuous	99	99·5	580		635	Unrestricted
Maximum dry (no reheat)	104		640	(Note 3 & 6)	700	30 minutes (Note 4)
Maximum reheat	104		640	(Note 3 & 6)	700	15 minutes (Note 4)
Part throttle reheat	104		640	(Note 3)	700	See Note 5
Minimum approach	70 (Note 7)			—		Unrestricted

Note 1: With a maximum overtemperature of 20°C for ten seconds during starting.

Note 2: The nominal minimum idle speed is 57% HP RPM (ISA, sea level static) with minimum auxiliary power offtakes, no air offtake and bleed valve closed. Idle speed will vary linearly by 1% HP RPM increase per 1500 feet increase in altitude. A setting tolerance of ±1% HP RPM is allowed, and for ambient, temperatures below 0°C and above +30°C the tolerance is extended to minus 2% and +2% respectively, from the nominal value.

Note 3: This temperature is automatically controlled by the TGT limiter and provided that the cockpit indication does not deviate by more than 10°C from this limit, it is acceptable.

Note 4: The total time in any one flight for any combination of these ratings must not exceed 30 minutes.

Note 5: There is no restriction on the time for which PTR may be operated below maximum continuous rating. Above maximum continuous rating the time in PTR must be included in the 30-minute limitation for the maximum ratings (Note 4).

Note 6: Except during engine starting, the normal TGT may be exceeded by a maximum value of 30°C provided that the TGT returns to within 5°C of the limiting value within 30 seconds (20°C for 20 seconds for Mk 104).

Note 7: This is the minimum RPM from which the engine is guaranteed, following a rapid opening of the throttle, to reach 95% of maximum dry thrust within 4·5 seconds.

Approved Fuels

2. Approved fuels are listed in Leading Particulars.

Ground Running

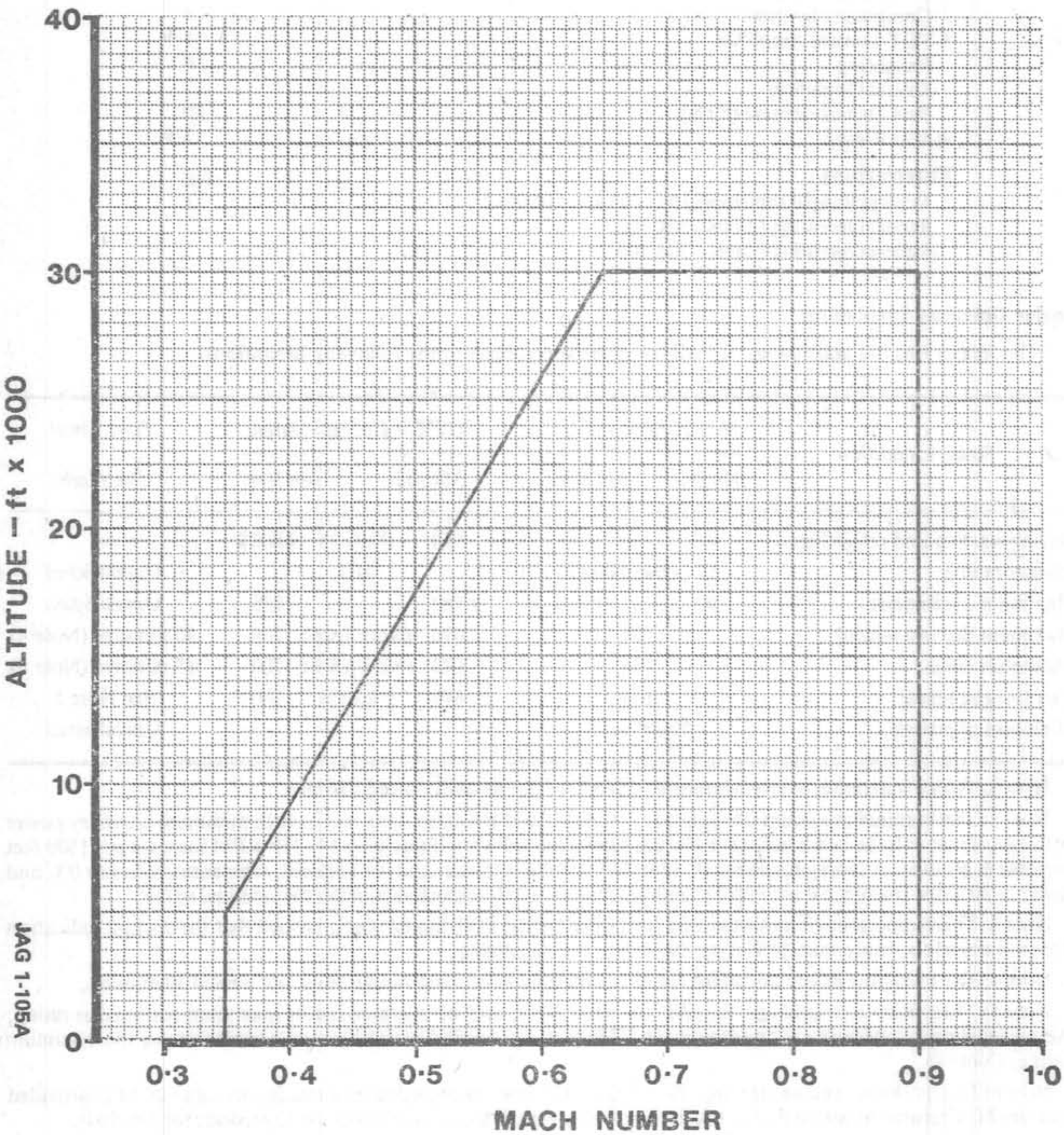
3. To avoid alternator overheating, the following limitations apply to each engine:

a. *Engine Acceleration/Deceleration*. After ten successive slam accelerations and decelerations on an engine there must be a three minute period at ground idle before a new sequence is started.

b. *Duration of Ground Running*. Above engine idle setting, the duration of ground running is to be restricted to 30 minutes.

Continuous Ignition

4. The continuous ignition system is only cleared for use when the throttle is set at the idle position.



2A—2 Fig 1 Normal Relight Envelope—Mk 102 and Mk 104

TGT Control Amplifier

5. If an amplifier failure results in an engine attaining a sub-idle condition with idle selected, the engine is to be accelerated slowly to at least 75% RPM before slam accelerations are made. The amplifier is only to be re-selected ON within the engine RPM band of 75 to 85%.

Relighting

6. When starting the engine in flight, relighting is not to be attempted until the bleed valve is open.

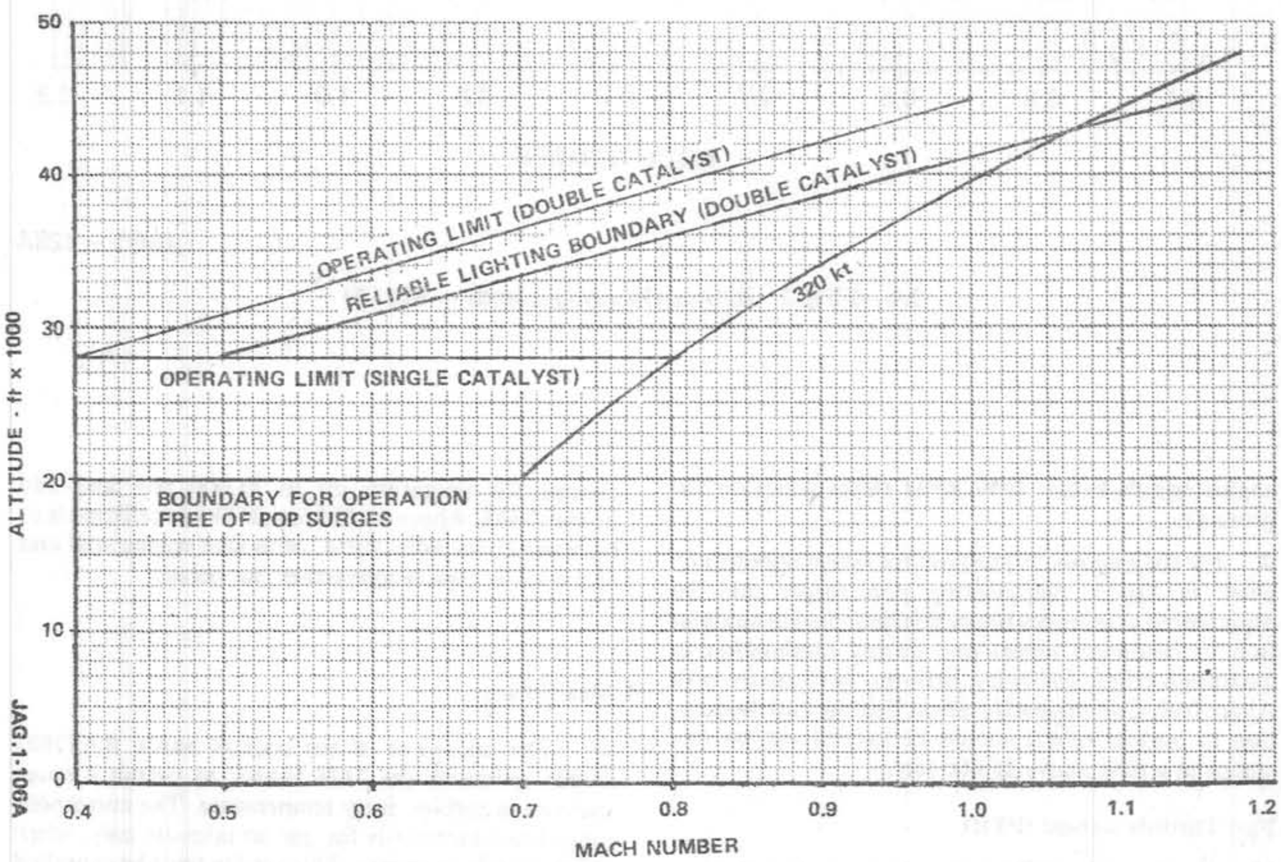
a. *Normal Relighting*. Normal relights are permitted within the envelope given at Fig 1. It should be noted, however, that reliable relighting has not always been achieved above 20,000 feet and the recommended optimum relight condition is 320 knots at 20,000 feet or below.

b. *Immediate Relights*. Immediate relights may be attempted at any speed and altitude.

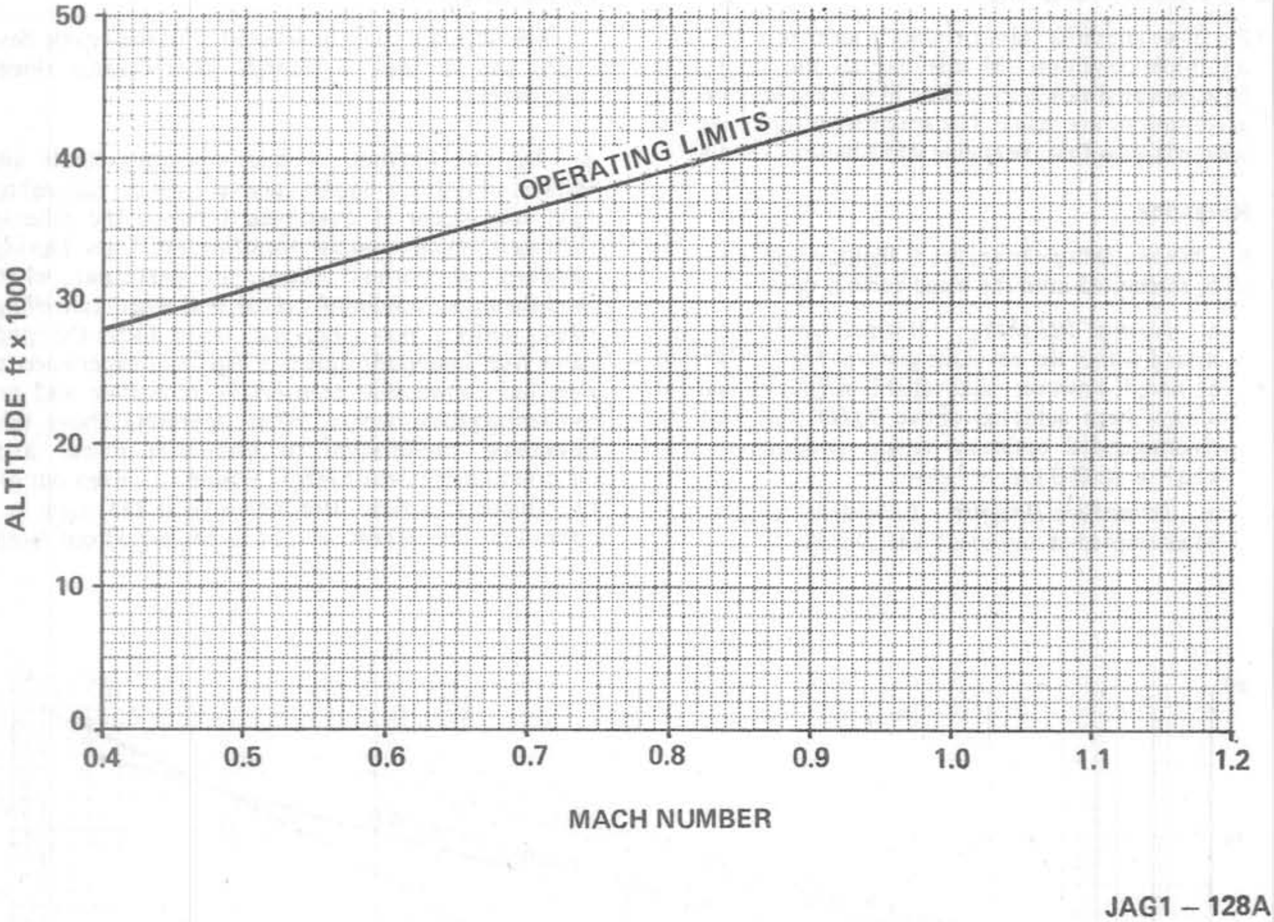
Reheat Operation

7. Reheat is not to be re-selected until the nozzle has closed and at least 3 seconds have elapsed since cancellation.

8. *Mk* 102 *Engines*. Reheat operating limits are shown in Fig 2. On double catalyst engines, failures to light may occur if attempted between the reliable lighting boundary and the operating limit lines. During handling in normal reheat, in particular when modulating to minimum reheat and when cancelling reheat under g, pop surges may occur above the 'pop surge free' boundary shown in Fig 2 but experience to date has shown that recovery is immediate and no overtemperature occurs. When operating above this boundary, modulation to minimum reheat and cancellation of normal reheat should be carried out on one engine at a time. Pre-Adour mod 143, slam accelerations into reheat are not to be carried out from



2A—2 Fig 2 Reheat Operating Limits—Mk 102



2A—2 Fig 3 Reheat Operating Limits — Mk 104

engine speeds below 70% RPM (80% when on the ground).

9. *Mk* 104 *Engines*. The limit for reheat operation is given in Fig 3. Self-clearing pop surges may be experienced at altitudes below this limit during modulation to minimum reheat and during modulation to maximum reheat following light-up, particularly with Avtag fuel. Consequently, reheat lighting and modulation in normal reheat should be carried out on one engine at a time above 25,000 feet.

Part Throttle Reheat (PTR)

10. Single catalyst PTR is cleared for operation up to 15,000 feet and 300 knots. Double catalyst PTR is cleared for operation up to 25,000 feet and 550 knots/0·9M. Above 10,000 feet, PTR cancellation is to be made above 90% RPM, otherwise engine stall and excessive jet pipe temperatures can occur.

Max Rating

11. The operation of the cockpit MAX RATING switch redatums the TGT limiter to permit a small increase in turbine entry temperature. The corresponding thrust increase is for use on take-off only, when operationally necessary. This facility must be cancelled once the aircraft is established in a safe flight condition.

PART 2A — GR 1 LIMITATIONS

CHAPTER 3 — PERMITTED CONFIGURATIONS AND ASSOCIATED CARRIAGE LIMITATIONS

(Completely revised)

General

Permitted configurations and associated limitations are given in detail in the Release to Service document at Annex D, Appendix 10.

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PART 2A—GR 1 LIMITATIONS

CHAPTER 4—MISCELLANEOUS LIMITATIONS

Contents

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Airfield Limitations

1. *Taxying*. Taxying with the canopy fully open is prohibited. When taxying with canopy partly open, the canopy is to be secured by the strut, and the wind plus taxying speed is not to exceed 40 knots. Operation on suitable unprepared surfaces is permitted (refer to Part 3, Chapter 11).

2. *Runways*. The aircraft is cleared for operation from tarmac and concrete runways.

3. *Crosswinds*

a. The crosswind limitations are given in the following table:

Nosewheel Steering	*Operative*		*Inoperative*	
Brake parachute	Deployed	Not deployed	Deployed	Not deployed
Wet/dry runway	23 knots	23 knots	10 knots	23 knots
Flooded runway	10 knots	10 knots	5 knots	10 knots

b. *Crosswind Operations with Heavy Asymmetric Stores*. Pre-planned take-offs and landings with heavy asymmetric stores are not permitted. In the event of an enforced recovery with a heavy asymmetric store, a crosswind landing should be avoided if possible. If a crosswind landing is unavoidable, the limitations are:

(1) With the asymmetric stores on the upwind side of the aircraft, as given in para 3a.

(2) With the asymmetric store on the downwind side of the aircraft, 10 knots.

Note: If circumstances permit, it is preferable to land with the asymmetric store on the upwind side of the aircraft.

c. *High Incidence Take-Off*. For take-offs in all configurations using an incidence greater than 15°, the crosswind component is not to exceed 15 knots.

Tyres and Brakes

4. *Tyres*

a. *Pre-mod* 921. The tyres (nosewheel 27A/6120647, mainwheels 27A/6120646) are cleared for rolling groundspeeds up to 195 knots (maximum weight 15,130 kg).

b. *Post-mod* 921. The tyres (nosewheel 27A/6149322, mainwheels 27A/6149321) are cleared for rolling groundspeeds up to 205 knots (maximum weight 15,700 kg) or 212 knots (maximum weight 14,400 kg). Nosewheel tyres are to be inflated to a pressure of 72·5 PSI (5 bar) if predicted true groundspeed on take-off is likely to exceed 205 knots.

c. *Mixed Pre- and Post-mod* 921 *Tyres*. Pre- and post-mod 921 tyres may be mixed provided the limitations applicable to the pre-mod standard are observed. If mainwheel tyres are mixed, the same tyre pressure should be used for all mainwheel tyres.

5. *Brakes*. The braking system is cleared for use subject to the limitations given in the MOD (AFD) Release Document.

Brake Parachute

6. The brake parachute is cleared for deployment subject to the following limitations:

Max normal deployment speed ... 150 knots
Max emergency deployment speed ... 185 knots

The brake parachute is only to be deployed when the nosewheel is on the ground and the throttles are to 'Idle'.

Airfield Arresting

7. *Aircraft Arrester Hook.* The aircraft arrester hook is cleared for emergency use against RHAG subject to the following limitations:

a. When a RHAG bowspring installation is used, it must include wire centre-span tie-downs.

b. The hook is not to be lowered until the main wheels are on the ground.

c. To avoid structural damage, the engagement speed should not exceed:

150 knots at aircraft weights up to 9000 kg
varying linearly to
140 knots at an aircraft weight of 13,500 kg.

d. Unrestricted practice engagements are cleared at speeds up to 50 knots at weights below maximum normal landing.

8. *Trampling of Arrester Cables.*

a. *RHAG—Aircraft With Mod* 845 *or SEM/ Jaguar*/02. The aircraft in any configuration is cleared to trample any rigged RHAG centre span cable at any speed.

b. *RHAG—Aircraft Without Mod* 845 or SEM/ Jaguar/02. The aircraft in any configuration is cleared to trample the RHAG centre span cable, subject to the following limitations:

(1) Tensioned and unsupported	Any speed at any weight
(2) Supported with bow springs and restrained by wire tie-downs	160 knots at any weight
(3) Supported with rubber discs and restrained by wire tie-downs	160 knots at any weight
(4) Supported with rubber discs but without wire tie-downs	160 knots up to 13,000 kg AUW 10 knots above 13,000 kg AUW

c. *SPRAG.* The aircraft in any configuration is cleared to trample a SPRAG centre span cable in the tensioned and unsupported condition at any speed.

9. *Airfield Barriers.*

a. *Mk 12A Arresting Barrier System.* The aircraft is cleared for emergency engagement of the Mk 12A barrier system with the barrier set to either the Light or Heavy aircraft setting, subject to the following conditions and limitations:

(1) At speeds above 120 knots the energy absorber brake units may not be sufficient to stop the aircraft completely. There will also be the risk of the aircraft bursting through the net.

(2) External stores and their mountings, particularly those projecting beyond the wing, may be damaged. External fuel tanks may be ruptured, giving a potential fire hazard if they contain fuel. This risk is reduced by jettisoning tanks at the moment of engagement with the barrier, but not before.

(3) If an aircraft carrying external fuel tanks does engage the barrier, the pilot should leave the aircraft without delay.

(4) The canopy must not be opened until the aircraft has come to rest.

b. *Mk 6 and Mk 12 Arresting Barrier System.* The Mk 6 and Mk 12 barriers are not cleared for use. These barriers are capable of stopping an aircraft, but projections on the nose of the aircraft may snag vertical members causing the steel wire top edge to be drawn down prematurely onto the canopy, with the risk of penetration and hazard to the pilot.

Canopy Jettison and Emergency Escape

10. *Canopy Jettison.* The canopy jettison system is cleared for use from zero forward speed to 600 knots, at any altitude.

11. *Emergency Escape.* The Type 9B Mk 2 ejection seat is cleared for use from zero forward speed to 600 knots at any altitude, provided that it is fitted with a minimum seat/canopy time delay of 0·25 seconds. Ejection must not be attempted on the ground with the canopy open.

PART 2A—GR 1 LIMITATIONS

CHAPTER 5—SYSTEMS LIMITATIONS

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Radio and Radar Installations

WARNING: In both the PTR 377 and Marconi/Magnavox UHF/VHF installations using the fin cap aerial, severe degradation or total loss of intelligibility is possible when in formation, in turns at high angles of bank and also when in conditions where terrain may cause additional reflected signals to be received (multi-path propagation).

1. *UHF/VHF (PTR 377).* The PTR 377 installation is cleared for use subject to the following conditions and limitations:

a. Owing to the poor azimuth polar diagram of the UHF aerial with the Passive Warning Receiver fairing on the fin, some loss of range performance may occur in the middle of the UHF band.

b. In the UHF homing mode, the head-up display deviation is to be ignored until the head-down indication shows a relative bearing within ±30°.

c. Allowance must be made when transmitting, for a small but noticeable delay which can occur between pressing the transmit button and actual transmission.

d. Transmissions on some frequencies may interfere with the ILS indications.

e. When formation flying, distorted reception can occur if TR + G mode is used on frequencies below 280 MHz.

f. UHF homing accuracy has not yet been assessed.

g. Evaluation of frequencies in the TR + G mode show that the signal/noise ratio is such that the use of the following frequencies is not recommended: 100·0, 118·0, 286·0, 300·0, 364·5 and 386·0 MHz.

2. *VHF/UHF (AD 120/ARC 164).* The AD 120/ARC 164 (Marconi/Magnavox) V/UHF is cleared for use subject to the following conditions and limitations:

a. Owing to the poor azimuth polar diagram of the UHF aerial with the PWR fairing on the fin, some loss of range performance may occur in the upper half of the UHF band.

b. No homing facility exists at present.

c. Transmission on some VHF frequencies may affect readings on fuel contents gauges and may occasionally cause slight undemanded control surface movements to occur.

d. Transmission on some frequencies may interfere with the ILS indications.

e. When formation flying, distorted reception can occur if TR + G mode is used on frequencies below 280 MHz.

f. The UHF set is known to have certain degraded frequencies. The use of the following frequencies is therefore not recommended: 241·075 to 241·15, 260·45, 279·825 to 279·975, 280·0 to 280·15, 300·3 to 300·375, 303·3 to 303·35, 319·325, 360·725 to 360·85 and 396·55 to 396·775 MHz.

3. *Passive Warning Receiver.* The Passive Warning Receiver is cleared for use provided the essential modifications listed in the Release to Service are embodied.

4. *ILS.* ILS is cleared for use subject to the following lowering conditions and limitations:

a. UHF/VHF transmissions may cause ILS interference.

b. The approach limitations given in Chapter 1 must be observed.

c. When turning onto the localiser, a momentary loss of glideslope indication may occur when the aircraft heading is approximately 90° to runway QDM.

d. Prolonged marker tone may be received (up to 30 seconds) and can interfere with communications.

5. *IFF/SSR.* The installation is cleared for use in all available modes, subject to the following conditions and limitations:

a. Compatibility with Rapier or with similar automatic rapid-response short-range missile defences has not been proved.

b. UHF transmissions in the bands 255 to 260 MHz and 340 to 346 MHz may cause loss of digital read-out on ATC displays.

6. *Standby UHF.* The standby UHF installation is cleared for use but should not be switched on unless required for use, as this can result in distorted side tone during HF or V/UHF transmissions.

7. *MF/HF.* The MF/HF installation is cleared for use in both Single (upper) Side Band (SBB) and Double Side Band (DSB) modes over the frequency band 2·06 MHz to 26·5 MHz, subject to the following conditions and limitations:

a. The autostabilisers are to be selected OFF before and during transmission.

b. Transmission is not permitted during weapon aiming, height fixing or ILS approaches.

c. Transmission is not permitted in close formation, or by either tanker or receiver during air-to-air refuelling.

d. The following erroneous cockpit indications may occur during transmission:

(1) Radar altimeter indication may jump.

(2) TGT may indicate a temperature rise.

(3) HUD symbology may jitter and break up.

(4) PMD may jitter and dump.

(5) CWP may indicate DIFF warning.

e. Due to residual self-interference problems, occasional transmitter trip-out may be experienced on some frequencies during transmission, especially on aircraft without mod 758 and 887. Recovery is obtained by changing the frequency first digit, then reselecting the original frequency.

f. Distorted side tone may occur during transmission unless the volume controls of the main UHF/VHF and standby UHF are turned to zero or the equipment is switched off.

8. *Tacan.* The Tacan equipment is cleared for use in the air-to-ground and air-to-air modes but when the ground air temperature exceeds +30°C, the Tacan equipment must not be operated for more than 30 minutes immediately before or after flight. Further ground running is permitted providing a cooling period equal to twice the last running period is allowed between runs and the maximum time of any one run does not exceed 30 minutes.

9. *Voice Recorder.* The voice recorder is cleared for use subject to the following conditions and limitations:

a. When in the 'record' mode, the tape can run inadvertently, due to cockpit noise. Modifications to reduce this noise are under development.

b. Cassettes are permanently damaged when subject to temperatures below minus 20°C or above +40°C. For this reason, they should not be loaded until immediately before flight.

10. *Communication Control System.* The CCS is cleared for use.

11. *Telebrief System.* The telebrief system is cleared for use provided the modification embodiment and connection instructions referred to in the MOD (AFD) Release Document are satisfied.

12. *Laser Ranger Marked Target Seeker.* The LRMTS is cleared for operation at ground ambient temperatures in the range minus 10°C to +40°C. Exposure below minus 10°C may damage the LRMTS. Mandatory modifications are listed in the MOD (AFD) Release Document.

13. *Radar Altimeter.* The radar altimeter is cleared for use for general navigation and weapon aiming over sea and rolling terrain at heights above 100 feet AGL. Indications should not be relied upon when the landing gear is down.

Instruments

14. *Standby Compass.* The standby compass is cleared for use, subject to the following conditions:

a. The readings are valid only when the probe heater, electro-hydraulic pump, landing and taxy lamps are switched off.

b. The readings may be up to 5° in error when the NAVWASS is running.

c. The compass is to be calibrated with the canopy shut and the canopy handle locked.

d. Compass calibrations are affected significantly by removal of the PDR.

Fuel System

15. *Ground Refuelling.* The fuel system including drop tanks is cleared for use subject to the following ground refuelling limitations:

a. Unless mod 854 has been embodied, refuelling pressure is to be limited to 25 PSI.

b. When mod 854 has been embodied, refuelling pressures of 50 PSI may be used provided precautions are taken to avoid full tanker pressure when the fuel selector is switched to OFF and the aircraft is fitted with external tanks.

16. *Fuel Dumping.* The fuel dumping system is cleared for use in emergency without special restrictions.

17. *Approved Fuels.* Refer to Leading Particulars.

18. *Air-to-Air Refuelling.* The aircraft is cleared for dry contact air-to-air refuelling training, and for wet contact air-to-air refuelling subject to observance of the limitations and handling procedures given in Part 3, Chapter 9.

NavWASS Temperature Limitations

19. There are no temperature limitations on the use of the NavWASS in flight. On the ground, operation is dependent on ambient air temperature, as follows:

a. *Below minus* 10°*C.* Use of the RAPID ALIGN is not permitted unless a previous run of at least one hour duration has been completed in the preceding six hour period. During a 'normal' alignment the air conditioning switch must be to OFF during the 35 minute (minimum) period required in the 'Heaters' mode: set the air conditioning switch to GROUND when the NavWASS is set to ALIGN.

b. *Between minus* 10°*C and* +30°*C.* Operation is unrestricted provided that the air conditioning is selected to GROUND when the NavWASS is selected to ALIGN.

c. *Above* +30°*C.* The following restrictions and procedures apply:

(1) The HTRS mode on the NCU is not to be used.

(2) Air conditioning is to be selected to GROUND as soon as the NavWASS is selected to ALIGN or, in conditions of strong solar radiation, 20 minutes before selecting ALIGN.

(3) Ground operation for more than 50 minutes in the range +30 to +35°C, reducing to 40 minutes in the range +35 to +40°C, can overheat the platform and operate the P and PSU lights on the NCU. In this event, the NavWASS must be switched OFF to avoid the risk of serious damage to the platform. The air data reversionary mode may be invoked by reselecting the NAV mode directly.

(4) During a rapid turn-round, the NavWASS may be left operating provided air conditioning is selected to GROUND. There is a risk of a P or PSU failure if the turn-round time exceeds 20 minutes.

(5) Once the NavWASS has been on for the full period permitted in sub-para c (3) or c (4), it must be switched OFF and allowed to cool as follows:

With air conditioning OFF ...	4 hours
With air conditioning to GROUND	1 hour

A cooling time using a mixture of cooling methods will be published in the Aircraft Servicing Manual.

Note: A further 20 minutes with air conditioning selected to GROUND must be allowed in conditions of strong solar radiation.

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PART 2B

T MK 2

LIMITATIONS

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PART 2B — T Mk 2 LIMITATIONS

CHAPTER 1 — AIRFRAME AND FLYING LIMITATIONS

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The limitations given in this Part are taken from the Release to Service Document, Stage 2, AL3. The Release to Service Document must be consulted to ascertain the latest release standard.

General

1. The Jaguar T Mk 2 is a two-seat trainer and tactical support aircraft released for use by day and night over land and sea subject to the limitations given in this Part and in the latest Release to Service Document. The aircraft is not to be flown solo from the rear cockpit.

2. *Definition of Limitations.* Certain limitations are given at two levels, these are:

a. *Normal Limits.* These values may be *reached* as often as the pilot's task requires, without undue risk, and may be exceeded occasionally by a small margin without untoward consequences. The pilot should not deliberately aim to exceed the quoted Normal Limits. Unless otherwise stated, the limitations given are Normal Limits.

b. *Never Exceed Limits.* In some cases a second and higher limit is quoted in addition to the Normal Limit. This represents the full Design Flight Envelope case or the highest figure for which all aspects have been investigated in flight and ground tests. These limits are *never* to be exceeded because consequential effects beyond these levels are either hazardous or unknown.

Flight Envelope

3. *Altitude.* The aircraft is cleared for operation up to 45,000 feet AMSL.

4. *Temperature.* The aircraft is cleared for operation at ground air temperatures in the range minus 15°C to +40°C subject to the following conditions and limitations:

a. If the aircraft is exposed to ground air temperatures below minus 15°C for a period of more than one hour, a time allowance must be made for the aircraft to warm up after temperature rises to above minus 15°C. Considerations resulting from operation down to minus 15°C are included in Part 3, Chapter 10.

b. When the ground air temperature exceeds +25°C, the dew point temperature must not exceed +16°C (+20°C on aircraft fitted with mod 891 or STI/Jaguar/114). If this limit is exceeded, severe fogging and misting may occur in the cockpit, sufficient to obscure the instruments, when cockpit conditioning is selected on.

c. When the ground air temperature exceeds +30°C in conditions of strong solar radiation, the canopy and windscreen must be shaded, otherwise temperatures may become excessive even with the canopy open, and equipment could be damaged.

5. *Speed.*

a. *Clean Aircraft With or Without Pylons.*

Normal limit ... The greater of 0·95M/575 kt up to a maximum of 1·3M

Never Exceed limit Up to 20,000 feet:
The greater of 1·0M/625 kt up to a maximum of 1·25M
Above 20,000 ft:
The greater of 1·25M/600 kt up to a maximum of 1·4M

b. *Aircraft With External Stores (Including Asymmetric Stores).* Unless an overriding limitation is imposed by individual stores or aircraft mod state, the speed limitations are:

Normal limit ... 0·9M
Never Exceed limit 0·95M

Airspeed Limitations

6. *Flaps.* The flaps are cleared for take-off and landing and for up to an average of 3½ additional cycles during each flight, subject to the following speed limitations:

Flap Angle	*Maximum Speed (kt)*
5° or 10°	280
15° or 20°	260
25° or 30°	240
35° or 40°	220

7. *Combat Slats.* For manoeuvres at speeds below 500 knots, slats are to be at the combat setting for incidences greater than 5°. Speed limitations depend on aircraft modification state and are given below.

Mod State	*Speed Limit*
Pre/post 762 Pre 843 872	*Auto*: 450 knots *Manual*: the lower of 500 knots/ 0·95M (pre 762) the lower of 550 knots/ 0·95M (post 762) Maximum speed for slat selection 500 knots Slat selection above 450 knots must be made in nominal 1g flight
Post 762 843 872	*Auto*: 500 knots. Auto retract at 500 knots *Manual*: the lower of 550 knots/ 0·95M Maximum speed for slat selection 500 knots

8. *Airbrakes.* The airbrakes are cleared for use throughout the full aircraft speed range, except that, pre-mod 716, with 1200 litre tanks on the inboard pylons, speed for airbrake extension is limited to 0·9M. Simultaneous extension of airbrakes and cancellation of reheat is to be avoided at speeds above 500 knots.

9. *Landing Gear.* The landing gear limiting speeds are:

Landing Gear Position	*Maximum Speed (kt)*
On selecting up or down	230 in 1g flight 220 with normal-acceleration 0 to +3g
Unlocked:	
a. After take-off	250
b. All other times	220
Locked down	250

Maximum Weight and Centre of Gravity

10. *Weight.*

a. *Take-Off Weight*

Maximum take-off weight (pre-mod 921) ... ... 15,130 kg
Maximum take-off weight (post-mod 921) ... ... 15,700 kg

b. *Landing Weights.*

Maximum normal landing weight ... 9600 kg
Maximum overload landing weight 13,600 kg
Maximum single-engined landing weight:
Ambient temperatures up to ISA 10,300 kg
varying linearly to
Ambient temperatures ISA+25°C 8500 kg

Note 1: Taxying, take-off and landing procedures for unprepared surfaces are given in Part 3, Chapter 11.

Note 2: These limits assume that PTR is being used and that the approach speed is held at 180 knots down to decision height. They are based on single-engine overshoot performance and may only be exceeded in an emergency which precludes reduction to the quoted maximum weight.

11. *Centre of Gravity.* The Mean Aerodynamic Chord (MAC) is 3·235 metres in length, and its leading edge is 6·747 metres aft of aircraft datum. The position of the centre of gravity is stated as a percentage of MAC aft of the leading edge of the MAC.

a. *Limits.* The centre of gravity is to be maintained within the limits in the Release to Service at D10.

b. *Flap Settings for Landing With Forward CG Positions.* Flap settings for landing with forward

CG positions are tabulated below. The flap angles are the maximum which can be used for standard approaches carried out at 13° incidence.

% MAC	Flap Angle
13	10°
14	20°
17	30°
20	40°

Incidence

12. *Clean Aircraft With Symmetric Stores or Asymmetric Lepus.* Incidence limits depend on configuration as given in the Release to Service document at Annex D, Appendix 10 (D 10).

13. *Aircraft With Centreline Fuel Tank* (*pre-mod 803 only*). On aircraft not embodying mod 803, control problems may be encountered at incidence angles above 12°. Refer to Part 3, Chapter 2, para 41.

14. *Aircraft With Heavy Asymmetric Stores.* Limitations for aircraft in heavy asymmetric stores configurations are intended only for emergency use in the event of a failure or unintentional asymmetric release. In general, manoeuvres in these configurations should be kept as gentle as possible and the asymmetric stores released or jettisoned as soon as circumstances permit. The aircraft in these configurations is incidence limited. The incidence limits given below are not to be exceeded as large spoiler angles would be required to maintain roll attitude and the sideslip angle would approach the structural limit.

Speed — knots	Incidence
350	9°
400	8°
450	7°
500	5°
550	4°

15. *With Flaps Extended.* When flaps are extended to 20° or more with the landing gear up or down, the incidence limits are:

Clean aircraft and aircraft with symmetric stores or asymmetric Lepus ... ... 17°

Aircraft with asymmetric heavy stores ... 15°

Note: 'Heavy stores' refers to BL755 and 1000 lb bombs.

Normal-Acceleration Limitations

Note: Under certain flight conditions the limits in para 16 and 17 are not achievable due to adverse handling characteristics (see para 20).

16. *Clean Aircraft With or Without Pylons.* For the clean aircraft with landing gear and flaps retracted, the normal-acceleration limits for 'symmetric' manoeuvres (manoeuvres involving negligible rate of roll and negligible roll acceleration) are given in Table 1.

17. *Aircraft With External Stores.*

a. *Aircraft With Symmetric Stores or Asymmetric Lepus.* Unless an overriding limitation is given in the Release to Service the normal-acceleration limits are:

◀ Normal limits ... minus 1g to +5·25g or 6g
Never Exceed limits minus 2g to +6g or 7g

The configurations and conditions for the +6g and +7g limits are given in the Release to Service document at Annex D, Appendix 10 (D 10). ▶

b. *Aircraft With Heavy Asymmetric Stores.* Aircraft with heavy asymmetric stores configurations are incidence limited (refer to para 14).

Table 1 — Normal-Acceleration Limits (clean, with or without pylons)

Mach No/Speed	*Aircraft Weight (kg)*	*Normal Limits*	*Never Exceed Limits*
◀ Up to 0·95	Up to 9800	−2g to +7·25g	−3g to +8g
	Above 9800	−2g to +6·5g	−3g to +7·25g
Above 0·95 ▶	All	−2g to +4·5g	−3g to +5g
Exception Above 500 knots, below 5000 feet	All	−2g to +5·5g	−3g to +6g

18. *All Configurations.*

a. Acceleration limitations applicable to rolling manoeuvres are given in para 24.

b. With flaps and landing gear down, the acceleration limits are 0 to +3g. If the landing gear is to be selected at 230 knots, the normal-acceleration must be +1·0g.

19. *Sustained Negative-g.* The aircraft is cleared for sustained negative-g, including inverted flight, subject to the following limitations:

a. The 100 KG (N_1 and N_2) fuel warning lights must not be on prior to the manoeuvre.

b. The elapsed time under negative-g is not to exceed 15 seconds in dry power or 7·5 seconds in reheat.

Incidence and Manoeuvre Limitations

20. *Pitching Manoeuvres.* The incidence during pitching manoeuvres is not to be increased beyond that point at which any of the following limitations is reached:

a. The incidence limitations given in para 12 to 15.

b. The normal-acceleration (g) limits given in para 16 to 19.

c. The onset of wing rock or wing drop.

d. The onset of heavy buffet.

e. The onset of 'yaw off' (a rapid increase of lateral g or sideslip).

f. Stick force per increment of normal-acceleration tending to zero: this may occur above 0·88M at greater than 6° incidence.

Slats are to be at the combat setting for incidences greater than 5° at speeds below 500 knots.

21. *Manoeuvring With Heavy Asymmetric Stores.* The speed and incidence limitations are given in para 5 b and 14 respectively. Associated handling information is given in Part 3, Chapter 6.

22. *Ground Attack Dives.* Ground attack dives are permitted up to 30° dive angle, provided that minimum recovery heights are calculated from Table 2. Column 2 of the table gives the minimum height loss achievable with the pertaining handling limitations and Column 3 gives the normal ground avoidance criteria allowance. No allowance has been made for debris zone. Column 4 (the sum of Columns 2 and 3) represents the recommended minimum height for initiation of dive recovery. Users are advised to choose a dive angle 5° above the planned attack condition in order to allow for variations in dive angle estimation.

23. *Ground Attack Dive Recovery.* Table 2 assumes that ground attack dive recoveries are made by pulling rapidly to the normal-acceleration limit, or to the ground attack recovery incidence limit (Release to Service, D10), whichever is reached first.

Table 2 — Ground Attack Dive Recovery

Column 1	*Column* 2			*Column* 3	*Column* 4		
Dive Angle	*Height Loss (ft)*			Ground Avoidance Safety Height	*Break-off Height AGL*		
	Configurations				*Configurations*		
	Pre-mod 803—without C/L tank Post-mod 803 — all configurations		Pre-mod 803 with C/L tank		Pre-mod 803—without C/L tank Post-mod 803—all configurations		Pre-mod 803 with C/L tank
	UP to 450 *kt*	*Above* 450 *kt*	*All Speeds*		*UP to* 450 *kt*	*Above* 450 *kt*	*All Speeds*
Up to 10°	Normal Criteria				Normal Criteria		
15°	550	650	650	350	900	1000	1000
20°	800	1000	1000	500	1300	1500	1500
25°	1100	1400	1400	600	1700	2000	2000
30°	1400	1800	1800	700	2100	2500	2500
35°	1650	2150	2150	850	2500	3000	3000

Table 3 — Rapid Rolling Limitations

Rolling Case	Roll Entry Limits				
	Speed Range	*Altitude Limit — ft*	*Incidence*	*Normal-accel*	*Max change of bank angle*
1	0·9M to lower of 1·2M/600 kt	36,000	NA	+1·0 to +2·0g	180°
2	250 kt to lower of 550 kt/0·9M	30,000	10° NA	+0·5 to +4·5g +1g	180° 360°
3	250 kt to 0·9M	30,000	10° NA	+1·0 to +4·0g +1g	180° 360°
4	250 kt to 0·9M	30,000	10°	+1·0 to +4·0g	180°
5	250 kt to lower of 550 kt/0·9M	30,000	10° NA	+1·0 to +4·0g +1g	180° 360°
6	250 kt to lower of 550 kt/0·9M	30,000	10°	+1·0 to +4·0g	180°
7	250 kt to lower of 530 kt/0·9M	30,000	10°	+1·0 to +4·0g	180°
8	250 kt to lower of 550 kt/0·9M	30,000	8°	+1·0 to +3·0g	180°

In the case of an unintentional asymmetric release, and assuming that the pilot is able to transfer to the appropriate lower incidence limits, the break-off heights given in column 4 of Table 2 remain adequate at weights up to 12,000 kg, but the safety margins are reduced.

Note: In configurations with a normal-acceleration limit of +6g (Normal Limit), attempts to pull to +6g below 0·75M may be inhibited by yaw-off or wing rock as incidence increases, particularly at higher weights.

24. *Rolling Manoeuvres*

a. *Gentle Rolling.* The aircraft in any cleared configuration is cleared for gentle rolling and for turning manoeuvres which remain within the normal-acceleration limits given in para 16 to 19. Continuous rolls in excess of 360° are prohibited.

Note: The phrase 'gentle rolling and normal turning manoeuvres' clears the aircraft for all practical In-Service Manoeuvre requirements providing discretion is used when approaching the symmetric g boundary. Under these conditions, but most particularly in flight at less than 1g, sustained large spoiler applications, high rates of roll and high lateral accelerations must be avoided.

b. *Rapid Rolling.* Rapid rolling (ie the use of coarse lateral control with large roll attitude changes) is permitted only within the limitations given in Table 3.

Note 1: The relevant rolling case to be used with a particular configuration is shown in the Release to Service (D10). Rolling cases 3 and 4 are not used for the T Mk 2 but are retained for commonality with the GR Mk 1.

Note 2: Limitations in Cases 1 and 2 for the clean aircraft are applicable at weights below 10,300 kg at speeds below 0·9M and below 9200 kg at speeds above 0·9M. When the clean aircraft exceeds the above weights, rolling is restricted to gentle manoeuvres only.

Note 3: The incidence limits in the table may, in certain configurations and at high mach numbers, be further limited by aircraft handling factors, eg wing rock. These handling boundaries are not to be exceeded.

Note 4: Rapid rolling is not permitted when more than one third lateral stick travel is needed to maintain lateral trim.

Note 5: Application of rudder during a rapid roll is to be avoided.

Note 6: Forward or aft movement of the control column during a rapid roll through angles greater than 100° is to be avoided.

Note 7: Autostabilisers are to be engaged for rapid rolling.

Note 8: Airbrakes are to be IN for rapid rolling.

Note 9: Rapid rolling is not permitted unless underwing 1200 litre tanks are empty.

Note 10: Rapid rolling with asymmetric heavy stores is not permitted.

25. *Formation Flying.* The aircraft is cleared for close formation flying. Line astern formation is permitted in dry power, provided vertical separation between adjacent aircraft is greater than 15 feet.

26. *Stalling and Spinning.* The aircraft is not cleared for deliberate stalling or spinning.

27. *Loft and Toss Bombing Recovery Manoeuvres.* The following minimum heights should be observed for starting a *full* 'roll and pull' manoeuvre (135° bank angle, 12° incidence) following a loft or toss bombing attack:

Climb Angle (degrees)	*Minimum Height AGL (ft)*
15	2300
20	2050
25	1750
30	1500

Flight in Icing Conditions

28. There is a continuously-operated engine anti-icing system but there is no airframe ice protection. Conditions likely to cause icing are to be avoided where possible.

Flight in Rain

29. The aircraft is cleared to fly in rain, provided rain repellant paste RR 990 has been applied to the windscreen.

Approach Limitations

30. *Visual Approaches.* The nominal approach incidence is not to exceed 13°.

31. *Instrument Approach Limitations.* The AAL using a 2·5 to 3° glideslope and not more than 13° nominal approach incidence are given below, for approaches using Precision Approach Radar (PAR), Surveillance Radar Approach (SRA), Instrument Landing System/HUD Flight Director (Rate ILS), or Instrument Landing System/Head Down Display HSI (Raw ILS).

a. *True Heights AGL*

PAR	*SRA*	*Rate ILS (See Note 1)*	*Raw ILS (See Note 1)*
200 ft	250 ft	200 ft	250 ft

b. *Corresponding Indicated Height on Head-Down Altimeters*

Display in Use	*PAR*	*SRA*	*Rate ILS (See Note 1)*	*Raw ILS (See Note 1)*
Front Cockpit				
Head up (See Note 2)	220 ft	270 ft	220 ft	N/A
Head up, ADC failed (See Note 2)	380 ft	430 ft	380 ft	N/A
Head down	220 ft	270 ft	N/A	270 ft
Head down, ADC failed	380 ft	430 ft	N/A	430 ft
Rear Cockpit				
Head up (see Note 2) with or without ADC failed	220 ft	270 ft	220 ft	N/A
Head down, with or without ADC failed	220 ft	270 ft	N/A	270 ft

Note 1: ILS approaches should be monitored by PAR or SRA wherever possible.

Note 2: Approaches may be made using the Head-Up Display provided continual cross reference is made to the Head Down Display attitude and air data instruments. In particular, Decision Height (DH) actions are to be initiated by reference to the Head Down altimeter.

Note 3: For approaches using a 3·5° glideslope, 60 feet should be added to the instrument approach limitations given above.

32. *Visual Committal Height.* The decision to overshoot from a single engined approach using PTR is to be made above 100 feet AGL with not more than 20° flap lowered, and not more than 13° incidence. Refer to para 10 for associated weight limitations.

PART 2B — T Mk 2 LIMITATIONS

CHAPTER 2 — ENGINE LIMITATIONS

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Engine Operating Limitations

1. The Adour Mk 102 and Mk 104 are cleared for operation subject to the following limitations:

Power Condition	*% HP RPM (NH)*		*TGT°C—Cockpit Gauge*		*Time Limit*
	Mk 102	*Mk* 104	*Mk* 102	*Mk* 104	*Per Flight*
During starting and relighting	—	—	550 (Note 1)	~~550~~ 600	— AL6
Minimum idle	57 (See Note 2)		450		Unrestricted
Maximum continuous	99	99·5	580	635	Unrestricted
Maximum dry (no reheat)	104		640 (Note 3 & 6)	700	30 minutes (Note 4)
Maximum reheat	104		640 (Note 3 & 6)	700	15 minutes (Note 4)
Part throttle reheat	104		640 (Note 3)	700	See Note 5
Minimum approach	70 (Note 7)		—		Unrestricted

Note 1: With a maximum overtemperature of 20°C for ten seconds during starting.

Note 2: The nominal minimum idle speed is 57% HP RPM (ISA, sea level static) with minimum auxiliary power offtakes, no air offtake and bleed valve closed. Idle speed will vary linearly by 1% HP RPM increase per 1500 feet increase in altitude. A setting tolerance of ±1% HP RPM is allowed, and for ambient temperatures below 0°C and above +30°C the tolerance is extended to minus 2% and +2% respectively, from the nominal value.

Note 3: This temperature is automatically controlled by the TGT limiter and provided that the cockpit indication does not deviate by more than 10°C from this limit, it is acceptable.

Note 4: The total time in any one flight for any combination of these ratings must not exceed 30 minutes.

Note 5: There is no restriction on the time for which PTR may be operated below maximum continuous rating. Above maximum continuous rating the time in PTR must be included in the 30 minute limitation for the maximum ratings (Note 4).

Note 6: Except during engine starting, the normal TGT may be exceeded by a maximum value of 30°C provided that the TGT returns to within 5°C of the limiting value within 30 seconds (20°C for 20 seconds for Mk 104).

Note 7: This is the minimum RPM from which the engine is guaranteed, following a rapid opening of the throttle, to reach 95% of maximum dry thrust within 4·5 seconds.

Approved Fuels

2. Approved fuels are listed in Leading Particulars.

Ground Running

3. To avoid alternator overheating, the following limitations apply to each engine:

a. *Engine Acceleration/Deceleration.* After 10 successive slam accelerations and decelerations on an engine there must be a 3 minute period at ground idle before a new sequence is started.

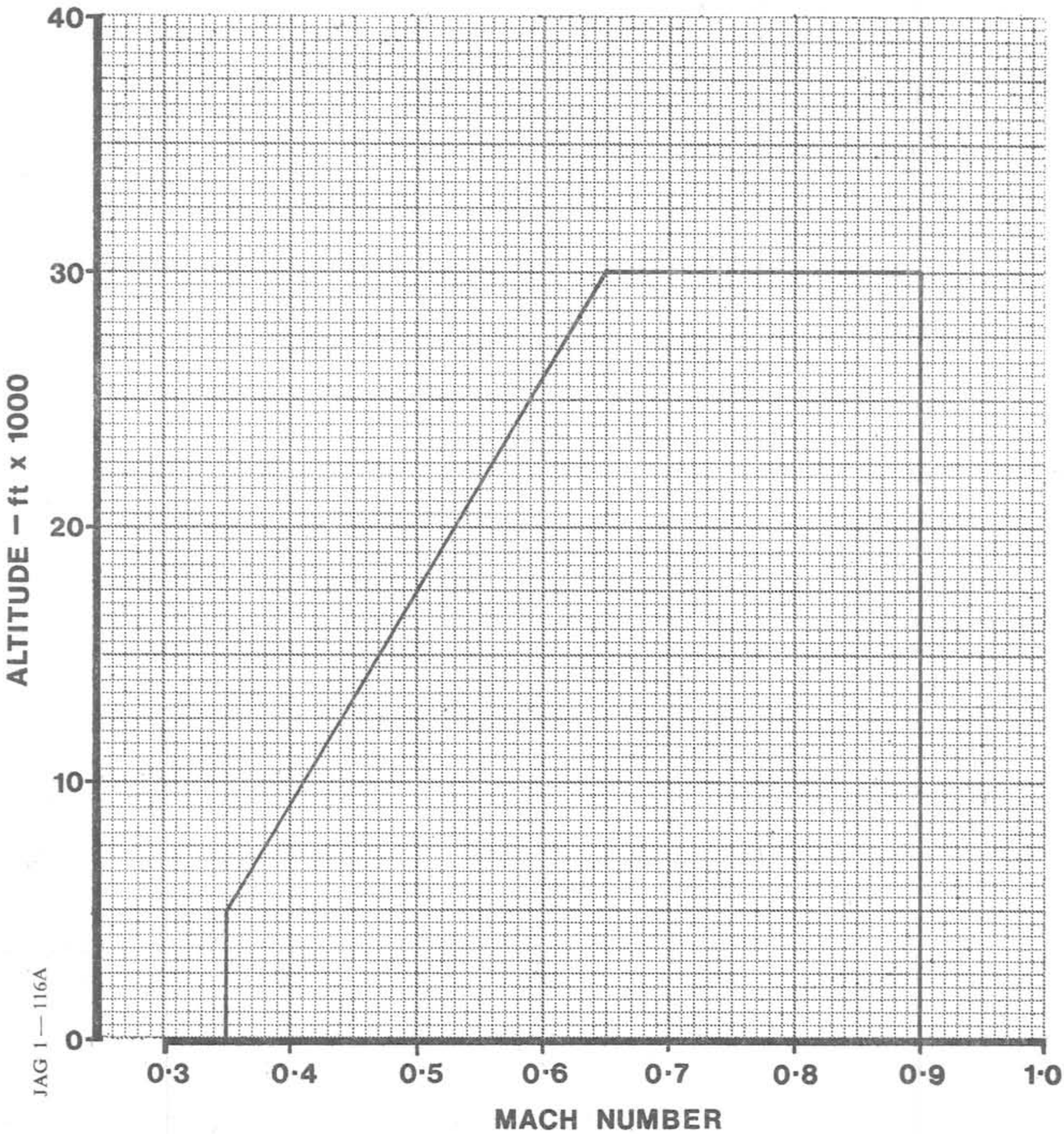
b. *Duration of Ground Running.* Above engine idle setting, the duration of ground running is to be restricted to 30 minutes.

Continuous Ignition

4. The continuous ignition system is only cleared for use when the throttle is set at the idle position.

Relighting

5. When starting the engine in flight, relighting is not to be attempted until the bleed valve is open.



◀ **2B—2 Fig 1 Relight Envelope — Mk 102 and Mk 104** ▶

a. *Normal Relighting.* Normal relights are permitted within the envelope given at Fig 1. It should be noted, however, that reliable relighting has not always been achieved above 20,000 feet and the recommended optimum relight condition is 320 knots at 20,000 feet or below.

b. *Immediate Relights.* Immediate relights may be attempted at any speed and altitude.

◀ **Reheat Operation**

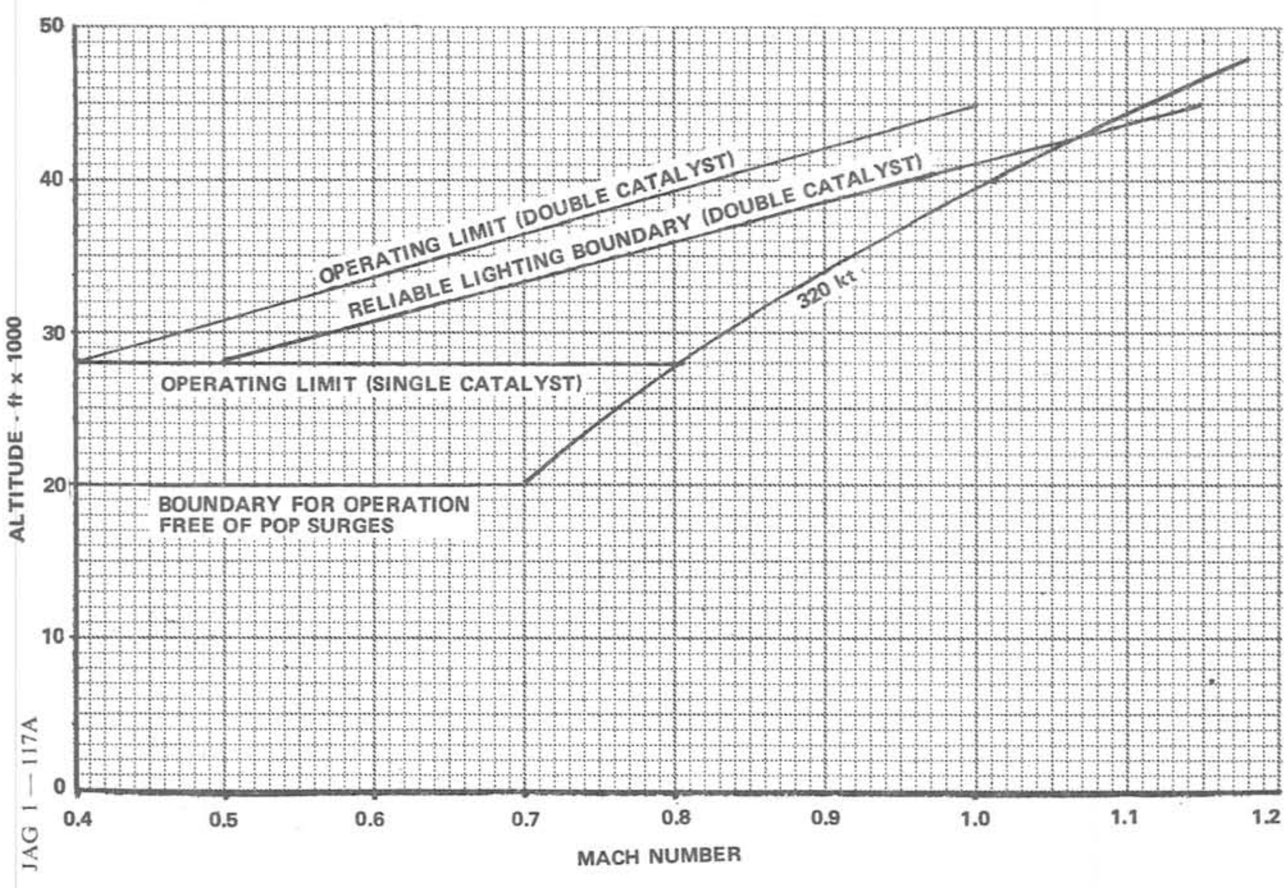
6. Reheat is not to be re-selected until the nozzle has closed and at least 3 seconds have elapsed since cancellation.

7. *Mk* 102 *Engines.* Reheat operating limits are shown in Fig 2. On double catalyst engines failures to light may occur if attempted between the reliable lighting boundary and the operating limit lines. During handling in normal reheat, in particular when modulating to minimum reheat and when cancelling reheat under g, pop surges may occur above the 'pop surge free' boundary shown in Fig 2 but experience to date has shown that recovery is immediate and no overtemperature occurs. When operating above this boundary, modulation to minimum reheat and cancellation of normal reheat should be carried out on one engine at a time. Pre-Adour mod 143, slam accelerations into reheat are not to be carried out from engine speeds below 70% RPM (80% when on the ground).

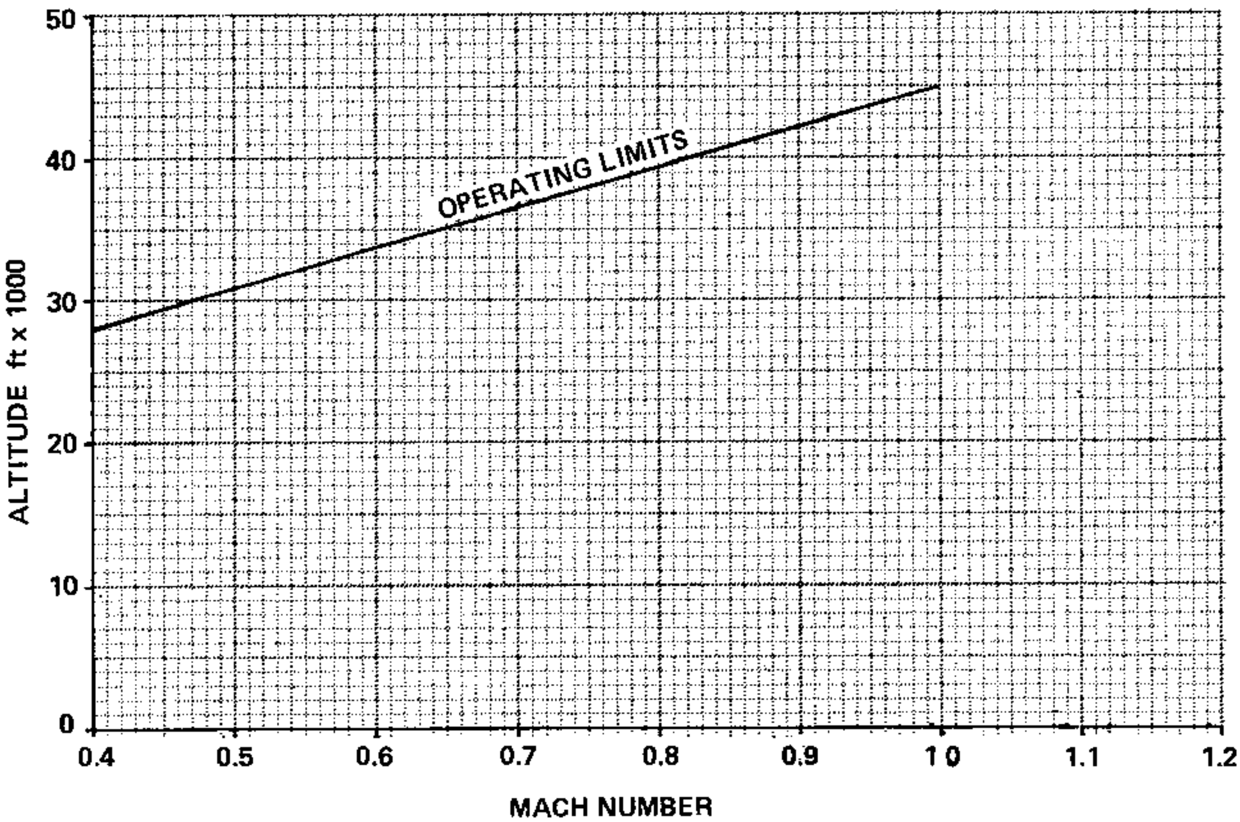
8. *Mk* 104 *Engines.* The limit for reheat operation is given in Fig 3. Self-clearing pop surges may be experienced at altitudes below this limit during modulation to minimum reheat and during modulation to maximum reheat following light-up, particularly with Avtag fuel. Consequently, reheat lighting and modulation in normal reheat should be carried out on one engine at a time above 25,000 feet. ▶

Part Throttle Reheat (PTR)

9. Single catalyst PTR is cleared for operation up to 15,000 feet and 300 knots. Double catalyst PTR is cleared for operation up to 25,000 feet and 550 knots /0·9M. Above 10,000 feet, PTR cancellation is to be made above 90% RPM, otherwise engine stall and excessive jet pipe temperatures can occur.



◀ **2B—2 Fig 2 Reheat Operating Limits — Mk 102** ▶



JAG1 – 129A

◀ **2B—2 Fig 3 Reheat Operating Limits — Mk 104** ▶

PART 2B — T Mk 2 LIMITATIONS

CHAPTER 3 — PERMITTED CONFIGURATIONS AND ASSOCIATED LIMITATIONS

(Completely revised)

General

Permitted configurations and associated limitations are given in detail in the Release to Service document at Annex D, Appendix 10.

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PART 2B — T Mk 2 LIMITATIONS

CHAPTER 4 — MISCELLANEOUS LIMITATIONS

Contents

	Para
Airfield Limitations	1
Tyres and Brakes	4
Brake Parachute	6
Airfield Arresting	7
Canopy Jettison and Emergency Escape	10

Airfield Limitations

1. *Taxying.* Taxying with the canopy fully open is prohibited. When taxying with the canopy partly open, the canopy is to be secured by the strut and the wind plus taxying speed is not to exceed 40 knots. Operation on suitable unprepared surfaces is permitted (refer to Part 3, Chapter 11).

2. *Runways.* The aircraft is cleared for operation from tarmac, concrete and grass surfaces.

3. *Crosswinds.*

a. The crosswind limitations are given in the following table:

Nosewheel Steering	*Operative*		*Inoperative*	
Brake parachute	Deployed	Not deployed	Deployed	Not deployed
Wet/dry runway	23 knots	23 knots	10 knots	20 knots
Flooded runway	10 knots	10 knots	5 knots	10 knots

b. *Crosswind Operations with Heavy Asymmetric Stores.* Pre-planned take-offs and landings with heavy asymmetric stores are not permitted. In the event of an enforced recovery with a heavy asymmetric store, a crosswind landing should be avoided if possible. If a crosswind landing is unavoidable, the limitations are:

(1) With the asymmetric store on the upwind side of the aircraft, as given in para 3 a.

(2) With the asymmetric store on the downwind side of the aircraft, 10 knots.

Note: If circumstances permit, it is preferable to land with the asymmetric store on the upwind side of the aircraft.

c. *High Incidence Take-Off.* For take-offs in all configurations using an incidence greater than 15°, the crosswind component is not to exceed 15 knots.

Tyres and Brakes

4. *Tyres.*

a. *Pre-mod* 921. The tyres (nosewheel 27A/6120647, mainwheels 27A/6120646) are cleared for rolling groundspeeds up to 195 knots (maximum weight 15,130 kg).

b. *Post-mod* 921. The tyres (nosewheel 27A/6149322, mainwheels 27A/6149321) are cleared for rolling groundspeeds up to 205 knots (maximum weight 15,700 kg) or 212 knots (maximum weight 14,400 kg). Nosewheel tyres are to be inflated to a pressure of 72·5 PSI (5 bar) if predicted true groundspeed on take-off is likely to exceed 205 knots.

c. *Mixed Pre- and Post-mod* 921 *Tyres.* Pre- and post-mod 921 tyres may be mixed provided the limitations applicable to the pre-mod standard are observed. If mainwheel tyres are mixed, the same tyre pressure should be used for all mainwheel tyres.

5. *Brakes.* The braking system is cleared for use subject to the limitations given in the Release to Service document.

Brake Parachute

6. The brake parachute is cleared for deployment subject to the following limitations:

Maximum normal deployment speed	150 knots
Maximum emergency deployment speed	185 knots

The brake parachute is only to be deployed when the nosewheel is on the ground and the throttles are to 'Idle'. ~~For operation in temperatures below minus 10°C, STI/Jag/76 must be satisfied.~~

Airfield Arresting

7. *Aircraft Arrester Hook.* The aircraft arrester hook is cleared for emergency use against RHAG subject to the following limitations:

a. When a RHAG bowspring installation is used, it must include wire centre-span tie-downs.

b. The hook is not to be lowered until the main wheels are on the ground.

c. To avoid structural damage, the engagement speed should not exceed:

150 knots at aircraft weights up to 9000 kg varying linearly to

140 knots at an aircraft weight of 13,500 kg.

8. *Trampling of Arresting Cables.*

a. *RHAG — Aircraft With Mod* 845 *or SEM/Jaguar*/02. The aircraft in any configuration is cleared to trample any rigged RHAG centre span cable at any speed.

b. *RHAG—Aircraft Without Mod* 845 *or SEM/Jaguar*/02. The aircraft in any configuration is cleared to trample the RHAG centre span cable, subject to the following limitations.

(1) Tensioned and unsupported	Any speed at any weight
(2) Supported with bowsprings and restrained by wire tie-down	160 knots at any weight
(3) Supported with rubber discs and restrained by wire tie-down	160 knots at any weight
(4) Supported with rubber discs but without wire tie-downs	160 knots up to 13,000 kg AUW 10 knots above 13,000 kg AUW

c. *SPRAG.* The aircraft in any configuration is cleared to trample a SPRAG centre-span cable in the tensioned and unsupported condition at any speed.

9. *Airfield Barriers.*

a. *Mk 12A Arresting Barrier System.* The aircraft is cleared for emergency engagement of the Mk 12A barrier system with the barrier set to either the Light or Heavy Aircraft setting, subject to the following conditions and limitations:

(1) At speeds above 120 knots the energy absorber brake units may not be sufficient to stop the aircraft completely. There will also be a risk of the aircraft bursting through the net.

(2) External stores and their mountings, particularly those projecting beyond the wing, may be damaged. External fuel tanks may be ruptured giving a potential fire hazard if they contain fuel. This risk is reduced by jettisoning the tanks at the moment of engagement with the barrier, but not before.

(3) If an aircraft carrying external fuel tanks does engage the barrier, the pilot should leave the aircraft without delay.

(4) The cockpit must not be opened until the aircraft comes to rest.

b. *Mk 6 and Mk 12 Arresting Barrier Systems.* The Mk 6 and Mk 12 barriers are not cleared for use. These barriers are capable of stopping an aircraft, but projections on the nose of the aircraft may snag vertical members causing the steel wire top edge to be drawn down prematurely onto the canopy, with the risk of penetration and hazard to the pilot.

Canopy Jettison and Emergency Escape

10. *Canopy Jettison.* The canopy jettison system is cleared for use from zero forward speed to 600 knots, at any altitude.

11. *Emergency Escape.* The Type 9B Mk 2 ejection seat is cleared for use from zero forward speed to 600 knots at any altitude, provided that the minimum seat/canopy time delays fitted to the front and rear seats are 0·35 seconds and 0·25 seconds respectively. Ejection must not be attempted on the ground with the canopy open.

PART 2B — T Mk 2 LIMITATIONS

CHAPTER 5 — SYSTEMS LIMITATIONS

Contents

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Fuel System	9
NavWASS Temperature Limitations	12

Radio Installalion

1. *UHF/VHF*. The PTR 377 installation is cleared for use subject to the following conditions and limitations:

a. Some loss of range performance may occur at the upper and lower ends of the UHF band.

b. In the UHF homing mode, the head-up display deviation is to be ignored until the head-down indication shows a relative bearing within $\pm 30°$.

c. A small but noticeable delay can occur between pressing the transmit button and actual transmission; users should allow for this delay.

d. Transmissions on some frequencies may interfere with the ILS indications.

e. UHF homing accuracy has not yet been assessed.

f. When formation flying, distorted reception can occur if TR + G mode is used on frequencies below 280 MHz.

g. Evaluation of frequencies in the TR + G mode show that the signal/noise ratio is such that the frequencies 100·0, 118·0, 286·0, 300·0, 364·5 and 386·0 MHz must be considered unusable.

2. *ILS*. ILS is cleared for use subject to the following conditions and limitations:

a. UHF/VHF transmissions may cause ILS interference.

b. The approach limitations given in Chapter 1 must be observed.

c. When turning onto the localiser, a momentary loss of glideslope indication may occur when the aircraft heading is approximately 90° to runway QDM.

d. Prolonged marker tone may be received (up to 30 seconds) and can interfere with communications.

3. *IFF/SSR*. The installation is cleared for use in all available modes, subject to the following limitations:

a. UHF transmission in the bands 225 to 260 MHz and 340 to 346 MHz may cause loss of digital read-out on ATC displays.

b. Compatibility with Rapier or with similar automatic rapid response short range missile defences has not been proved.

4. *Standby UHF*. The standby UHF installation is cleared for use but should not be switched on unless required for use, as this can result in distorted side tone during V/UHF transmissions.

5. *Tacan*. The Tacan equipment is cleared for use in the air-to-ground and air-to-air modes subject to the condition that when the ground air temperature exceeds +30°C, the Tacan equipment must not be operated for more than 30 minutes immediately before or after flight. Further ground running is permitted providing a cooling period equal to twice the last running period is allowed between runs and the maximum time of any one run does not exceed 30 minutes.

6. *Communication Control System*. The CCS is cleared for use. ▶◀

7. *Radar Altimeter*. The radar altimeter is cleared for use for general navigation and weapon aiming over sea and rolling terrain at heights above 200 feet AGL.

Instruments

8. *Standby Compass.* The standby compass is cleared for use, subject to the following conditions:

a. *When Fitted to the Windscreen Arch* (Pre-mod 621):

(1) A compass calibration is to be carried out after each change of Pilot's Display Unit.

(2) The readings are valid only when the HUD is switched 'off' and the reflector glass is manually parked in the position furthest from the pilot.

(3) The compass is to be calibrated with the canopy shut and the canopy handle locked.

(4) Compass calibrations are affected significantly by removal of the PDR.

b. *When Fitted on the Cockpit Right Longeron* (Post-mod 621):

(1) The readings are valid only when the probe heater, electro-hydraulic pump, landing and taxy lamps are switched off.

(2) The readings may be up to 5° in error when the NavWASS is running.

(3) The compass is to be calibrated with the canopy shut and the canopy handle locked.

(4) Compass calibrations are affected significantly by removal of the PDR.

Fuel System

9. *Ground Refuelling.* The fuel system, including drop tanks, is cleared for use subject to the following ground refuelling limitations:

a. Unless mod 854 has been embodied, refuelling pressure is to be limited to 25 PSI.

b. When mod 854 has been embodied, refuelling pressures of 50 PSI may be used provided precautions are taken to avoid fuel tanker pressure when the fuel selector is switched to OFF and the aircraft is fitted with external tanks.

10. *Fuel Jettison.* The fuel jettison system is cleared for use in emergency without special restrictions.

11. *Approved Fuels.* Refer to Leading Particulars.

NavWASS Temperature Limitations

12. There are no temperature limitations on the use of the NavWASS in flight. On the ground, operation is dependent on ambient air temperature, as follows:

a. *Below minus* 10°*C.* Use of RAPID ALIGN is not permitted unless a previous run of at least one hour duration has been completed in the preceding six hour period. When the NavWASS is selected to ALIGN, the air conditioning switch must be to OFF during the period required in the 'Heaters' mode: set the air conditioning switch to GROUND when the NavWASS is set to ALIGN.

b. *Between minus* 10°*C and* +30°*C.* Operation is unrestricted provided that the air conditioning is selected to GROUND when the NavWASS is selected to ALIGN.

c. *Above* +30°*C.* The following restrictions and procedures apply:

(1) The HTRS mode on the NCU is not to be used.

(2) The air conditioning is to be selected to GROUND as soon as the NavWASS is selected to ALIGN or, in conditions of strong solar radiation, 20 minutes before selecting ALIGN.

(3) Ground operation for more than 50 minutes in the range +30 to +35°C, reducing to 40 minutes in the range +35 to +40°C, can overheat the platform and operate the P and PSU lights on the NCU. In this event, the NavWASS must be switched OFF to avoid the risk of serious damage to the platform. The air data reversionary mode may be invoked by reselecting the NAV mode directly.

(4) During a rapid turnround, the NavWASS may be left operating provided air conditioning is selected to GROUND. There is a risk of a P or PSU failure if the turnround time exceeds 20 minutes.

(5) Once the NavWASS has been on for the full period permitted in sub-para c. (3) or c. (4), it must be switched off and allowed to cool as follows:

With air conditioning OFF ... 4 hours
With air conditioning to GROUND 1 hour

A cooling time using a mixture of cooling methods will be published in the Aircraft Servicing Manual.

Note: A further 20 minutes with air conditioning selected to GROUND must be allowed in conditions of strong solar radiation.

PART 3

HANDLING PROCEDURES

List of Chapters

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HANDLING IN FLIGHT	2
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HIGH ANGLES OF INCIDENCE — STALLING — LOSS OF CONTROL AND RECOVERY	4
FLYING IN BAD WEATHER CONDITIONS	5
FLYING WITH ASYMMETRIC LOADS	6
SINGLE ENGINE FLYING AND RELIGHTING	7
AUTOSTABILISER FAILURE	8
AIR TO AIR REFUELLING (GR 1 ONLY)	9
OPERATION IN EXTREME CLIMATIC CONDITIONS	10
OPERATION ON UNPREPARED SURFACES	11
◀ BANNER TARGET TOWING	12 ▶

All incidence values quoted in this publication refer to HUD incidence indications, unless otherwise stated.

PART 3 — HANDLING

CHAPTER 1 — PREPARATION FOR FLIGHT

Contents

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Items to be Checked During External Checks — T Mk 2 ...	4

WARNING 1: The aircraft assisted escape system is a potential source of danger and inadvertent operation can cause fatal injuries. Safety precautions are to be observed at all times, ie the aircraft is to be left in the 'Safe for Parking'* or 'Safe for Servicing'** condition as applicable.

*Safe for parking—safety pins fitted to the canopy jettison unit sear, the ejection seat firing handle, the rocket initiator and the manual separation handle.

**Safe for servicing — safety pins also fitted to the main gun sear.

WARNING 2: The pilot must ensure that the master armament switch in the cockpit is set to SAFE at all times except from just before take-off to immediately after landing.

Minimum Acceptable HP RPM and TGT

1. *General.* A check of engine serviceability can be made before take-off by comparing the maximum indicated HP RPM and TGT with the minimum acceptable values. The manufacturer establishes the HP RPM and LP RPM obtained at maximum non-reheat conditions during the engine acceptance check. These values, called 'placard RPM' are unique for each engine and are given in F700 and placarded in the cockpit.

2. *Correction Factors.* Fig 1 and 2 relate to Mk 102 and Mk 104 engines respectively and give an HP RPM correction factor for a placard LP RPM for a range of OAT. This correction factor is subtracted from the placard HP RPM to determine the minimum acceptable HP RPM for take-off. The graphs also give the minimum acceptable TGT relative to placard LP RPM for a range of outside air temperature (OAT).

3. *Procedure.*

a. Obtain the placard HP RPM and LP RPM values.

b. Obtain the predicted OAT for take-off.

c. From Fig 1 or Fig 2 as appropriate, using OAT and placard LP RPM obtain for each engine (refer to examples for method):

(1) The minimum acceptable TGT.

(2) The % RPM to be subtracted from the placard HP RPM.

d. Subtract the value obtained in c (2) from the placard HP RPM to obtain the minimum acceptable HP RPM.

e. The values of HP RPM and TGT obtained are the minimum values which should be seen during maximum dry power checks prior to take-off.

4. *Example.* The following example relates to Mk 102 engines: refer to Fig 1. (Use of Fig 2 to

obtain minimum power parameters for Mk 104 engines is identical.)

Placard HP RPM and LP RPM

No 1 Engine	No 2 Engine
HP RPM=100%	HP RPM=101%
LP RPM=102%	LP RPM=104%
OAT=0°C	

No 1 Engine.

From 0°C on the OAT scale move vertically up towards the 102% LP RPM line of the upper graph. Note that the TGT limiting line is reached before the 102% LP RPM line and therefore the minimum acceptable TGT is the controlled TGT limit which could be seen 10°C below the controlled value due to indication errors (ie 640°C minus 10°C). Repeat the procedure on the lower graph (TGT again limiting) and from the left side read off the HP RPM correction (1·8) to be subtracted from the placard HP RPM. The minimum acceptable power parameters for this engine at an ambient temperature of 0°C are thus:

TGT	630°C
HP RPM (100 minus 1·8)	98·2%

No 2 Engine.

Repeat the above using the No 2 engine placard figures, noting that this time the vertical intersects the placard LP RPM line. The derived minimum acceptable power values are:

TGT	617°C
HP RPM (101 minus 2·55)	98·45%

External and Internal Checks

5. Carry out the **External Inspection** and **Internal Checks** as laid down in the FRC.

6. Fig 2 (GR1) and Fig 3 (T Mk 2) indicate the location of the main external items to be checked.

7. Adjust the rudder pedals before strapping in, keeping the feet clear of the pedals.

Starting the Engines

8. Start the engines in accordance with the drills in the FRC. The following considerations should be borne in mind:

a. It is advisable that the aircraft should be facing into wind.

b. Ensure that the engine running danger zones are clear of ground equipment.

c. Access ladders are to be removed before start-up and, if starting with the canopy open, ensure that there are no loose articles in the cockpit.

d. If, during starting, the TGT limit is rapidly approached and appears likely to be exceeded, move the throttle to the 'stop' position.

◀ **Internal Start**

9. The aircraft can be started on internal battery power, if required. With the BATT switch to ON complete the **Internal Checks** as far as possible, including ON selections of the ALT and TRU switches. Ensure that the FUEL PUMPS switches are OFF. Start the engines in the normal sequence, close the bleed valves without delay and start the NavWASS alignment. During the NavWASS alignment time, complete the **Internal Checks** again and then carry out the **After Start Checks**. ▶

Failure to Start

10. If an engine fails to start at the first attempt, a second attempt may be made using the **Failure to Start** drill in the FRC. Before making a second attempt check all relevant switches and indications. Note that if the CORRECT ROTATION light fails to come on during the start cycle, ignition will not occur. If the engine fails to start at the second attempt, the air generator should be shut down and the cause investigated. Additional starting limitations are given in the FRC.

Checks After Starting

11. Carry out the **After Start Checks** listed in the FRC.

12. The air generator shuts down automatically after the second engine starts, but the air GENERATOR switch must be selected OFF otherwise it is impossible to operate the airbrakes.

13. Open up the engines slowly (to avoid surge) to 65% RPM to close the bleed valves; they will then remain closed at idling RPM. Closure is indicated by an increase in idling RPM of 2% to 6% and a decrease in TGT of 25° to 50°C. Idle RPM with bleed valves closed are approximately 57%.

Taxying

14. Carry out the **Taxying Checks** listed in the FRC. Release the parking brake and increase the RPM on both engines to start the aircraft moving. Check the brakes and nosewheel steering as the aircraft moves off. Nosewheel steering is sensitive and ◀ effective, making taxying easy. At AUW above 15,000 kg, minimise lateral accelerations by using gentle taxying manoeuvres only. ▶

15. Minimum radius turns can only be achieved at very low speeds. At higher speeds the nosewheel steering jack stalls, increasing the radius of turn, particularly at heavy weights and at extreme forward CG, where small amounts of differential braking may be necessary to initiate sharp turns. Nosewheel steering only should be used whenever possible.

16. A tendency for the aircraft to pull one way when taxying can be corrected by slight rudder trim adjustment within the zero band on the rudder trim indicator. Taxying without nosewheel steering requires large amounts of differential braking; this may lead to brake overheat and to damage or deflation of the tyres. Taxying without nosewheel steering is not recommended except in an emergency, eg to clear the runway after landing.

17. The airbrakes must not be selected out when taxying as the resultant drop in No 2 hydraulic services pressure makes nosewheel steering inoperative for up to 5 seconds.

18. If it is necessary to taxy on one engine, No 1 engine should be shut down and the associated HYD BY PASS switch set to OFF. In the event of brakes malfunction, set the No 1 HYD BY PASS switch to ON to restore normal braking through operation of the PTU. Use the brakes emergency handle if necessary.

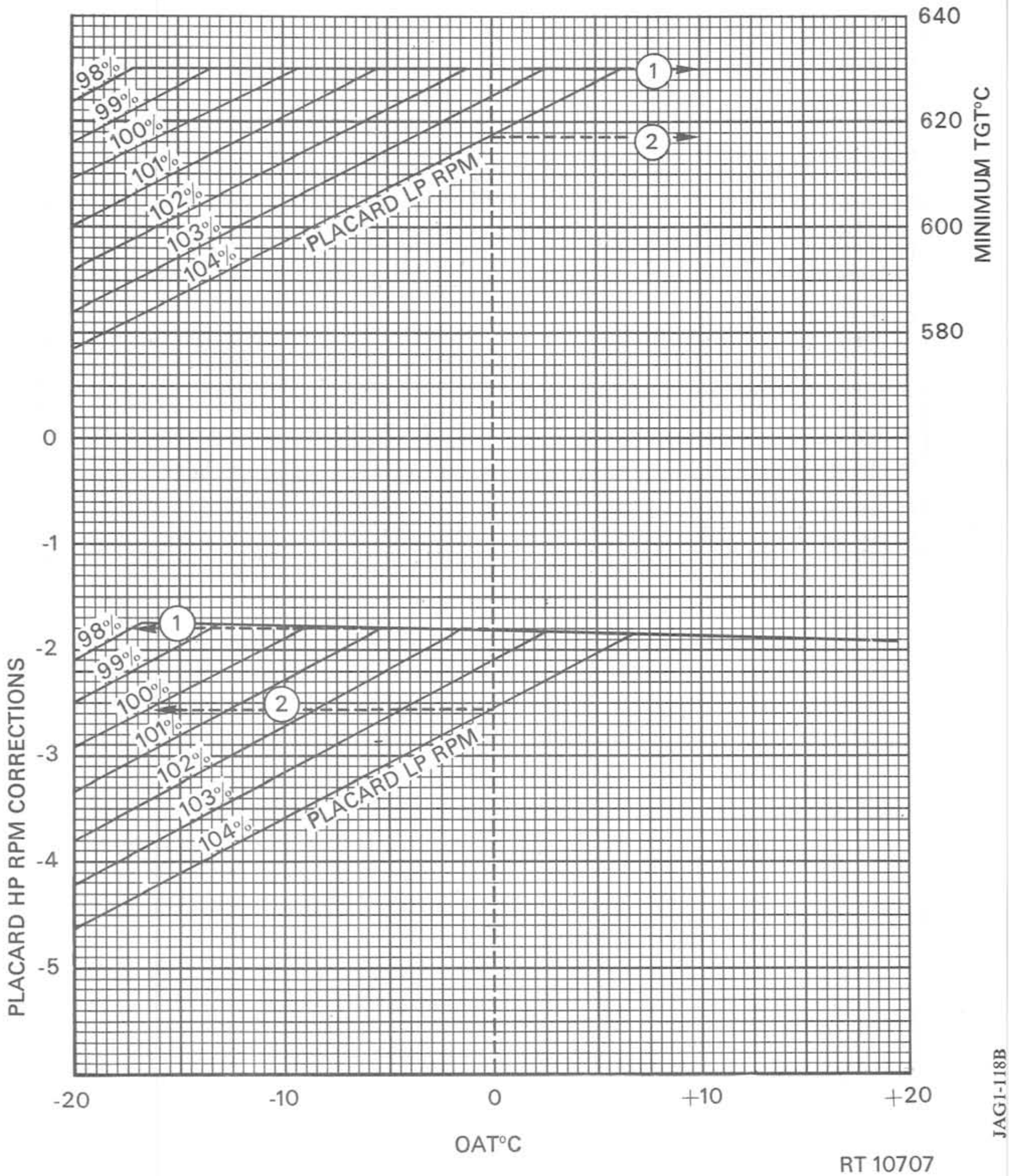
19. Fuel consumption with both engines at ground idle is about 7 kg per minute.

20. Taxying with the canopy fully open is prohibited. When taxying with the canopy partially open, the canopy is to be secured by the strut and the wind plus taxy speed is not to exceed 40 knots.

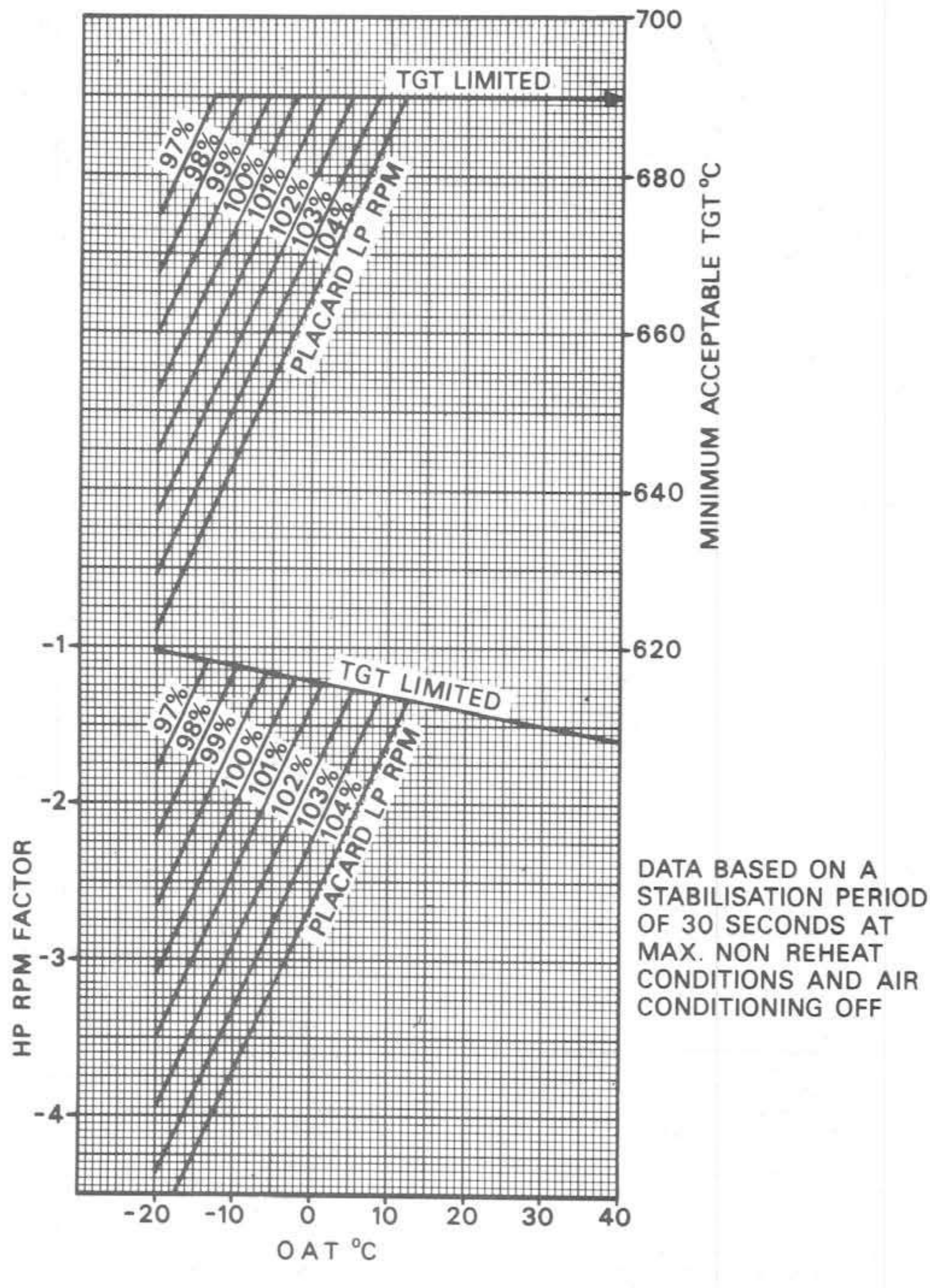
21. The brakes are very effective. Care must be taken not to taxy with any pressure on the brake pedals as this will lead to brake overheating.

22. The hydraulic gauge should be selected to the SERV position and the pressure monitored. No 2 system is selected automatically if a pressure drop occurs at the brakes in No 1 services system. Alternatively No 2 system may be selected manually by pulling the brake handle to the first detent. When the brakes are operating on the No 2 system the anti-skid facility is inoperative.

Note: The parking brake is not progressive and should only be used when the aircraft is stationary.

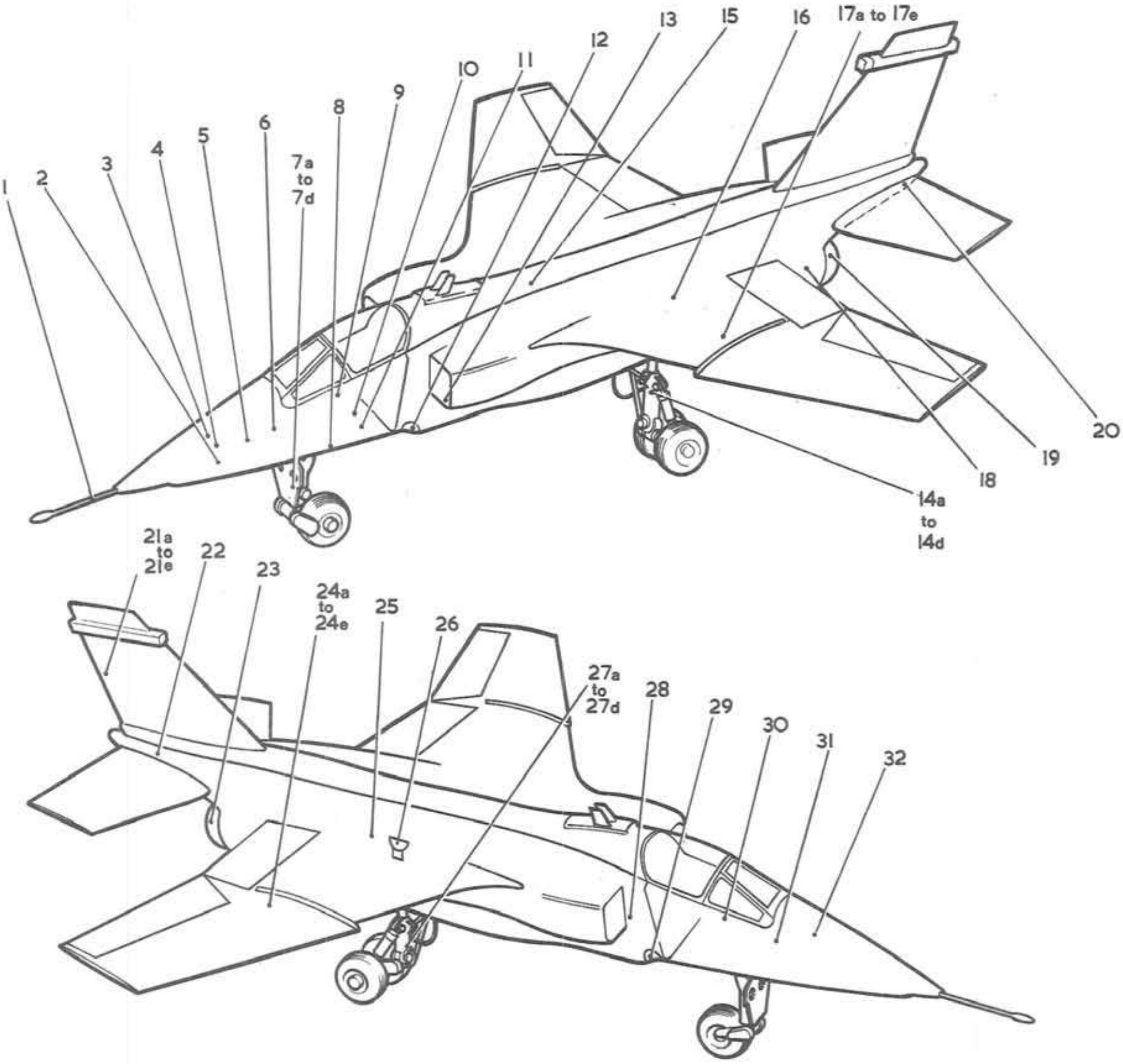


3 – 1 Fig 1 **Minimum Acceptable HP RPM and TGT for Take-Off – Mk 102**



JAG 1 – 127A

◀ 3 – 1 Fig 2 Minimum Acceptable HP RPM and TGT for Take-Off – Mk 104 ▶



ITEM NO.	ITEM	ITEM NO.	ITEM
1	PITOT HEAD/COVER	18	AIRBRAKES
2	INCIDENCE PROBE (LEFT) COVER	19	NO.1 ENGINE TAIL PIPE/COVER
3	TOTAL PROBE COVER	20	FIRE BOTTLE INDICATORS/(LEFT REAR FUSELAGE)
4	TEMPERATURE PROBE COVER	21	TAIL UNIT a. TAIL PLANE b. RUDDER c. AERIALS d. NAVIGATION LAMP e. TAIL CONE
5	COCKPIT RAM AIR INTAKE/COVER	22	ARRESTER HOOK STATIC DEVICE (REAR LOWER FUSELAGE)
6	CANOPY EXTERNAL EMERGENCY RELEASE HANDLE	23	NO.2 ENGINE TAIL PIPE/COVER
7	NOSEWHEEL DOOR AND COMPARTMENT ~~a. NOSEWHEEL GROUND LOCK SAFETY PIN~~ a. NOSEWHEEL CASTERING UNIT LOCKING PIN (AL 6) b. NOSEWHEEL TYRE, WEAR, CUTS AND CREEP c. OLEO EXTENSION 170 mm (6.69") TO 250 mm (8.1") EXTENSION DEPENDENT ON A.U.W. AND C.G. d. ARMAMENT SELECTIONS	24	RIGHT WING a. FLAP b. SPOILER c. NAVIGATION LAMP d. SLAT e. WING FENCE
8	COCKPIT ACCESS LADDER	25	NO.2 HYD. SYSTEM PRESS. 1500 P.S.I. ± 50
9	STATIC VENTS/PLUGS (LEFT SIDE)	26	REFUEL PANEL
10	WHEELBRAKES ACC. PRESS 1500 – 3000 P.S.I.	27	RIGHT MAIN LANDING GEAR a. LANDING GEAR DOORS SAFETY LOCKS b. TYRES WEAR CUTS AND CREEP c. BRAKE CONNECTION d. OLEO EXTENSION 40 mm (1.58") TO 97 mm (3.8") EXTENSION DEPENDENT ON A.U.W. AND C.G.
11	NOSEWHEEL ACC. PRESS 235 – 400 P.S.I.	28	NO.2 ENGINE AIR INTAKE/COVER
12	LEFT GUN PORT/COVER	29	RIGHT GUN-PORT/COVER
13	NO.1 ENGINE AIR INTAKE/COVER	30	STATIC VENTS/PLUGS
14	LEFT MAIN LANDING GEAR a. LANDING GEAR DOORS SAFETY LOCKS b. TYRES WEAR CUTS AND CREEP c. BRAKE CONNECTION d. OLEO EXTENSION 40 mm (1.58") TO 97 mm (3.8") DEPENDENT ON A.U.W. AND C.G.	31	OXYGEN CONTENTS (SKIN GAUGE)
15	UPPER FUSELAGE a. ANTI COLL. LAMP b. AERIALS	32	TOTAL PROBES (RIGHT)/COVER
16	NO.1 HYD. SYSTEM PRESS. 1500 P.S.I. ± 50		
17	LEFT WING a. FLAP b. SPOILER c. NAVIGATION LAMP d. SLAT e. WING FENCE		

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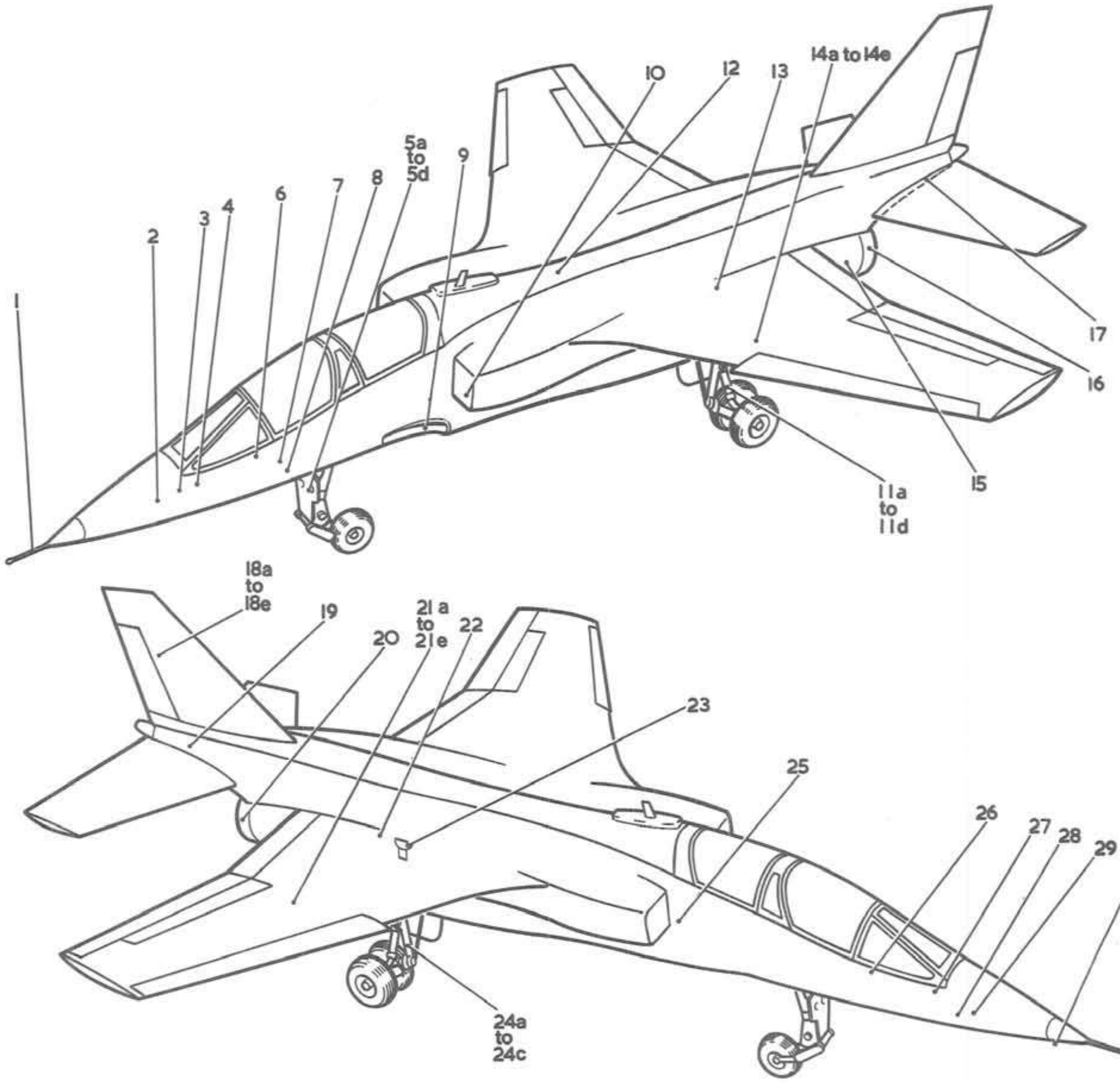
3 – 1 Fig 3 Items to be Checked During External Checks – GR 1



ITEM NO.	ITEM	ITEM NO.	ITEM
1	PITOT HEAD/COVER	15	AIRBRAKES
2	COCKPIT RAM AIR INTAKE/COVER	16	NO.1 ENGINE TAIL PIPE/COVER
3	CANOPY EXTERNAL EMERGENCY RELEASE HANDLE	17	FIRE BOTTLE INDICATORS (LEFT REAR FUSELAGE)
4	TOTAL PROBES (LEFT) COVER	18	TAIL UNIT
5	NOSEWHEEL DOOR AND COMPARTMENT		a. TAIL PLANE b. RUDDER c. AERIALS d. NAVIGATION LAMP e. TAIL CONE
	NOSEWHEEL CASTERING UNIT LOCKING PIN (AL6) → ~~a. NOSEWHEEL GROUND LOCK SAFETY PIN~~ b. NOSEWHEEL TYRE, WEAR, CUTS AND CREEP c. OLEO EXTENSION 170 mm (6.69") TO 250 mm (8.1") EXTENSION DEPENDENT ON A.U.W. AND C.G. d. ARMAMENT SELECTIONS	19	ARRESTER HOOK STATIC DEVICE (REAR LOWER FUSELAGE
6	STATIC VENTS/PLUGS (LEFT SIDE)	20	NO.2 ENGINE TAIL PIPE/COVER
7	WHEELBRAKES ACC. PRESS 1500 – 3000 P.S.I.	21	RIGHT WING
8	NOSEWHEEL ACC. PRESS 235 – 400 P.S.I.		a. FLAP b. SPOILER c. NAVIGATION LAMP d. SLAT e. WING FENCE
9	LEFT GUN PORT/COVER	22	NO.2 HYD. SYSTEM PRESS 1500 P.S.I. ± 50
10	NO.1 ENGINE AIR INTAKE COVER	23	REFUEL PANEL
11	LEFT MAIN LANDING GEAR	24	RIGHT MAIN LANDING GEAR
12	a. LANDING GEAR DOORS SAFETY LOCKS b. TYRES WEAR CUTS AND CREEP c. BRAKE CONNECTION d. OLEO EXTENSION 40 mm (1.58") TO 97 mm (3.8") DEPENDENT ON A.U.W. AND C.G.		a. TYPES WEAR CUTS AND CREEP b. BRAKE CONNECTION c. OLEO EXTENSION 40 mm (1.58") TO 97 mm (3.8") EXTENSION DEPENDENT ON A.U.W. AND C.G.
12	UPPER FUSELAGE	25	NO.2 ENGINE AIR INTAKE/COVER
	a. ANTI COLL LAMP b. AERIALS	26	STATIC VENTS/PLUGS
13	NO.1 HYD SYSTEM PRESS 1500 P.S.I. ± 50	27	TOTAL PROBES (RIGHT) COVER
14	LEFT WING	28	INCIDENCE PROBE/COVER
	a. FLAP b. SPOILER c. NAVIGATION LAMP d. SLAT e. WING FENCE	29	OXYGEN CONTENTS SKIN GAUGE
		30	TEMPERATURE PROBE COVER

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3 – 1 Fig 4 Items to be Checked During External Checks – T Mk 2

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PART 3 — HANDLING

CHAPTER 2 — HANDLING IN FLIGHT

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WARNING: In atmospheric conditions where both the temperature and water vapour content are high, severe fogging can be experienced in the cockpit, sufficient to obscure the instrument panel. However, critical conditions are not likely to occur at a dew-point of less than +16°C (+20°C post-mod 891). The procedure to be used in the event of severe cockpit fogging after take-off, or in the cruise at low level is given in Part 1, Chapter 8.

TAKE-OFF

Note 1: Following an aborted take-off, a further attempt must not be made because of the risk of tyre deflation from overheating.

Note 2: If ODM calculations indicate the need for use of MAX RATING power (take-off distance marginal) and the amber light does not come on when MAX RATING is selected, *do not take off*.

Considerations

1. In the event of an engine failure, single engine climb over a wide speed range (see ODM) is dependent on jettisoning external stores. It is therefore most important that the armament circuit is tested and the master armament switch set to LIVE before take-off.

2. There is a possibility of inboard tanks striking the landing gear if jettisoning is carried out during landing gear operation. In these circumstances the landing gear must be checked before landing.

3. Detailed information on take-off and subsequent operation is contained in the ODM.

4. The following take-off information is based on a flap setting of 20°. The flaps are not retracted automatically but a flap speed warning operates at 260±5 knots (refer to Part 1, Chapter 7, para 6).

5. The air conditioning master switch should be set to 'GROUND' to ensure maximum thrust in the event of an engine failure.

Take-Off

WARNING: Unless mod 872 is embodied, the autoslat facility is not to be used.

6. *Normal Take-Off*.

a. Note Rotation, Unstick and Safety speeds for the configuration.

b. Carry out the **Before Take-Off** and **Take-Off** checks listed in the FRC.

c. Align the aircraft on the runway with the nosewheel straight and apply the brakes. Hold the aircraft on the toe brakes, open the throttles to maximum dry, and when indications for both engines have stabilised (see Note), check that:

(1) HP RPM values are *not less* than those calculated.

(2) TGT are *not less* than, or excessively more than, those calculated.

If MAX RATING power is required, set the switch to 'on' and check the integral light comes on. On Mk 102 engines no other indication occurs: on Mk 104 engines check that TGT increases by 6±1°C and HP RPM increase by 0·25 to 0·5%. If the outside air temperature is within the range minus 8°C to +22°C the engine may change over from being TGT limited to being LP speed limited when MAX RATING power is selected and no HP RPM or TGT change will be seen. Providing these conditions are satisfied, both engine bleed valves are closed, the expected thrust is being produced, and the take-off can be continued.

Note: In the event of a TGT overswing on Mk 102 engines to 670°C maximum, check that TGT returns to 640±5°C within 30 seconds. On Mk 104 engines, check that if TGT overswings to 720°C maximum, it returns to 700±5°C within 20 seconds.

d. Release the brakes and immediately select 'maximum reheat'. Confirm that the nozzles have opened to between position '6' and '8' and that the TGT and RPM are stable and within limits. The aircraft will accelerate rapidly. HUD speed indications commence at 50 knots. Directional control is straightforward, the nosewheel steering sensitivity increasing with speed.

e. At the correct rotation speed, pull the stick back quickly and smoothly to rotate the aircraft to the climb-out incidence. If the figures for ground-roll and airborne distance to 50 feet given in the ODM are to be achieved with any degree of consistency, it is important that the rotation is continuous and at the correct rate and that it is initiated at the correct speed (eg a 5 knot delay in unstick results in about a 10% increase in ground roll). As a guide to the correct rotation rate, the climb-out incidence of 15° on the HUD (14° on the strip indicator) should be achieved 3 seconds after correct rotation speed. To help achieve an accurate rotation speed, it is recommended that it is set on the HUD SET DEM SPEED scale, and the HUD speed error scale used. The tailplane control is powerful and care must be taken to avoid over rotating.

f. When safely airborne, retract the landing gear and cancel MAX RATING if used. If the light fails to go out when the switch is pulled after take-off, cancel reheat and reduce TGT as soon as possible. Subsequent action, ie abandoning the sortie or continuing, will depend on the urgency of the operation. Continuous operation of an engine at maximum power with MAX RATING engaged has a marked effect on engine life and duration of operation in such conditions must be reported after landing.

g. When clear of obstacles, the incidence may be reduced to permit a more rapid acceleration. Retract flap at a safe speed depending on AUW. When the aircraft is lightly loaded, a fairly steep climb-out is necessary to ensure that the landing gear and flap speed limitations are observed. If autoslat has been selected the slats retract as incidence reduces below 4°. If autoslats have not been engaged, the slats may be manually retracted or left in the 'combat' setting as desired. Minor trim changes will be felt during landing gear retraction due to landing gear door operation and rudder gearing changeover. At 300 knots or above, depending upon configuration, cancel both reheats to maximum dry power, or as required. When cancelling reheat, bring each engine into the dry power range individually, checking that nozzle position, TGT and fuel flow are correct.

Note: Pre-mod 919, the stall warning system will operate frequently during take-off. To avoid over-familiarity, the system should be switched off for take-off when not required to be demonstrated. Post-mod 919, the system must be on and the appropriate incidence selected to become effective after take-off.

7. *High Incidence Take-Off*. This take-off technique is recommended when references to the ODM indicates that take-off distance is critical. Nosewheel

steering is to be engaged and the crosswind component is not to exceed 15 knots.

a. Align the aircraft on the runway and, holding the aircraft on the toe brakes, apply and check minimum reheat. Release the brakes and select maximum reheat.

Note: This may cause damage to tar surfaces, barriers and arrester cables.

b. The technique is similar to that described in para 6 except that the rotation speed obtained from the ODM is lower for a given AUW, and the rotation is continued to a climb-out incidence of 17° on the HUD (16° on the strip indicator). The rotation rate remains the same as in the 'Normal Take-Off' technique, thus the climb-out incidence should be achieved in 4 seconds instead of 3 seconds.

WARNING: Care must be taken to avoid rotating at a speed slower than that obtained from the ODM as the recommended incidence may be exceeded at lift-off with consequent difficulty in climbing or accelerating.

Note 1: With large centre-line stores, with 20° flap or more at the higher incidences, the roll rate in response to lateral control movements is reduced. Whilst roll control is adequate for the high incidence take-off in these configurations, it is recommended that prolonged manoeuvring above about 14° incidence is avoided. Furthermore, because spoiler applications induce small increases in incidence and the effect is particularly noticeable in these configurations, incidence must be monitored closely.

Note 2: Pre-mod 919 the stall warning system will always operate during a high incidence take-off. Post-mod 919 the system must be on and will serve as a warning for incidence overshoot.

8. *Crosswind Take-Off.* The aircraft may lean slightly out of wind during the ground roll. The spoilers should remain neutral until lift-off as their use on the ground to correct lean will produce a yaw into wind. Some into-wind spoiler control will be required at lift-off to counteract wing drop and to maintain heading. When a centreline fuel tank or a reconnaissance pack is carried, up to $\frac{2}{3}$ spoiler may be required to maintain lateral control during normal take-off in strong and gusty crosswind conditions at or near the crosswind limit.

Engine Failure During Take-Off

◀9. *On the Ground.* If an engine fails, or one or both reheats extinguish during take-off whilst the wheels are still in contact with the ground, the take-off should be abandoned: bring the throttles to idle, apply the brakes using the maximum braking technique (Chapter 3), stream the brake parachute and lower the hook. Check that the nosewheel steering is still engaged and adjust the aircraft's position on the runway to engage the cable in the centre at 90°. Release the brakes before crossing the cable. ▶

Note: If the cable is taken, be prepared for some rearward movement after stopping as the cable detensions. If necessary, control the rearward movement with engine power. After coming to a halt, do not apply the brakes if they have been used extensively as there is a risk of hot brakes welding on. If the pull-back is violent, the use of brakes could cause the nosewheel to lift and the rear fuselage to strike the ground.

◀10. *In Flight.* If an engine fails after lift-off whilst still below safety speed (V SAFE), jettison stores by use of the CLEAR A/C button and then raise the landing gear (Note 3). Climb at 170 knots (7° to 8° incidence) until clear of obstacles and then accelerate to a safe speed and height, retracting the flaps when above 220 knots. ▶

Note 1: The live engine must be maintained at 'max reheat' until the landing gear is locked up and V SAFE speed is achieved.

Note 2: Stores may be retained if, at the time of engine failure, the landing gear is fully retracted, the speed is above V SAFE and the aircraft is clear of obstacles.

Note 3: There is a risk of collision between mainwheels and underwing drop tanks if the latter are jettisoned during retraction. Unless unavoidable, underwing tanks should not be jettisoned during landing gear cycling.

CLIMBS, CEILINGS AND CRUISING

Climbs

11. The optimum climbing speeds for the more usual configurations are given in Table 1. Refer to the ODM for more detailed information. Climb performance is sensitive to speed change. The HUD height director will ensure a smooth transition from climb to level flight if selected 2000 feet before reaching the desired height. Use of reheat on the climb reduces time to height and, in some circumstances, fuel consumption (see ODM). Reheat burning and lighting boundaries are given in Part 2A and 2B. Some engines may exceed these boundaries but lighting will become slower and burning may become unstable; in the latter case reheat should be cancelled.

Table 1 — Climbing Speeds — Selected Configurations

Loading			*Drag Index*	*Climbing Speeds (kt/Mach No)*			
Fuselage Station	*Wing Stations*			*Mk 102 Engine*		*Mk 104 Engine*	
	Inboard	*Outboard*		*Max Dry Power*	*Max Reheat*	*Max Dry Power*	*Max Reheat*
Pylon	Pylon	Pylon	15	385/0·87	485/0·91	385/0·76	485/0·91
Pylon	Tank	Pylon	33	370/0·86	470/0·90	370/0·73	470/0·90
Recce Pod	Tank	Pylon	41	360/0·86	460/0·90	360/0·70	460/0·90
CBLS	Tank	Pylon	46	355/0·86	455/0·90	355/0·68	455/0·90
Pylon	Tank	CBLS	59	350/0·85	440/0·89	340/0·65	440/0·89
Recce Pod	Tank	CBLS	67	350/0·85	430/0·89	335/0·63	435/0·89

Note: The recommended Mach No climbing speeds in dry power for the Mk 102 engine give the best rate of climb; the Mach No climbing speeds in dry power for the Mk 104 engine give the best range climb up to approximately 30,000 feet.

Ceilings

12. Aircraft 1g ceilings for maximum dry and maximum reheat power are given in Fig 1. Reheat burning limitations may prevent the aircraft reaching the 1g ceiling shown.

Cruising

13. Cruising flight optimum range and endurance figures are given in the ODM.

ENGINE HANDLING

Engine Control

14. Basic control of the engine is by the pilot's throttle lever which manually positions the throttle valve in the fuel control unit to vary fuel flow and hence thrust. The fuel flow as scheduled by the throttle valve is compensated for variations in altitude and forward speed. It is important that throttle movements are made slowly and smoothly and that TGT are closely monitored, both during and after throttle selections.

15. To prevent the engine exceeding its maximum temperatures, pressures and shaft speeds, automatic controls and governors reduce the scheduled fuel flow if the maximum engine conditions are reached. Operation of the automatic controls and governors is effected by one of the four following parameters according to the flight conditions:

a. TGT.

b. LP speed.

c. HP speed.

d. Fuel flow.

16. During take-off at full throttle at ambient temperatures above approximately ISA minus 10°C, the engine is TGT limited; at ambient temperatures below approximately ISA minus 10°C, the engine is LP speed limited. During climb at full throttle, the engine is TGT, LP speed or fuel flow limited depending upon the altitude, ambient temperature and mach number. When the engine is LP speed limited or fuel flow limited, the TGT and HP RPM are reduced from maximum values, eg at maximum rating and ISA minus 20°C, sea level static conditions, there is a reduction of approximately 20°C TGT and 0·9% HP RPM.

Engine Surge

17. Engine surges can occur during dry or reheat operation.

a. *Dry Power.* Surges may be experienced during engine accelerations above 25,000 feet under adverse intake conditions (ie, incidences greater than 10°, air-to-air refuelling, etc). The surges are audible and are accompanied by a sudden rise in TGT.

b. *Normal Reheat and PTR.* On Mk 102 engines, rapid modulation, cancellation or extinction of reheat at high altitudes or cancellation at intermediate altitudes with application of g may be accompanied by pop surges. The surge will normally self-clear and is unlikely to damage the engine. The boundary for operation free of pop surges is shown in Part 2A and 2B, Fig 2. On Mk 104 engines, pop surges can occur during normal reheat and PTR selections above 15,000 feet, particularly during manoeuvres and when using Avtag. The severity of the surge increases with altitude and above 25,000 feet may not be self-clearing. If difficulty is experienced in engaging reheat, reduce incidence and descend until light-up is obtained. Above the 'pop surge free' boundary for Mk 102 engines or above 25,000 feet for Mk 104 engines, reheat lighting, modulation in normal reheat and reheat cancellation should be carried out on one engine at a time.

◀ Note: When using AVCAT fuel there is a possibility of reheat burning instability and pop surges when modulating or cancelling reheat when within 3000 feet of the reheat operating limit. ▶

c. *Surge Recovery*. If a surge is accompanied by a rapid rise in TGT, appropriate action must be taken as detailed in Part 1, Chapter 4 and in the FRC.

Normal Reheat Operation

WARNING: Slam decelerations from any reheat positionin to idle RPM must be avoided to prevent engine damage.

18. Reheat is selected by moving the throttles to the maximum dry position and lifting a latch which allows the throttles to be moved into the reheat range as required. Slam accelerations into reheat are not permitted on Mk 102 engines pre-Adour mod 143 from below 70% (80% when the aircraft is on the ground). When reheat is selected, the nozzle moves to the pre-open position and there is an increase in fuel flow. The pre-open position is normally indicated by a nozzle position indication of between 1 and 2.

19. A successful light-up is confirmed by an increase in nozzle area to a position of approximately 3·5 or above, depending upon the degree of reheat selected, and a further increase in fuel flow. Within the reheat lighting envelope, a reheat light-up from stabilised maximum non-reheat conditions normally occurs within 8 seconds. If, following reheat selection, the nozzle fails to open, cancel reheat selection and operate the engine in the non-reheat range provided there are no other symptoms of engine malfunction.

20. Reheat is cancelled by throttling back into the non-reheat range. Following normal reheat extinction or cancellation, wait at least 3 seconds before reselection.

Part Throttle Reheat Operation

WARNING: Slam decelerations from any PTR position to idle RPM must be avoided to prevent engine damage.

21. Part throttle reheat is normally selected by moving the throttle to the maximum dry position or into the normal reheat range then selecting the MOD REHEAT switches ON. PTR may be selected at any throttle position within the PTR range, but light-up may not be as rapid at low RPM. Reheat can then be used down to an RPM between 80% and 86%. This minimum position is indicated by a detent on the throttle quadrant.

Note: When PTR is lit at high mach number and low RPM, the nozzle is at or near the pre-open position. To confirm light-up, momentarily open the throttle and check corresponding nozzle movement.

22. When PTR is selected, thrust up to maximum reheat is still obtainable when the throttle lever is moved into normal reheat range, and there are no restrictions on the selection or re-selection of the normal reheat range. On Mk 102 engines incorporating Adour mod 143 and Mk 104 engines, slam accelerations and re-selections of PTR within the range idle RPM to maximum PTR are permitted. On Mk 102 engines pre-Adour mod 143, slam accelerations and re-selections are not permitted from below 70% RPM (80% when on the ground). When cancelling PTR through the PTR detent from the normal reheat range, wait at least 3 seconds before re-selection. However, when operating within the range minimum PTR to maximum dry, there is no restriction on immediate re-selection of PTR. Indications of PTR selection are the same as for normal reheat, ie nozzle position and fuel flow.

IN-FLIGHT HANDLING

Acceleration and Deceleration

23. Acceleration when using reheat is good and care must be taken to avoid exceeding airspeed and mach number limitations. At high altitude both acceleration and maximum achievable IMN are affected by temperature. With the aircraft in the clean configuration, limiting IMN can only be achieved in a dive. Throttling back below the maximum dry position in a supersonic dive can result in a large intake disturbance causing heavy vibration. It is recommended, therefore, that the power is not reduced below maximum dry until the speed is below 1·1M. A reduction in reheat is sufficient to ensure rapid deceleration and may be made without inducing any vibration. With certain stores fitted it is possible to achieve the associated lower limiting IMN in level flight or when using the constant IAS climb technique (see ODM).

24. Slight longitudinal trim changes occur with operation and modulation of reheat, eg the trim change is nose-down when reheat is selected. The trim changes are more pronounced when the aircraft has an aft CG configuration and are particularly significant with underwing stores. The airbrakes are very effective at high speed and, pre-mod 716, their use is accompanied by a marked nose-up trim change. Cancelling reheat and simultaneously extending the airbrakes increases the pitch-up. Air-brake operation limitations are given

in Part 2A and 2B, Chapter 1. At low speed, airbrake effect and corresponding trim change is smaller. With the airbrakes selected out, the pitch autostabiliser loses its effect. Post-mod 716, the autostab effectiveness is restored about 5 seconds after airbrake operation.

General Handling and Manoeuvrability

25. *General.* The aircraft has been demonstrated to be stall free in manoeuvre within the current numerical operating limits. Outside these limits, however, various phenomena may be encountered, broadly between 10° and 20° incidence, which effectively limit manuouvres. The phenomena vary with speed, configuration and altitude and are described in the following paragraphs. Use of reheat and/or loss of height is required to sustain high g manoeuvres (see ODM). If excess lateral trim is required in level flight, care should be taken during manoeuvre as the aircraft handling can be critical with asymmetric loads (see Chapter 6).

26. *At All Mach Numbers.*

a. *Buffet.* Buffet occurs from a threshold of approximately 6° incidence, depending upon mach number, and builds up to a level which depends upon penetration from this threshold, and IAS. At high incidence and high IAS it may become heavy and provide a good warning of stall approach. At IAS below 300 knots it is relatively light and care must be taken not to exceed normal operating limits, particularly when using reheat when stick forces are also light.

b. *Wing Rock/Yaw Off (Divergent Dutch Roll).* An unstable dutch roll oscillation with a period of about 2 seconds may occur at incidences above the limits at low mach number and slightly earlier at transonic mach numbers. This normally appears to the pilot as a wing rock, the aircraft motion in the cycle being quite large. The cyclic nature of this motion is only apparent if the aircraft is held at incidence and the motion allowed to develop. The motion is not immediately dangerous but its onset should be taken as a warning of manoeuvre limit and incidence must be reduced. The configurations with lower directional stability, ie with centreline stores, exhibit this behaviour at a slightly lower incidence, at low mach number, and the yawing motion which starts the oscillation is more noticeable to the pilot. Recovery is always achieved by reducing incidence. Chasing the motion with spoilers/rudder may lead to loss of control and should be avoided.

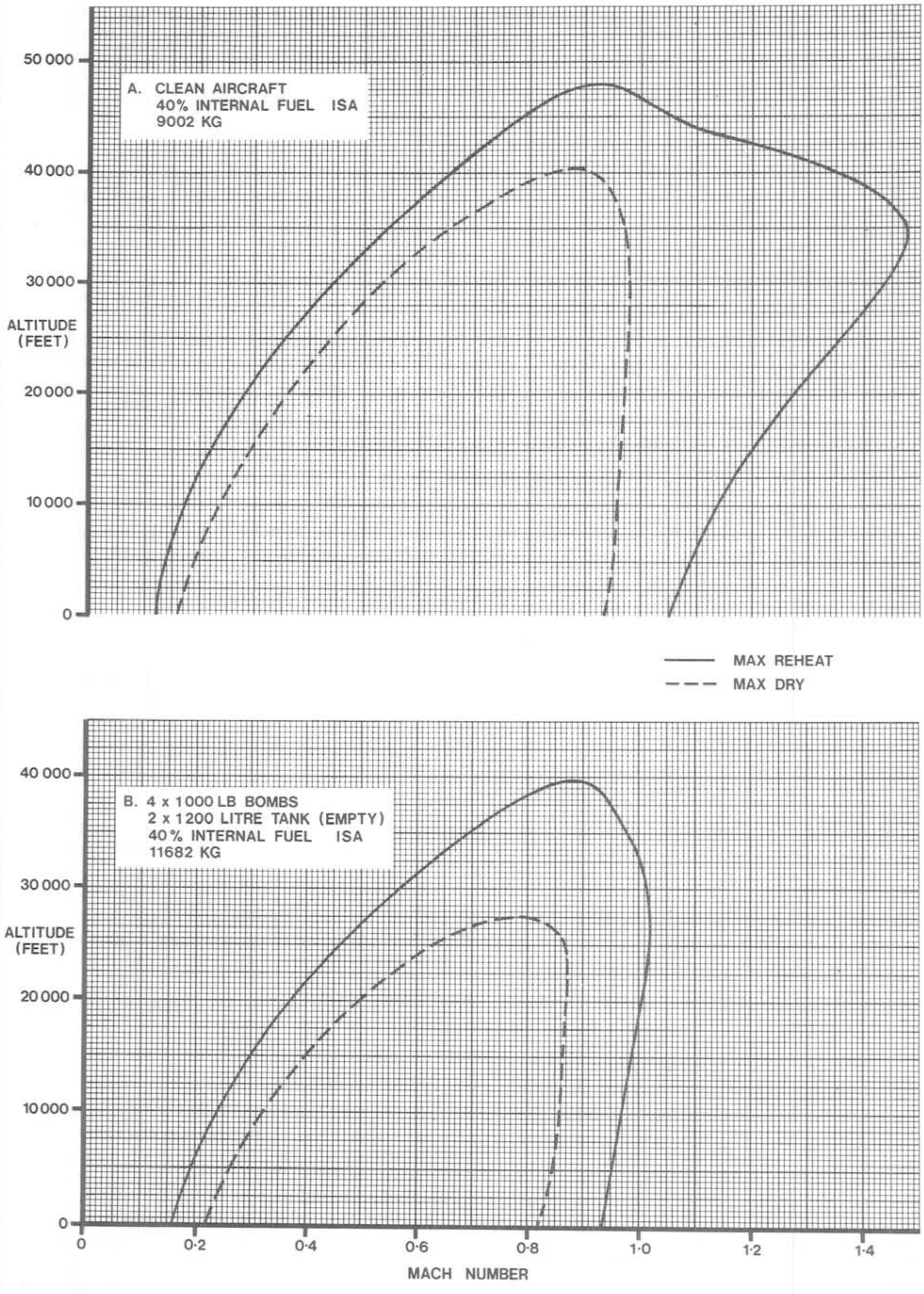
Note: Should dutch roll occur in stable flight conditions, it may be caused by yaw or roll autostabiliser malfunction (see Part 3, Chapter 8).

27. *At Transonic Mach Numbers.*

a. *Transonic Wing Rock.* At transonic speeds, broadly above mach 0·75, wing rocking can occur through an incidence band having a threshold at about 6°, thereby forming a firing limit. This wing rocking is due to asymmetric flow breakdown on the outer wing, the occurrence of which varies with minor configuration changes and with mach number. Rate of application of incidence has a significant effect on the motion experienced in that prolonged steady incidence gives the phenomenon an opportunity to build up to a moderate limit cycle, while a rapid pull can pass through the same incidence band without producing any significant motion. The divergent dutch roll which occurs at higher incidence is a completely separate phenomenon and a clean aircraft can be pulled through the transonic wing rock and then meet the dutch roll. Equally, it can happen that the two merge, the wing rock at 6° giving an input to the higher incidence effect so that, to the pilot, the whole sequence appears as a general wing rock or yaw off starting at about 6° incidence.

b. *Transonic Wing Drop.* During flight with configurations which include wing stores, sudden and unexpected wind drop may occur (predominately with slats retracted) at incidences between 5° and 12° in the speed range 0·87M to 0·94M. Transonic wing drops of a reduced severity may also be experienced under the same conditions in clean or empty pylons configurations. There may also be an associated pitch-up phenomenon giving an increment of normal acceleration of up to 1·0g. This wing drop and pitch-up can be largely avoided by using slats and, post-STI 245, autoslats may be used to the lower of 580 knots/0·95M. However, owing to the time delay in their operation in the auto mode, slats should be manually selected to the combat position prior to manoeuvres in the speed range 0·87M to 0·94M in heavy configurations, thus avoiding the wing drop/pitch-up which can be expected while awaiting autoslat extension. Post-STI 245 the slats retract in the auto mode above 580 knots; a manual selection ensures the slats remain in the combat position up to 0·95M, the limiting speed. If roll and/or pitch-up occur they can be arrested by reducing incidence and by using corrective spoiler. Care is to be taken when manoeuvring at low altitude above 0·87M, especially in configuration with all 5 stations loaded and slats retracted, to avoid exceeding the g limitations should pitch up occur.

c. *Transonic Yaw Off.* With configurations



3 – 2 Fig 1 lg Ceilings – Max Dry and Max Reheat
(Mk 104 Engines)

having lower directional stability, the flow changes on the wing at about 10° incidence can lead initially to a yawing motion rather than a wing rock. With these same configurations the divergent dutch roll threshold transonically is lower. As incidence is increased the initial yaw disturbance merges into the divergent dutch roll. The yawing motion described is more disturbing to the pilot than wing rocking and is likely to lead to instinctive recovery.

d. *Excessive Spoiler Trim.* This is caused by the rudder moving under g at a time when the roll control is at its least effective. It is therefore apparent to the pilot under g above 400 knots (no differential tailplane) and above 10° incidence (spoiler less effective). The amount of g that can be applied is limited by full spoiler control. Recovery is effected by reducing incidence. Modification action incorporating spine bending compensation has reduced this problem. At all speeds the maximum usable incidence is likely to be obtained if the aircraft is kept in trim directionally.

e. *Spoiler Effectiveness.* At an IAS higher than 400 knots with the incidence above 10° at 0·7M, and above 7° at 0·9M, the effectiveness of the spoilers may be significantly reduced or completely lost in manoeuvre. If spoiler effectiveness is lost, reduce incidence to regain control: if this is impracticable, apply rudder progressively in the direction of the required roll to produce the desired angle of bank.

Note: The use of rudder recommended above is to be confined to cases where it is necessary to regain lateral control; rudder is not to be used to increase normal rolling response to lateral control inputs.

f. *Longitudinal Stick Forces.* Longitudinal stick force per g varies with speed and with aircraft configuration but is acceptable throughout the cleaned aircraft flight envelope. The following gives a guide to the changes:

- Stick forces increase with increasing airspeed and increase sharply with increasing transonic mach number.
- Forces in dry power are higher than in reheat.
- Without stores, or with centre line stores, forces are lighter than when underwing stores are carried. The particular combination of underwing drop tanks and outboard stores gives the highest forces.
- Due to the non-linear stick-to-tailplane gearing, the effect of CG movement is not large.

From the above it can be seen that the lightest forces will be experienced on a clean aircraft at low speed (about 300 knots) in reheat. The heaviest forces will be felt with underwing drop tanks and outboard stores at high speed in maximum dry power. It should be noted that, in this condition, lighting reheat to pull out of a high-speed dive will have an overall effect if increasing stick force due to the trim change with reheat.

Note 1: Care must be taken not to exceed the incidence limits in configuration with centreline 1200 litre tank and aft loaded tandem-beams, and with centreline 1200 litre tank and Lepus on tandem-beams due to the very light longitudinal stick forces when in reheat.

Note 2: In configurations with outboard 1000 lb bombs and with four underwing 1000 lb bombs stick forces lightening may ocur at high g values just above 0·9M, and short period disturbances in pitch may occur in the recovery from these manoeuvres. Care is to be taken to avoid exceeding the mach number Normal Limits in these configurations.

◀ Low Altitude Flying

28. Flight at altitudes below 120 feet AGL, when authorised, should be minimised because of the probable height loss in the event of a nose-down pitch autostabiliser runaway. ▶

Aerobatics

29. *General.* The IAS, g and rolling limitations in Part 2 must be observed.

30. *Rolling Manoeuvres.* The optimum speed for rolling manoeuvres is between 300 and 500 knots.

31. *Looping Manoeuvres.* Reheat or maximum dry power may be used. If reheat is used it should be selected and checked before commencing the manoeuvre. Until experience is gained, the minimum entry speed for a loop is 450 knots and loops should be entered between 5000 and 10,000 feet. An initial acceleration of about 4g should be applied and control at the top of the loop can be maintained on incidence (ideally 12°). Speed should be increased to about 500 knots for a half roll off the top of the loop.

Inverted Flight

32. The recommended speed for inverted flight is 400 knots. The OIL captions on the CWP will light ▶◀ immediately but the audio alarm and attention-getters are held off for 10 seconds. Inverted flying is limited to 15 seconds in max dry power and to 7·5 seconds in reheat. Recovery from inverted flight is also limited by rapid rolling considerations: in most configurations rapid rolling (ie coarse use of the control column laterally) is not permitted with less

than + 1·0g and this limitation must be strictly observed (see Parts 2A and 2B, Chapter 1, sub-para 24b).

33. Precise entry into level inverted flight from level erect flight requires co-ordinated use of top rudder. Normally it is preferable to roll to the inverted position in a slight climb. From trimmed + 1·0g erect flight at 400 knots a marked push force is required to hold level inverted flight. If the speed is allowed to decay without retrimming, the push force will increase considerably until two hands may be required by 300 knots. Full forward control column will not maintain inverted flight below about 250 knots.

34. If the nose is allowed to drop during inverted flight, considerable height will be lost on the recovery. At 400 knots at high weights, full forward control column will only give an increment of approximately minus 1·0g, therefore bunted recovery to level flight will be slow. Care must be taken during inverted manoeuvres not to allow the nose to drop too low. Heights in excess of 1000 feet may be required to achieve recovery from a gentle inverted dive.

35. Recovery from inverted flight can be best achieved by the co-ordinated use of lateral control column and rudder. Excessive use of rudder should be avoided, but if the rudder is not used the aircraft will barrel slightly resulting in loss of height. Only sufficient lateral control to achieve a smooth recovery to erect flight should be applied. Coarse use of the control column laterally whilst under negative g conditions is prohibited by the rapid rolling limitations as it could result in autorotation followed by loss of control and, in any case, will lead to large g and sideslip excursions. Equally, high angles of incidence and course lateral control, ie a rolling pullout, must be avoided in the later stages of recovery to erect flight; in most configurations rapid rolling inputs are prohibited above 10° of incidence (in one case the limit is 8°).

Formation Flying

36. Formation flying with autostabilisers operating is straightforward. The pitch autostabiliser will be inoperative with airbrakes selected out. Slight trim changes will occur with reheat operation and modulation of reheat. The airbrakes are very effective at high speed and their use is accompanied by a marked nose-up trim change: at low speed the corresponding change is smaller. The limitations applicable to close formation flying are given in Part 2A, Chapter 1 (GR1) and Part 2B, Chapter 1 (T Mk 2).

Instrument Flying

37. Instrument flying can be carried out by reference to either the Head Up Display (HUD) or Head Down Display (HDD). Prolonged periods of instrument flying are likely to be less fatiguing if the HDD is used; the analogue presentation allows a trend to become quickly apparent. The HUD cannot be regarded as one instrument but requires scanning in a similar way to the HDD. In the case of height and speed scales, rather more concentration is required because the digits have to be read on each scan. The HUD may be used for recovery from unusual attitudes in the GEN mode, provided its validity is cross-checked with the HDD. It should be noted that during combat or aerobatic manoeuvres the HDD attitude indicator may topple. The HDD is a conventional attitude presentation, whereas on the HUD, the relation between the aircraft symbol and the horizon bars shows climb and dive angle except in the reversionary and weapon aiming modes when it displays attitude. (Refer to Book 2).

Night Flying

38. To avoid distraction it may be necessary to switch off the anti-collision lights during flight in cloud. The wander lamp on the left console can be clipped to the left sill to provide emergency lighting. Use of the landing lamp is limited to three minutes.

39. The lighting of the PMD and WAMS panel may be switched off when not required to avoid distraction or reflection, eg during approach and landing. Although the landing lamp is of fairly short range, it is adequate for judging touchdown.

40. When flying in formation at night, the lead aircraft should have anti-collision lights off, formation lights on and navigation lights dim.

Handling with Large Centreline Stores

41. Particularly with fuel tank or recce pod but also to a lesser extent, two bombs on the centreline, there can be a quite marked interaction between lateral and longitudinal control which manifests itself as an apparent (mild) pitch-up effect during manoeuvre entry. The reasons for the effect, which are fairly complex, are fundamental to the arcraft's design and are therfore present in all configurations. However, the end result tends to become obtrusive only when the centreline station is loaded with large stores. The main factors involved are summarised below:

a. The spoiler-pitch compensation law is optimised for approximately 500 knots. A residual nose-up pitching effect results from spoiler application at lower speeds. Its magnitude is a direct function of the amount of spoiler used. In general, larger spoiler angles are needed for manoeuvre in these configurations and so the effect appears more marked.

b. Spoiler efficiency reduces with increased incidence. The large spoiler angles needed for manoeuvre in these configurations result in a marked adverse-yaw effect. The aircrafts' low directional stability due to configuration and the sideslip generated in these manoeuvres, result in a nose-up pitching moment.

c. Clearly the combined nose-up pitching effect of the above two characteristics becomes most marked when large spoiler angles are used for manoeuvre entry and during manoeuvre at medium to low IAS.

d. Although lighting reheat causes an intial nose-down trim change, its overall effect is to lighten the longitudinal stick forces. Consequently, depending upon the conditions under which reheat is lit, its use can cause an apparent magnification of the 'pitch-up' effect in manoeuvre.

e. Because it supresses the amount of sideslip generated by spoiler application, spoiler-rudder coupling (mod 803) tends to alleviate the effect in manoeuvres which exceed +3g.

f. All the above effects are magnified if the aircraft is operated in conditions which cause the aft CG limit to be approached.

42. Aircraft not fitted with mod 803 (spoiler-rudder coupling) when operating in any configuration which includes a 1200 litre fuel tank on the centre pylon or a reconnaissance pod, often need increasing amounts of spoiler to maintain the desired bank angle as g is increased during pitching manoeuvres. Above 12° incidence full spoiler control may not be sufficient to prevent an uncontrolled roll against the applied spoiler. The recommended recovery action is to relax the g and roll to the required attitude. The height lost during recovery will depend upon intial aircraft attitude and IAS. Therefore, when manoeuvring at low altitudes in these configurations, great care must be taken to avoid steep nose-down attitudes in circumstances which will require more than 12° incidence for recovery.

WARNING: In the configuration of recce pod, inboard drop tanks and BL755 on the outboard pylons, wing drops and yaw-offs with associated pitch-ups may be experienced around 10° AOA (9° AOA HDD incidence gauge) above 0·87M.

Handling During Stick Release of 1000 lb Bombs

43. During all stick releases, the normal-acceleration tends to reduce initially and then increase quite sharply. This is caused by movement of the CG during the release, and by a slight change in wing incidence when bombs are released from the forward portion of tandem carriers. Above 550 knots the aircraft's behaviour during stick releases is not so predictable and can end with a rapid nose-down pitch which may require up to +3g during recovery.

Multiple Stores Release

44. The aircraft is sensitive in pitch at high speeds and low altitude with reheat engaged and there is an inherent tendency to overcontrol. When a multiple stores release is made at speeds at or above 500 knots, the initial small pitch disturbances caused as the weapons leave the aircraft can induce the pilot to make instinctive corrections to the flight path, producing substantial, but controllable, pitch oscillations.

45. Although reheat may be in use in order that a release speed above 500 knots can be maintained when multiple stores are carried, pilots are to avoid making reheat selections or cancellations near the point of release. Similarly, airbrake selections are to be avoided. Special care should be taken after pitch autostab failure; reducing the speed below 500 knots and using unreheated power will greatly reduce the intial disturbance experienced at the point of release.

PART 3 — HANDLING

CHAPTER 3 — DESCENTS, CIRCUITS AND LANDINGS

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Descents

WARNING: Severe cockpit fogging can occur when descending into atmospheric conditions of high temperature and water vapour content. To avoid cockpit fogging, set the cabin air lever to RAM AIR CLOSED when below 10,000 feet. The procedure to be used if fogging still occurs is given in Chapter 10 of this Part.

1. *General.* Three types of descent together with associated settings are given below. More detailed descent information is given in the ODM.

2. *Instrument Descent.*

Speed ...	... 0·85M/300 knots
Airbrakes	... Out
Throttles	... 85%

3. *Tactical Descent.*

Speed ...	... 0·85M/400 knots
Airbrakes	... Out
Throttles	... 85%

4. *Range Descent.*

Speed ...	... 0·85M/400 knots
Airbrakes	... In
Throttles	... 85%

Circuits and Landings

5. *General.*

a. Aircraft handling at normal approach speed and configurations is good provided the limitations are observed and power is not reduced prematurely on the approach. Approach techniques may be varied to suit local conditions. Fig 1 shows IAS related to AUW for various approach configurations.

b. On joining the circuit, speed may be reduced by use of airbrakes and progressive lowering of the flaps. Lowering the landing gear results in marked increase in drag which requires considerable power compensation.

Note: If the rudder is not neutral when the landing gear is lowered, the deflection is increased by the change in rudder gearing. Re-trimming may be necessary.

c. The following configurations will occur during the circuit. The IAS values provide a cross check with the incidence values for the configurations shown:

— 20° flap, landing gear up, 8° incidence (193 knots at 9000 kg).

— 20° flap, landing gear down, 10 incidence (183 knots at 9000 kg).

— 40° flap, landing gear down, 12° incidence (148 knots at 9000 kg).

Speed varies approximately 8 knots per 1000 kg above or below 9000 kg.

d. Carry out the **Checks Before Landing** listed in the FRC.

WARNING 1: In the T2 front cockpit the CSI airspeed indication is taken from the right pitot probe and the fuselage static vents (see Fig 6 of Part 1, Chapter 9). These sources cause pressure error. With the landing gear and full flap lowered the front cockpit CSI in the T2 will overread by a maximum of 11 knots at 200 knots IAS and by 14·25 knots at 150 knots IAS.

WARNING 2: In the GR1, mod 807 introduces a static supply changeover valve which provides an alternative, fuselage static source for the HDD pressure instruments. This facility is intended only to provide emergency static pressure for the HDD VSI and the altimeter in the S mode. However, the CSI airspeed indications will show pressure error with the valve selected to emergency and, if HUD IAS is not available, incidence indications should be used to achieve the correct landing speed.

6. *Visual Approach — Normal Length Runway.*

a. Lower full flap at the start of the turn onto finals.

b. Carry out a normal 2·5 to 3° approach at 12° incidence and round out smoothly, closing the throttles to 'idle'. Lower the nosewheel onto the runway and engage nosewheel steering.

c. Stream the brake parachute. Very little braking is necessary.

d. In the event of a nosewheel steering failure after brake parachute has been deployed, the parachute should be jettisoned if handling difficulties arise.

Note 1: During the approach, trim out the longitudinal control forces to ensure that sufficient tailplane control is available for round-out. It may not be possible to trim out the aircraft, for example, during an approach with 40° flap and CG forward of 20% MAC. In this event there are two options, reduce flap or reduce incidence. The effect of reduced flap on landing distance is small.

Note 2: At higher weights it is important not to throttle back too soon, otherwise the ventral fins may contact the runway if incidence at touchdown exceeds 20·5°.

Note 3: Pre-mod 919, the stall warning may operate as the aircraft is flared for landing. If this is a distraction, the stall warning may be switched off for landing. Post-mod 919 the system must remain on.

7. *Instrument Approach.*

a. Before intercepting the glidepath, fly the aircraft with 20° flap, landing gear up and 8° incidence, or, 20° flap, landing gear down and 8° to 10° incidence.

b. On intercepting the glidepath, lower full flap and continue the descent at 10° incidence, increasing to 12° incidence for the landing.

c. Carry out a normal approach and landing.

d. Adequate control is available for a last minute side-step manoeuvre.

8. *Engine Failure During a Normal Approach.*

WARNING: Preliminary investigations have shown that, depending on AUW, aircraft configuration, ambient temperature, etc, if an engine fails during a normal approach after 40° flap has been lowered, any attempt to overshoot will involve a height loss of between 500 and 1000 feet. If an engine fails during a normal approach, an overshoot must not be attempted below 500 feet.

In the event of engine failure on the approach, take the action appropriate to the decision to land or overshoot, as follows:

a. *Continued Approach.*

Select maximum reheat on both engines.

Jettison stores if necessary.

Select PTR on the good engine and modulate reheat as required.

Shut down the failed engine if time permits.

b. *Overshoot.*

Select maximum reheat on both engines and roll wings-level.

Jettison stores if necessary.

Raise landing gear and set flaps to 20°.

Set air conditioning to GROUND, if practicable (see Note).

Accelerate to 250 knots, select PTR and carry out engine failure drill on the appropriate engine as soon as practicable.

Note: With air conditioning switched ON, thrust is 8 to 11% (about 580 lb) less than the thrust available with GROUND selected.

9. *Crosswind Landings.* The crab technique is recommended for approaches in crosswind conditions. When using rudder to eliminate drift, any slight roll due to yaw can easily be corrected. Lower the nosewheel onto the runway immediately after landing. Engage and confirm nosewheel steering *before* streaming the brake parachute. The nosewheel steering can only be engaged when rudder deflection is less than 7°. The aircraft may run along the runway with the downwind wing low, but this is not critical and should not be corrected. Spoilers should be centralised as soon as possible after landing to avoid increasing the into-wind yawing moment or downwind rolling moment. In marginal conditions or on wet runways, minimum use of brakes is recommended as heavy braking detracts from the tyre capability to counter drift. If directional control difficulties are experienced consideration should be given to jettisoning the brake parachute.

Note: If it is necessary to land in a crosswind with a heavy asymmetric store, the crosswind limitations may be more stringent, refer to Part 2A or 2B, Chapter 4.

10. *Flapless Landings.* Carry out a shallower approach at 10° incidence. It may be necessary to raise the seat to improve forward visibility. Slats should be used if available. The following considerations apply:

a. Approach speeds will be approximately 50 knots higher than on a normal approach at the same weight at 12° incidence with 40° flap.

b. Weight may have to be reduced before landing to avoid exceeding the maximum tyre speed. ▶◀

c. The normal maximum deployment speed for the brake parachute is 150 knots. In an emergency, deployment up to 185 knots will be successful.

d. Maximum braking speed must be observed.

e. Consideration should be given to lowering the hook immediately after touchdown.

◀11. *Flapless Landings with Heavy Centreline Stores.* With slats extended, if available, carry out a shallow approach at 12° incidence and land using ▶

minimum flare. This technique must not be used if the crosswind component exceeds 10 knots.

12. *Roller Landings.* Roller landings may be carried out using reheat or dry power. The use of reheat is recommended if the aircraft weight is greater than 10,000 kg and the landings are taking place on a runway of 2500 yards or less.

a. Carry out a normal approach and touchdown. To enable rapid engine response to be available if required and to avoid surge, RPM are not to be reduced below 80%.

b. After touchdown, reduce incidence, select and check maximum dry or maximum reheat power as required. In maximum reheat power, aim to unstick at the normal scheduled speed: with maximum dry power selected (below 10,000 kg AUW) aim to unstick at about 150 knots.

Note: When on the ground (including roller landings) slam accelerations to maximum reheat are not to be made from below 80% RPM on Mk 102 engines which do not embody Adour-mod 143.

13. *Maximum Braking Technique.* Minimum stopping distance is achieved by use of maximum wheelbraking without operation of the anti-skid system; anti-skid operation, felt as tugging, dumps brake pressure and prolongs the landing run. To achieve the best possible braking efficiency, lower the nosewheel onto the runway and apply the brakes progressively to about ⅔ pedal travel when below the maximum speed. Provided that retardation is perfectly smooth, full wheelbrake may be applied gradually below 90 knots avoiding tugging due to over-application of brake pressure. Braking should be eased below 15 knots, the speed at which anti-skid becomes inoperative. The maximum brakes-on speeds for a full-stop landing (ie using maximum wheelbraking throughout) are shown in the ODM.

14. *Anti-Skid Operation.* The anti-skid units need to be 'spun up' after touchdown and do not provide maximum braking efficiency until the aircraft is firmly on the ground. Consequently they do not prevent scuffing of the tyres if brakes are applied immediately after the aircraft has landed. Although the units normally prevent the wheels from locking when excessive brake pressure is applied, it is possible to scuff the tyres and lock the wheels if maximum brake pressure is continuously applied. If a skid is felt, release the brakes momentarily; continuous application during a skid can lead to wheel locking with consequent scuffing and possible bursting of tyres. Unless the shortest possible landing run is required, more gentle use of the brakes is recommended. Excessive brake pressure will always result in increased tyre wear.

15. *Aerodynamic Braking Technique.* Provided adequate runway length is available following an intentional chuteless landing, aerodynamic braking may be used to reduce brake and tyre wear. Carry out a normal approach and touchdown at the correct speed. Immediately after touchdown, hold the control column at, or just short of, the aft stop and maintain the pitot probe aligned with the horizon. When reducing speed causes the nose to lower, lower the nosewheel onto the runway, engage nosewheel steering and apply the brakes sparingly.

Note: The use of aerodynamic braking results in a longer landing run than is achieved by lowering the nosewheel onto the runway immediately after touchdown, engaging nosewheel steering, and applying the normal braking technique.

16. *Cable Engagement.* When making an approach-end engagement:

a. Close the throttles and lower the hook after touchdown.

b. Release the brakes before reaching the cable.

c. Aim for the centre at 90°.

d. Anticipate pull-back resulting from cable detensioning after the aircraft has been stopped. Do not apply the brakes because:

(1) If the pull-back is violent, the use of brakes may cause the nosewheel to lift and the rear fuselage to strike the ground.

(2) If the brakes have been used extensively there is a risk of hot brakes welding on.

Note: A violent pull-back should be countered by the use of engine power, not brakes.

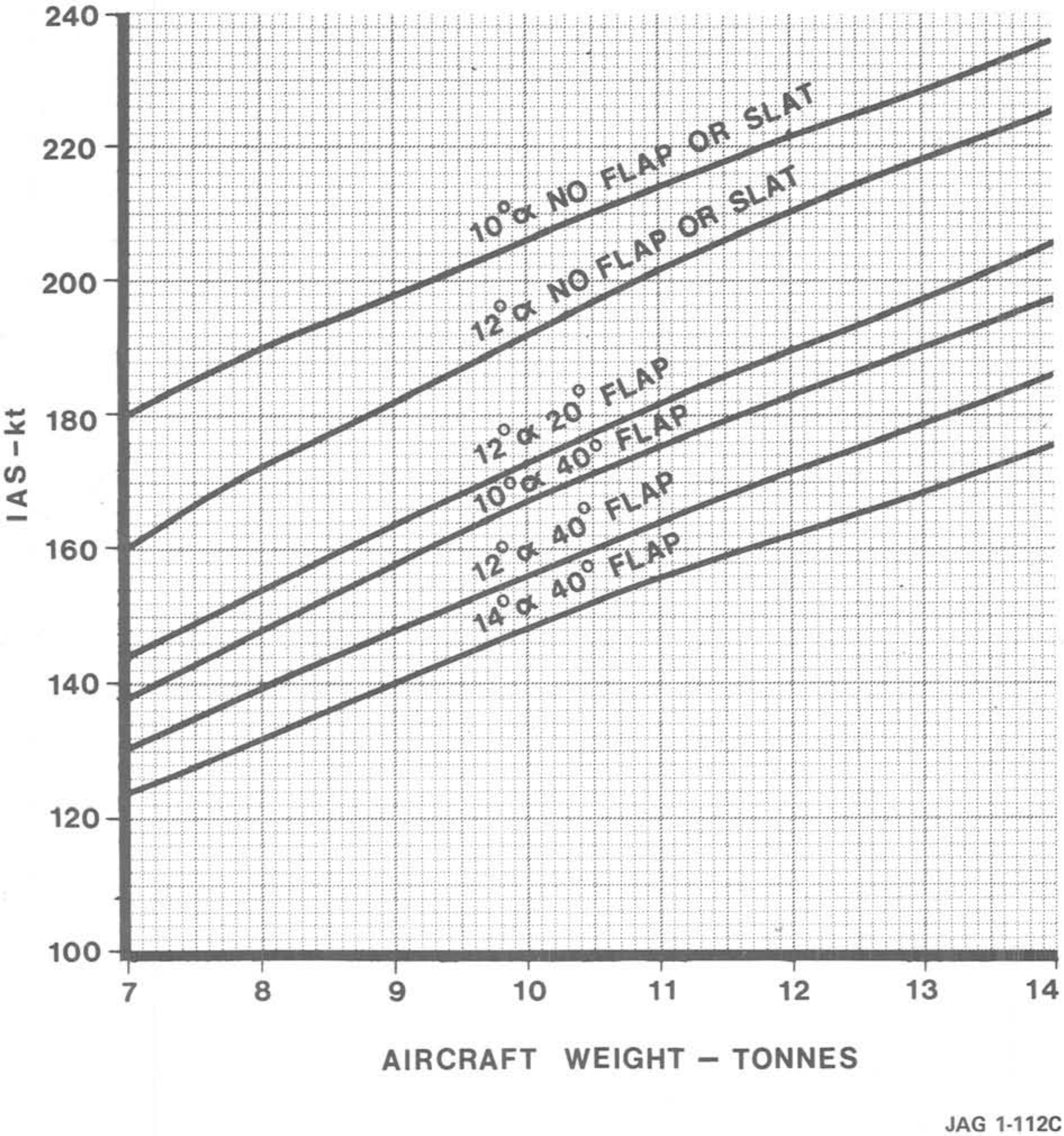
Return to Dispersal and Shut-Down

17. Carry out the **Checks After Landing** listed in the FRC. After clearing the runway, single engine taxying is recommended to minimise use of wheelbrakes during the return to dispersal.

18. If heavy braking has been used during the landing, the minimum braking necessary should be used during taxying to avoid wheel overheat or tyre deflation.

19. Air conditioning should be selected to GROUND and the cabin air lever to the fully aft position before opening the canopy.

20. At dispersal carry out the **Shutdown** checks listed in the FRC.



3 – 3 Fig 1 IAS v Weight at Various Approach Configurations

PART 3 — HANDLING

CHAPTER 4 — HIGH ANGLES OF INCIDENCE — STALLING — LOSS OF CONTROL AND RECOVERY

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General

1. The following information is provided to acquaint pilots with the high incidence handling and loss of control characteristics and associated recovery procedures.

High Angles of Incidence

2. In general, lateral and directional manoeuvrability at incidences beyond the limits is very poor. Both rudder and spoiler power reduce progressively above about 15° incidence below about 400 knots and above about 10° incidence at higher speeds. The tailplane, on the other hand, is extremely powerful, and very large pitch rates can be achieved quite effortlessly, particularly at low airspeeds.

3. Coarse use of lateral or rudder control, or attempts to generate high roll rates at or near the incidence limits, especially in dynamic manoeuvring situations, can exacerbate any high incidence phenomena which may be present or are imminent.

4. In heavy stores configurations, exceeding the incidence limits in both cruise and approach configurations can cause very large airspeed losses.

WARNING: At incidences beyond the limits, severe roll and yaw departures can be encountered, particularly with configurations which include a centreline store. The absence of effective natural warning combined with the overall longitudinal handling characteristics of the aircraft, especially its high tailplane authority, make these limitations difficult to respect. Great care is therefore necessary, not only when manoeuvring close to the incidence limits, but also during manoeuvres which will result in high incidences being approached at high pitch rates. When manoeuvring at speeds below 350 knots, the rapid application of as little as one-eighth back-stick can result in the incidence limits being exceeded significantly if the applied stick is maintained until high incidences are approached.

Stalling

5. *Approach to the Stall in* 1g *Flight.* The aircraft is controllable to the incidence limit in any configuration. Increase of incidence is marked by a gradual increase in buffet level, which varies with configuration, and some lateral/directional instability which can be experienced below the current numerical incidence limits. Recovery is straightforward and is achieved by smoothly reducing the back pressure to reduce incidence. Changes in configuration vary the characteristics of the approach to the stall as follows:

a. *Clean Aircraft.*

(1) *Combat Slat Only.* Buffet levels are initially light and start at about 10° incidence, increasing slowly but progressively at higher incidences. As incidences increases, lateral/directional control becomes imprecise above about 18°.

(2) *Flap and Landing Gear Down.* The initial buffet levels are higher but increase very little as incidence is increased. At about 18° the aircraft may enter a slow wing rock, which slowly diverges in roll at higher incidence. The control column is noticeable further aft and the

aircraft cannot be trimmed to the incidence limit. With full flap, slight stick force lightening occurs at about 18°.

b. *Aircraft With External Stores.* With landing gear down, buffet levels are higher in all configurations, particularly with full flaps and centreline stores. Greater inertia in roll produces less tendency to wing rock at high incidence; however, with centreline stores, slight directional wandering may accompany any wing rock.

Note: At heavy weights, considerable loss of height may occur during a slow-down manoeuvre and subsequent recovery: therefore, a minimum altitude of 10,000 feet is recommended for demonstration of approach to the stall.

Loss of Control

6. *General.* In 1g decelerations both marks of aircraft can be flown to high incidences without demonstrating any marked tendency for a 'departure' leading to loss of control. However, violent departures occur (often with little warning) at much lower incidences in manoeuvring flight and, even when immediate recovery action is taken, can result in a fully developed spin or inertia coupled autorotation. The T2 is slightly more critical than the GRI. In manoeuvring flight the incidences at which departures occur vary according to the configuration (the incidence is significantly reduced with a centreline store) and it is essential, therefore, that the incidence and handling limits be strictly observed.

7. *Characteristics.* Loss of control is characterised by rolling and yawing motion of varying degrees of severity. In their mildest form, these departure phenomena do not constitute a total loss of control and are observed as gentle yaw-off and wing rock, which can be experienced below the current numerical incidence limits. As incidence increases, the motion may become so sudden and violent that the pilot becomes disorientated, and the aircraft may pitch up to higher incidence. From this condition the aircraft may enter either a spin or a sustained inertia coupled autorotation, depending on the initial flight conditions and, to some extent, the actions of the pilot. Any directional mistrim aggravates the characteristics and reduces the incidence at which departures occur.

8. *Recovery.* If the loss of control is gentle, the incidence should be reduced as necessary to regain control. For the more violent and disorientating departure the technique is essentially the same but care must be taken because, although moving the stick rapidly forward and centralising laterally is the best recovery action to avoid the spin, this tends to excite the rotational components and can produce sustained autorotation. The best compromise, therefore, is to centralise the stick by a smooth forward movement to a point somewhere near or just in front of the trimmed position (the exact point is not important) and to centralise the lateral and directional controls.

Inertia Coupled Autorotation

◀9. *Characteristics.* Inertia-coupled autorotation is a form of sustained autorotation in which the aircraft continues to roll rapidly owing to inertia coupling effects, even with the lateral controls central. Entry into this mode depends upon the exact entry conditions and the pilot's reaction to loss of control. Autorotation is identified by oscillating incidence in the 5° to 25° range, IAS above 170 knots, roll rates up to 200° per second and g increments of minus 4·0 to +8·0 g or more, depending on configuration and the severity of the pilot's inputs. Experience has shown that it is very difficult for the pilot to distinguish between inertia-coupled autorotation and the spin because the two motions have a number of features in common; eg high yaw rates, large normal and lateral accelerations, and severe oscillatory motions about all axes. The most reliable indication which enables the pilot to differentiate between autorotation and the spin is the IAS. If the IAS is less than 150 knots the aircraft is in a developed spin; if greater than 170 knots the aircraft is in autorotation. The movement may be so violent, especially at a high entry IAS, that it is difficult to read the flight instruments but every effort must be made to do so. On recovery from a spin or departure it is possible that the aircraft may enter autorotation in roll, particularly if the stick is held forward of the central position. The rate of descent in an autorotation may be in the order of 40,000 feet/minute.

10. *Departure at Low Altitude.* If simultaneous applications of longitudinal and lateral control are made, for example in a rolling pull-out or an on-track attack manoeuvre, the rapid rolling limits may easily be exceeded. All configurations are subject to the rapid rolling limits and in most of them rapid rolling is prohibited above an incidence of 10°, above +4·0 g and below +1·0 g (see Parts 2A and 2B, Chapter 1, Table 3). In this sort of situation the intentional rolling motion is likely to mask all warning that a departure is about to occur and, if the incidence or the positive or negative g limits for large lateral control column inputs are exceeded, the aircraft is likely to depart from controlled flight (into inertia-coupled autorotation) violently and with little or no warning. If the aircraft departs violently below 5,000 feet AGL the crew must eject without delay, if possible while the aircraft is in an erect position; however, it must be remembered that the direction ▶

of roll following a departure may reverse suddenly and without warning.

11. *Recovery.* Initial recovery action after a departure into inertia-coupled autorotation is 'stick release' (and this is the same for a spin initially). Should 'stick release' not be successful after 5 to 10 seconds, and the pilot is sure that the aircraft is in autorotation, he should ease the stick progressively back, which will ensure recovery. However, moving the stick back is pro-spin in effect, hence the importance of checking that the IAS is above 170 knots before taking this action. The pilot must also monitor height whilst making the recovery.

Spinning

12. *Characteristics.*

a. *GR Mk* 1. The aircraft is not spin prone. During flight trials it was not possible to make the aircraft enter a fully developed spin at speeds above 300 knots, even below that speed the aircraft seldom entered a spin if the controls were centralised fully developed spins, two spin modes were experienced. Both were highly oscillatory in pitch, roll and yaw, but they differed in certain basic characteristics. In the more common mode there was a definite direction of rotation (irrespective of direction of initial departure, the spin was always to the right during flight trials), incidence was off scale (greater than 22°) and the IAS was either on the bottom stop or oscillating between the stop and any speed up to about 150 knots. The other mode was likened to a falling leaf of motion. There was no sustained direction of rotation, the roll and yaw oscillations being symmetrical. Incidence was again off scale, but IAS, although below 150 knots, was higher and far less oscillatory in this mode. In either mode, the pilot became severely disorientated. Maximum recorded rates of descent were about 20,000 feet per minute.

b. *T Mk* 2. Flight trials on a T Mk 2 aircraft, supplemented by wind tunnel tests, have not suggested that spin characteristics differ significantly from those of the GR Mk 1.

13. *Recovery.*

WARNING: If control has not been regained by 10,000 feet (15,000 feet when 2 persons carried), or if unacceptably high accelerations are noticed particularly in a forward sense, or if altitude cannot be satisfactorily monitored:

EJECT

a. GR Mk 1. On only one occasion during flight trials (in the completely clean, no pylons configuration) was the action of releasing the stick unsuccessful in achieving recovery within the 15,000 feet height loss permitted by trials safety requirements. Even on that occasion, however, there were signs of impending recovery. Consequently, if sufficient height is available, over 20,000 feet may be required, the aircraft should eventually recover. The self centring ensures that the stick is correctly positioned throughout the manoeuvre. The recovery is achieved in a steep nose-down attitude with the airspeed increasing through 150 knots, possibly with some residual rolling motion.

b. *T Mk* 2. No technique for successful recovery has been demonstrated for the T Mk 2, although flight trials have indicated some tendency towards recovery with the stick released. Under some circumstances full recovery may result; hence the 'stick released' technique is recommended.

c. *Both Marks.* Following recovery action, if the IAS is above 170 knots the aircraft is *not* spinning.

14. *Fast Flat Spin.* Wind tunnel results indicated the possibility of a fast flat spin characterised by high yaw rates and longitudinal acceleration levels which would probably prevent a successful ejection. This mode has not been encountered in flight test: all spins to date have been of the oscillatory type. If the fast flat spin is encountered, the technique given in para 13 should be applied initially but, because the build-up of centrifugal force throwing the pilot forward will prejudice the eventual ejection, *an early ejection is recommended.*

Engine Considerations

15. Departures from controlled flight during which the aircraft has pitched up to over 30° of incidence have inveriably resulted in engine surge or flame-out; on occasions, even when control was regained within 5 seconds, both engines were in surge. It is therefore of great importance to move the throttles to idle if the aircraft does not recover immediately.

Consolidated Recovery Drill

16. If heavy buffet, wing rock, wing drop, yaw-off or stall warning are experienced:

Reduce incidence immediately.

Note: Post-mod 792 and 919, the stall warning system provides a guide to the approaching limit (providing the system is not selected off.)

16. If control is lost at high incidence, the following drill is to be used:

Actions	*Considerations*
Immediate Actions	
Centralise the controls smoothly.	Moving the stick rapidly forward may produce sustained autorotation. Recovery may be followed by some residual rolling motion.

WARNING: If control has not been regained by 10,000 feet (15,000 feet when two persons carried), or if unacceptably high accelerations are noticed particularly in a forward sense, or if altitude cannot be satisfactorily monitored:

EJECT

Actions	*Considerations*
Subsequent Actions	
a. *If recovery is not immediate*:	
(1) Release the stick.	Self-centring ensures correct stick positioning throughout the manoeuvres. In the GR1, recovery from a spin should follow stick release.
(2) Engines to idle.	Engine surge and/or flame-out is likely.
(3) Monitor altitude.	Height loss before recovery from a spin may vary between 500 feet to over 20,000 feet. In autorotation, the rate of descent may be up to 40,000 ft/min.
b. *If control is regained*:	The first sign of spin recovery is the ASI showing readings of steadily increasing peak values.
(1) Above 200 knots, gently recover to a normal attitude.	Full recovery from a spin is characterised by a reduction of incidence to on-scale values, *an IAS of more than* 170 *knots*, and usually a steep nose-down attitude. After the violent oscillations die away there may be some residual rolling motion after recovery.
(2) Check engines.	Shutdown and immediate relight may be necessary.
(3) Check and reset alternators, TRU, differential tailplane and autostabs.	—
c. *If control is not regained and autorotation is positively identified*:	Positive identification is incidence oscillating in the 5° to 25° range, IAS above 170 knots, and a high roll rate which may be oscillatory.
(1) Ease the stick progressively back until the rotation subsides.	Roll rate will reduce and autorotation will cease.
(2) As the roll rate stops, ease the stick forward to neutral.	—

Note 1: Following recovery with both engines flamed-out, up to 10,000 feet may be required to regain normal powered flight.

Note 2: Do not attempt to stream the brake parachute as an aid to spin recovery as it is unlikely to be effective and may prejudice ejection or foul the aircraft.

Note 3: Do not attempt to select the differential tailplane switch to SPIN REC.

Note 4: External stores should not be jettisoned while the aircraft is out of control but, if necessary, the stores may be jettisoned *after* recovery to reduce the loss of altitude whilst the engines are being relit.

Note 5: In the event of violent departure or spin with heavy external stores, it is likely that the airframe will be over-stressed; the aircraft should be returned to base as soon as possible using gentle manoeuvres only. If possible, the structure, particularly the stores and pylon attachment points, should be visually checked for signs of damage before landing.

PART 3 — HANDLING

CHAPTER 5 — FLYING IN BAD WEATHER CONDITIONS

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Turbulence

1. Side gusts in extreme turbulence may produce uncomfortable lateral accelerations at high IAS. The recommended turbulence speed is 300 knots.

Icing

2. There is no anti-icing protection for the air intake system or for the airframe, although a hot air bleed provides continuous engine protection. It is recommended that flight in icing conditions should be avoided.

a. On the ground, intake icing may be expected when all the following conditions are fulfilled:

(1) The dry bulb temperature is below +8°C. The wet bulb temperature is below +4°C. Visible moisture is present in the form of rain, sleet, snow, fog, hail or wet runways.

(2) If the wet bulb temperature is not known and the following conditions are fulfilled:

(a) The dry bulb temperature is below +10°C.

Visible moisture is present on wet runways.

(b) If visible moisture (fog or mist) reduces visibility to 1000 metres or less and the outside temperature is below +8°C.

Note: In icing conditions the ground running time before take-off must be kept to a minimum.

b. If moderate or heavy icing is encountered in flight, climb or descend out of icing conditions as quickly as possible at the highest practicable engine speed. Normal engine handling may be used but it is recommended that after an inadvertent icing encounter, the engine response be checked before the final approach to land.

Heavy Rain

3. Regular treatment of the windscreen and quarter panels with rain repellant should ensure satisfactory visibility in rain. It is advisable to have the screens cleaned and the repellant re-applied after exposure to salt spray.

PART 3 — HANDLING

CHAPTER 6 — FLYING WITH ASYMMETRIC LOADS

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General

1. The aircraft is not intended for normal flight with wing store asymmetry, and prolonged flight with heavy asymmetric stores is not permitted except in emergency. Handling effects for 4 lb and 28 lb practice bomb asymmetry are insignificant and, for the purpose of this chapter, practice bombs can be ignored. Effects of a single asymmetry when carrying Lepus flares are small, and handling problems are not expected within the anticipated flight envelope clearance.

2. The two cases which are important, and do impose special limitations and handling techniques, are flight with single store asymmetry due to release failure or mis-selection, and flight with fuel imbalance caused by wing drop tank fuel transfer failure. These two cases are covered in detail below.

General Handling and Limitations

3. Load asymmetry implies a change in lateral trim of the aircraft and the application of spoiler trim to oppose roll towards the heavy wing. Because spoiler trim is required for level flight conditions, it follows that roll effectiveness is reduced away from the heavy wing but increased towards it. The amount of spoiler trim required, and the degree to which roll effectiveness is reduced, depends primarily on the weight and type of store concerned and IAS; the position of the store, inboard or outboard, is not significant.

4. For a given asymmetry and speed, manoeuvre from trimmed straight and level flight initially requires application of more spoiler to oppose roll towards the heavy wing. In manoeuvring flight as incidence and g are increased, however, it has been found that the aircraft begins to yaw and then roll *away* from the heavy wing. The ultimate condition is when roll control is lost, the aircraft rolling rapidly away from the heavy wing, or when the structural sideslip limits are reached.

5. *Limitations*. To avoid loss of control and overstressing, the limitations given in Part 2 are to be strictly observed when flying with asymmetric loads. Following a load asymmetry situation, the aircraft is to be recovered for landing using gentle manoeuvres only.

Detection of Load Asymmetry and Immediate Action

6. The two failure cases which result in asymmetric loads, namely store hang-up and wing drop tank fuel transfer failure, are considered separately. Information concerning tandem beam asymmetries will be issued at a later date.

a. *Store Asymmetry*. A store release failure may occur due to equipment failure or control panel mis-selection. If during a weapon attack a hang-up occurs, the weapon release system interrupts the release pattern to ensure that only a single wing store asymmetry results. The pilot will detect a tendency to roll and yaw initially towards the heavier wing as soon as the asymmetry occurs, the effect becoming more pronounced during the initial pull-out phase of the attack. As g and incidence are increased, however, the direction of roll and yaw is reversed. The amount of spoiler required to oppose the rolling tendency depends on the factors described in para 3. To retain good roll control and debris/ground avoidance during the pull-out phase of an attack in the event of a hang-up, the pilot must ease off the back pressure on the control column to within the quoted limitations as soon as the rolling tendency is felt. In all cases it should be possible to achieve ground/debris clearance assuming 'top of the line' releases. Having pulled out of the dive the store asymmetry can be identified on the WCP BOS indicators and appropriate selective jettison action carried out.

Note 1: Because use of rudder to correct any sideslip can result in a cross-controlled situation and as the yaw and rolling motion may cause confusion, the rudder should be left neutral during dive attack recoveries.

Note 2: Pilots should be prepared to operate the CLEAR A/C button if a hard pull-out capability is required.

b. *Wing Drop Tank Fuel Transfer Failure.* Wing drop tank fuel transfer failure can be detected by an increasing requirement for spoiler trim, and will eventually be indicated by the fuel control panel as the asymmetry builds up. The limitations set out in para 5 apply.

Approach and Landing

7. For the approach and landing it is recommended that the rudder is trimmed to give approximately 1 ball displacement and the spoilers are trimmed as required.

8. Carry out a low speed handling check at a safe height in the approach configuration at 10° incidence. When lowering the landing gear, apply rudder to maintain spoilers central and retrim (rudder trim authority is adequate at landing incidences even with a full/empty wink tank asymmetry). A small amount of bank may be necessary at low speeds to maintain straight flight.

9. Carry out a normal GCA type approach if fuel permits, or a larger circuit than normal if a visual approach is necessary. Trim the aircraft for a 10° incidence final approach with full flap extended. If crosswind conditions cannot be avoided, the approach should be made with the heavy wing into wind to obtain the best possible control for upwind flight path corrections, and to minimise out of wind roll on the runway after landing. On an approach with heavy wing into the wind, normal crosswind limitations apply; with the heavy wing on the downwind side, however, the crosswind limit is 10 knots.

10. Make a normal round-out, anticipating the need for further spoiler deflection away from the heavy wing as speed is reduced. After touchdown close the throttles to 'idle', engage the nosewheel steering, deploy the brake parachute, and carry out gentle braking as for a normal landing. Be prepared for a tendency for the asymmetric store to 'run on' when the brake parachute is deployed and during braking, resulting in yaw away from the heavy wing; the aircraft can be easily kept straight using the nosewheel steering.

PART 3—HANDLING

CHAPTER 7—SINGLE ENGINE FLYING AND RELIGHTING

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General

1. Handling procedures in the event of an engine failure during take-off or during a normal approach are described in Chapters 2 and 3 respectively.

Stopping an Engine in Flight

2. Before shutting down a failed engine in flight, an appropriate power increase should be made on the serviceable engine.

3. An engine should only be shut down in flight in an emergency or for practice relighting. For simulated single engine flying one engine should be throttled back to 70 to 80% RPM and the airbrakes selected 'out'. This configuration approximates to the actual engine failure case.

4. To shut down an engine in flight for practice purposes, select the throttle to idle, wait 30 seconds for RPM and TGT to stabilise then set the throttle lever to 'stop'. The engine must not be shut down from high power except in an emergency, to avoid thermal shock. Subsequent actions, dependent upon the nature of the failure, are listed in the FRC.

WARNING: If the appropriate ALT warning does not appear on the CWP following an engine shutdown or flame-out, set the associated ALT switch to OFF to trip the alternator and thereby enable the operating engine alternator to feed the failed side busbars (TRU warning out). This ensures that the relight facility will be available for the failed engine.

Single Engine Flying

5. Immediately following an engine failure in flight, increase thrust on the operating engine to maintain a safe speed. As a general rule it is best to select maximum reheat to stop speed decay and then to adjust power as necessary thereafter. Thrust margins in dry power are low, resulting in rapid loss of speed in turns, particularly when flying below 300 knots at bank angles in excess of 20°: keep airspeed above 300 knots at low level until joining the recovery pattern. With the CROSSFEED switch set to OPEN manage the fuel system to maintain the aircraft CG within limits.

6. Asymmetric effects associated with single engine flying are slight and easily corrected. Changes of power, particularly into and out of reheat, may cause slight yaw and trim changes due to flow effects on one side of the tailplane.

Single Engine Landing and Overshoot

7. If possible, reduce aircraft weight by using or dumping fuel. ▸◂ Consideration should be given to jettisoning stores, particularly if they are damaged. Refer to para 17 for advice on overweight single-engine landings.

8. In the early stages of the recovery, check PTR operation on the good engine before selecting any aircraft services. The throttle should not subsequently be closed below the minimum PTR detent until touchdown.

9. Plan a straight-in approach, preferably from an instrument pattern if time and fuel permit, or join wide downwind into the visual circuit pattern. Set the air conditioning switch to GROUND. Lower 20° flap below 260 knots: aim to be at the end of the downwind leg at between 210 and 220 knots.

10. Extend the downwind leg, ideally aiming for a 3° straight-in approach from at least 2·5 NM.

11. Turn finals, taking care not to exceed 10° incidence in the turn.

12. When straight in and ready to decend on a 3° approach, lower the landing gear and fly at 8° incidence, not exceeding 10° incidence. Do not fly a shallow approach as this requires more thrust for a particular mass and gives a smaller power reserve. The drag penalty for flying at an incidence greater than 10° at various weights is demonstrated in Fig 1 to 3 and Fig 5 to Fig 7 (refer to para 18).

◂ 13. When certain of reaching the runway, lower full flap, maintain 10° incidence and carry out a normal landing at the selected touchdown point. ▸

14. When on the runway, leave the flaps down.

15. The decision to overshoot from a single-engine approach is to be made above 100 feet AGL with not more than 20° flap lowered. Select maximum reheat and retract the landing gear: climb at 7 to 8° incidence. Flaps should remain at 20° until a safe height and speed is achieved.

16. On landing, throttle back through the PTR detent and switch off PTR during the **Checks After Landing.**

WARNING: If reheat is not available on the good engine, a straight-in approach is recommended. A steeper glidepath than normal should be used. Incidence must never exceed 8°: limit flap to 10° until straight-in. Bank angle must be as low as possible in turns. Overshoot capability is uncertain.

Overweight Single Engine Landing

17. An overweight single engine landing may only be carried out in an emergency which precludes reduction to the single engine landing weight limitations. The procedure is the same as for an approach within the weight limitations (para 7 to 16) but note that excessive rates of descent and speed losses will occur if the incidence is allowed to exceed 10°. It may be possible to overshoot but this depends on mass, drag and the ambient temperature.

18. Fig 1, 2 and 3 (Mk 102 engine) and 5, 6 and 7 (Mk 104 engine) predict how critical weight and incidence can be during a single engine approach. The graphs relate to engines with No 1 at maximum reheat and No 2 windmilling, air conditioning selected to GROUND, 20° flap and landing gear down. The +2° gradient line indicates the limit of overshoot capability and the 3° approach line indicates the limit for maintaining a 3° approach. The figures in circles indicate incidence. Fig 4 (Mk 102 engine) and 8 (Mk 104) shows the mass, altitude and temperature limits above which it is impossible to maintain height in the single engine approach configuration whilst holding 9° incidence. The graphs serve to emphasise the importance of observing the limitations with regard to mass in relation to temperature given in Part 2A and 2B, Chapter 1.

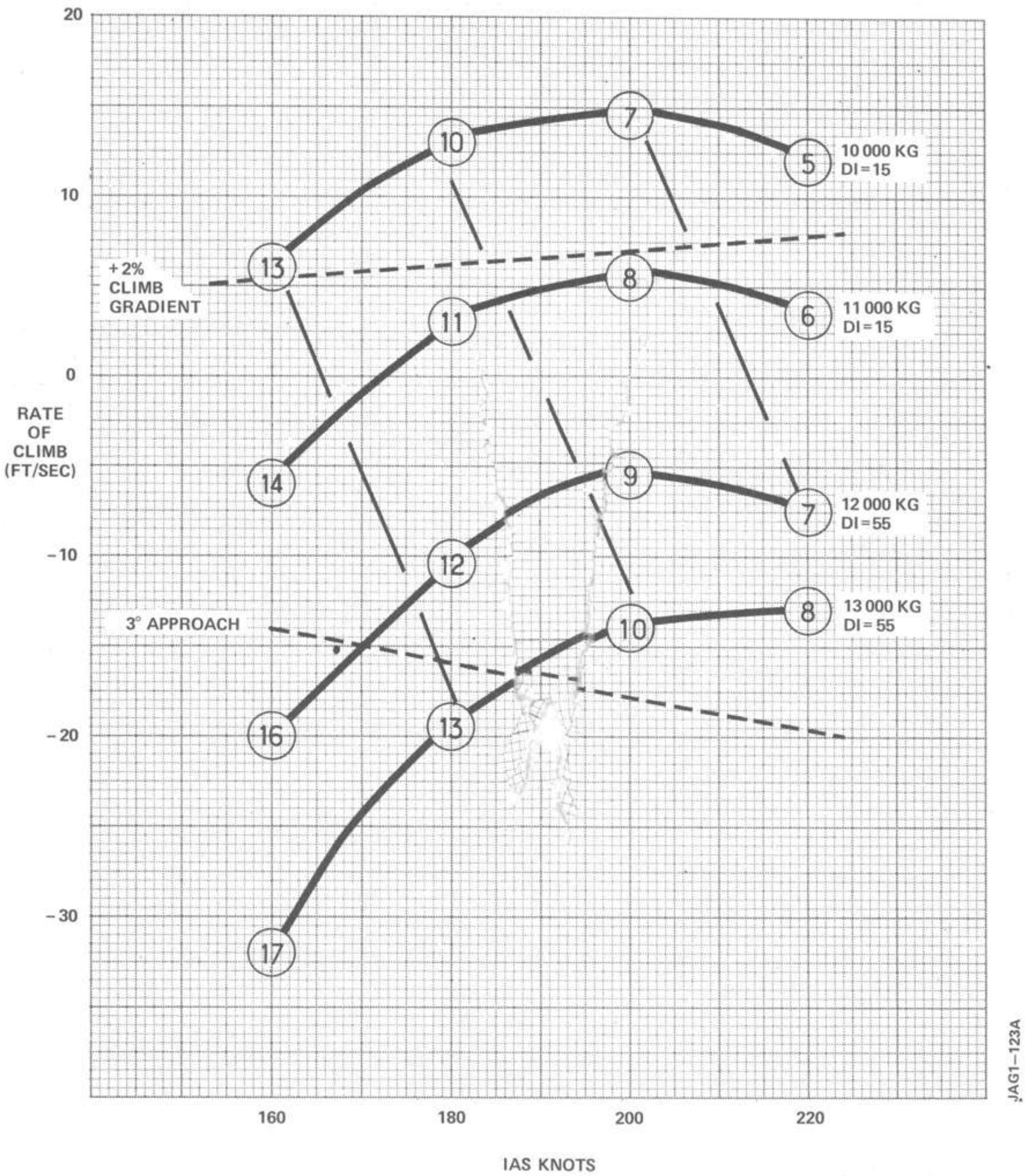
Relighting an Engine in Flight

19. There are two methods of relighting an engine in flight: normal relight and immediate relight. A relight should not be attempted if symptoms of mechanical failure have occurred (eg, RPM indicating zero). Normal relights are permitted within the envelope given in Fig 9. It should be noted, however, that reliable lighting has not always been achieved above 20,000 feet and the recommended optimum relight conditions are 320 knots at 20,000 feet or below. At low altitude, conditions are more

favourable for a normal relight if the windmill RPM are at or above 13%. An immediate relight may be attempted at any height and speed since the engine is stopped only momentarily and re-started well before the engine has reduced to windmill RPM.

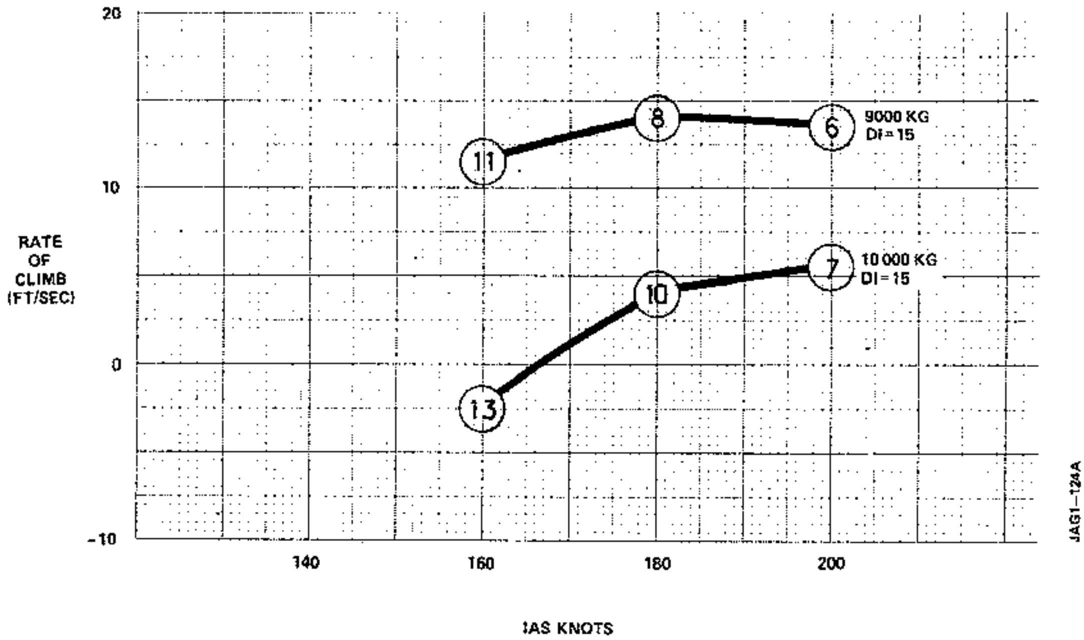
20. *Normal Relight.* To carry out a normal relight, first ensure that the aircraft is flying within the relight envelope. With the throttle to 'stop', the LP cock OPEN and the RPM above 13%, press the relight button (for a maximum of 30 seconds) and move the throttle to idle (the BP caption may light). Monitor the RPM and TGT. Release the relight button as the RPM increase above 35%. When the engine has stabilised at flight idle, open the throttle slowly to maximum dry power to prove engine operation. If in high altitude and low airspeed conditions the RPM stagnate below flight idle, increase airspeed to assist the relight. If the TGT exceeds the starting limit abandon the relight attempt. Should the engine fail to light up after 30 seconds, or appear unlikely to accelerate satisfactorily after one minute, or if the TGT exceeds the starting limit, place the throttle to 'stop' and release the relight button. After an unsuccessful attempt allow the engine to drain for at least one minute, ensure that the hydraulic pump and alternator are off line, and then attempt a further relight at a lower altitude and/or higher airspeed if practicable. If the engine repeatedly fails to relight, further attempts may be made selecting the appropriate CONTINUOUS IGN switch to ON as well as pressing the relight button. Ensure that the throttle is not moved forward of the idle position with CONTINUOUS IGN selected ON: return the switch to OFF when the engine has relit or when it has failed to relight within 30 seconds.

21. *Immediate Relight.* The immediate relight is most likely to be used when a locked-in surge has occurred. It may be attempted at any height and speed and relies on catching the RPM at a higher value than is experienced in a normal relight. The throttle is placed to 'stop', the relight button is pressed and held, and the throttle returned to the idle position with the minimum of delay to avoid the decay of RPM. Monitor the RPM and TGT; if the TGT exceeds the starting limit or the engine fails to light up within 30 seconds, select the throttle to 'stop' and carry out a normal relight after allowing one minute for the engine to drain. After a successful immediate relight prove the engine slowly from flight idle to power required (but note the limits if relighting after a surge).



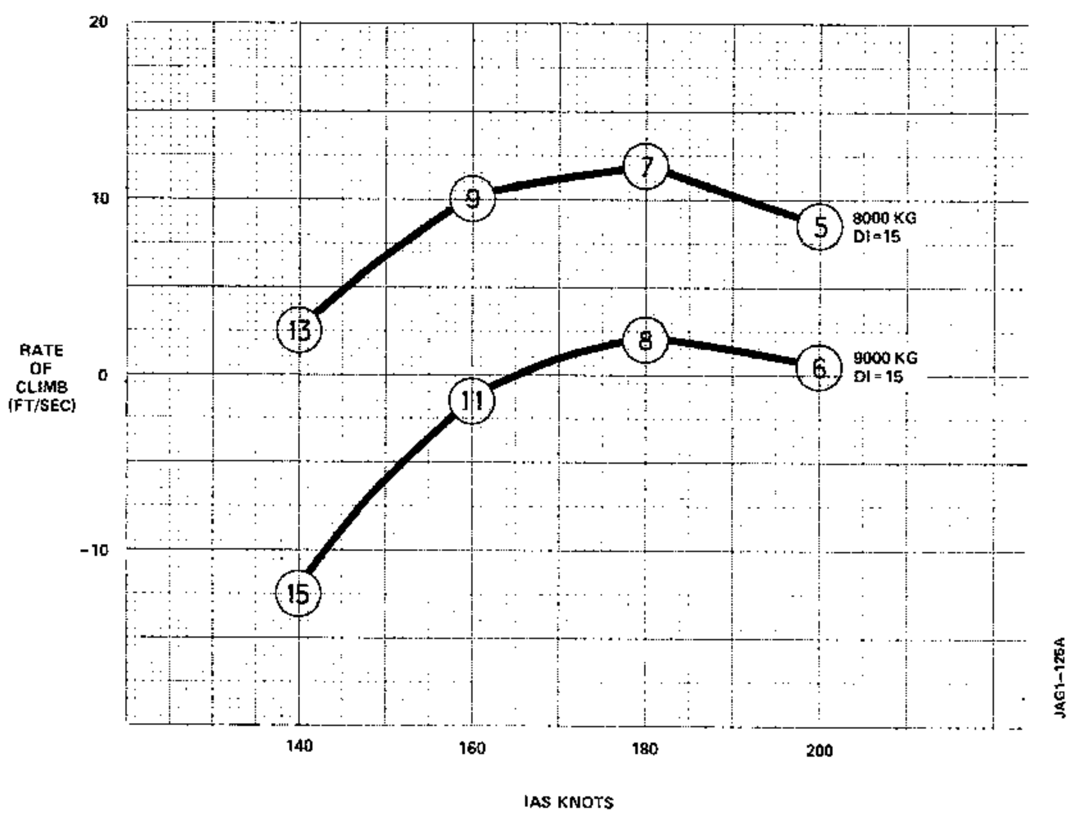
Note:— Figures in circles represent incidence (HFD)

◀3 – 7 Fig 1 Single Engine Performance – ISA, Sea Level (Mk 102)▶



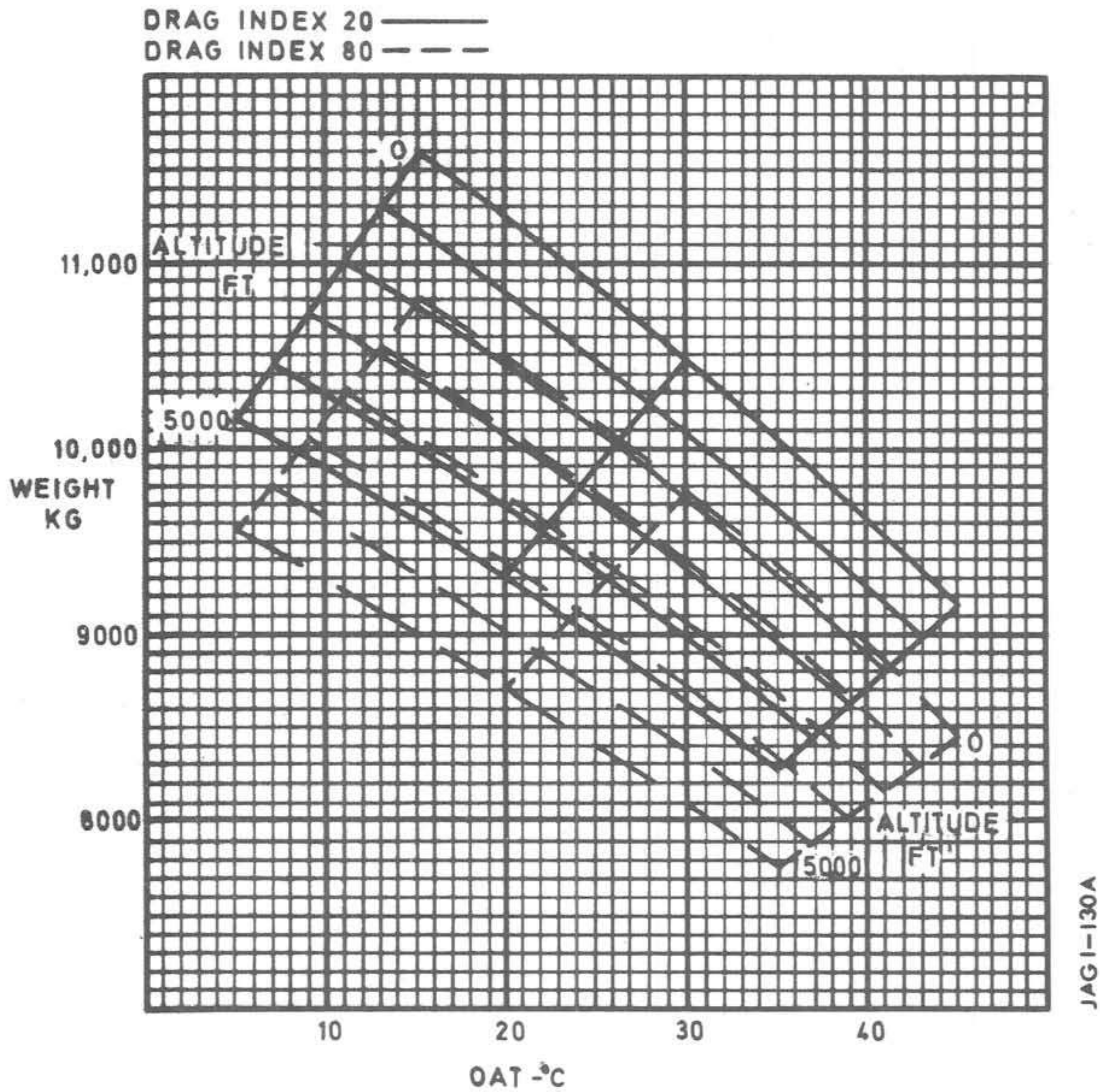
Note:– Figures in circles represent incidence (HFD)

◀3 – 7 Fig 2 Single Engine Performance – ISA + 15°C, Sea Level (Mk 102)▶

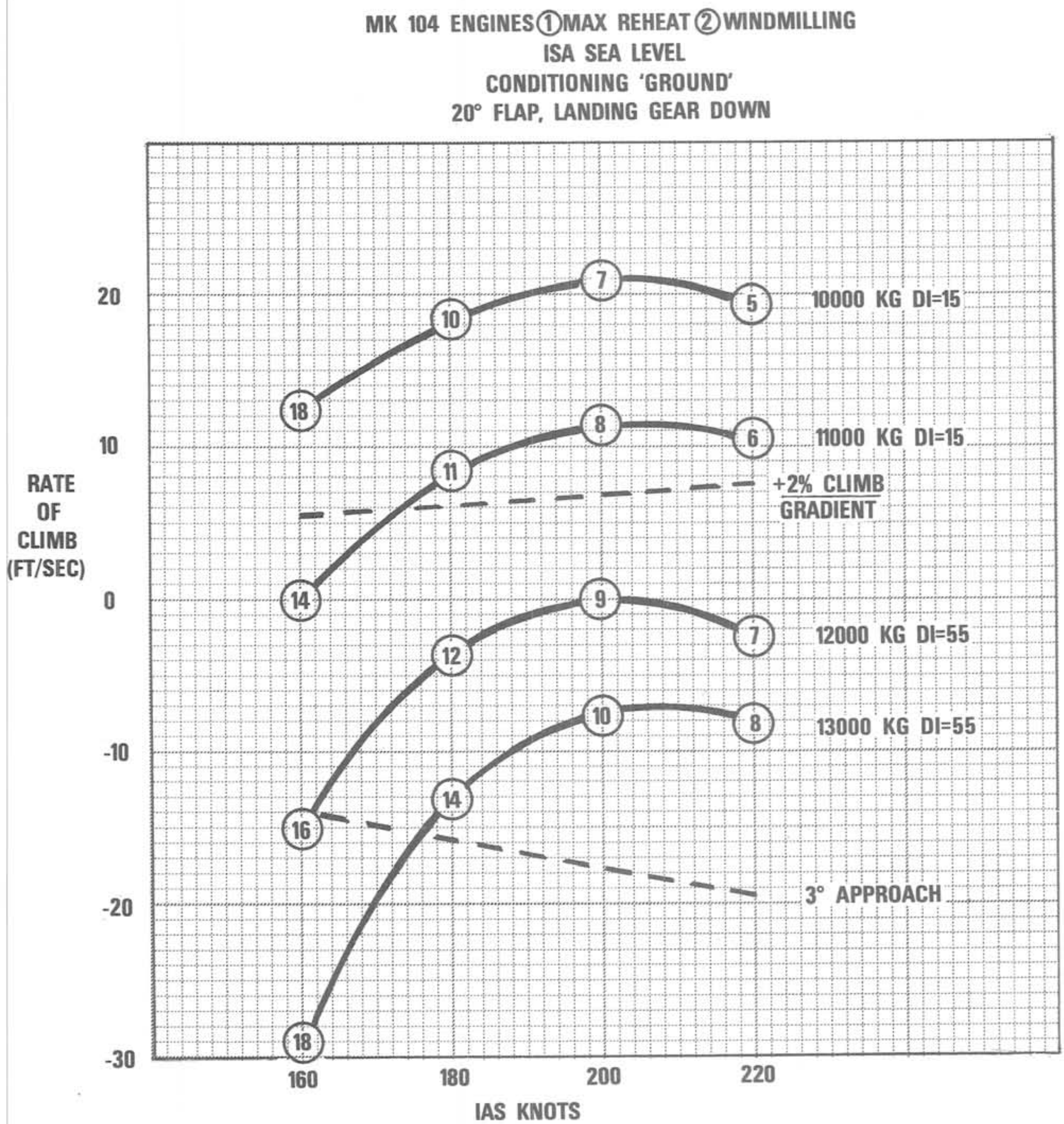


Note:– Figures in circles represent incidence (HFD)

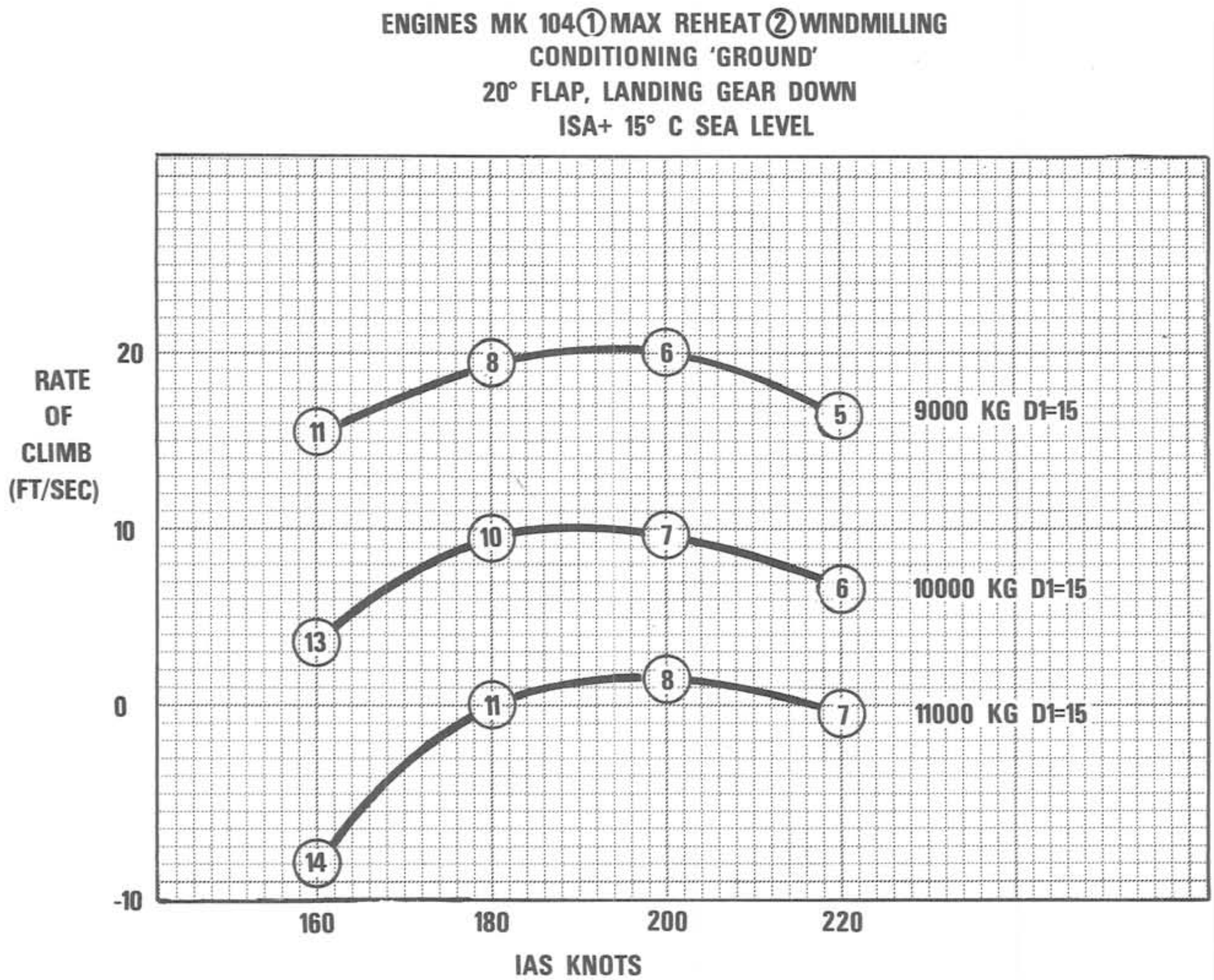
◀3 – 7 Fig 3 Single Engine Performance – ISA + 30°C, Sea Level (Mk 102)▶



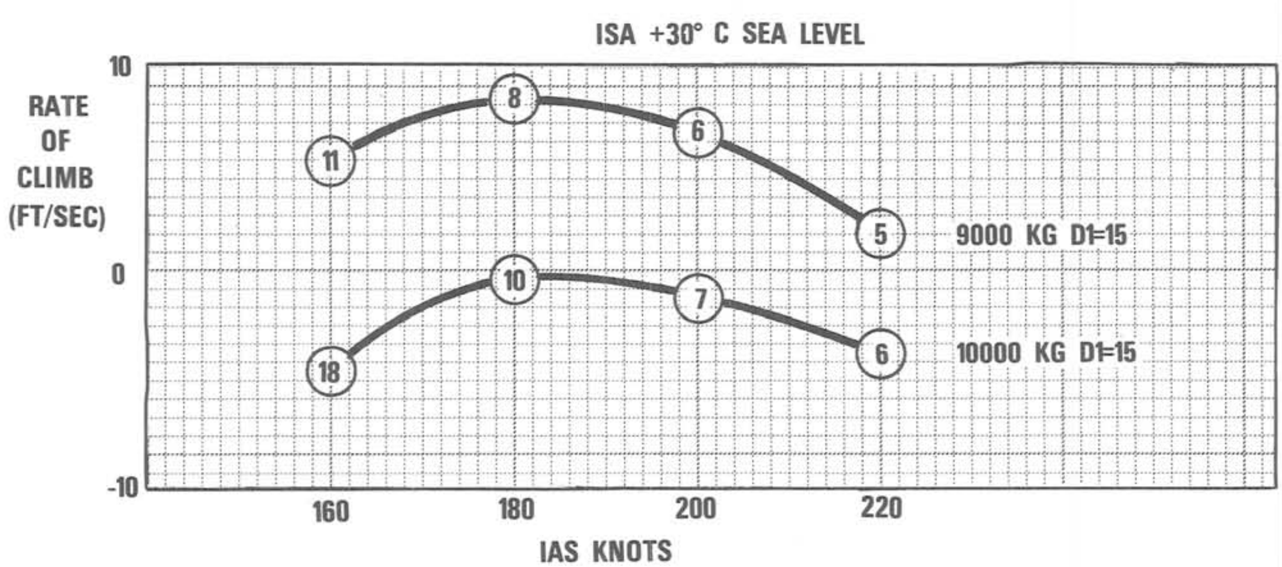
◀3 – 7 Fig 4 Single Engine Weight – Altitude – Temperature Limitations (Mk 102)▶



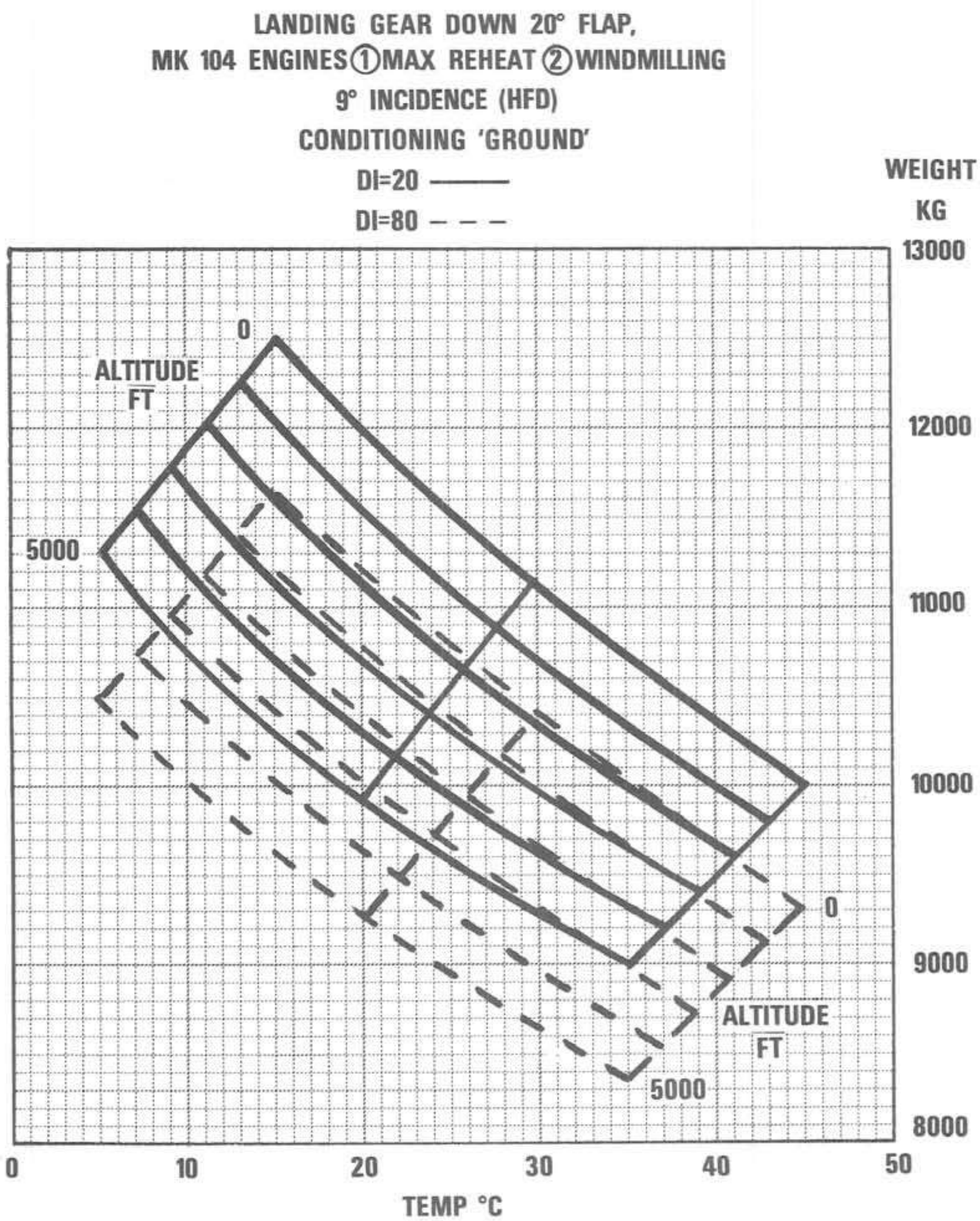
◀3 – 7 Fig 5 Single Engine Performance – ISA, Sea Level (Mk 104)▶



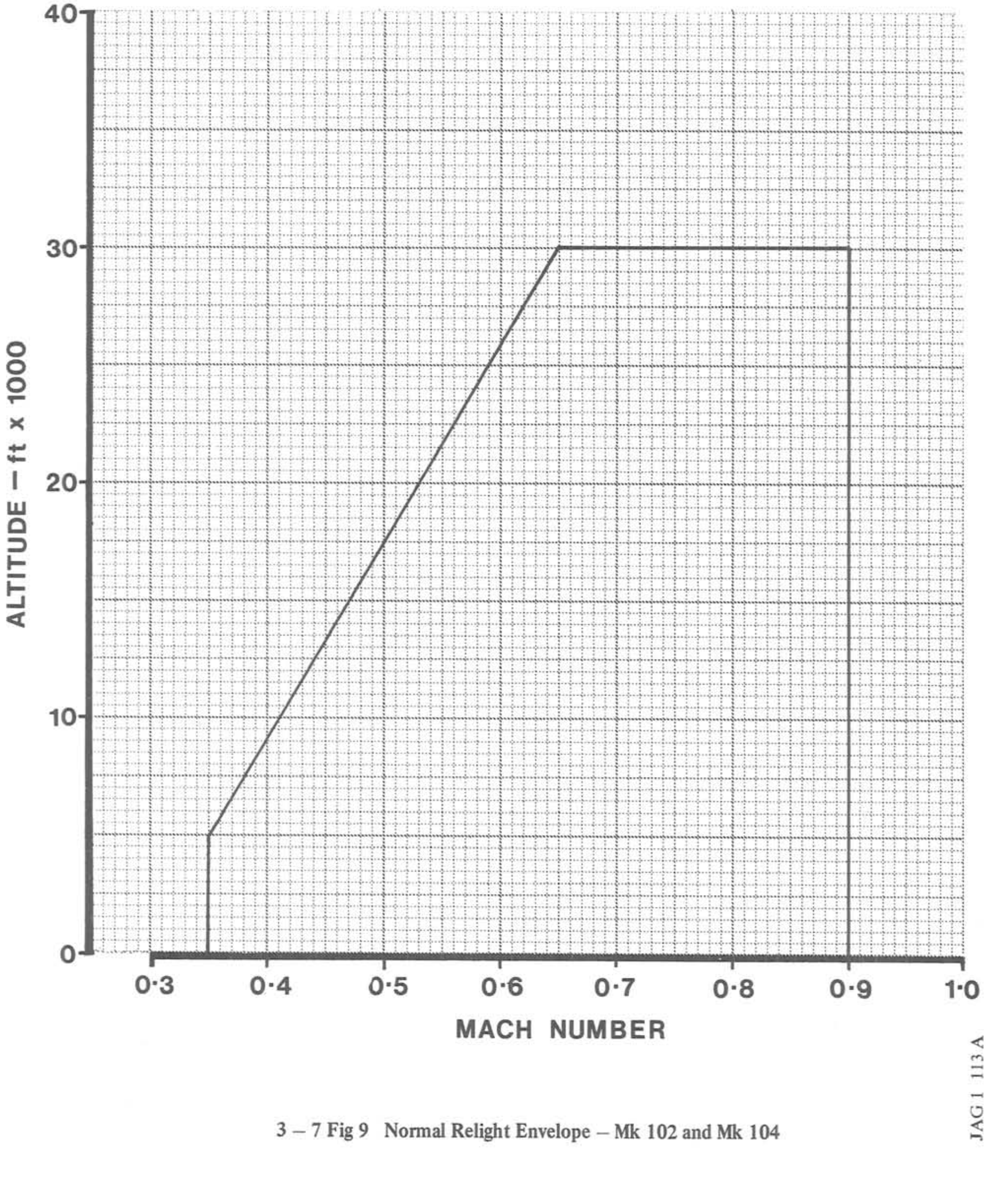
◀3 – 7 Fig 6 Single Engine Performance – ISA + 15°C, Sea Level (Mk 104) ▶



◀3 – 7 Fig 7 Single Engine Performance – ISA + 30°C, Sea Level (Mk 104) ▶



◀3 – 7 Fig 8 Single Engine Weight – Altitude – Temperature Limitations (Mk 104)▶



3 – 7 Fig 9 Normal Relight Envelope – Mk 102 and Mk 104

PART 3—HANDLING

CHAPTER 8—AUTOSTABILISER FAILURE

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General

1. The pitch, roll and yaw autostabiliser channels are completely separate, therefore failure of any one channel should not affect the other two. Failure indications may be one or more of the following:

a. The relevant autostabiliser switch returning to the OFF position (eg power failure).

b. A step change in trim (eg hard-over failure).

c. Random movement in any axis (eg faulty gain circuits).

d. Poor damping in one axis (eg system failure downstream of supplies).

2. Where a failure adversely affects the handling qualities of the aircraft, all three channels must be tripped by using the cut-out on the control column. Use of the cut-out for all three autostabilisers axes can cause some transient pilot-induced oscillations or dutch rolling activity, especially at high speeds. The cut-out should not, therefore, be used until the aircraft has been recovered to safe flight conditions. Selective re-engagement of channels may be attempted when the aircraft is in a safe flight condition, ie in straight and level flight above 1000 feet AGL and at speeds of 250 to 300 knots. Random movements in any axis may also be caused by a differential tailplane fault which fails to bring on the DIFF caption. Therefore, if random movements continue after the autostabiliser cut-out has been operated, select the DIFF T/P switch to EMERGY to reduce oscillations.

3. With all three channels disengaged the aircraft may safely be flown within the normal airframe limitations. Operational capability may be diminished depending upon the degree of turbulence, therefore it is advisable, where possible, to avoid flying in areas of severe turbulence and also to avoid close formation flying in these conditions.

WARNING: In the configuration of recce pod, inboard drop tanks and BL755 on the outboard pylons, control may be difficult during approach and landing if severe turbulence is encountered with autostabilisers failed or switched OFF. In these circumstances a low speed handling check should be performed in the turbulent conditions (if practicable) to determine whether stores jettison (ie the BL755) is required or not.

4. The roll and yaw channels are, to a large extent, interdependent in their effect. At subsonic speeds, retention of either channel provides considerable damping in both axes. At supersonic speeds it is advisable to select the roll channel OFF if the yaw channel fails. Handling considerations associated with the loss of each channel are described in para 5 to 9.

Pitch Channel Failure

5. Failure of the pitch channel is most apparent if it occurs during high speed flight at low altitude, especially in turbulent conditions. In the worst case, ie at 575 knots, a full nose-down runway could result in a height loss of up to 60 feet. In these circumstances there may be a tendancy to over-control which could lead to pilot-induced oscillations of small amplitude along the flight path. If it is essential to continue the flight in these conditions, the aircraft should be kept trimmed and the coarse use of controls avoided.

6. Spoiler pitch compensation is lost resulting in small g increments when rolling. This will be most noticeable when tracking a target. At high normal accelerations, the g increment with spoiler increases and for this reason rapid rolling under g should be avoided. Airbrake pitch compensation will be lost resulting in a strong nose-up change of trim when airbrakes are selected out at moderate and high speeds. In configurations of aft CG and low longitudinal stabiltiy, this may lead to over-controlling.

Yaw Channel Failure

7. Failure of the yaw autostabiliser at high speed results in greater degradation of aircraft handling than with the failure of the pitch or roll channels and large spoiler authority is required to counter the rolling moment. With the yaw channel failed, the aircraft is prone to dutch rolling when disturbed in turbulence or through violent manoeuvring. These effects will also make tracking more difficult when carrying out weapon aiming in turbulent conditions.

8. The natural stability of the aircraft is increased when heavy underwing stores are carried. The handling qualities depend to a great extent on the combination of stores carried. In the worst cases dutch rolling may occur at altitude in level flight, the severity increasing as incidence increases. Switching the differential tailplane to EMERGY eliminates the oscillations but at the expense of reducing roll control. The differential tailplane should be selected to NORMAL at low altitude.

Note: Following a yaw channel failure, the normal-acceleration limit is minus 2g to +4g.

Roll Channel Failure

9. Failure of the roll autostabiliser results in random movements in roll in extreme turbulence; however, handling remain at an acceptable level, particularly at high speeds.

Radio Interference

10. On certain frequencies in the V/UHF and HF bands, transmissions may cause transient inputs into the autostabiliser circuits. This will be felt as a slight trim change when transmissions are taking place. Modification is in hand to overcome this.

PART 3—HANDLING

CHAPTER 9—AIR TO AIR REFUELLING (GR 1 ONLY)

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WARNING: If a tanker drogue is damaged during a contact, no further contacts should be made on that drogue because of the risk of loose items from the damaged drogue entering the right engine intake.

Considerations

1. There are two separate sets of clearances for air-to-air refuelling (AAR) in force for the aircraft: those which lay down general limitations for normal AAR and those which extend the normal limitations for long range exercise deployments.

2. *Normal Limitations.* The following conditions and limitations must be observed before normal AAR is commenced by day or night:

a. Contact is only permitted with the wing and centreline drouges of Victor K Mk 2 tankers.

b. Contact may only be made within the envelope 250 to 300 knots and below 25,000 feet in PTR and reheat with PTR selected; no height limit in dry power. The use of reheat in the range between minimum reheat and maximum reheat is permitted on one or both engines as an extension of the PTR range. The use of reheat is not permitted on any engine on which PTR is not selected.

c. The probe is not to be selected in or out at speeds above 300 knots or at heights above 30,000 feet.

d. The probe is not to be locked out at speeds above 350 knots/0·85M or at heights above 30,000 feet.

e. With the probe out the aircraft is restricted to gentle manoeuvres only.

f. HF transmissions by either the tanker or Jaguar are not permitted when in contact or in close proximity.

g. Contact is permitted in all cleared configurations.

3. *Long Range Deployment Limitations.* The following additional clearances and associated extra limitations apply to long range exercise deployments and work-up training:

a. *Altitude and Speed.* AAR is cleared between 25,000 and 27,000 feet within the speed band of 280 to 300 knots IAS.

b. *Fuel.* Only AVTUR/FSII (F-34 or JP-8) fuel is to be used.

c. *Tanker.* Only the wing hoses of the Victor Tanker are cleared for use. Turns are not to be made whilst in contact.

d. *Engine Handling.* Adour Mk 104 engines must be fitted. The aircraft is to be flown with the left engine in PTR, or in reheat with PTR selected; the right engine is to be in dry power. PTR selection and cancellation must not be made whilst in contact.

WARNING: Slam throttle movements above 25,000 feet with PTR selected may result in engine surge.

e. *Pre-Deployment Check.* Prior to a deployment flight requiring the use of PTR within the height band 25,000 to 27,000 feet an earlier flight should be made in the expected flight conditions to check engine behaviour. If the check is satisfactory, subsequent operation of the aircraft under similar conditions using the same techniques can be made with a strong degree of confidence as to engine behaviour at high altitude. The following drill is recommended to check surge-free operation of the left engine in PTR:

(1) Fly at 27,000 feet at 280 knots IAS in 1g level flight.

(2) Set the right engine at full dry power.

(3) Left engine; carry out the following drill with a 15-second pause between each action:

Set full dry power
Select PTR
Slam to minimum PTR
Slam to maximum reheat
Slam to minimum PTR
Slam to maximum PTR
Cancel PTR

The following malfunctions should be considered unsatisfactory:

Locked-in surge
Severe, self-clearing pop surge
Large nozzle instability

4. *Dry Contacts.* For dry contacts additional conditions are:

a. Blanks must be fitted to the tanker drogues to prevent fuel flow from a primed hose unless the Jaguar has mod 854 embodied.

b. The tanker fuel supply must be selected off for the refuelling station in use.

c. If in addition to mod 685 and 854, mod 567 is incorporated, then mod 934 must be incorporated. Contacts must not be made if the contents of F4 tank are in excess of 700 kg.

5. *Wet Contacts.* For wet contacts additional conditions are:

WARNING 1: On aircraft without mod 854 embodied there is a significant risk of failure in F1 and F2 fuel gallery during refuelling.

WARNING 2: If, on aircraft pre-mod 934, contact is made with the FLIGHT REFUEL switch set to OUT and the tanker transfer flow is selected on, high surge pressures will occur which may cause damage to the refuel gallery.

a. Aircraft pre- and post-mod 685 and 854 are cleared for wet contact AAR in an operational emergency only. In addition they must comply with the following supplementary operating procedures:

(1) Immediately the rear group is full, select F1/F4 isolating switch to STOP and set the fuel transfer switch to REAR.

(2) Allow remaining tanks to fill.

(3) When approaching the end of the AAR operation select F1/F4 isolating switch outboard and break contact immediately F4 is full.

(4) Return the fuel transfer switch to AUTO.

b. On aircraft without mod 854 a failure in the F1 gallery is indicated initially by excessive fuel venting observed through the tanker periscope, or by adjacent aircraft. After breaking contact the failure is indicated by a decrease in the front group contents when the centre group pumps are feeding the collector tanks. If this failure is suspected the following procedures should be used until a repair has been effected:

(1) Carry out manual fuel balance as detailed in FRC.

(2) If further AAR is necessary break contact when the front group contents reach approximately 650 kg to prevent excessive pressures in the F1 tank.

Note: Some fuel should get through to centre and rear groups, but the amount will depend on the exact nature of the failure in F1 tank.

(3) During subsequent operation of the aircraft without AAR, CG control must be maintained manually or, if no drop tanks are fitted, the TRL valve may be closed and rendered inoperative.

c. Aircraft post-mods 854 and 934 are cleared for wet contact AAR subject to the following conditions:

(1) The FLIGHT REFUEL switch must not be operated whilst in contact with the tanker drogues.

(2) Planned transfers should be for not less than 200 kg.

(3) If the Jaguar drops back during the latter stage of a refuel bracket (all tanks indicated full), and the tanker green light is extinguished, contact is to be broken and not re-established until the contents of F4 tank have fallen by 100 kg.

(4) Single engine AAR using PTR is cleared for emergency use in the clean configuration.

Actions Before AAR

6. a. Check fuel contents and balance.

b. HF function switch OFF.

c. Check clear of drogue and tanker wake and No 1 and No 2 engine RPM stabilised (90 to 95%, non-reheat if possible).

Table 1—Practical AAR Ceilings

Aircraft Weight (kg)	*Power*	*C/L Hose Ceiling (feet)*	*Wing Hose Ceiling (feet)*	*Comments*
11,000	Dry	20,000	26,000	Thrust limited
	PTR	25,000	25,000	PTR operating limit
12,000	Dry	17,000	23,000	Thrust limited
	PTR	25,000	25,000	PTR operating limit
13,000	Dry	13,000	18,000	Thrust limited
	PTR	24,000	—	Thrust limited
	PTR	—	25,000	PTR operating limit
14,000	Dry	9000	15,000	Thrust limited
	PTR	19,000	23,000	Thrust limited
15,000	Dry	5000	11,000	Thrust limited
	PTR	16,000	20,000	Thrust limited

d. FLIGHT REFUEL switch ... ... OUT (dry contact)
REFUEL (wet contact)

e. No 2 engine TGT ... Check

f. AAR lights:

Red ... ... Out

Green ... ... On (not with OUT selected)

g. F1/F4 isolating switch ... ... Outboard

Note: When the FLIGHT REFUEL switch is in the OUT position it is not possible to transfer fuel from external tanks.

Engine Handling

7. The engine handling techniques and limitations under long range deployment conditions are given in para 3. Under normal AAR procedures, the techniques for PTR operation are:

a. Left engine in PTR, right engine in dry power; both throttles operated together (clean and centreline tank configurations).

b. Left engine at maximum dry power, right engine in PTR; only right throttle operated (centreline tank configurations).

c. Both engines in PTR; both throttles operated together (centreline tank and two underwing tank configurations).

Practical AAR Ceilings

8. Table 1 gives practical ceilings for refuelling to full in level flight. Altitudes are given in flight levels.

RV and Join

9. Without the use of reheat the Jaguar's lack of available power and low turning performance at altitude, require speeds to be as high as possible, particularly if the receiver will be required to turn. Magnetic headings should be used for RV and accompanied flight.

Stabilised Position

10. When cleared astern the tanker wait approximately 20 feet behind the drogue. As a guide to the vertical position, GEN should be selected on the HUD and the attitude display positioned just under the pod. Retrimming may be necessary, and the slip ball should be trimmed initially then the spoiler trim used as required. The aircraft is more lively when approaching for a left side contact.

Making Contact

11. Ensure manual slat is selected (to prevent cycling), extend the probe and trim the aircraft before moving to a position 5 to 8 feet astern the drogue. Monitor the HUD attitude display relationship to the pod. Rudder gearing may be selected to HI if the pilot wishes to reduce the foot loads. Synchronise speed and retrim. Contact is achieved by increasing power smoothly to achieve a 2 knot overtake speed. As the aircraft moves forward, wing station drogues move sharply outward prior to contact, however, the movement of the centreline drogue is less predictable. The drogue is well in view throughout the phase of closing up for contact, however, the pilot should position the aircraft with reference to the tanker. Overcontrolling will result if the aircraft is flown with reference to the drogue alone.

In Contact

12. Having obtained good contact adjust power to move forward until the middle of the amber section of the hose is approximately in the tunnel entrance. Maintain this position with the hose at the natural trail angle. Monitor fuel contents digital indicators, and if an abnormal full condition occurs select F1 F4 isolating switch to STOP to prevent an aft CG problem. There is a directional trim change associated with flight in contact which can either be trimmed out on the rudder trimmer or held on the rudder control. Slight variations in aircraft position relative to the tanker result in noticeable changes in trim.

13. Tanker wing stations should be used in preference to the centre station where possible. Engine rumble or pop surge on cancellation of PTR when refuelling from a centre hose may be alleviated by changing to a wing station or reducing altitude.

Breaking Contact

14. Reduce power slightly (approximately 2% per side) and withdraw the hose at a low rate (less than 5 feet/second) keeping the hose at the natural trail angle. Separation will occur at full trail. If the speed of withdrawal is excessive, a brake is automatically applied to the hose and premature separation occurs. This may delay refuelling of other receiver aircraft. Larger power reductions result in the receiver falling well behind the tanker, resulting in longer join up times.

Emergency Break

15. Reduce power to idle; do not extend airbrakes. When the rate of withdrawal exceeds 7 feet/second separation occurs.

Irregular Contacts

16. If an irregular contact occurs the pilot will see the problem easily, and early action will avoid complications. Occurrences sometimes met with during the approach and contact phase of AAR are:

a. *Soft Contact.* A soft contact, where the probe tip fails to mate properly with the hose coupling, may cause fuel to stream from the hose. This fuel spillage may result in contamination of the cabin conditioning system.

b. *Rim Contact.* A rim contact may slide into the drogue or bounce of the rim. A particularly violent rim contact may develop into a spokes contact.

c. *Spokes Contact.* If the probe pierces the drogue perihery or becomes entangled in the metal spokes, every effort should be made to withdraw directly astern to minimise damage. A high, low, or lateral withdrawal may damage the drogue and ingestion of damaged material into the right engine intake may occur.

Hose/Drogue Malfunctions

17. Structural failure of the hose or drogue may result in excessive fuel spillage. In this event, contact must be broken and the right engine monitored for signs of surge.

AAR with Autostabs Disconnected

18. a. With single channel failures, control of the aircraft is more sensitive. In calm conditions AAR presents no problems, but in conditions of strong turbulence pilot workload will be high and contact success rate could be low.

b. With more than one channel disengaged, AAR is possible in calm conditions but should not be attempted in strong turbulence.

Night AAR

19. Making contact and AAR at night presents no particular difficulty. Lighting is not good in these two aspects:

a. The probe light is too bright.

b. Difficulty may be found in adjusting the rheostat which controls both the 'g' meter and HDD incidence gauge lighting to a satisfactory balance of light.

Actions After AAR

20. a. FLIGHT REFUEL switch ... ... IN

b. No 2 engine TGT ... Check

c. Check ARR lights:

Green ... ... Out

Red ... ... On; then out when probe fully in

d. HF ... ... As required

e. Detotaliser ... ... Set to total fuel state

Note: If, when the FLIGHT REFUEL switch is selected to IN, the probe fails to retract or the AAR lights do not sequence correctly do not recycle.

PART 3 — HANDLING

CHAPTER 10 — OPERATION IN EXTREME CLIMATIC CONDITIONS

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LIMITATIONS

1. Refer to Parts 2A and 2B and to the appropriate Release to Service document for applicable aircraft and systems operating and temperature limitations.

COLD WEATHER OPERATION

General

2. The aircraft is capable of withstanding deep cold soaks at low ground temperatures without damage and, depending on certain limitations, is capable of satisfactory operation after being subjected to ambient ground temperatures down to minus 25°C, although the aircraft is not yet cleared to this temperature.

3. Depending on aircraft modification standard, specific cold weather problems which may be encountered are given in the following paragraphs. Where applicable, additional precautionary procedures are included and are complementary to those required for normal operation of the aircraft.

External Checks

4. In addition to the normal external checks given in the FRC, check the fuel jettison pipe outlet above the tailcone for signs of deterioration or cracking.

5. At temperatures below minus 10°C, the canopy counterbalance system rubber bungee cords progressively lose their effectiveness, leading to the possibility of fingers being trapped between the canopy and cockpit side.

Strapping-In

6. At temperatures below 0°C, it becomes increasingly difficult to insert the leg restraint line taper plugs into the seat pan sockets: leg restraint release is not affected.

7. At about minus 15°C, rudder pedal adjuster stiction can occur, preventing rudder pedal adjustment. However, this can be quickly rectified by the application of moderate heat from a warm air trolley.

Internal Checks

8. The oxygen gauging amplifier may give unreliable contents indications after cold soaking below minus 10°C. Pending further investigations, the LOX container must be weighed before each flight to ensure full contents.

Taxying

9. During cold weather trials, the aircraft was satisfactorily taxied on 4 to 6 inches of dry snow at

speeds up to 60 knots with no adverse handling characteristics or penetration of snow into landing gear bays or openings. Trials involving operation in wet snow or slush conditions have not been carried out and the aircraft is not yet cleared for take-off or landing in conditions of slush or snow.

Take-Off

10. In low temperatures, if engine throttle friction has not been preset on high limits before flight, throttle spring-back during take-off can be encountered at and below minus 15°C. If spring-back does occur, the throttles must be held firmly forward during take-off and subsequent climb to a safe height.

HOT WEATHER OPERATION

General

11. No problems should be encountered when operating in conditions of high ambient temperatures, providing the applicable operating limitations contained in Parts 2A and 2B are observed. Where appropriate, Parts 2A and 2B also include systems operating conditions as well as limitations, and they are therefore not repeated in this section. Unless otherwise stated, normal handling procedures and techniques should be used.

Pre-Start Checks

12. Carry out the normal external and internal checks and ensure that instruments, equipment and controls are dry.

13. In conditions where solar radiation is high and the ambient temperature exceeds +30°C, ensure that the canopy and windscreen are shaded; otherwise excessive cockpit temperatures will result and instruments may be damaged.

Taxying and Braking

14. Use of normal taxying and braking procedures should result in brake temperatures remaining within satisfactory limits. Excessive use of brakes should be avoided.

In Flight

15. Ensure that the cabin conditioning master switch is set to GROUND before take-off and when carrying out single engine approaches. If the conditioning is inadvertently left on, the effect reduces thrust and single engine climb performance significantly.

◀16. *Cockpit Misting or Fogging.* These effects and associated actions are given in Part 1, Chapter 8. ▶

17. *Engine Handling.* There are no handling problems when operating in high ambient temperatures; slam accelerations, relight and dry and reheat power operations remain satisfactory within the current operating envelope.

18. *Landing.* Aircraft handling during the landing phase is satisfactory and normal procedures should be followed. However in hot conditions more anticipation is required for the flare.

Performance

19. During take-off and the approach for landing, the aircraft's operating safety margins are much reduced in some circumstances; refer to the ODM for appropriate performance details.

PART 3—HANDLING

CHAPTER 11—OPERATION ON UNPREPARED SURFACES

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Taxying

1. Jaguar GR Mk 1 and T Mk 2 are cleared to taxy over grass and unprepared surfaces in all configurations, except those employing tandem carriers with stores other than Lepus flares. The maximum taxying speed is 15 knots but this is to be reduced to a walking pace when crossing from or to a metal surface or when carrying out a sharp turn. The minimum separation between aircraft in line astern is to be 150 metres. If an aircraft ahead uses reheat this separation is to be 300 metres. Taxying in line abreast is permitted providing caution is used when turning.

2. The maximum permitted continuous longitudinal gradient is 5% and lateral gradient 4%. Grass thickness or snow covering should not be great enough to conceal limiting obstructions. The aircraft is not to traverse wheel ruts or step heights in excess of 60 mm including the effect of any rut adjacent to the step. The ground must exhibit increasing strength with depth. Minimum California Bearing Ratios (CBR), measured using a cone penetrometer, are to be 2% at 75 mm depth and 4% at 150 mm depth. To evaluate ground strength the loading of an aircraft may be simulated with reasonable accuracy by a 4x4 ton GS truck loaded to a total weight of 8 tons. Such a vehicle should be used to evaluate potential taxying routes. Soft or damaged areas of ground may be repaired by filling and compacting to the level of the surrounding surface and laying a PSA patch using adequate ground anchors (Harrier landing pad retaining pins or similar items).

3. The Jaguar is easy to taxy on these surfaces. The good visibility from the cockpit enables the pilot to see easily any ground irregularities. High dry power settings (80 to 85% RPM) may be necessary to start moving on soft ground, but the power required to sustain momentum reduces as the aircraft gains speed. Directional control by the nosewheel steering is direct and positive, and the aircraft may be stopped by throttling the engines to idle alone or by throttling back together with an application of wheelbrakes. Slow the aircraft before crossing ruts and ground irregularities, avoiding completely steps and ruts in excess of 60 mm.

4. The aircraft is susceptible to regular ground undulations with a spacing of 3 to 10 metres. These undulations may start a resonant pitch and heave motion which, if unchecked, could result in structural damage or loss of control. Therefore, any pitch or heave motions must be eliminated by throttling back to idle and allowing the aircraft to slow down or stop. The use of brakes or nosewheel steering during such a motion is to be kept to a minimum.

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PART 3 — HANDLING

CHAPTER 12 — BANNER TARGET TOWING

(Issued at AL5)

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General

1. Both the Jaguar GR Mk 1 and T Mk 2 are cleared to tow the radar reflective 30 ft × 6 ft banner target from the brake parachute attachment. Target towing is prohibited when 3 drop tanks are fitted but the aircraft may carry any other symmetrical combination of drop tanks, bare pylons or CBLS. The overall length of the equipment is approximately 1040 feet, consisting of a standard parachute attachment lug, 5 inches of 20 cwt steel cable, 18 feet of 35 cwt steel cable, a target towing coupler, 40 feet of 35 cwt steel cable, a second target towing coupler, 900 feet of nylon rope, 50 feet of triple webbing strop and the banner assembly. The 5-inch length of 20 cwt steel cable provides a weak link so that after separation caused by excessive drag from the equipment, very little of the cable is retained. After a weak link separation it is not necessary to drop the remaining cable and shackle before landing; however, if the equipment separates at any other point, the remaining cable is to be released over the normal dropping or other designated area.

2. Because the brake parachute release is used to secure the banner equipment to the aircraft, no braking parachute is fitted in the target towing role. This will affect the calculations for take-off abort speeds, and landing distances.

Pre-Take-Off

3. Before starting up, the first 18 ft of steel cable and weak link back to the first target towing coupler are attached to the brake parachute release. Check that the towing cable is securely fitted to the release point and routed over the tailcone retaining claw, over the top of and round the leading edge of the tailplane and secured to the trailing edge by a pip pin. **Internal Checks** are normal except that the braking parachute handle is left fully out. Before commencing the after starting control checks, ensure that the groundcrew have disconnected the retaining pip pin and are holding the cable clear of the tailplane. The cable is reattached to the tailplane for taxying, consequently tailplane control movements must be kept to an absolute minimum until lined up on the runway with the cable disconnected from the tailplane and the banner handling party clear.

4. When cleared to enter the runway the pilot is marshalled to the correct position on the centreline, the 18 ft cable is disconnected from the tailplane and attached to the remaining cable and banner target. Leave the engines at idle power until attachment is complete, then taxy forward or allow the ground personnel to straighten the cable behind the aircraft before take-off power is applied.

5. Either drag-launch or snatch-launch take-offs may be made. For a drag launch the whole length of the cable is laid along the runway centreline with a consequent loss of over 1000 ft of the available runway. For a snatch launch the banner is positioned beside the aircraft and the cable laid in an 'S' shape behind. The 50 ft webbing strop and 50 feet of cable are positioned ahead of the banner in the direction

of take-off so that the cable will not drag the banner sideways or turn it over as the slack is taken up during the take-off roll. It is also necessary to have 350 feet of towline straight behind the aircraft to prevent jet efflux interference with the towline layout where it doubles back on the runway. During a snatch launch there is thus a loss of some 350 feet of the available runway.

Take-Off

Note 1: Take-off with a banner attached is prohibited from flooded runways or in heavy rain.

Note 2: The approach-end cable must be derigged for take-offs with a banner attached.

6. With the **Take-Off** checks complete, the engines are run up to full dry power in the normal way, reheat being selected on the roll. Maintain the runway centreline. The pilot is not aware of any reduction in acceleration as the cable becomes taut. Either the normal or the high incidence take-off technique may be used. Following lift-off, as the airspeed increases, incidence should be progressively decreased to 12° and held there until Air Traffic Control informs the pilot that the banner is airborne, after which normal climb rates and incidence can be established. Take-off distance is little affected by the drag of the banner; the ground run is increased by approximately 50 feet. The banner leaves the ground at about the same position as the aircraft when the above technique is used.

WARNING: When calculating the take-off distance from the ODM the pilot must take into account the runway lost at the beginning of the take-off roll because of the starting position, the fact that no brake parachute is fitted to assist an abort and also the distance the overrun cable is from the overrun threshold. With full internal and drop tank fuel the combination of temperature, wind velocity, runway length available and overrun cable position may make a full fuel configuration hazardous.

Crosswind Take-Off

7. There are no extra crosswind limitations on take-off when a banner is being towed off. There is no untoward behaviour of the banner in crosswind components as high as 13 knots, but care should be exercised on take-offs when the crosswind component exceeds 15 knots.

Engine Failure on Take-Off

8. The clearance of obstacles following an engine failure after lift-off will be reduced by the lower rate of climb available and by the droop of the banner below the aircraft's flight path (about 100 ft). For this reason the banner should be released immediately in the event of an engine failure after lift-off if such a failure occurs before a safe altitude has been reached. Normal safety speed actions will then apply.

Climb

9. Climb the aircraft in maximum dry power, 20° flap maintained, at 200 knots.

General Handling

10. The following limitations apply to flight with a banner attached:

a. *Speed.* The maximum speed is 250 knots except in an emergency. The weak link is designed to operate at 340 to 360 knots. If the banner is shot away or breaks off other than at the weak link, to avoid rope lashing the speed should be held below 200 knots until the cable can be released. Normal flap limiting speeds apply.

b. *Incidence.* The maximum incidence with a banner on tow is 12° (HUD) except during take-off with the flaps extended to 20°.

c. *Manoeuvre.* The maximum and minimum normal accelerations with a banner on tow are +1·5g and +0·5g respectively. Turns are to be limited to a maximum of 45° angle of bank.

d. *Centre of Gravity.* The centre of gravity limits for target towing are the same as those for the aircraft without a target.

e. *HF Operation.* The EMC aspects of making HF transmission with a banner attached have not been investigated: HF transmissions are, therefore, not to be made.

11. Handling with the banner on tow with 20° flap down is satisfactory, the banner having little noticeable effect apart from extra drag. Care must be taken not to exceed the maximum incidence in turns. The recommended towing speed is 220 knots, which gives a reasonable incidence margin when turning. Towing at 250 knots increases target wear and may cause some instability. With 20° angle of bank or more the banner can be seen in the rear view mirror.

12. Trim changes with a banner attached are similar to those experienced without the banner when landing gear, airbrakes or reheat are cycled.

Engine Failure in Flight

13. If an engine failure should occur in flight whilst towing at a high mass, reheat power on the operating engine should permit the pilot to maintain height until a suitable dropping area is reached. A single-

engine approach to land should not be made with the banner attached because of the limited overshoot capability. Normally, the banner should be jettisoned over a safe dropping area as soon as possible after an engine failure in flight.

Banner Release

14. The banner is released by pushing in the brake parachute handle. During the run-in to the dropping zone it should be remembered that the target droops approximately 100 feet below the height of the aircraft. Release should be made between 180 and 200 knots in straight and level flight with full flap selected (AL6). At the higher speed there is a possibility that the steel portion of the towing cable will kink in response to the sudden reduction in tension on release; to prolong the life of the cable it is recommended that releases should be made at 180 knots. When the banner is released or the weak link breaks there is a slight but unmistakeable acceleration as the load is lost.

Banner Release Failure

15. If the banner should fail to release after pushing in the brake parachute handle the pilot has two options: speed can be increased until the weak link operates at 340 to 360 knots and a normal landing made, or a landing may be made with the banner attached. In the former case the aircraft should be positioned over a suitably large dropping area before increasing the speed since the exact speed and therefore the precise position of weak link separation cannot be accurately forecast.

16. When forced to land with a banner attached, a 3° approach path should be adopted and the approach adjusted so that the landing is made 2000 feet down the runway. The banner's droop below the flightpath will cause it to touch down before the aircraft. When landing with a banner attached the pilot must take into account the lack of a braking parachute together with the loss of the first 2000 feet of runway and their effect on the landing run in the prevailing conditions. (It may also be necessary to consider the damage that will be caused to the runway when the banner strikes the ground and the position of both the upwind and downwind cables.)

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PART 4

EMERGENCIES AND MALFUNCTIONS

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PART 4

CHAPTER 1—EMERGENCIES INDEX

Contents

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General 1

General

1. All system malfunctions, malfunctioning drills, and emergency handling drills are covered in the appropriate chapters of the manual and in the Flight Reference Cards (FRC) as shown in the table below.

Emergency	*Part*	*Text Chap*	*Page*	*FRC*
ABANDONING				
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AIR CONDITIONING AND PRESSURISATION				
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Loss of cockpit conditioning	1	8	12	Card 7
Loss of pressurisation	1	8	12	Card 7
Smoke or fumes	1	8	12	Card 1R
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(continued)

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PART 4

CHAPTER 2—EMERGENCY PROCEDURES

(*Issued at AL 6*)

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General

1. Although system malfunctions are covered in the text of this Manual and in the FRC, considerations to be borne in mind and background information on certain emergencies are given in this Chapter.

DOUBLE ALTERNATOR FAILURE

Note: A total electrical failure, without CWP indications, can be caused by the inadvertent operation of the crash switches. In this case, to restore electrical supplies, set the crash switches forward (CWP now operative) and reset the alternators and TRU as necessary. No fire extinguishing facilities are available after the operation of the crash switches.

Indications

2. Double alternator failure is indicated on the CWP by the ALT1, ALT2, TR1 and TR2 captions coming on together with the flashing ALARM attention-getter and audio warning.

Immediate Actions

3. Having established a safe flight situation, it is important first to set both ALT switches to OFF thus ensuring that a malfunctioning alternator cannot be on line during attempts to reset the other. Then attempt to reset an alternator, making two attempts with each. If these initial attempts are unsuccessful, two further resetting attempts should be made on each alternator in turn with the *associated* engine RPM set between 80 and 85%. Throttling back to this range of RPM may assist since the lower RPM reduces the frequency (Hz) in the idling alternator, thus allowing the control and protection unit more chance of regulating the alternator output as it is reset.

4. As soon as one alternator resets it is important to leave the other at OFF, since an attempt to reset the second alternator may re-introduce the original double malfunction. When one alternator is regained, reset both TRU if necessary and land as soon as possible. If the reset alternator should subsequently trip off line, attempt to reset the other alternator; if the second alternator then resets, the first must be left at OFF.

Recovery with Double Alternator Failure

5. If neither alternator will reset, recovery is made on battery power with limited instruments, no fuel booster pumps and fuel feed problems. A landing should be made as soon as possible.

6. *Load Shedding*. To conserve battery life, the following services should be switched OFF as soon as possible:

NAVWASS
Main radio (use standby radio)
Pitot heaters (if not required)
External lights
Cockpit lights (if not required)
IFF
Recce pod
Select 100% oxygen

Selecting 100% oxygen off-loads the oxygen flow sensors. Further savings could be made by switching off the AJAX and DIFF TAIL, but these actions are not recommended unless there is a range problem to the nearest suitable airfield and therefore battery life is critical (see para 7). If AJAX and DIFF TAIL are switched off, they should be reselected on for approach and landing.

7. *Battery Life Considerations*. With a 95%-charged battery, and having shed non-essential

services, battery endurance is 1½ to 2 hours. Do not attempt to conserve battery power by switching off the BATT switch because:

a. Fuel pressurisation and transfer, TGT control and cockpit temperature control are lost.

b. High surge currents when switching ON the battery will consume more battery life than a controlled, steady-state discharge.

The state of the battery is assessed by monitoring the voltmeter. If it initially appears to be much lower than the expected 24 volts it can be assumed that the prospective life is shorter than the minimum of 1½ hours expected from a well-charged battery, and subsequent actions must be accelerated if possible. Below 21 volts various services are not guaranteed, eg normal gear lowering, flap operation and stores jettison. To conserve battery power avoid the constant and instinctive use of trim (use emergency pitch trim) and minimise standby radio transmissions.

8. *Engine Handling*. After double alternator failure the engines operate normally providing the battery is left on line and battery power is available. Reheat and PTR still operate if required and the TGT amps are still working through the static inverter. However, because of fuel feed problems (see para 10 to 13), it is advisable to fly at or close to the minimum drag speed to reduce the fuel usage rate. The best speed is 300 knots for drag indices between 0 and 10; this speed increases slightly at a higher drag index. Flying at this speed gives comfortable aircraft handling and reduces the rate of fuel consumption.

9. *Instruments and Navigation Aids*. It is obviously prudent, regardless of the expected battery life, to establish VMC below cloud as soon as practicable unless other considerations, such as fuel available and range to the airfield, dictate otherwise. On battery power alone the following instruments and navigation aids are available:

Attitude indicator (not T2 rear cockpit)
Head-down altimeter in S mode
CSI
VSI
E2 compass
Standby radio

Note: The turn and slip indicator is **not** available.

10. *Recovery and Landing*. Normally the flaps and landing gear should be lowered before battery voltage drops below 21 volts. If external stores are to be jettisoned, this should be done before the voltmeter drops below 21 volts. However, if range to the airfield and fuel availability combine to preclude gear lowering before this voltage, the gear can always be lowered on the emergency system. The head-down incidence indicator is available for the approach and landing whilst battery power is available.

Fuel Management After Double Alternator Failure

11. After double alternator failure the actions to manage the available fuel depend on the fuel state when the failure occurs. It should be noted that tanks N1, N2, F2, F3 and F4 are not subject to transfer pressure air.

12. *Centre Group Full*. If the wing and drop tanks have not finished feeding at the time of the failure, ie the gauged CENTRE fuel is reading approximately 870 kg or more, the fuel remaining in the wing and drop tanks is transferred direct to the collector tanks (N1 and N2) via the refuelling lines. This is achieved by selecting the transfer switch to CENTRE, the N1N2 switch to OPEN and the wing transfer switch to OPEN. These actions open valves RF1, RF3, RV1 and RV2 (see Part 1, Chapter 3, Fig 11). (Valve IC is also opened but this has no significance.) Fuel then feeds direct from the wing and drop tanks to the collector tanks under air pressure once the fuel in the N1/N2 tanks has dropped to level 3 (the level 2 INTER warning does not come on because the N1N2 switch is to OPEN). Since the wing and drop tank fuel and also the F1 tank fuel are subject to the same air pressure, the FRONT fuel indication may reduce if F1 fuel feeds first but the wing and drop tank fuel is always eventually available. Some of the wing/drop tank fuel may feed into the centre group, topping up the 20 kg which was used before normal drop tank transfer commenced. At the same time centre group fuel may feed to the collector tanks, by syphoning effect, along the normal transfer lines past the inoperative pumps. It should be noted, however, that if the centre group is completely full (910 kg) valve RF3 will close because the high level float switch overrides the fuel transfer panel switch selections. As the drop tanks empty, valves RL1 and RL2 close under the action of the tank low level float switches; when the wing tanks are empty their fuel/no air valves close. Therefore, once the drop tanks and wing tanks have finished feeding, there is no pressure along the refuelling lines. The remaining F1 fuel will then feed under air pressure into the collector tanks. To summarise, the fuel available after double alternator failure when the centre group is full is as follows:

Remaining wing and drop tank fuel
Front group fuel (707 kg)
Some centre group fuel depending on level head and syphoning effect.

Note: Tank F4 fuel cannot be transferred which may cause an aft centre of gravity problem as front group fuel is used.

13. *Centre Group Not Full*. If the double generator failure occurs after the wing and drop tank fuel has been used the centre group gauge indicates less than 870 kg, ie it is not full. In this situation no switching actions are necessary initially. F1 fuel feeds to tanks N1 and N2 under air pressure when the collector tanks have reduced to level 3. (The INTER light comes on as the fuel

level passes level 2; the N1N2 switch may be moved to OPEN to operate cock IC and extinguish the light, but this has no effect on the situation). At the same time some of the remaining F2/F3 fuel (if any) *may* feed along the normal transfer lines through the inoperative pumps by syphoning or gravity effect; as soon as the collector tank fuel level drops below level 1, the high level float valves are open in tanks N1/N2 and there is unpressurised space available in those tanks. When the FRONT fuel gauge reads approximately 230 kg the F1 tank is empty and only that 230 kg of collector tank fuel is guaranteed to feed. However, by selecting the transfer switch to CENTRE and the N1N2 switch to OPEN at this stage, valves RF1 and RF3 are opened thereby providing a second route along the refuelling lines to the collector tanks for any fuel remaining in the centre group. This centre group fuel can only feed by syphoning or gravity effect and is not guaranteed. Again, F4 fuel cannot be transferred. Therefore, with the centre group partially filled, the fuel available is the front group gauged fuel (707 kg if full) plus some centre group fuel by syphoning or gravity effect; if the centre group is empty, only the front group fuel is available.

14. Fuel cannot be dumped after a double alternator failure because the fuel transfer pumps are inoperative.

ENGINE OIL PRESSURE FAILURE

Indications

15. When engine oil pressure differential across the gearbox metering nozzles falls below approximately 10 PSI, the appropriate red OIL 1 or OIL 2 warning is lit on the CWP. The attention-getter and audio alarm are delayed for 10 seconds to avoid nuisance warnings which would otherwise occur during short periods of negative g.

Actions

16. If the oil warnings have been triggered by negative g, pressure is restored and the captions go out after returning to a positive g flight condition. However, if a warning remains on after returning to positive g flight, or if a warning occurs during normal flight, the associated engine must be shut down as soon as possible by putting the throttle to stop and the LP cock to CLOSED. Subsequently the crossfeed cock is selected OPEN and the aircraft landed as soon as practicable. The drill is in the FRC.

17. Although it is advisable to shut down as soon as possible to avoid engine damage, if the failure occurs during a critical stage of flight (eg below safety speed but above V-stop on take-off) the shut-down may be delayed by up to a maximum of 30 seconds whilst a safe flight regime is established. Delaying shut-down beyond that period may result in a catastrophic engine seizure. Therefore, when an oil warning occurs during a critical stage of flight, the engine is to be shut down without further delay as soon as a safe flight condition is reached.

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PART 5

ILLUSTRATIONS

PART 5

CHAPTER 1 — ILLUSTRATIONS

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General

1. This Part contains illustrations depicting the layout of the cockpit of the GR Mk 1 and the front cockpit of the T Mk 2. The layout of the rear cockpit of the T Mk 2 is illustrated in Supplement 1.

KEY TO FIG 1

LEFT CONSOLE AND SIDE WALL

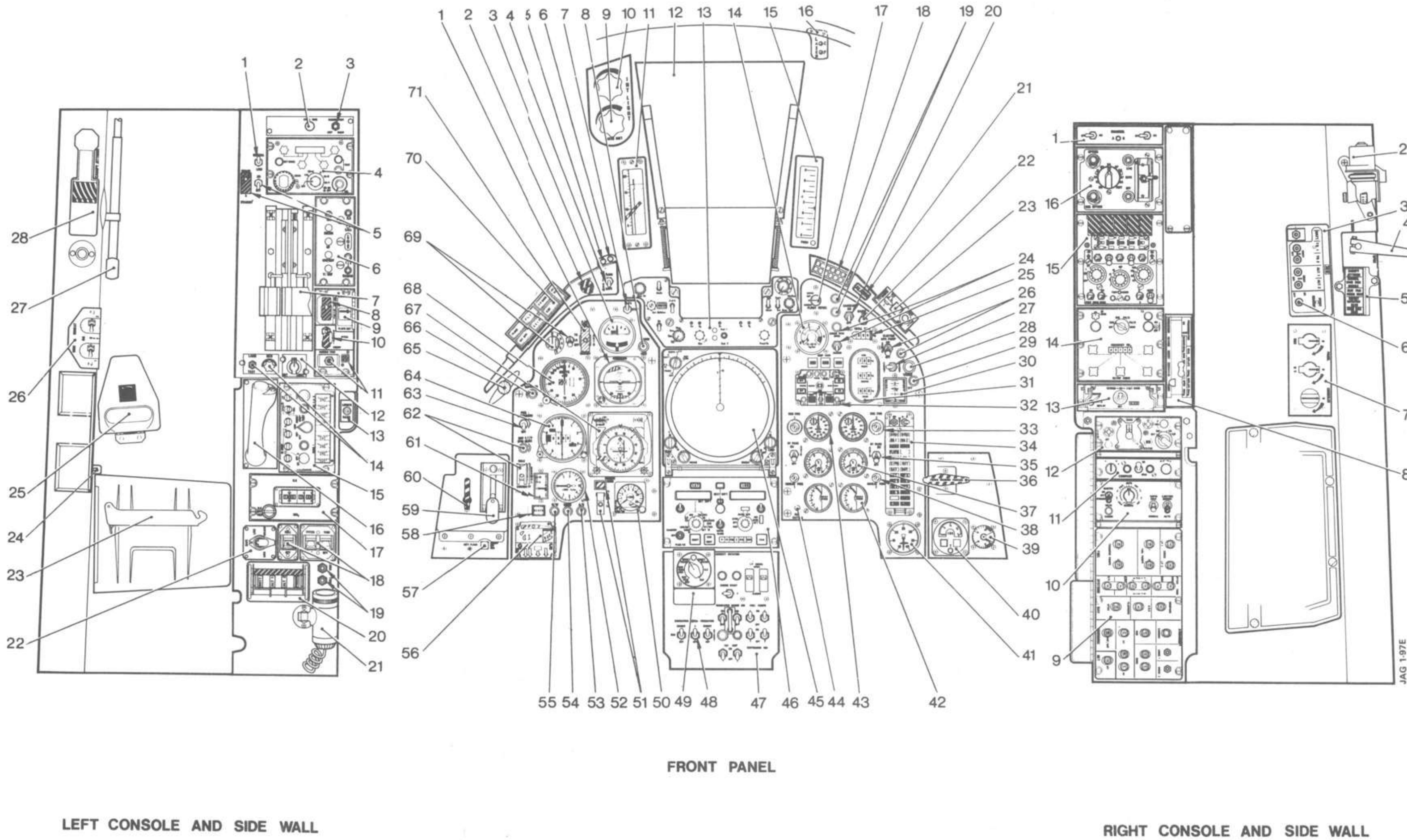
1 MUTE SENSITIVITY SWITCH
2 STALL WARNING BUTTON/INDICATOR
3 RUDDER TEST SWITCH
4 V/UHF CONTROLLER
5 STANDBY UHF SWITCHES
6 CCS CONTROLLER
7 THROTTLE BOX
8 SLAT OVERRIDE SWITCH
9 FLAP SELECTOR
10 PITCH TRIM NORMAL/EMERGENCY SELECTOR
11 RUDDER TRIM SWITCH AND INDICATOR
12 INTERNAL LIGHTS DIMMER
13 SEAT RAISE/LOWER SWITCH
14 LAND/TAXI LIGHTS SWITCH AND NCU DIMMER
15 IFF/SSR CONTROLLER
16 HAND CONTROLLER AND LASER COMMIT SWITCH
17 ILS CONTROLLER
18 AUTOSTABLISER SWITCHES
19 ROLL AND YAW TRIM CIRCUIT-BREAKERS
20 CRASH SWITCH
21 WANDER LAMP
22 MASTER ARMAMENT SAFETY SWITCH
23 PEC COVER STOWAGE
24 STALL WARNING INCIDENCE SELECTOR SWITCH
25 EXTERNAL LADDER WINDING HANDLE (INOPERATIVE)
26 PTR SELECTOR SWITCHES
27 ARRESTER HOOK HANDLE
28 CANOPY JETTISON HANDLE

FRONT PANEL

1 ATTITUDE INDICATOR
2 CLEAR AIRCRAFT JETTISON BUTTON
3 TURN AND SLIP INDICATOR
4 LATE ARM SWITCH
5 LOW ALTITUDE WARNING LIGHT
6 HEAD UP GEAR NOT DOWN WARNING LIGHT
7 F1/F4 REFUEL ISOLATION SWITCH
8 LASER TEST PUSH BUTTON
9 INCIDENCE INDICATOR LIGHT DIMMER
10 INTEGRAL LIGHTING DIMMER
11 INCIDENCE INDICATOR
12 HUD
13 HUD CONTROL PANEL
14 FUEL FLOWMETER
15 ACCELEROMETER
16 LASER INDICATOR LIGHTS
17 AIR-TO-AIR REFUELLING SELECTOR
18 PASSIVE WARNING RECORDER
19 AIR-TO-AIR REFUELLING LIGHTS
20 HUD CAMERA MASTER SWITCH
21 ATTENTION GETTER
22 FUEL GAUGE TEST BUTTON
23 SPECIAL WEAPON CONTROL PANEL
24 FUEL CROSSFEED SWITCH AND INDICATOR
25 FUEL DETOTALISER
26 EHP SWITCH AND INDICATOR
27 CONT/SERV SWITCH
28 TELEBRIEF INDICATOR
29 IFF FAILURE LIGHT
30 HYDRALICE PRESSURE GAUGE
31 FUEL CONTENTS GAUGE
32 FUEL TRANSFER PANEL AND DROP TANK INDICATORS
33 ENGINE FIRE WARNING BUTTON/INDICATORS
34 CWP
35 HYDRAULIC BYPASS SWITCHES (2)
36 BRAKES SELECTOR HANDLE
37 TGT INDICATORS (2)
38 REHEAT FIRE WARNING INDICATORS (2)
39 VOLTMETER
40 OXYGEN CONTENTS GAUGE
41 CABIN ALTIMETER
42 NOZZLE AREA INDICATORS (2)
43 PERCENTAGE RPM INDICATORS (2)
44 MAX RATING SWITCH
45 PROJECTED MAP DISPLAY
46 NAVIGATION MODE CONTROL PANEL
47 ENGINE SWITCH PANEL
48 EXTERNAL LIGHTS SWITCHES
49 HSI MODE SWITCH
50 RADAR ALTIMETER
51 RUDDER GEARING SWITCH AND INDICATOR
52 VSI
53 AIRBRAKE INDICATOR LIGHT
54 ARRESTER HOOK INDICATOR LIGHT
55 NOSEWHEEL STEERING INDICATOR LIGHT
56 SLAT/FLAP/LANDING GEAR POSITION INDICATORS
57 ANTI-DAZZLE LIGHTS SWITCH
58 COMBAT SLATS BUTTON/INDICATOR
59 LANDING GEAR SELECTOR
60 LANDING GEAR EMERGENCY SELECTOR
61 PITCH TRIM INDICATOR
62 DIFF TAIL PLANE SWITCH AND INDICATOR
63 FUEL JETTISON SWITCH
64 ALTIMETER
65 BRAKE PARACHUTE HANDLE
66 ILS MARKER LIGHT
67 HSI
68 CSI
69 LASER CONTROLS
70 WEAPON AIMING MODE SELECTOR PANEL
71 AJAX SWITCH

RIGHT CONSOLE AND SIDE WALL

1 TWO-CHANNEL SWITCH PANEL
2 STANDBY COMPASS
3 ELECTRICAL GENERATION SYSTEM CONTROLS
4 CANOPY LOCKING HANDLE
5 SAFETY PIN STOWAGE
6 PITOT HEATERS SWITCH
7 INTERNAL LIGHTS PANEL
8 CABIN AIR/DEMISTING CONTROLS
9 CIRCUIT BREAKER PANEL
10 AIR CONDITIONING CONTROL PANEL
11 COMPASS CONTROL PANEL
12 TACAN CONTROLLER
13 COCKPIT VOICE RECORDER
14 HF CONTROLLER
15 CONVENTIONAL WEAPON CONTROL PANEL
16 SPECIAL WEAPON FUZE CONTROL UNIT OR RECONNAISSANCE CONTROL PANEL



Part 5 Fig 1 GR Mk 1 Cockpit
◀ *LP Cocks and HYD BYPASS switches transposed* ▶

KEY TO FIG 2

LEFT CONSOLE AND SIDE WALL

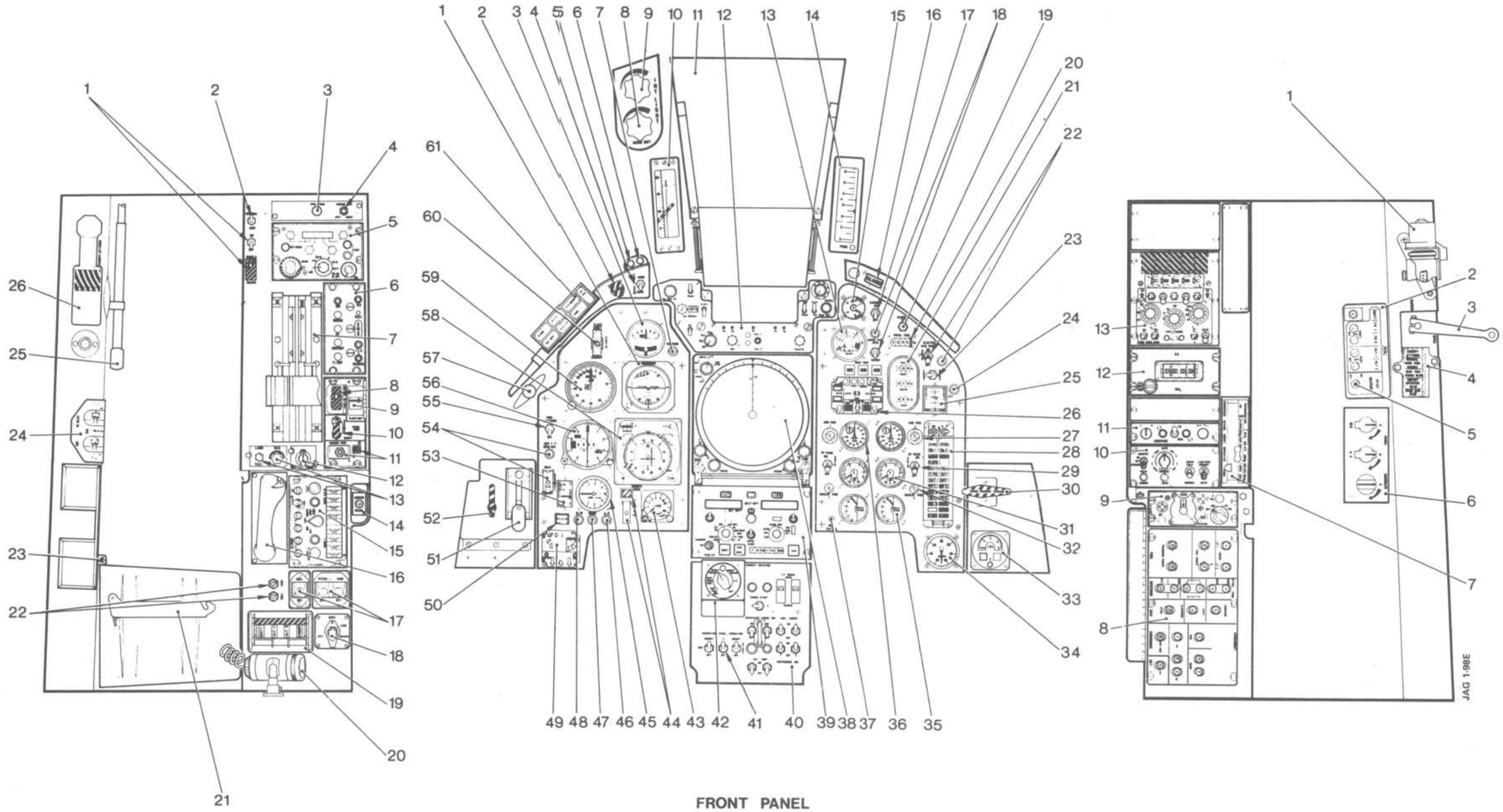
1 STANDBY UHF SWITCHES
2 MUTE SENSITIVITY SWITCHES
3 STALL WARNING BUTTON/INDICATOR
4 RUDDER TEST SWITCH
5 V/UHF CONTROLLER
6 CCS CONTROLLER
7 THROTTLE BOX
8 SLAT OVERRIDE SWITCH
9 FLAP SELECTOR
10 PITCH TRIM NORMAL/EMERGENCY SELECTOR
11 RUDDER TRIM SWITCH AND INDICATOR
12 INTERNAL LIGHTS DIMMER
13 LAND/TAXI LIGHTS SWITCH AND NCU DIMMER
14 SEAT RAISE/LOWER SWITCH
15 IFF/SSR CONTROLLER
16 HAND CONTROLLER
17 AUTOSTABILIZER SWITCHES
18 MASTER ARMAMENT SAFETY SWITCH
19 CRASH SWITCH
20 WANDER LAMP
21 PEC COVER STOWAGE
22 ROLL AND YAW TRIM CIRCUIT-BREAKERS
23 STALL WARNING INCIDENCE SELECTOR SWITCH
24 PTR SELECTOR SWITCHES
25 ARRESTER HOOK HANDLE
26 CANOPY JETTISON HANDLE

FRONT PANEL

1 ATTITUDE INDICATOR
2 CLEAR AIRCRAFT JETTISON BUTTON
3 TURN AND SLIP INDICATOR
4 LATE ARM SWITCH
5 LOW ALTITUDE WARNING LIGHT
6 HEAD UP GEAR NOT DOWN WARNING LIGHT
7 ILS MARKER LAMP
8 INCIDENCE INDICATOR LIGHTING DIMMER
9 INTEGRAL LIGHTING DIMMER
10 INCIDENCE INDICATOR
11 HUD
12 HUD CONTROL PANEL
13 FUEL FLOWMETER
14 ACCELEROMETER
15 VOLTMETER
16 ATTENTION-GETTER
17 HUD CAMERA MASTER SWITCH
18 FUEL CROSSFEED SWITCH AND INDICATOR
19 FUEL GAUGE TEST BUTTON
20 FUEL DETOTALISER
21 FUEL CONTENTS GAUGE
22 EHP SWITCH AND INDICATOR
23 CONT/SERV SWITCH
24 IFF FAILURE LAMP
25 HYDRAULIC PRESSURE GAUGE
26 FUEL TRANSFER PANEL AND DROP TANK INDICATORS
27 ENGINE FIRE WARNING BUTTON/ INDICATOR (2)
28 CWP
29 HYDRAULIC BYPASS SWITCHES (2)
30 BRAKES SELECTOR HANDLE
31 TGT INDICATORS (2)
32 REHEAT FIRE WARNING INDICATORS (2)
33 OXYGEN CONTENTS GAUGE
34 CABIN ALTIMETER
35 NOZZLE AREA INDICATORS (2)
36 PERCENTAGE RPM INDICATORS (2)
37 MAX RATING SWITCH
38 PROJECTED MAP DISPLAY
39 NAVIGATION MODE CONTROL PANEL
40 ENGINE SWITCH PANEL
41 EXTERNAL LIGHTS SWITCHES
42 HSI MODE SWITCH
43 RADAR ALTIMETER
44 RUDDER GEARING SWITCH AND INDICATOR
45 VSI
46 AIRBRAKE INDICATOR LIGHT
47 ARRESTER HOOK INDICATOR LIGHT
48 NOSEWHEEL STEERING INDICATOR LIGHT
49 SLAT/FLAP/LANDING GEAR POSITION INDICATOR
50 COMBAT SLATS BUTTON/INDICATOR
51 LANDING GEAR SELECTOR
52 LANDING GEAR EMERGENCY SELECTOR
53 PITCH TRIM INDICATOR
54 DIFF TAIL PLANE SWITCH AND INDICATOR
55 FUEL JETTISON SWITCH
56 ALTIMETER
57 BRAKE PARACHUTE HANDLE
58 HSI
59 CSI
60 AJAX SWITCH
61 WEAPON AIMING MODE SELECTOR PANEL

RIGHT CONSOLE AND SIDE WALL

1 STANDBY COMPASS
2 ELECTRICAL GENERATION SYSTEM CONTROLS
3 CANOPY LOCKING HANDLE
4 SAFETY PIN STOWAGE
5 PITOT HEATERS SWITCH
6 INTERNAL LIGHTS PANEL
7 CABIN AIR/DEMISTING CONTROLS
8 CIRCUIT BREAKER PANEL
9 TACAN CONTROLLER
10 AIR CONDITIONING CONTROL PANEL
11 COMPASS CONTROL PANEL
12 ILS CONTROLLER
13 CONVENTIONAL WEAPON CONTROL PANEL



LEFT CONSOLE AND SIDE WALL

FRONT PANEL

RIGHT CONSOLE AND SIDE WALL

Part 5 Fig 2 T Mk 2 Front Cockpit
◀ *LP Cocks and HYD BYPASS switches transposed* ▶

SUPPLEMENT No 1

JAGUAR T Mk 2 REAR COCKPIT

SUPPLEMENT No 1 TO JAGUAR AIRCREW MANUAL — BOOK 1

JAGUAR T Mk 2 REAR COCKPIT

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INTRODUCTION

1. This supplement gives details of the layout and the facilities provided in the rear cockpit of the Jaguar T Mk 2. Fig 1 shows the cockpit layout and identifies panels etc: Fig 6 at the end of this Supplement is a diagram of the controls and indicators in the cockpit. The following text gives details of the differences between the facilities in the front and rear cockpits and for convenience, is arranged in the same sequence as the chapters in Part 1 of the manual.

ELECTRICAL SYSTEM

Description

2. The electrical system controls consist of crash switches for the alternators and battery: alternator, TRU and battery control switches are not provided. Alternator, TRU and battery warning captions are on the CWP but there is no voltmeter.

Normal Use or Management

3. Before starting, check that the crash switches are all forward. As the checks proceed, note that the CWP captions go out in the expected sequence and ensure that all are out before take-off.

Malfunctioning or Use in Abnormal Conditions

4. In the event of an emergency on the ground, the crash switches may be operated from the front or rear cockpit. If electrical system failure warnings occur, monitor the actions of the occupant of the front cockpit.

FAILURE WARNING SYSTEM

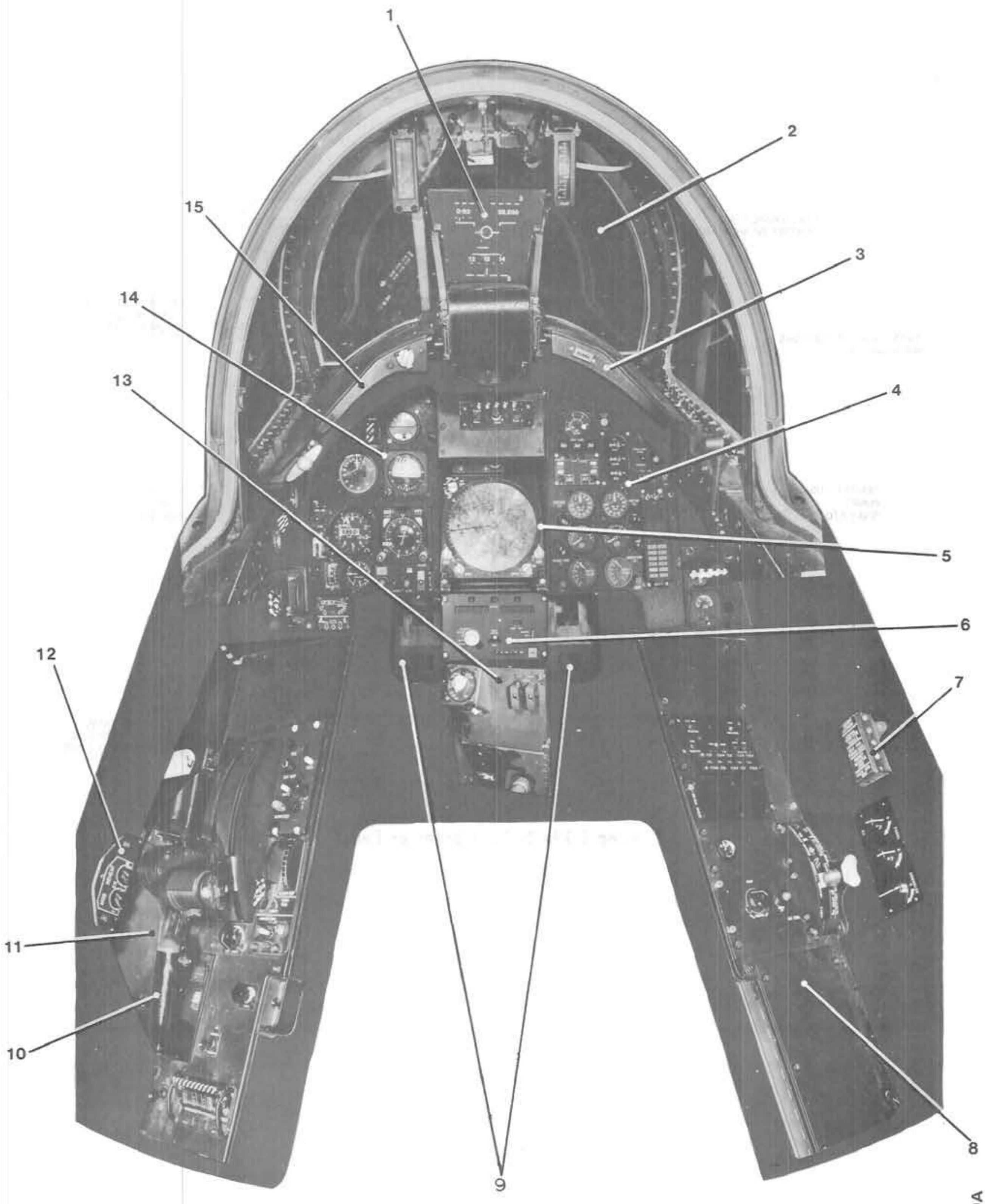
Description

5. The system controls and indicators are identical to those in the front cockpit.

6. Use of the test facility in either cockpit tests the warnings in both cockpits. Similarly, selecting MUTE in either cockpit mutes the appropriate warnings in both cockpits and both attention-getters remain on continuously. The N-D switch in the rear cockpit only dims the appropriate indications in that cockpit.

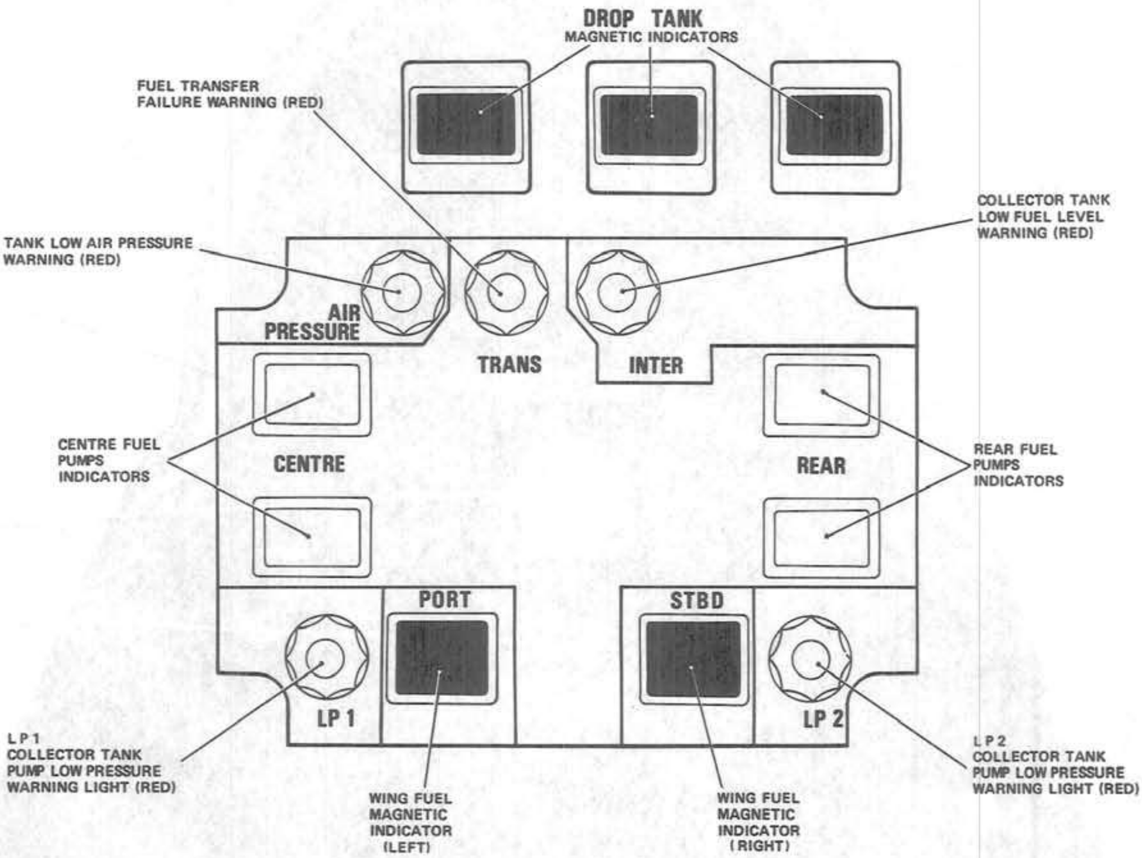
Normal Use or Management

7. On entering the cockpit and before starting the engines, set the TEST/ON/MUTE switch to ON and the N/D switch to D. Cancel the attention-getters and check that the correct warning captions are on for the condition of the aircraft. The system may be tested from either cockpit: when testing is complete, set the N/D switch as required. Before take-off ensure that all warnings are out.



1 HUD UNIT
2 WINDSCREEN
3 MAIN INSTRUMENT PANEL COAMING, RIGHT
4 MAIN INSTRUMENT PANEL, RIGHT
5 PROJECTED MAP DISPLAY
6 NAVIGATION CONTROL UNIT
7 RIGHT SILL
8 RIGHT CONSOLE
9 RUDDER BAR FOOT RESTS
10 HAND CONTROLLER
11 LEFT CONSOLE
12 LEFT SILL
13 CENTRE CONSOLE
14 MAIN INSTRUMENT PANEL, LEFT
15 MAIN INSTRUMENT PANEL COAMING, LEFT

Supp 1 Fig 1 T Mk 2 Rear Cockpit Layout



Supp 1 Fig 2 Fuel Transfer Panel

FUEL SYSTEM

Description

8. The only controls provided in the rear cockpit are the jettison button, the crossfeed valve switch, the LP cocks switches and the fuel contents test button. The indicators, which are identical repeaters of those in the front cockpit, consist of a fuel contents indicator, a fuel remaining digital indicator, a fuel flowmeter, a fuel transfer panel (Fig 2) and a crossfeed valve indicator light.

9. The jettison button allows all external stores to be jettisoned from the rear cockpit. The crossfeed valve switch is in parallel with that in the front cockpit so that, while the valve can be opened from either cockpit, both switches must be to CLOSED to close the valve. The LP cock switches are similarly wired so that all four switches must be to OPEN to start the engines. Pressing the fuel contents test button in either cockpit checks the indicators in both cockpits.

Normal Use or Management

10. *Cockpit Checks.* During the cockpit check, carry out the following:

a. Check that the LP cock switches are to CLOSED.

b. Check fuel tank contents. Press the GAUGE TEST button and check that the counters slowly move towards zero and return to the previous readings when the button is released.

c. Check that the TOTAL FUEL counters are set for the appropriate full state.

d. Check that the CROSSFEED switch is to CLOSED (light out). Select OPEN, check light comes on. Re-select CLOSED and check that the light goes out.

e. Check that the flowmeter reads 0-0.

f. Check the drop tank indicators for correct indication.

g. Check the fuel transfer panel as follows:

(1) AIR PRESSURE warning ... On

(2) TRANS light ... ... Out

(3) INTER light ... ... Out

(4) CENTRE and REAR pump indications ... ... OFF

(5) PORT and STBD wing fuel indicators ... ... Correct

(6) LP1 and LP2 warnings ... On

AL5.

h. Check that the ~~100 KG~~ (N1, N2) captions on the CWP are out and that the BP1 and BP2 captions are on.

11. *Before Starting.* Before starting the engines, set the LP cocks switches to OPEN.

12. *After Starting.* Monitor the starting and after-starting fuel system checks carried out by the pilot in the front cockpit. Compare flow indications with the front cockpit and monitor the fuel transfer panel throughout flight for correct indications.

Malfunctioning or Use in Abnormal Conditions

13. Jettison of all external stores can be made from the rear cockpit. If necessary, an engine can be shut down by means of the controls in the rear cockpit and the remaining engine cross-fed. In the event of other fuel system malfunctions, monitor the actions of the occupant of the front cockpit.

ENGINES

Description

14. The controls and indicators, and their location, are identical to those in the front cockpit, except for the engine starting panel. In respect of engine controls and indicators, this panel only includes an engine starter air valve open light and two LP shaft correct rotation lights.

15. The controls in the rear cockpit do not permit engine starting but provide control of engine power, relighting and operation on one engine. The throttles are interconnected with those in the front cockpit and move in unison: the latches and detents are identical in both cockpits.

Normal Use or Management

16. Before starting, ensure that the MOD REHEAT switches are OFF. During the start, monitor all engine parameters and check that the starter air valve and correct rotation lights operate normally and that the OIL 1 and OIL 2 captions go out.

Malfunctioning or Use in Abnormal Conditions

17. If necessary, an engine can be shut down and fire extinction attempted from the rear cockpit, and the serviceable engine subsequently operated in PTR.

18. In the event of engine malfunctions or emergencies, monitor the actions of the occupant of the front cockpit. Ignition cannot be separately selected from the rear cockpit but is automatically switched on by operation of the relight button.

HYDRAULIC SYSTEM

Description

19. No hydraulic system controls are provided in the rear cockpit and the only indicators consist of the HYD 1 and HYD 2 warnings on the CWP.

Normal Use or Management

20. As each engine is started, check that the associated warning caption on the CWP goes out. Throughout the flight, ensure that the HYD warnings remain out.

FLIGHT CONTROLS AND PILOTING AIDS

Description

21. *General.* The controls and indicators are identical to those provided in the front cockpit except that no autostabiliser switches or supply circuit breakers are fitted. The control columns and rudder pedals in the two cockpits are mechanically interconnected and move in unison. Switch functions relative to those in the front cockpit are given below.

22. *Switch Functions.* The flight controls switches in the rear cockpit operate as follows:

a. *Normal Trim Button.* Slide-type thumbswitch moving laterally for roll trim and fore-and-aft for pitch trim. Parallel operation with front cockpit switch. Opposing selections in the other cockpit result in no trim adjustment.

b. *Emergency Pitch Trim Switch.* Setting the switch guard to EMERGY (in either cockpit) disables both normal trim buttons and allows the emergency trim switch to take over pitch trimming. Opposing selections in the two cockpits results in no trim adjustment.

c. *Rudder Trim Switch.* Parallel operation with front cockpit switch. Opposing selections in the two cockpits results in no trim adjustment.

d. *Rudder Sensitivity Switch.* Selecting HI or LO overrides an opposite selection in the front cockpit. The aircraft is normally flown with both switches guarded to AUTO.

e. *Tailplane Differential Master Switch.* The rear cockpit switch has overall authority and can override a front cockpit selection of EMERGY or MAX by opposite selection. However, if after an incorrect selection, the front cockpit switch is not returned to NORMAL, re-setting of the rear cockpit switch to NORMAL allows the front cockpit switch to resume authority.

f. *Ajax Artificial Feel Master Switch.* Parallel operation with front cockpit switch. Setting either switch to EMERGY de-clutches the normal motor and computer; a second motor drives the Ajax system to a fixed emergency setting.

Normal Use or Management

23. While strapping in, adjust the rudder pedals to the leg reach required.

24. Check that the emergency pitch trim switch is guarded NORMAL, the rudder gearing master switch is guarded to AUTO, the tailplane differential master switch is guarded at NORMAL and the Ajax master switch is guarded to AUTO. Press to test the tailplane maximum differential light. Confirm that the tailplane differential master switch is able to override the front cockpit switch: return the switch to NORMAL and set the guard. Check that the rudder sensitivity indicator shows a large triangle.

25. Check that the trimmers, including the emergency pitch trim, operate in the correct sense. Operate the primary controls over their full range of travel, checking for freedom of movement, normal forces and self-centring.

26. *Before Take-Off.* Check the trim settings and that the rudder sensitivity indicator shows a large triangle. Ensure that the AJAX, STAB and DIFF warnings are out.

27. *In Flight.* When the landing gear locks up after take-off, check that the RUDDER SENS indication changes to a small triangle. If training procedures require that switch settings other than the normal selections are made, ensure that normal facilities are fully restored before proceeding with other exercises. When the landing gear is extended before landing, check that the RUDDER SENS indication changes to a large triangle.

Malfunctioning or Use in Abnormal Conditions

28. *General.* With the exception of those procedures requiring operation of the autostabiliser switches and circuit breakers, all flight control system malfunctions can be dealt with equally from the front or rear cockpit.

OTHER AIRCRAFT CONTROLS

Description

29. *General.* The slats, flaps and airbrakes controls and indicators in the rear cockpit are similar to those in the front cockpit except that no auto combat slats button, slats override switch or circuit breakers are fitted: an airbrakes override switch is provided. The landing gear, brake parachute and arrester hook controls are identical in both cockpits except that the circuit breaker is only fitted in the front cockpit and the rear cockpit brake handle cannot be locked for parking.

30. *Slats Control.* Combat slats can be selected out or in by means of the throttle switches, and override the slat operation resulting from use of the auto combat slats button in the front cockpit.

31. *Flaps Control.* Front and rear cockpit flap controls are interconnected and move together. No provision is made for overriding the slats sequence switches.

32. *Airbrakes Control.* An AIRBRAKES override control is on the left console. When the switch is selected from NORMAL to OVERRIDE, the front cockpit airbrakes rocker switch becomes inoperative and the airbrakes can only be controlled from the rear cockpit. With the switch to NORMAL, the rocker switch in either cockpit may be operated provided both are initially neutral. If one rocker switch is operated and not returned to neutral, the switch in the other cockpit is inoperative.

33. *Configuration Test Panel.* Pressing the TEST button in either cockpit tests all the lights on both panels.

Normal Use or Management

34. *External Checks.* Before entering the cockpit, check that all ground safety pins or locks have been removed.

35. *Internal Checks.* Ensure that all safety pins attached to the security cord are removed and the cord stowed. Check the airbrakes override switch and leave set to NORMAL. Test the lights on the configuration indicator by pressing the TEST button. Confirm that the landing gear emergency lowering ◀handle is fully forward and wired. Ensure that the brake parachute handle latch is fitted in accordance with current SOP. Check that the airbrake light is▶ on and the hook and nosewheel steering lights are out: press-to-test.

36. *After Starting.* With the engines running, confirm that the landing gear red indicator is out. Before taxying, check nosewheel steering and brakes operation: both brake handles must be forward to obtain normal braking.

37. *Take-Off and During Flight.* At take-off, check that nosewheel steering disengages and that the landing gear indicators cycle correctly during retraction. If necessary during flight, the airbrakes can be selected manually by use of the throttle buttons, with the AIRBRAKES override switch to NORMAL or OVERRIDE as required. Monitor the combat slat indicator for correct automatic operation.

38. *Landing.* Before, during and after landing, monitor operation of the slats, flaps, landing gear, brake parachute wheelbrakes and nosewheel steering for correct operation. Before shutdown, confirm that the airbrakes are open.

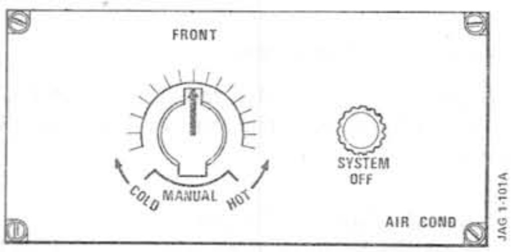
Malfunctioning or Use in Abnormal Conditions

39. Except for those procedures which require operation of the auto combat slat button, the slat override switch or the circuit breakers, system malfunctions and failures can be dealt with equally from the front and rear cockpits.

AIR CONDITIONING AND PRESSURISATION

Description

40. *General.* No cockpit altimeter is fitted and the air conditioning control panel differs from that in the front cockpit: the remaining controls and indicators are the same. The rear cockpit control panel is shown on Fig 3.



Supp 1 Fig 3 Air Conditioning Control Panel

41. *Air Supply and Temperature Control.* Indication that the main pressure regulating valve is closed is given by the SYSTEM OFF light on the control panel. When the light is out, the occupant of the rear cockpit can take over control of conditioned air temperature by rotating the knob on the control panel from FRONT to MANUAL: in this position it is spring-loaded to a neutral (central) position. Air temperature is then controlled by making selections of HOT or COLD to reposition the temperature control valves. Selection of MANUAL is indicated in the front cockpit by the light marked REAR on the air conditioning control panel, which comes on when manual temperature control has been selected in the rear cockpit.

42. *Distribution and Pressurisation Control.* The canopy locking lever operates separately from that in the front cockpit but it is necessary for both levers to be in the 'canopy locked' position before either canopy seal can be inflated or air conditioning turned on. The cabin air and demisting control levers in the front and rear cockpits are interconnected, thus, cockpit air distribution and demisting can be controlled by either cockpit. If either canopy locking lever is in the 'canopy unlocked' position, or if cockpit altitude exceeds 27,000 feet, the C/PR ~~(PRESS)~~ warning appears on the CWP in each cockpit.

Normal Use or Management

43. *Before Starting.* Check that the temperature control knob is to FRONT and the SYSTEM OFF light is on. Set the demisting control to CABIN and the cabin air lever fully forward (with canopy closed).

44. *Before Take-Off.* Close and lock the canopy: check that the C/PR ~~(PRESS)~~ caption is out (both canopies locked) and confirm that the SYSTEM OFF light is on.

45. *After Take-Off.* As the air conditioning is turned on, check that the SYSTEM OFF light goes out and that cabin differential pressure builds up.

46. *Landing.* Check that when the air conditioning is turned off the SYSTEM OFF light comes on. Ensure that the cabin air lever is fully back before unlocking the canopy.

Malfunctioning or Use in Abnormal Conditions

47. In the event of air conditioning or pressurisation failures, monitor the actions of the occupant of the front cockpit. If temperature cannot be controlled from the front cockpit, set the rear control knob to MANUAL and attempt selections of HOT or COLD as required to restore the required temperature.

FLIGHT INSTRUMENTS

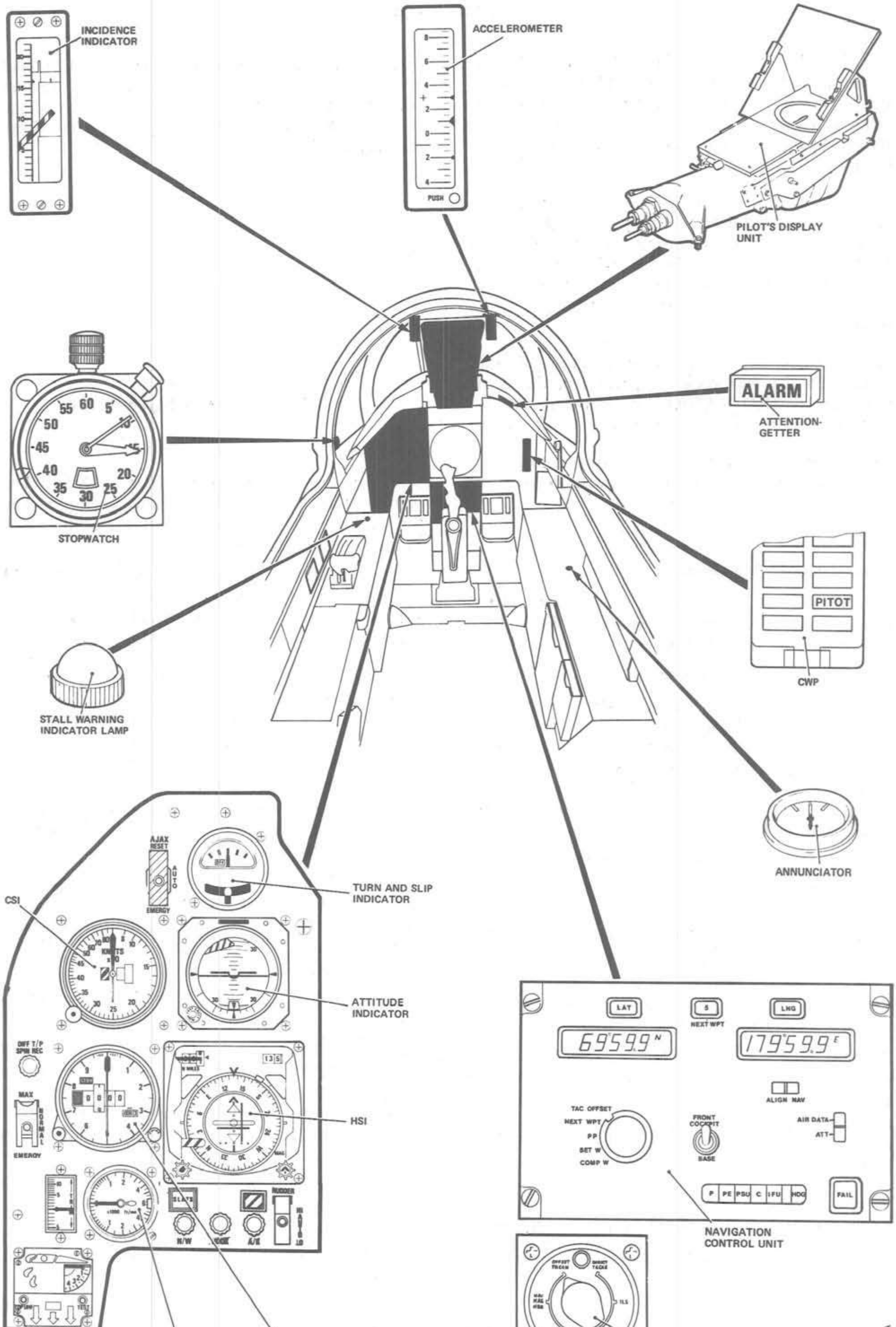
Description

48. *General.* Controls and indicators are shown on Supp 1 Fig 4. Features specific to the rear cockpit are covered in the following paragraphs.

49. *Gyro Heading and Attitude Reference.*

a. *C2J Compass.* The C2J gyro-magnetic compass cannot be controlled from the rear cockpit but an annunciator is provided on the right console to give remote indication of compass synchronisation.

b. *HSI Mode Switching.* Selection of a 'computer' mode ie NAV TRUE HDG, NAV MAG HDG or OFFSET TACAN on the HSI mode switch in the front cockpit overrides the selection of any 'computer' mode in the rear cockpit and both HSI display the presentation selected from the front cockpit. Selection of a 'direct' mode ie DIRECT TACAN, ILS or UHF in either cockpit slaves the associated HSI independently to the selected service. When the selection on the rear cockpit HSI mode selector coincides with that in the front cockpit, a green light on the rear cockpit selector comes on.



Supp 1 Fig 4 Flight Instruments — Controls and Indicators

50. *Pitot-Static System.* Control of probe heating is not provided but an amber PITOT caption on the CWP indicates heating failure of the pitot-static probe or either pitot probe. Pressure sources for the instruments in the rear cockpit are shown in Part 1, Chapter 9.

51. *Incidence Installation.* The incidence indicator is connected direct to the probe but the HUD presentation of incidence is via the HUD waveform generator and is selected by the switch in the front cockpit. A STALL WNG light at the forward end of the left console is a repeater of the light in the front cockpit.

52. *Radar Altimeter.* The only indication of radar altitude in the rear cockpit appears on the HUD when the BARO/RADIO switch on the pilot's control panel in the front cockpit is set to RADIO.

53. *Standby Compass.* No standby compass or associated deviation card is provided in the rear cockpit.

Normal Use or Management

54. When the C2J compass is set to MAG set the rear cockpit HSI mode switch to DIRECT TAC and observe synchronisation.

55. During the internal checks:

a. Set the QFE on the altimeter, switch to R and check that the indication is 0 ± 35 feet. Check the altimeter readings in the reset and standby modes and ensure the readings agree. When the HUD is selected to display BARO height, check that the HUD indication agrees with the altimeter (selected to R).

b. Check the functioning of the HSI and set as required.

c. Check the condition of the VSI and accelerometer and check that the stopwatch is wound and set.

d. Check the condition of the CSI, attitude indicator, turn-and-slip indicator and incidence indicator and that all flags are clear.

56. While taxying, check the operation of the turn-and-slip indicator. Before take-off, check that when the pitot probe heaters are switched on, the PITOT caption on the CWP goes out. Check that all instrument indications are normal. Reset the accelerometer.

Malfunctioning or Use in Abnormal Conditions

57. In the event of malfunctions in the instrument display, cross-check with the corresponding indications in the front cockpit. Since the CSI and altimeter in the rear cockpit utilise different pressure sources to those in the front cockpit, failure of the latter can be overcome by flying the aircraft from the rear cockpit.

COMMUNICATIONS EQUIPMENT

Description

58. *Communications Control System (CCS).* The rear cockpit CCS controller is shown on Fig 5. The functions and facilities provided by the controls and indicators are as follows:

a. *NORM/SBY Selector Button.* With NORM selected, the rear cockpit mic/tel is connected to the main V/UHF set or standby UHF set as selected in the front cockpit. When SBY is selected, provided either the V/UHF or SBY UHF is selected in the front cockpit, the front and rear press-to-transmit and modulation facilities are connected exclusively to the standby UHF set. If no selection is made on the front cockpit CCS controller, the front cockpit volume control facilities are not available to the standby UHF.

b. *SBY UHF Light.* An amber light which comes on when UHF/SBY is selected at the front cockpit CCS controller (the light may have a rotating N-D cover).

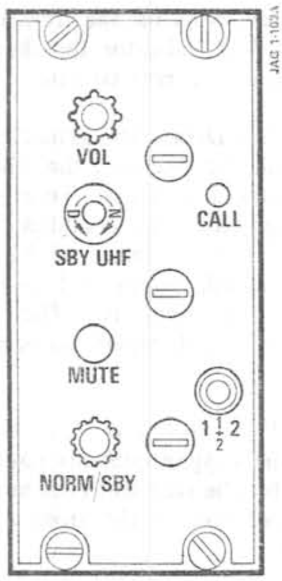
c. *MUTE Button.* The MUTE button enables the rear crew member to mute all audio signals from the main V/UHF and standby UHF receivers, to both crew members.

d. *VOL Control.* Adjusts the level of all audio signals (except centralised warning audio) to the rear cockpit tels.

e. *CALL Button.* The CALL button allows the rear crew member to speak to the front crew member at high volume even if the front cockpit INT control is turned to low volume. The button is held and pressed while speaking.

f. *1/1+2/2 Switch.* Separate control of rear CCS amplifiers as for front cockpit.

g. *Panel Lamps.* Lighting of the controller is by three red panel lamps supplied by 28 V DC and controlled by the cockpit lighting dimmer.



Supp 1 Fig 5 Rear Cockpit CCS Controller

59. *CCS Associated Controls*

a. *Press-to-transmit Button.* Located on the control column handgrip.

b. *Mute Button.* A second mute button, having a similar function to the CCS controller MUTE button is on the front face of the left throttle.

60. *V/UHF Installation.* The V/UHF controller is in the front cockpit and the rear cockpit crew member can only transmit and receive on the selected frequency when his NORM/SBY switch is to NORM.

61. *Standby UHF.* The standby UHF controller is in the front cockpit but setting the NORM/SBY switch on the rear cockpit CCS controller to SBY with the standby UHF switched on connects both sets of mic-tels to the standby UHF set.

62. *IFF/SSR Installation.* The controller is in the front cockpit but a duplicate IFF failure light is on the right instrument panel of the rear cockpit.

Normal Use or Management

63. Check the system before flight as follows:

a. Set the NORM/SBY switch to NORM, the VOL control to mid position and the amplifier switch to 1+2.

b. Check the operation of both amplifiers, then leave 1+2 selected.

c. Operate the CALL button to check its override capability.

d. When V/UHF inputs are available, check the operation of both mute switches.

e. When the standby UHF is selected to channel A, set the NORM/SBY switch to SBY and check operation of the standby UHF with cut-out of the main V/UHF. Return the switch to NORM.

f. Check operation of the IFF failure warning light during switch-on and testing.

Malfunctioning or Use in Abnormal Conditions

64. *CCS.* If interference occurs on the communications system try single amplifier (1 or 2) operation. If the interference is on front and rear circuits it may be possible for the front crew member to clear the fault.

65. *Standby UHF.* To make an emergency call from the rear cockpit, check that the SBY UHF light is on, set the NORM/SBY switch to SBY and make the call in the normal manner.

COCKPIT EQUIPMENT

Description

66. *General.* The rear cockpit canopy controls and indicators are identical to those in the front cockpit: separate external handles are provided for each canopy. Identical control column handgrips and external stores jettison buttons are fitted in each cockpit. Internal lighting facilities are detailed below. No external lighting controls are fitted.

67. *Rear Cockpit Floodlighting.* This is similar to the front cockpit except that only one lamp unit is provided above the right console.

68. *Panel Integral and Additional Lighting.*

a. *Integral Lighting.* An INT LIGHT dimmer on the left console controls integral lighting on the left and right consoles and the HSI mode switch and the intensity of three red lamps which illuminate the forward portion of the left console.

b. *Additional Lighting.* An NCU dimmer on the left console controls lighting of the NCU. Two ON/OFF dimmers on the left support of the windscreen control dimming of the incidence indicator (internal lights) and variable lighting of the incidence indicator, the accelerometer and the stopwatch.

Normal Use or Management

69. Before flight, adjust lighting intensity as required. Ensure that the canopy jettison firing unit sear pin is stowed during the seat checks and replaced in the sear after landing. The canopy must be held firmly closed before the locking handle is moved forward: check that with the canopy locked, the C/PR (PRESS) caption on the CWP is out.

PILOT EQUIPMENT AND ASSOCIATED SYSTEMS

Description

70. *General.* The front cockpit is fitted with a Type 9B1 Mk 2 seat and the rear cockpit with a Type 9B2 Mk 2 seat. The seats are not interchangeable and are marked FRONT and REAR respectively. The rear seat has a reduced firing delay. The oxygen and anti-g system is as for the front cockpit except that a remote flow indicator for the front cockpit system is fitted in the rear cockpit.

71. *Ejection Seat Delay.* The assisted escape system is designed with the intention that the occupant of the rear seat should eject first. To ensure this, even if the seat firing handles are operated simultaneously, the rear seat fires a minimum of 0·25 second after the handle is pulled, as opposed to a minimum of 0·35 second for the front seat. The front and rear seats are ejected on divergent trajectories to avoid collision.

72. *Oxygen Flow Indication.* A flow blinker is fitted beside the oxygen contents gauge in the rear cockpit to enable the rear seat occupant to check for satisfactory operation of the front crew member's oxygen system.

Normal Use or Management

73. During the pre-flight checks of the rear cockpit, check that the oxygen flow blinker for the front cockpit indicates normal operation. Check that all pins are stowed before take-off and that the seat is made 'safe for parking' after shutdown and before leaving the cockpit.

Fig 6 and key overleaf

KEY TO SUPP 1 Fig 6

LEFT CONSOLE AND SIDE WALL

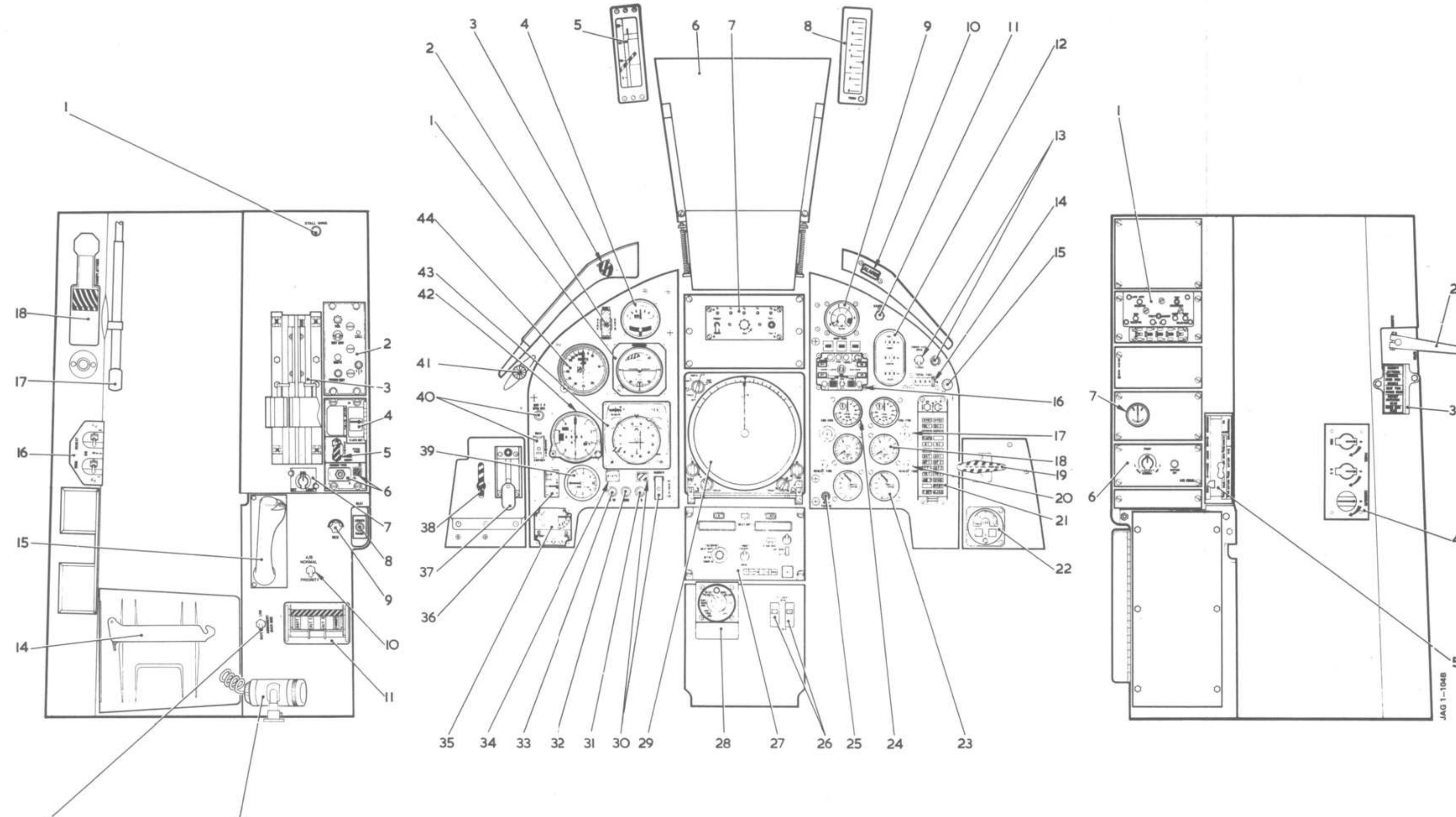
1 STALL WARNING INDICATOR
2 CCS CONTROLLER
3 THROTTLE BOX
4 FLAP SELECTOR
5 PITCH TRIM NORMAL/EMERGENCY SELECTOR
6 RUDDER TRIM SWITCH AND INDICATOR
7 INTERNAL LIGHTS DIMMER
8 SEAT RAISE/COVER SWITCH
9 NCU DIMMER
10 AIRBRAKE PRIORITY SWITCH
11 CRASH SWITCH
12 WANDER LAMP
13 ARMAMENT OVERRIDE SWITCH
14 PEC COVER STOWAGE
15 HAND CONTROLLER
16 PTR SELECTOR SWITCHES
17 ARRESTER HOOK HANDLE
18 CANOPY JETTISON HANDLE

FRONT PANEL

1 ATTITUDE INDICATOR
2 AJAX SWITCH
3 CLEAR AIRCRAFT JETTISON BUTTON
4 TURN AND SLIP INDICATOR
5 INCIDENCE INDICATOR
6 HUD
7 HUD CONTROL PANEL
8 ACCELEROMETER
9 VOLTMETER
10 ATTENTION-GETTER
11 FUEL GAUGE TEST BUTTON
12 FUEL CONTENTS GAUGE
13 FUEL CROSSFEED SWITCH AND INDICATOR
14 FUEL DETOTALISER
15 IFF FAILURE LIGHT
16 FUEL TRANSFER PANEL AND DROP TANK INDICATORS
17 ENGINE FIRE WARNING BUTTON INDICATORS (2)
18 EGT INDICATORS (2)
19 BRAKE SELECTOR HANDLE
20 REHEAT FIRE WARNING INDICATORS (2)
21 CWP
22 OXYGEN CONTENTS GAUGE
23 ◀ NOZZLE AREA INDICATORS (2)
24 PERCENTAGE RPM INDICATORS (2)
25 MAX. RATING INDICATOR ▶
26 LP COCKS SWITCHES
27 NAVIGATION MODE CONTROL PANEL
28 HSI MODE SWITCH
29 PROJECTED MAP DISPLAY
30 RUDDER GEARING SWITCH AND INDICATOR
31 AIRBRAKE INDICATOR LIGHT
32 ARRESTER HOOK INDICATOR LIGHT
33 NOSEWHEEL STEERING INDICATOR LIGHT
34 COMBAT SLATS BUTTON/INDICATOR
35 SLAT/FLAP/LANDING GEAR POSITION INDICATOR
36 PITCH TRIM INDICATOR
37 LANDING GEAR SELECTOR
38 LANDING GEAR EMERGENCY SELECTOR
39 VSI
40 DIFF TAIL-PLANE SWITCH AND INDICATOR
41 BRAKE PARACHUTE HANDLE
42 ALTIMETER
43 HSI
44 CSI

RIGHT CONSOLE AND SIDE WALL

1 ARMAMENT MONITOR PANEL
2 CANOPY LOCKING HANDLE
3 SAFETY PIN STOWAGE
4 INTERNAL LIGHTS PANEL
5 CABIN AIR/DEMISTING CONTROLS
6 AIR CONDITIONING CONTROL PANEL
7 COMPASS ANNUNCIATOR



FRONT PANEL

LEFT CONSOLE AND SIDE WALL

RIGHT CONSOLE AND SIDE WALL

Supp 1 Fig 6 Rear Cockpit – Controls and Indicators