AP 101B-1003,
5 & 6-15A

OC13

LIGHTNING F Mk 3, T Mk 5 & F Mk 6

AIRCREW MANUAL

BOOK 1 - AIRCRAFT

RESTRICTED

LIGHTNING
F Mk 3, T Mk 5 and F Mk 6

AIRCREW MANUAL

BOOK 1—AIRCRAFT

BY COMMAND OF THE DEFENCE COUNCIL

Clive Whitmore.

Prepared by the Procurement Executive, Ministry of Defence

NOTES TO USERS

1. This Manual is complementary to the Lightning F3, T5, F6 — Aircrew Manual Weapon System (AP 101B-1003, 5 & 6-15B) and to the Lightning F3, T5, F6 Flight Reference Cards (AP 101B-1003, 5 & 6-14).

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

Preliminary Matter
Part 1 — Description and Management of Systems
Part 2 — Limitations
Part 3 — Handling
Part 4 — Emergencies 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 3 is Page 3 of Part 1, Chapter 3.

3. All Parts of this Manual relate to the Lightning F Mk 3, T Mk 5 and F Mk 6, any differences being identified as necessary in the text.

4. The limitations given in Part 2 are mandatory. Instructions in other Parts containing the words 'is to' or 'are to' are also mandatory.

5. The Manual and the 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 to 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 symbols positioned in the text thus: ◀.........▶ or thus ◀▶.........◀▶ to show the extent of new or amended text and thus ▶◀ or thus ◀▶ ◀▶ to show where text has been deleted. The number of the Amendment List by which a sheet was initially issued or re-issued will appear at the bottom of the odd-numbered pages and any symbols 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 symbols 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.

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 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 Manual, 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 AL No and insert the date of incorporation.

AL No.	AMENDED BY	DATE
1	R R Ad	12 May
2	R R Adams	25 Nov
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ANA 1 and 2 are already incorporated.

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MODIFICATION NUMBERS MENTIONED IN THE TEXT

Mod No	*Brief Description*	*Location of Details* *Part*	*Chap*	*Para*
2459	Deletes fuel recuperators	1	2	9
4212	Introduces triple pressure gauge (F Mk 6)	1	6	25
4682	Introduces Mk 6 brake units (F Mk 3, T Mk 5)	3	2	16
4846	Introduces radar altimeter (F Mk 3, F Mk 6)	1	7	45
SEM/031/STC	Introduces dimmer switch for the rad alt warning light (in control knob) and repositions remote low height warning light	1	7	47

INTRODUCTION

1. The Lightning F Mk 3 and F Mk 6 are single-seat, twin-engined, supersonic interceptor fighters, having highly swept, cambered-leading-edge, mid-mounted mainplanes and slab tailplane. The Lightning T Mk 5 is the 2-seat supersonic trainer version. In all three marks the ailerons, rudder and tailplane are fully power operated, and incorporate artificial feel for each control; hydraulic supplies to these controls are duplicated. Hydraulically operated undercarriage, airbrakes and trailing edge flaps are fitted. A braking parachute is housed in a compartment on the underside of the rear fuselage.

2. The power units are Avon Mk 302 axial-flow gas turbines developing approximately 12,600 lb static thrust at sea level (16,300 lb with maximum reheat). The engines are mounted in the fuselage, No 2 to the rear of and above No 1.

3. Internal fuel is carried in integral wing tanks and in the flaps. Externally the F Mk 3 and T Mk 5 are fitted with jettisonable ventral tanks; the F Mk 6 ventral tank cannot be jettisoned. However, the F Mk 6 may, in addition, be fitted with overwing tanks. Provision is made for air-to-air refuelling.

4. Electrical power is derived from a generator and an alternator, both driven by an air turbine unit powered by air tapped from the engine compressors. A standby generator is fitted for emergency use; service and emergency batteries are provided.

5. The weapon system of the aircraft consists of an AI 23 radar and fire control system, a Light Fighter Sight and Red Top or Firestreak air-to-air homing missiles. In the F Mk 6 an Aden gun pack may be fitted in the forward part of the ventral tank. Cameras and AI recorders are also fitted. Full details of the weapon system are given in AP 101B-1003, 5 & 6-15B.

6. An integrated flight instrument and control system (IFIS) supplies speed, height, attitude and direction information to the flight instruments and provides auto-stabilisation, programmed climb, attitude hold, height and heading locks, and ILS coupling.

7. Cockpits are pressurised and equipped with ejection seats. The clamshell canopy is hydraulically operated and electrically controlled and can be jettisoned by a canopy jettison handle or, on ejection, by either of the ejection seat firing handles (on either seat in the T Mk 5). An external canopy jettison handle is provided.

8. In the F Mk 3 and F Mk 6, entry to the cockpit is gained from the left side of the aircraft by a ladder which is part of the ground equipment. In the T Mk 5, two similar ladders are provided and access to the cockpit is gained from the left and right sides. In all cases the canopy is opened from the outside by means of a handle and switch located behind a panel on the left side of the fuselage spine.

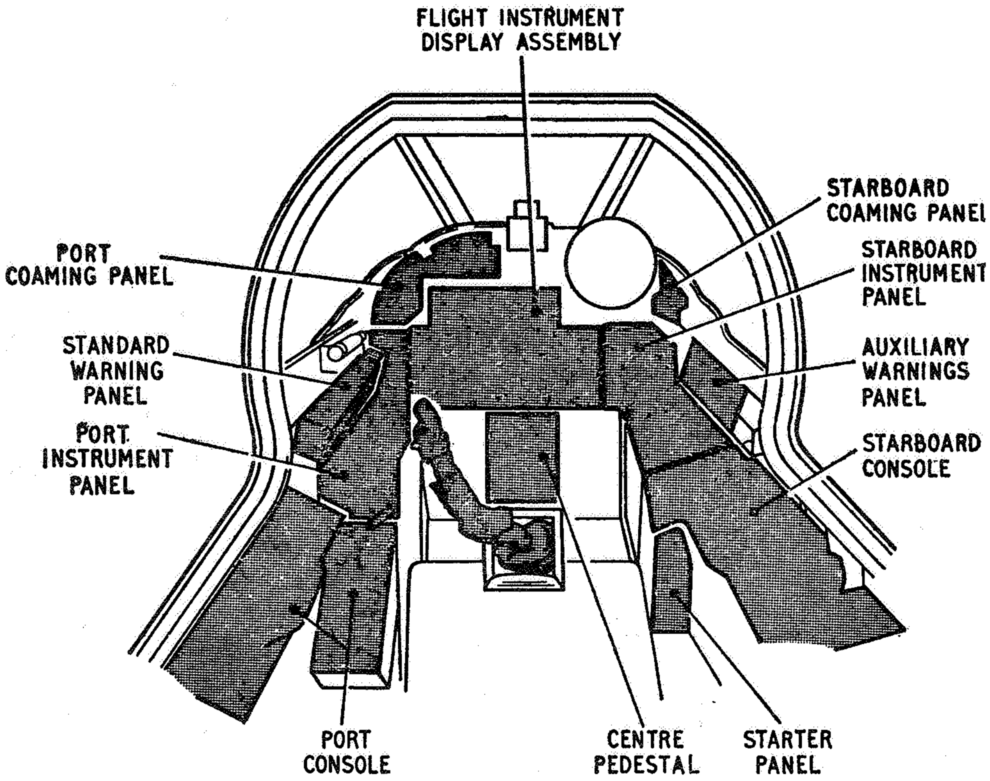
9. All emergency warning lights are grouped together on a standard warning panel (SWP) and on an auxiliary warning panel (AWP).

10. The various panels on which the controls and indicators are located are shown in Fig 1 (F Mk 3 and F Mk 6) and Fig 2 (T Mk 5).

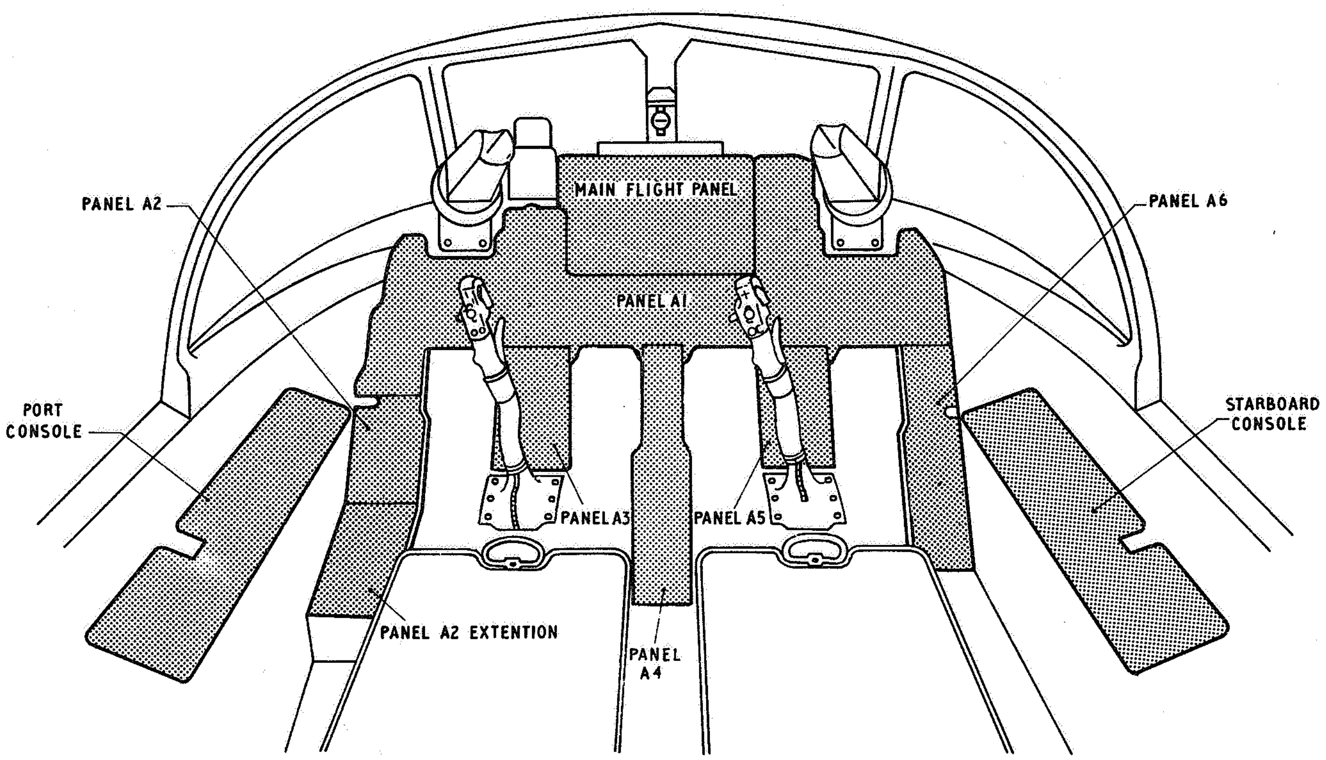
11. A detailed list of associated publications is given in the Aircraft Servicing Manuals.

12. The principal dimensions of all three marks of aircraft are:

Length overall	55ft 3in
Height overall	19ft 7in
Wing span	34ft 10in
Tailplane span	14ft 6in
Canopy height	11ft 6in



Prelims Fig 1 — Cockpit Panels F Mk 3 and F Mk 6



Prelims Fig 2 — Cockpit Panels T Mk 5

LIST OF ABBREVIATIONS

Abbreviation	*Explanation*
AAL	Aircraft approach limitations
AAR	Air-to-air refuelling
AC	Alternating current
ADF	Automatic direction finding
AI	Airborne interceptor radar
AMCU	Air motor control unit
ANM	Air nautical miles
AP	Autopilot, Air Publication
ASAP	As soon as possible
ASU	Altitude sensing unit
AUW	All up weight
AVS	Air ventilated suit
AWP	Auxiliary warning panel
BAC	Bank angle control
C	Celsius (centigrade)
CG	Centre of gravity
CPU	Control and protection unit
DC	Direct current
DG	Directional gyro
DI	Direction indicator
DL	Data link
EOA	Engine out allowance
FCC	Flight control computer
FCS	Flight control system
FD	Flight director
ft	Feet, foot
g	Normal acceleration due to gravity
GC	Groundcrew
HDG,HDNG	Heading
HDU	Hose and drum unit
HE	High explosive
Hz	Hertz (cycles per second)
IFF	Identification friend and foe
IFIS	Integrated flight instrument system
I/P	Identification of position
JPT	Jet pipe temperature
kHz	Kilohertz
kt	Knots
kVA	Kilovolt amps
lb	Pound(s)
LCN	Load classification number
LFS	Light fighter sight
LOX	Liquid oxygen
M	Mach, mega
Max	Maximum
MHz	Megahertz
MI	Magnetic indicator
min	Minimum
mins	Minutes
MRG	Master reference gyro
ODM	Operational Data Manual
O/W,o'wing	Overwing
P	Port
PFCU	Powered flying control unit
QDM	Magnetic track
QFE	Airfield pressure setting
QRF	Quick release fitting
RCDI	Rate of climb and descent indicator
RHAG	Rotary hydraulic arrester gear
S	Starboard
S/B, SBY	Standby
sec	Second(s)
SFC	Specific fuel consumption
TDFU	Time delay firing unit
TO, T/O	Take-off
TTC	Top temperature control
UC	Undercarriage
V	Volts
VCH	Visual committal height
VP	Violet Picture
VSC	Vertical speed control

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PART 1

DESCRIPTION AND MANAGEMENT OF THE SYSTEMS

List of Chapters

PART 1

CHAPTER 1—ELECTRICAL POWER SYSTEM

Contents

CONTROLS AND INDICATORS

1. Details of the controls and indicators of the electrical system are listed in Table 1 for the F Mk 3 and F Mk 6; see Table 2 for the T Mk 5. Table 3 deals with supply failure warnings. Fig 1 and 2 illustrate the positions of the controls and indicators in the single-seat aircraft and the T Mk 5 respectively.

Table 1 — Electrical System Controls and Indicators — F Mk 3 and F Mk 6

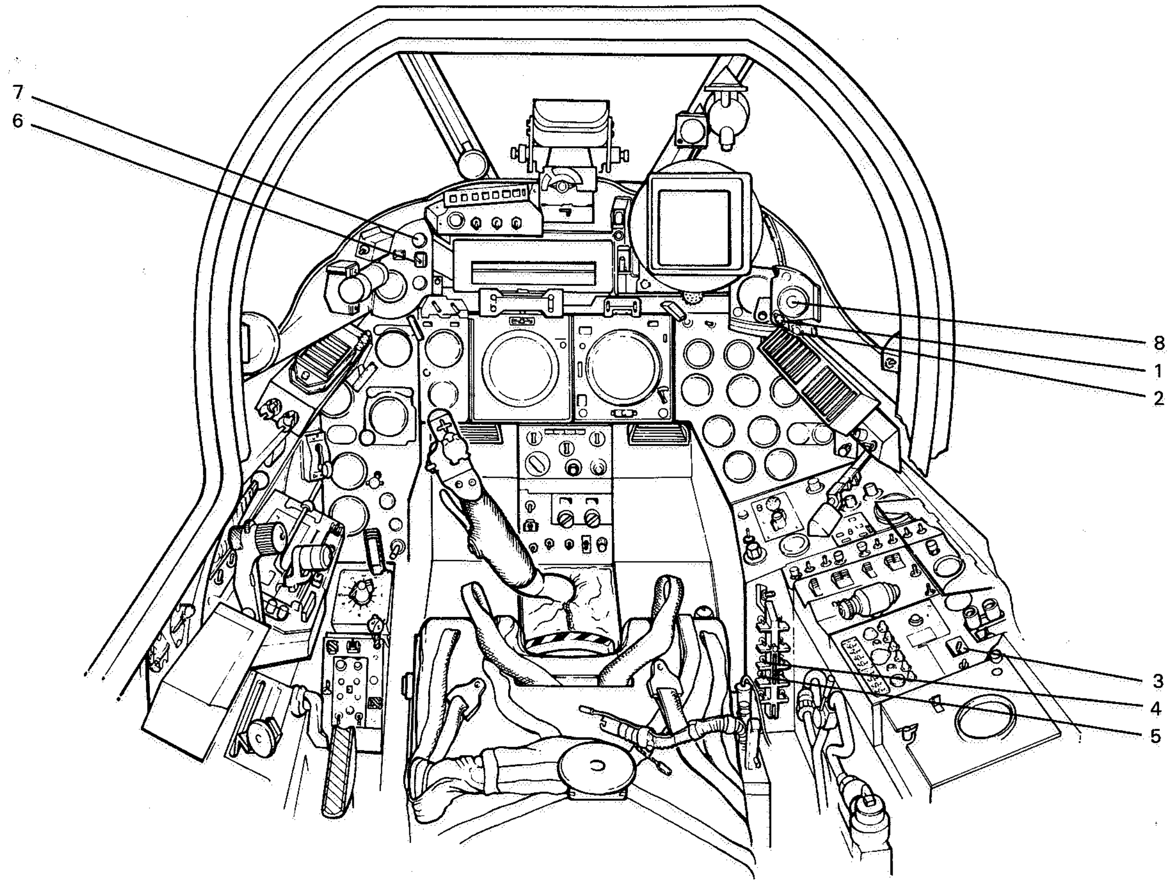
Item No	*Item*	*Markings*	*Remarks*
1	AC reset button	AC	—
2	DC reset button	GEN	—
3	Generator control switch	NORMAL/STBY/LIFT FOR EMERG	Guarded away from EMERG position
4	Battery switch	BATTERY	Up for on
5	Instrument master switch	INST MASTER	Up for on
6	Standby inverter switch	NORMAL/STANDBY INVERTER	—
7	Standby inverter MI	Black/ON	—
8	Voltmeter	See text	—

Table 2 — Electrical System Controls and Indicators — T Mk 5

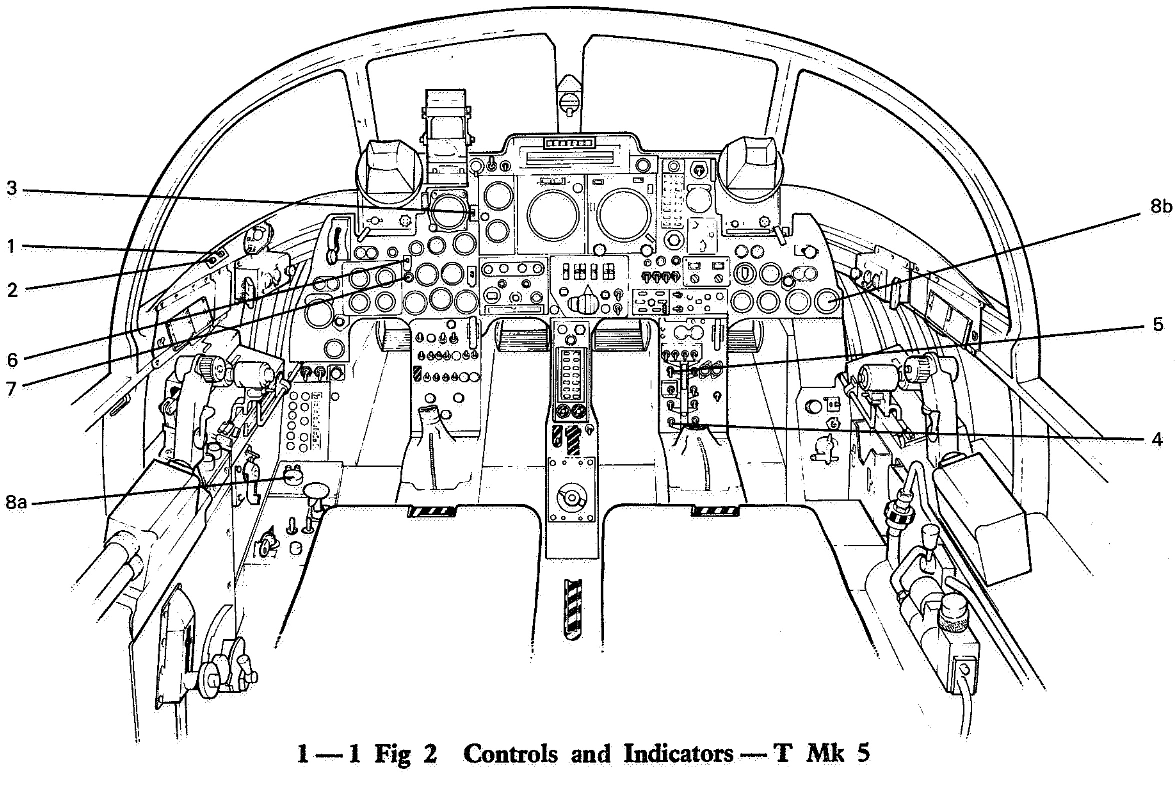
Item No	*Item*	*Markings*	*Remarks*
1	AC reset button	AC RESET — AC	—
2	DC reset button	RESET GEN — GEN	—
3	Generator control switch	GEN — NORMAL/STBY/EMERGY	Guarded away from EMERGY position
4	Battery switch	BATTERY — ON	—
5	Instrument master switch	INSTRUMENT MASTER — ON/OFF	—
6	Standby inverter switch	NORMAL/STANDBY INV	—
7	Standby inverter MI	Black/ON	—
8	Voltmeters	See text	Two indicators: a. Pupil b. Instructor

Table 3 — Supply Failure Warning Captions

SWP	*AWP*	*Effect of Indication*
GEN	GEN	Both generators off line
—	GEN	Main generator off line Standby generator on line
AP	AC	Alternator off line
AP	AC and TURB	Alternator main contactor tripped owing either to underspeeding of turbine or operation of nozzle stall switch
AP	AC, TURB, GEN	As for AC and TURB. Generator output reduced below 25·5 volts
GEN, AP	AC, TURB, GEN	Failure of main turbine and standby generator also off line or not selected



1—1 Fig 1 Controls and Indicators—F Mk 3 and F Mk 6



1—1 Fig 2 Controls and Indicators—T Mk 5

DESCRIPTION OF THE SYSTEM

General

2. The primary power supplies are provided by an alternator and a generator which are mounted on an air turbine motor driven by air tapped from the engine compressors. The alternator produces 200 volts, 3-phase, 400 Hz current to the AC busbar; the generator supplies 28 volts DC to the DC busbar.

3. A standby generator supplies 28 volts DC to the DC busbar when switched into service. It is driven by its own air turbine motor using air tapped from either or both engine compressors.

4. In the F Mk 3 and F Mk 6 a 24-volt, 18 amp hour battery is fitted; in the T Mk 5 the battery is also 24-volt but has a 35 amp hour life. In all three aircraft the battery is connected to the DC busbar by the BATTERY switch relay and it is charged by whichever generator is running providing the BATTERY switch is on. It provides standby power for all DC services and, via the DC busbar and an inverter, AC for certain AC-operated instruments and services. In the T Mk 5, control equipment automatically switches the battery out of the charging circuit at a given temperature until normal working temperatures prevail; however, if both generators fail with the battery off line, it is automatically restored to the DC busbar provided the BATTERY switch is on.

5. In the F Mk 3 and F Mk 6, a 24-volt, 0·4 amp hour emergency battery supplies emergency cockpit lighting (see Part 1, Chapter 9). In the T Mk 5 a 22·8-volt, 7 amp hour emergency battery supplies cockpit lighting, standby UHF radio power, and the standby artificial horizon and direction indicator when all other power sources have failed (see Part 1, Chapters 7 and 13). The emergency batteries are not connected to the DC busbar and are not charged from the aircraft system.

6. Switching for both AC and DC operated services is 28-volt DC controlled.

Air Turbine Motor

7. The air turbine motor is supplied with high pressure bleed air from a duct fed by the 15th stage of both engine compressors. When the air supply is sufficient, motor speed is controlled by an integral governor so that alternator output is maintained at a constant frequency. The motor incorporates three automatic switches:

a. *Overspeed Switch.* If turbine speed becomes excessive, the overspeed switch operates to close the main turbine shut-off cock which takes the main generator and alternator off line. The shut-off cock can only be reset on the ground (see Fig 4).

b. *Nozzle Stall Switch.* If bleed air pressure falls below the minimum value to maintain turbine speed, the nozzle stall switch operates to bring on the TURB caption on the AWP and open the alternator contactor (AC caption on AWP). The switch resets and AC can be restored when bleed air pressure increases.

c. *Underspeed Switch.* If the nozzle stall switch fails to operate as turbine speed decreases, the underspeed switch acts to disconnect the alternator and bring on the TURB caption. AC power can be reset when the turbine speed is at a correct value.

DC Power Generation — Main Generator

8. The primary source of DC power is the brushless main generator which produces 28±0·5 volts, 200 amp current for the DC busbar. Its output is automatically monitored by a control and protection unit (CPU). A fuse provides further protection.

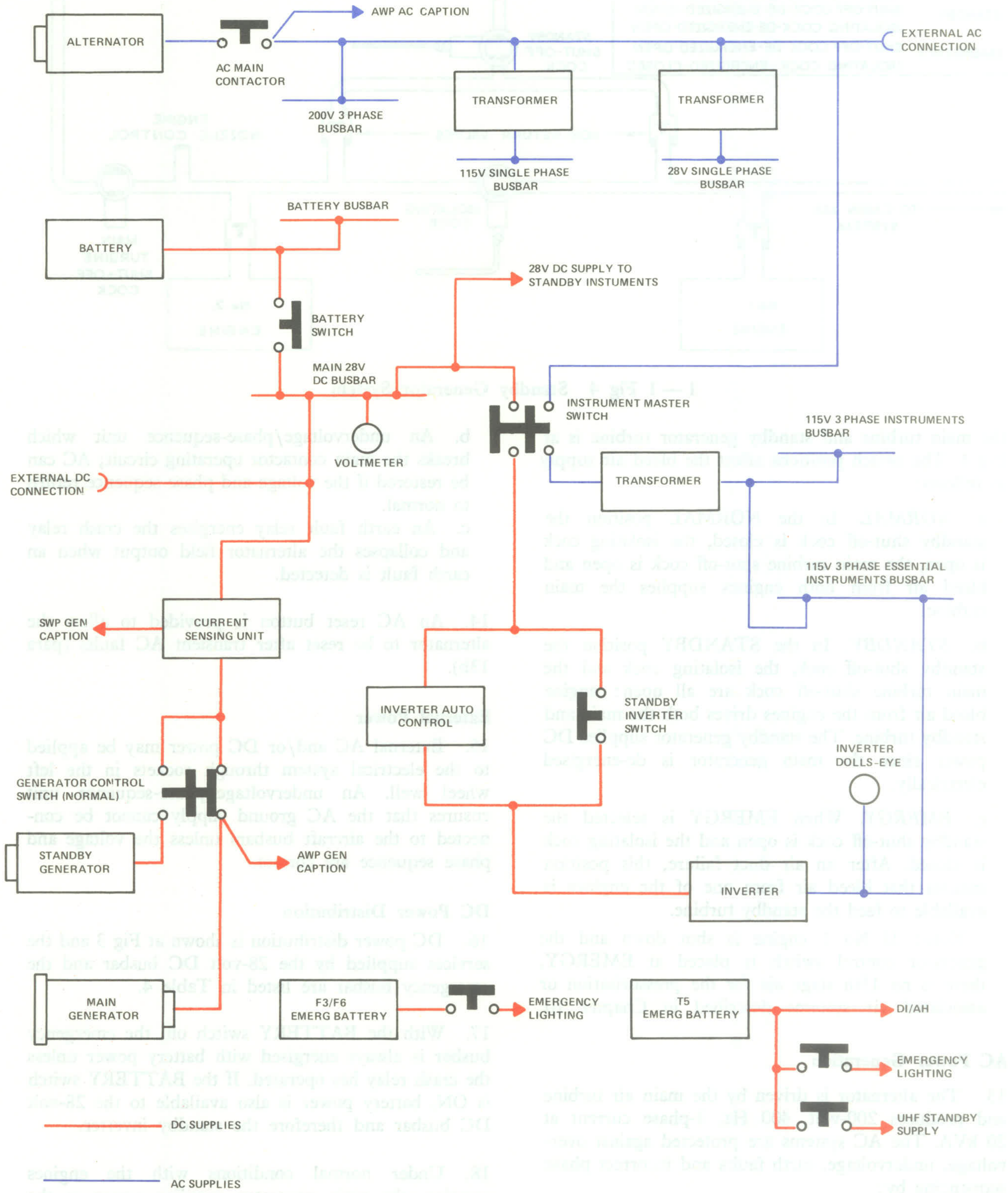
9. The CPU incorporates overvoltage and undervoltage protection circuits. If the turbine is running at normal speed and the voltage rises above 30·5±0·5 volts, or if the voltage produced drops below 25·5±0·5 volts, the generator is shut down. If an undervoltage is caused by the turbine underspeeding, the CPU lights the GEN caption on the AWP but does not shut down the generator immediately. Pressing the DC reset button resets the generator after a transient failure.

10. The generator comes on line automatically when an engine is accelerated through approximately 40% RPM and it achieves full output at about 50% RPM. When the RPM of both engines falls below approximately 35% the generator is taken off line as the turbine underspeeds.

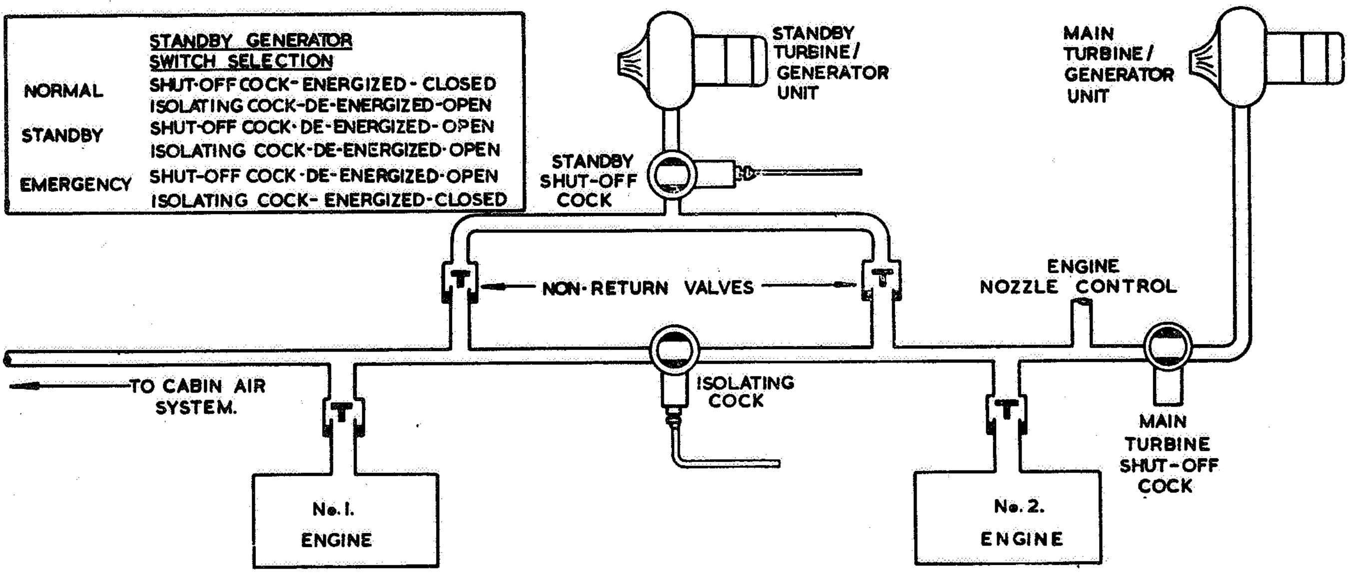
DC Power Generation — Standby Generator

11. The standby generator supplies a maximum output of 2·8 kW (100 amp) at 28 volts to the DC busbar. Its operation is controlled by the generator control switch.

12. Selecting the 3-position generator control switch from NORMAL to STANDBY or EMERGY de-energises the main generator contactor and the main generator is disconnected from the DC busbar. A diagram showing the routeing of the air supplies to



1—1 Fig 3 Electrical Power Distribution



1—1 Fig 4 Standby Generator System

the main turbine and standby generator turbine is at Fig 4. The switch positions affect the bleed air supply as follows:

a. *NORMAL.* In the NORMAL position the standby shut-off cock is closed, the isolating cock is open, the main turbine shut-off cock is open and bleed air from both engines supplies the main turbine.

b. *STANDBY.* In the STANDBY position the standby shut-off cock, the isolating cock and the main turbine shut-off cock are all open: engine bleed air from the engines drives both the main and standby turbine. The standby generator supplies DC power since the main generator is de-energised electrically.

c. *EMERGY.* When EMERGY is selected the standby shut-off cock is open and the isolating cock is closed. After an air duct failure, this position ensures that bleed air from one of the engines is available to feed the standby turbine.

Note: If No 1 engine is shut down and the generator control switch is placed at EMERGY, there is no 15th stage air for the pressurisation or associated air systems described in Chapter 10.

AC Power Generation

13. The alternator is driven by the main air turbine and produces 200-volt, 400 Hz, 3-phase current at 20 kVA. The AC systems are protected against over-voltage, undervoltage, earth faults and incorrect phase sequencing by:

a. An overvoltage relay which de-energises the alternator field. This relay can only be reset by shutting down the main air turbine.

b. An undervoltage/phase-sequence unit which breaks the main contactor operating circuit; AC can be restored if the voltage and phase sequence return to normal.

c. An earth fault relay energises the crash relay and collapses the alternator field output when an earth fault is detected.

14. An AC reset button is provided to allow the alternator to be reset after transient AC faults (para 13b).

External Power

15. External AC and/or DC power may be applied to the electrical system through sockets in the left wheel well. An undervoltage/phase-sequence unit ensures that the AC ground supply cannot be connected to the aircraft busbars unless the voltage and phase sequence are correct.

DC Power Distribution

16. DC power distribution is shown at Fig 3 and the services supplied by the 28-volt DC busbar and the emergency busbar are listed in Table 4.

17. With the BATTERY switch off, the emergency busbar is always energised with battery power unless the crash relay has operated. If the BATTERY switch is ON, battery power is also available to the 28-volt DC busbar and therefore the standby inverter.

18. Under normal conditions with the engines running, the main generator supplies power to the 28-volt DC busbar and, providing the BATTERY switch is ON, to the emergency busbar, thus charging the battery. When the generator control switch is

selected away from NORMAL to STANDBY or EMERGY, the main generator is electrically disconnected and the standby generator supplies power to the system in the same way as the main generator.

AC Power Distribution

19. AC power distribution is shown in Fig 3. Alternator or external 200-volt, 3-phase current is fed direct to a busbar for services requiring that power. 115-volt, single-phase and 28-volt, single-phase transformers supply separate busbars. A 115-volt, 3-phase transformer supplies two busbars through the INSTRUMENT MASTER switch, one of which is protected after AC failure by an inverter connected to the 28-volt DC busbar. The standby inverter starts automatically when 115-volt, 3-phase power fails or when the standby inverter switch is moved from NORMAL to STANDBY providing the INSTRUMENT MASTER switch is ON. The services associated with the five AC busbars are listed in Table 5.

Voltmeters

20. In the F Mk 3 and F Mk 6 a voltmeter is fitted to the right cockpit shroud. In the T Mk 5 two voltmeters are fitted, one on panel A2 and the other on the right of panel A1. The voltmeters show 28-volt DC busbar voltage. Each indicator is divided into a red sector for voltages of 15 to 22 volts, an amber sector for voltages between 22 and 25, a white sector for voltages between 25 and 29 and a further red sector for voltages above 30 volts.

Inertia Crash Switches

21. Two inertia crash switches are fitted, connected in series. When both inertia switches operate the following automatic events occur:

Battery isolation
Main generator, Standby generator, Alternator } field circuits interrupted
Both fire extinguishers operate

MANAGEMENT OF THE SYSTEM

Starting

22. Before starting, the generator control switch is to be set at NORMAL. Normally, both AC and DC external power is connected for starting.

23. Prior to starting, the external AC supply may be used to warm up the AI equipment, which requires a total of five minutes on external and/or internal power before becoming operational. If the AC power supply is broken during the 5-minute warm-up period the cycle must be recommenced.

24. With a ground DC supply connected, the GEN caption on the AWP goes out when the main contactor closes but the GEN warning on the SWP may remain lit depending on the relative outputs of the aircraft and ground supply; if the SWP warning remains on, it goes out when the external supply is removed.

25. Up to 70% RPM may be required to extinguish the TURB and AC captions. Thereafter run No 2 engine at 58% RPM or above to maintain AC supplies, except during the standby generator check.

26. If an external DC supply is not connected, the battery supports all the DC loads, including the engine starting and standby inverter loads. After starting, the GEN caption on the SWP goes out when the generator output is between 15 and 25 amps, followed by the GEN caption on the AWP when the voltage increases to 25·5 volts, indicating that the generator has accepted the load.

27. With no external AC supply, the standby inverter automatically starts up when the BATTERY and INSTRUMENT MASTER switches are selected ON. See Part 1, Chapter 7 regarding MRG starting in this situation.

28. When both engines have been started and the external supply disconnected, check the function of the standby generator as follows:

a. On the first sortie of the day set the No 1 and No 2 engines at 65% and 50% RPM respectively (on subsequent sorties set idle/fast idle). Check TURB, AC and both GEN warnings are out.

b. Select the generator control switch to STBY. The GEN caption on the AWP comes on indicating that the main generator has gone off line. The GEN warning on the SWP comes on momentarily, the voltmeter records a slight fall and the attention-getter and audio warning operate prior to the standby generator coming on line, when the SWP GEN caption goes out. Check the voltmeter reads 28 volts.

Note: If the SWP GEN caption does not come on momentarily after selecting STBY, the standby generator was operating prior to the selection.

c. Reselect the generator control switch to NORMAL and check both GEN warnings are out and the voltmeter reads 28 volts.

d. Increase No 2 engine to 58% RPM and then return No 1 engine to idle.

In Flight

29. The air turbine maintains sufficient speed to hold the alternator on line and develop full generator output at or above 58% RPM, which corresponds to idling RPM at approximately 250 knots at 15,000 feet. At idle RPM below this altitude, the air turbine speed reduces, the alternator drops off line and the GEN warning appears on the AWP.

30. To prevent oil starvation in the air turbine gearbox, negative g flight is not to be sustained for longer than 15 seconds.

31. Periodically during flight, check that the voltmeter pointer indicates in the white sector.

32. Owing to limited equipment cooling, the standby generator is not to be used unless the main generator fails.

After Landing

33. During the **Checks after Landing,** select the No 2 engine to fast idle (58% RPM) to keep the AC on line during single-engine taxying. In dispersal switch OFF the MRG before shutting down the No 2 engine and then ensure that all electrical services are off before switching off the BATTERY. The items listed in Table 4 under the heading Battery Busbar are on line with the engines shut down and the battery switch off.

MALFUNCTIONS OF THE SYSTEM

AC Failure

34. *Indications.* AC failure is indicated by the AC warning on the AWP and the AP warning on the SWP; the standby inverter MI shows ON and most of the AC services listed in Table 5 are lost.

35. *Actions.* Cancel reheat and press the AC reset button; further attempts may be made at 2- to 3-minute intervals if the first is unsuccessful. If AC power cannot be restored, land as soon as practicable. The standby inverter supplies the Essential Instrument services listed in Table 5 and the standby artificial horizon and direction indicator continue to run on DC power, but all other AC services are lost. The full drill is to be found in FRC.

36. *Intermittent AC Failure.* If intermittent AC failure occurs, an output surge from the JPT controllers may occur at engine temperatures above 550°C, resulting in a reduction of fuel flow to the engines and a consequent transient loss of thrust. Therefore, if the AC supply becomes intermittent or if repeated operation of the AC reset button is necessary, switch OFF the JPT controllers and maintain the engine within limits manually.

Generator Failure

37. *Indications.* Failure of the main generator is indicated by the GEN captions on the SWP and AWP; the voltmeter indicates battery voltage.

38. *Actions.* Attempt to regain the main generator by pressing the DC reset button. If this is not successful, select STBY on the generator control switch. When the standby generator comes on line, the GEN caption on the SWP goes out and all DC services are normal. The GEN caption on the AWP remains on. Monitor the voltmeter. Land as soon as practicable.

Double Generator Failure

39. If the standby generator fails to come on line, both GEN captions remain lit. All DC services are borne by the battery, which may be relied upon to provide normal DC services whilst the voltmeter reads above 22 volts. Once below 22 volts the battery discharges rapidly. When the battery fails, all AC and DC services are lost except those supplied by the emergency battery. The drill is given in the FRC.

40. *Load Shedding.* A guide to load-shedding is also given in the FRC. It is important to switch off the DC pumps and to leave them off, and to select the UHF and UHF power to STANDBY and the main set OFF. When load-shedding is complete, minimise the use of the remaining services, eg, restrict radio transmissions to a minimum and avoid constant/instinctive use of trim; consideration should be given to switching OFF the pitot heaters if conditions permit. Do not use the ILS unless essential.

41. *Recovery and Landing.* If range is not critical, descend to VMC below cloud. If range is critical, cruise at optimum altitude until the voltmeter reads 23 volts and then descend. With the DC pumps switched OFF there is a danger of fuel starvation; increase attitude to 7° nose up for 15 seconds halfway down the descent and maintain a nose-up attitude whenever possible once at low altitude. Approximately 100 lb/side of gauged fuel is unusable with the DC pumps OFF. If practicable lower the flaps, and the undercarriage on the normal system, before the voltage drops below 22 volts. (The undercarriage can always be lowered on the emergency system but there are no undercarriage position indications if the battery has failed.) Land as soon as possible.

42. *Battery Failure.* When the battery fails, all electrical flight instruments are lost except in the T Mk 5, where the emergency battery supplies the standby

artificial horizon and the direction indicator. In all marks, emergency lighting is also available until the standby battery fails. The major electrical services lost are listed in the FRC. However, in VMC the aircraft may still be landed after lowering the undercarriage on the emergency system; flaps and airbrakes are not available unless previously extended but the braking parachute and wheelbrakes operate.

Generator Overvolting

43. If the main generator produces more than 30·5±0·5 volts, it is taken off line automatically. However, if a sustained voltage of 30 volts or more is indicated and the CPU fails to take the main generator off line, select STBY on the generator control switch and check that the voltage settles at 28 volts as the standby generator takes over. The GEN caption appears on the AWP. No DC services are lost. Monitor the voltmeter.

44. If, subsequently, the standby generator should also overvolt, return the generator control switch to NORMAL and isolate the battery from the overvoltage from the main generator by selecting the BATTERY switch off. The GEN caption on the AWP goes out. Put the BATTERY switch on again in the circuit prior to landing.

45. If, with the BATTERY switch off to protect the battery from overvolting, the main generator is switched out by the CPU, the standby shut-off cock automatically opens because there is no power to hold it closed with the battery off, and the standby generator runs up. When the standby generator comes on line, the standby shut-off cock is energised closed, the standby generator runs down and comes off line. The standby generator cycles on- and off-line every two seconds giving symptoms of electrical oscillations or power surges. Selecting the generator control switch to STBY holds the standby shut-off cock open when power is next applied to the DC busbar and the standby generator stays on line.

Main Air Turbine Malfunctions

46. Illumination of the TURB caption on the AWP indicates either that the turbine is underspeeding or that it has failed completely. In the latter case the failure may have been caused by an automatic shut-down after an overspeed condition or by mechanical failure. However, the TURB caption does not come on in isolation and the additional indications show the nature of the turbine failure. The indications and remedial actions are as follows:

a. *Underspeed.* The turbine underspeeds when insufficient bleed air is available to maintain the necessary turbine RPM. As the turbine speed falls through a critical value, the TURB and AC captions on the AWP and the AP caption on the SWP come on and AC failure is experienced. The audio warning and attention-getter operate. If the turbine speed reduces further, the generator undervolt relay acts to bring on the GEN caption on the AWP and the battery is discharging. Increasing the engine power restores the turbine to its correct operating speed and the warnings go out.

b. *Overspeed or Turbine Failure.* If the turbine fails, or if it overspeeds and is automatically shut down, the TURB, AC and GEN captions on the AWP, and the GEN and AP captions on the SWP all come on, together with the audio warning and attention-getter. Selecting the generator control switch to STBY starts the standby generator (SWP GEN caption out) and restores DC to normal, but all AC services are lost except those served by the standby inverter via the Essential Instruments busbar (Table 5). The standby artificial horizon and direction indicator continue to run on DC power. The drill for recovery and landing is given in the FRC. After an overspeed and automatic shut-down, the main turbine cannot be restarted in the air.

Burst Air Duct

47. A rupture of the air duct carrying bleed air to the main turbine is indicated by the TURB, GEN and AC captions on the AWP and the GEN and AP captions on the SWP together with audio warning and attention-getter (identical to warnings given for a turbine overspeed or failure). However, with a burst air duct, pressurisation is lost (and the CPR caption on the AWP comes on at altitude), loss of jet pipe nozzle control may occur and hot air leaking from the duct may trigger the fire warnings. Nevertheless, the failure may also manifest itself simply by a loss of thrust without the attendant warnings.

48. If the nozzles are at the fully open position and loss of thrust has occurred, ensure that both engines are running and then select EMERGY on the generator control switch. The isolating cock in the air duct between No 1 and No 2 engine closes (see Fig 4), the standby shut-off cock opens, and the standby generator comes on line to restore DC electrical supplies.

49. The position of the rupture in the air duct can now be identified by reference to Fig 4:

a. *Rupture on No 1 Engine Side.* If the burst has occurred on No 1 engine side of the isolating cock, pressurisation failure remains but nozzle control is regained; the main turbine speeds up and the TURB caption goes out if a minimum of approximately 65% RPM is maintained on No 2 engine.

AC power is available from the alternator, and the standby generator continues to provide DC power. Leave the generator control switch at the EMERGY position to maintain the isolated situation. Note that if No 2 engine is shut down complete electrical failure occurs and nozzle control is lost on No 1 engine.

b. *Rupture on No 2 Engine Side.* If the burst is on No 2 engine side of the isolating cock, nozzle control is lost and the alternator cannot be regained. Experience suggests that the nozzles can be expected to remain in the position they were at the time of the failure of the air supply. However, there is a remote possibility that they may blow open under exhaust gas pressure.

Table 4 — DC Distribution

28V DC Busbar

Airbrake control and indication	LFS
Armament circuits	Lighting:
AI circuits	Cockpit and anti-dazzle
Artificial horizon (standby power)	4-volt IFIS control
Auxiliary warning system	Navigation
Brake parachute jettison	Anti-collision
Brake pressure gauge	Taxy
Camera and AI recorder control	Missile telemetry switching (Mk 5)
Cockpit air control	Nozzle position indicator
Cockpit temperature control (manual)	Overwing tank fuel dumping
Direction indicator (standby power)	Oxygen air-mix valve (Mk 5)
Engine and duct anti-icing	Oxygen contents and flow
Engine starting and relighting	Radar altimeter (Mk 3 and Mk 6)
Feel cut-out	Radio
Flap control and indication	Radio compass (if fitted)
Flight control system	Rain dispersal control
Fuel:	Reheat system
Transfer pumps	Seat height adjustment
LP cocks	Standard warning system
Gauge tests	Standby generator control
AAR	Tacan
Heaters:	Trims:
Pitot and Vent Valve control	Control and indication
Pitot (standby)	Tailplane auto trim
Ice warning system (inoperative)	Undercarriage:
IFF	Control (normal)
ILS	Indication
Inverter supply and control	Ventral emergency transfer (Mk 6)

24/28V DC Emergency (Battery) Busbar

Canopy:	Missile jettison
Operation	Refuelling
Audible warning	Telebriefing
Fire extinguishers	
Inertia crash switches	

Table 5 — AC Distribution

200V, 3-Phase AC Busbar

AI 23	Spraymat
Canopy blower motor	Ventral fuel pump (Mk 6)
Data link	Windscreen heaters (centre and side)
Missile supply	

115V, 3-Phase AC Instrument Supply

Note: These services are *not* transferred to the standby inverter after AC failure; however, the DI and standby artificial horizon have alternative DC sources.

Air data computer:	Direction indicator (DI)
Height	FCS control
Strip speed	JPT
Vertical speed	Standby artificial horizon

115V, 3-Phase AC Essential Instruments Busbar

Note: These services are transferred to the standby inverter after AC failure.

Cockpit temperature control (auto)	Fuel contents
Fire detection	MRG (attitude and navigation display)

115V, Single-Phase AC Busbar

IFF	Spraymat (auto)
Radar altimeter (Mk 3 and Mk 6)	Tacan

28V, Single-Phase AC Busbar

Heaters:	Services pressure gauge
Pitot (main and standby) (normal)	
Vent valves (normal)	

Intentionally Blank

PART 1

CHAPTER 2—FUEL SYSTEM

Contents

CONTROLS AND INDICATORS

1. Details of the controls and indicators of the fuel system for the F Mk 3, T Mk 5 and F Mk 6 are listed in Tables 1, 2 and 3 respectively. Fig 1 illustrates the cockpit positions of the F Mk 3 and F Mk 6 items, and Fig 2 the T Mk 5 items.

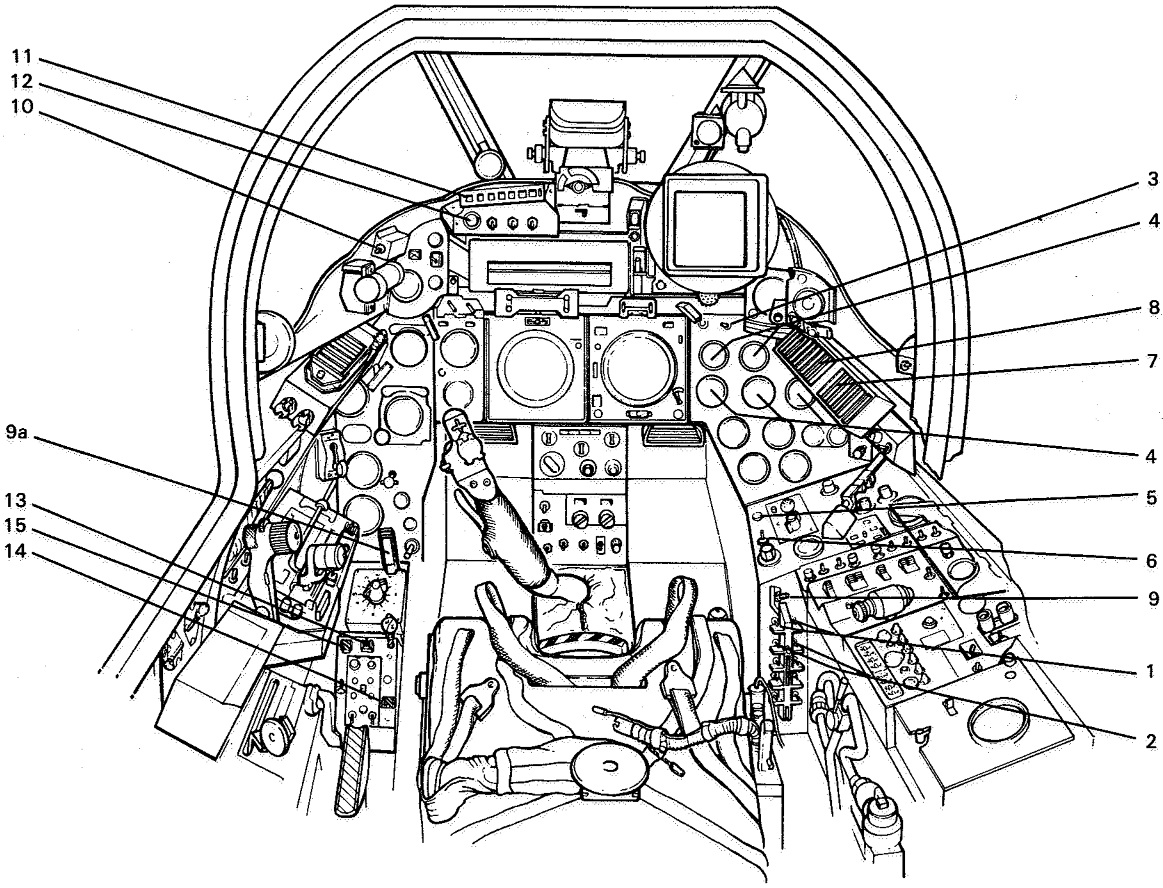
Table 1 — Fuel System Controls and Indicators — F Mk 3

Item No	*Item*	*Marking*	*Remarks*
1	LP fuel cocks (2)	FUEL COCK No 1, FUEL COCK No 2	Lock toggle switches in the on (up) position. Ganged switches
2	DC pumps switches (2)	DC PUMPS PORT, DC PUMPS STBD	Up for on. Ganged switches
3	Wing-to-wing transfer switch	TRANSFER — P/off/S	Three-position switch
4	Fuel contents gauges (3)	MAIN (2), VENTRAL	Capacitor gauges
5	Flap tanks contents button	FUEL CONTENTS T/E	—
6	Gauge test switch	GAUGE TEST — FULL/EMPTY	Spring-loaded to centre (off) position
7	Fuel pressure warnings	FUEL 1, FUEL 2	On when fuel pressure less than 5·75±0·75 PSI
8	Fuel pressure warnings	PUMPS P, PUMPS S	Appropriate caption on when: 1. Both DC pumps in one wing failed or uncovered 2. One pump uncovered and other failed
9	Vent valve heating	PITOT HEATER — NORMAL/ OFF/STANDBY	No vent valve heating in OFF or STANDBY
9a	Ventral tank jettison handle	—	Black and yellow striped
10	AAR switch	FL REFUEL/NORMAL	—
11	AAR panel	Captions: WG PRT, FLP PRT, OW PRT, VEN, OW STB, FLP STB, WG STB	OW PRT and OW STB captions inoperative
12	Probe lighting switch	PROBE LIGHT — ON/OFF	Inoperative unless NAV LTS set to ALL ON or TIPS
13	Ventral tank emergency transfer switch	VENTRAL TANK — EMERGENCY TRANSFER	Inoperative
15	Overwing tank jettison switch	OVERWING TANK — JETN/OFF	Inoperative

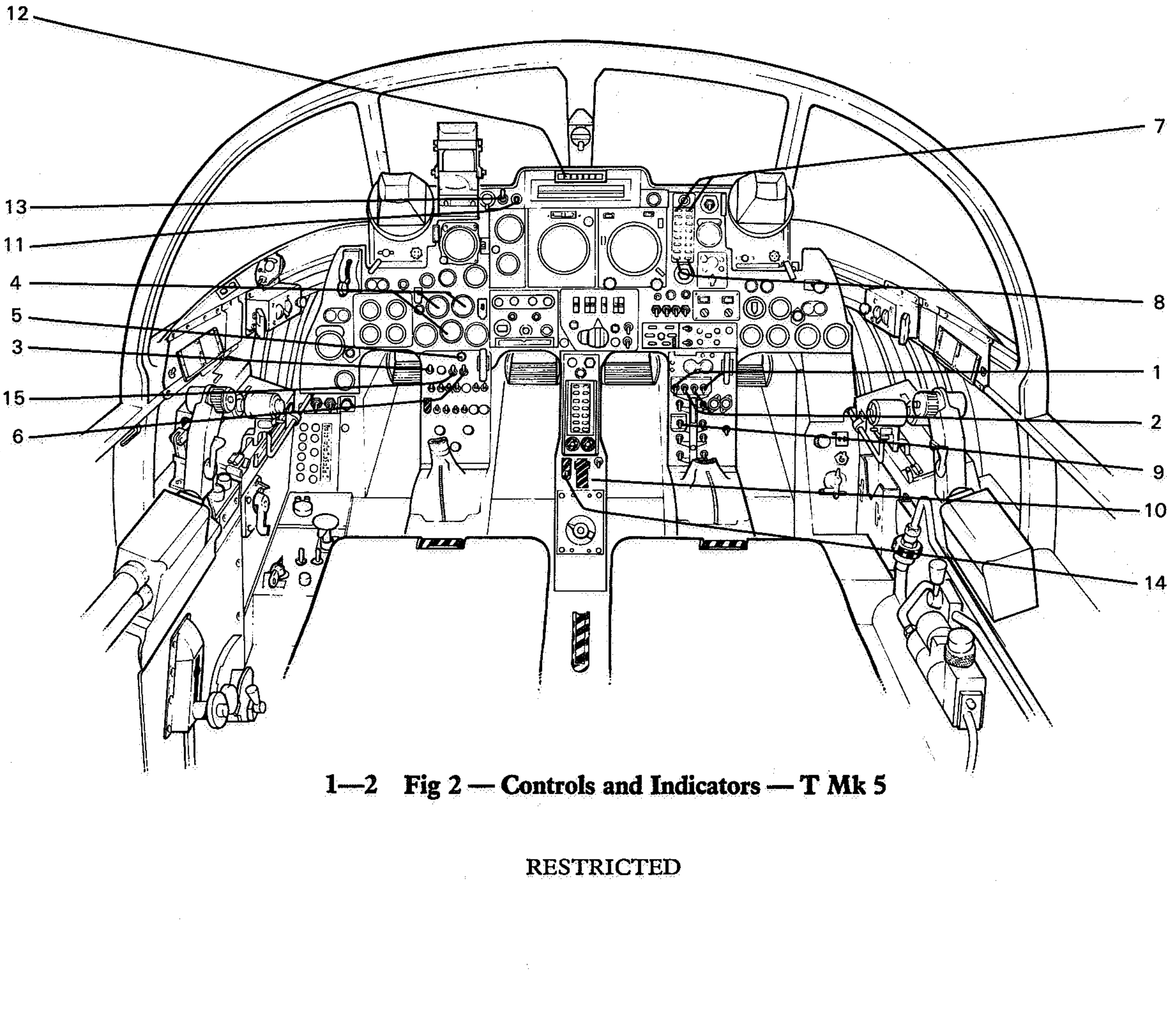
Table 2 — Fuel System Controls and Indicators — T Mk 5

Item No	*Item*	*Marking*	*Remarks*
1	LP fuel cocks (2)	PORT No 1 ENG COCK, No 2 ENG STBD COCK — OPEN	Up for OPEN. Ganged switches
2	DC pumps switches (2)	FUEL PUMPS — PORT No 1 ENG, No 2 ENG STBD — ON	Up for ON. Ganged switches
3	Wing-to-wing transfer switch	FUEL TRANSFER — PORT/off/STBD	Three-position switch
4	Fuel contents gauges (3)	MAIN (x2), VENTRAL	Capacitor gauges
5	Flap tanks contents button	FUEL CONTENTS T/E TANK	—
6	Gauge test switch	FUEL TEST — FULL/EMPTY	Spring-loaded to centre (off) position
7	Fuel pressure warnings	FUEL 1, FUEL 2	On when fuel pressure less than 5·75±0·75 PSI
8	Fuel pressure warnings	PUMPS P, PUMPS S	Appropriate caption on when: 1. Both DC pumps in one wing failed or uncovered 2. One pump uncovered and other failed

continued



1—2 Fig 1 — Controls and Indicators — F Mk 3 and F Mk 6



1—2 Fig 2 — Controls and Indicators — T Mk 5

Table 2 — Fuel System Controls and Indicators — T Mk 5 — *continued*

Item No	*Item*	*Marking*	*Remarks*
9	Vent valve heating	PITOT — ON/OFF/STANDBY	No vent valve heating in OFF or STANDBY
10	Ventral tank jettison handle	DROP TANK JETTISON — PULL HANDLE	Black and yellow striped
11	AAR switch	FLIGHT REFUEL — OFF/ON	—
12	AAR panel	Captions: WG PRT, FLP PRT, OW PRT, VEN, OW STB, FLP STB, WG STB	OW PRT and OW STB captions inoperative
13	Probe lighting switch	PROBE LIGHT — ON/OFF	Inoperative unless NAV LIGHT switch to STEADY or HI FLASH
14	Overwing tank jettison switch	O/WING TANK JETTISON	Inoperative
15	Ventral tank emergency transfer switch	VENTL TRANS — NORMAL/EMERGY	Inoperative

Table 3 — Fuel System Controls and Indicators — F Mk 6

Item No	*Item*	*Marking*	*Remarks*
1	LP fuel cocks (2)	FUEL COCK No 1, FUEL COCK No 2	Lock toggle switches in up (on) position. Ganged switches
2	DC pumps switches (2)	DC PUMPS PORT, DC PUMPS STBD	Up for on. Ganged switches
3	Wing-to-wing transfer switch	TRANSFER — P/off/S	Three-position switch
4	Fuel contents gauges (5)	MAIN (2), O/WING (2), VENTRAL	Capacitor gauges
5	Flap tanks contents button	FUEL CONTENTS T/E	—
6	Gauge test switch	GAUGE TEST — FULL/EMPTY	Spring-loaded to centre (off) position
7	Fuel pressure warnings	FUEL 1, FUEL 2	On when fuel pressure less than 5·75±0·75 PSI
8	Fuel pressure warnings	PUMPS P, PUMPS S	On when: 1. Both DC pumps in one wing failed or unvovered 2. One pump uncovered and other failed
9	Vent valve heating	PITOT HEATER — NORMAL/off/STANDBY	No vent valve heating in OFF or STANDBY
10	AAR switch	FL REFUEL/NORMAL	—
11	AAR panel	Captions: WG PRT, FLP PRT, OW PRT, VEN, OW STB, FLP STB, WG STB	—
12	Probe lighting switch	PROBE LIGHT — ON	Inoperative unless NAV LTS switch set to ALL ON or TIPS
13	Ventral tank emergency transfer switch	NORMAL/EMERG TRANSFER/OFF	Guarded from NORMAL to EMERG TRANSFER and from EMERG TRANSFER to OFF
14	Overwing fuel dump switch	FUEL DUMP/OFF	Guarded switch
15	Overwing tank jettison button	O/WING TANK JETTISON	Operates only after FUEL DUMP is selected

DESCRIPTION OF THE SYSTEM

General

2. Internal fuel is carried in integral tanks in the wings and flaps. External fuel is carried in a ventral tank and, in the case of the F Mk 6, in overwing tanks if fitted. The left and right fuel systems are independent of each other, the left system supplying No 1 engine and the right system No 2 engine; the ventral tank feeds equally to each system and there is provision to balance the two systems through a wing-to-wing transfer system if fuel asymmetry occurs. Fuel is transferred to the collector box in the outboard section of each wing by a combination of gravity feed, DC pump pressure, air pressure and, in the case of the F Mk 6 ventral tank, by air pressure and AC pump pressure. Fuel is delivered to the engine and reheat fuel systems from the collector box by a fueldraulic pump.

Fuel Tanks

3. *Wing and Leading-Edge Tanks.* Each wing tank comprises a leading-edge tank and a two-compartment main tank. The outboard compartment of each main tank serves as a collector box from which LP fuel is delivered to the engine HP pumps and reheat pumps via fueldraulic pumps and the LP cocks.

4. *Flap Tanks.* Flap tank fuel is transferred to the main tanks by air pressure at 7 PSI.

5. *Ventral Tanks — F Mk 3 and T Mk 5.* In the F Mk 3 and T Mk 5 the jettisonable ventral tank supplies fuel to both main tanks under air pressure at 13 PSI.

6. *Ventral Tank — F Mk 6.* In the F Mk 6 a larger, non-jettisonable ventral tank is fitted, the fuel being transferred to the wing tanks by an AC pump supplemented by air pressure. The AC fuel pump takes its power from the 200-volt AC busbar and is therefore inoperative after AC failure. The tank has three compartments: a forward hatch tank, a centre tank and a rear tank. The hatch tank is removable and interchangeable with a fuel/gun pack containing two Aden guns, ammunition and fuel. The centre tank carries the fuel and air connections to the fuselage and contains the AC pump plus the refuelling and fuel transfer system.

7. *Overwing Tanks — F Mk 6.* The F Mk 6 can be fitted with two overwing tanks, the fuel being transferred to the main tanks under air pressure plus gravity. The fuel may be dumped from the overwing tanks providing air pressure is available; without air pressure the dumping rate is very slow.

8. *Fuel Tank Venting.* All tanks are vented outward and inward, outward venting being prevented during negative-g flight. All vent valves are heated by a 28-volt AC supply, the heaters being controlled by the pitot heater switch. With the switch in the NORMAL position the vent valves are heated; in the OFF or STANDBY positions, vent valve heating is not available. To avoid fuel asymmetry an interconnecting pipe between the left and right wing tanks ensures that the air pressure in both tanks remains equal if a wing tank vent valve fails.

Fuel Tank Capacities

9. The usable fuel tank capacities for the F Mk 3 and T Mk 5 are shown in Table 4, and for the F Mk 6 in Table 5.

Table 4 — Fuel Tank Capacities, F Mk 3 and T Mk 5

Tank	*Capacity—Gallons*	*Capacity—Pounds*	
		AVTUR 8·0 *lb/gall*	*AVTAG* 7·7 *lb/gall*
Main and leading edge	2 x 320	2 x 2560	2 x 2464
Flap	2 x 33	2 x 264	2 x 254
Ventral	1 x 250	1 x 2000	1 x 1925
Total fuel	956*	7648	7361

*Approximately 7 gallons/side extra gauged fuel available when mod 2459 is embodied.

Table 5 — Fuel Tank Capacities, F Mk 6

Tank	*Capacity—Gallons*	*Capacity—Pounds*	
		AVTUR 8·0 *lb/gall*	*AVTAG* 7·7 *lb/gall*
Main and leading edge	2 x [illegible] 325	2 x 2600	2 x 2503
Flap	2 x 33	2 x 264	2 x 254
Ventral	1 x 610*	1 x 4880	1 x 4697
Total fuel	1326	10,608	10,210
Overwing	2 x 260	2 x 2080	2 x 2002

*When guns are fitted, ventral tank capacity is reduced to 535 gallons.

Fuel Transfer

10. A diagram of the fuel system is shown at Fig 3. With AC and DC power, and air pressure available, fuel transfer to the main tanks and collector boxes is automatic. As the fuel level drops by 120 to 160 lbs, Mk 44 valves in the main tanks open to allow fuel from the ventral and flaps tanks to flow into the main tanks; they close to stop fuel transfer to the main tanks if the main tanks are full. The Mk 44 valves incorporate non-return valves to prevent reverse flow.

11. *Overwing Tank Transfer (F Mk 6 Only).* In the F Mk 6, when overwing tanks are fitted, the fuel feeds under air pressure to the main tanks when the Mk 44 valves are open. The overwing tanks are divided into compartments, the feed from the tanks being arranged to ensure that CG limits are not exceeded. As each tank becomes empty, a low-level float switch closes a refuel/shut-off cock in the tank; the AC pump in the ventral tank starts when both low-level float switches have closed.

12. *Ventral Tank Transfer (F Mk 6 Only).* If overwing tanks are fitted, both the overwing tank low level float switches must operate before ventral tank fuel can be transferred. If overwing tanks are not fitted, the Mk 44 valves control ventral tank transfer. In either case, ventral fuel transfers to both main tanks under AC pump and air pressure. The rear tank of the ventral empties first, followed by the hatch and centre tanks together. When the ventral tank is empty, a low level float switch turns off the AC pump, closes the Mk 47 transfer valve in the centre tank and opens the flaps tanks' Mk 27 valves.

13. *Ventral Tank Transfer (F Mk 3 and T Mk 5).* In the F Mk 3 and T Mk 5, the ventral tank fuel transfers under air pressure once the Mk 44 valve opens. When the ventral tank is empty, a Mk 7 fuel/no air valve closes and electrically opens Mk 27 valves in the flaps tanks, allowing flap fuel to feed.

14. *Flaps Tanks Transfer (All Marks).* When the ventral tank is empty the Mk 27 valves open to allow flap fuel to transfer to the main tanks under air pressure. Fuel transfer rate from the flap tanks is slow, and with the flaps lowered up to 200 lb of fuel per tank may be trapped and unusable until the flaps are raised.

15. *Wing Tanks Feed (All Marks).* Fuel from the inboard compartment of the main tanks feeds by gravity into the collector tanks (outboard compartments). In addition, two DC transfer pumps in each wing feed fuel from the inboard compartments and the leading-edge tanks respectively to the collector tanks to sustain a good fuel level for the fueldraulic pumps.

Fueldraulic Booster Pump

16. The fueldraulic booster pump system is designed to ensure a sufficient supply of vapour-free fuel to the engines through the full range of engine settings, at all altitudes and attitudes. A fueldraulic pump is fitted in each collector tank to supply fuel to the associated engine and reheat systems.

17. Each independent system has an engine-driven hydraulic supply pump which uses fuel drawn from the engine low pressure fuel system as a medium. The supply pump is of a fixed cam-plate type; consequently its output varies in direct proportion to engine speed. The output of the supply pump drives the fuel booster pump, also with a fixed cam-plate, so that booster pump output is also proportional to engine speed.

18. The booster pumps are double-ended and are fitted in such a manner that one end is always immersed in fuel. Thus, in negative-g conditions, fuel pressure is maintained at a safe value. However, note that for air turbine lubrication reasons, negative-g flight is not to exceed 15 seconds.

Fuel Pressure Monitoring

19. A pressure switch downstream of each fueldraulic booster pump operates to bring on the appropriate FUEL 1 or FUEL 2 caption on the AWP if the difference between tank pressure and pump delivery pressure falls below $5{\cdot}75 \pm 0{\cdot}75$ PSI. If reheat is in use when the pressure switch operates, reheat is automatically tripped.

DC Transfer Pumps

20. Two DC-powered transfer pumps are fitted in each wing, one in the leading-edge tank and one in the main tank, to transfer wing fuel to the collector tank. Each pair of pumps is controlled by one DC pump switch (see Tables 1, 2 and 3). If a booster pump is not running or has failed, a pressure-sensitive shuttle valve diverts the output of the DC pumps into the engine feed line.

DC Transfer Pump Monitoring

21. If both DC pumps in one wing fail, or if one pump fails and the other is not covered with fuel, the associated PUMPS P or PUMPS S caption on the AWP comes on, indicating that fuel is not being transferred from the leading edge and main wing tanks to the collector tank by the DC pumps. Fuel can be transferred to the collector tank by gravity if a nose-up attitude is maintained.

Wing-to-Wing Transfer

22. In conditions of fuel asymmetry, fuel may be transferred to the low side by the wing-to-wing transfer system. A wing-to-wing transfer switch, positioned and labelled as shown in Tables 1, 2 and 3, controls two isolating cocks in separate fuel transfer lines (see Fig 3). When P (PORT) is selected the isolating cock in the right wing is opened and fuel is transferred to the left fuel system from the right under right fueldraulic booster pump pressure or DC pumps pressure. A selection to S (STBD) similarly transfers fuel from the left fuel system to the right. An associated indicator light shows only that a transfer selection has been made and can come on either when a cock is closed and the

transfer switch is to P or S or when a cock is moving. Therefore monitor the fuel gauges to ensure transfer is taking place. When the transfer switch is returned to the central (off) position, the indicator light goes out momentarily, comes on again for 2 or 3 seconds, and then goes out.

23. *Rate of Transfer*. If the fueldraulic booster pump on the side from which fuel is being transferred is operating, the rate of fuel transfer is approximately 210 lb/minute at 100% RPM or 160 lb/minute at 85% RPM. If the engine on the high fuel side has been shut down, or if booster pump on the high side has failed, fuel is transferred providing the DC pumps are operating; in this case the rate of transfer is approximately 75 lb/minute.

24. If the DC pumps alone are transferring fuel, there may be up to 400 lb of fuel which cannot be transferred in straight and level flight.

Fuel Contents Gauges

25. Capacitor fuel gauges are fitted as shown in Tables 1, 2 and 3. In the F Mk 3 and T Mk 5 there are two MAIN gauges and a VENTRAL gauge. In the F Mk 6, in addition to the two MAIN gauges and one VENTRAL gauge, there are two O/WING gauges to indicate the associated overwing tank contents. In all marks, the MAIN gauges indicate the contents of the main and leading-edge tanks; flap tanks contents are indicated as an increased reading on the associated MAIN gauge when the FUEL CONTENTS T/E button is pressed.

26. A gauge test switch, spring-loaded to the centre (off) position, is used to check the serviceability of the contents gauges. When FULL or EMPTY is selected, all gauges register full scale or zero respectively.

27. The gauges require 115-volt AC power and only operate when the instrument master switch is on. If the normal AC power supply fails, the gauges continue to operate from the standby inverter supply.

Air-to-Air Refuelling (AAR) System

28. Air-to-air refuelling (AAR) is made through a detachable probe fitted below the left mainplane. AAR is controlled by the AAR switch and monitored by the dimmable AAR panel captions, the captions coming on when the AAR switch is selected to FL REFUEL and going out when the associated tank is full. The switch and panel position, and a list of the applicable captions, are given in Tables 1, 2 and 3.

29. Setting the AAR switch to FL REFUEL has the following effects:

a. Air pressure is released in the ventral tank, flap tanks and, in the F Mk 6, the overwing tanks.

b. In the F Mk 6, the AC fuel pump is switched off.

c. All refuelling valves are energised open and, in the F Mk 6, the Mk 39 refuel/emergency transfer valve in the ventral tank is opened.

d. The captions on the AAR panel come on to indicate which tanks are not full.

30. As the tanks fill during AAR, the captions go out and the associated fuel gauge shows full. After breaking contact with the tanker, reselect NORMAL on the AAR switch to restore normal fuel transfer.

Note 1: In the F Mk 6, the ventral tank emergency transfer switch is not to be set to EMERG TRANSFER during AAR.

Note 2: It is possible to lose the ability to transfer ventral and flap tank fuel in the F Mk 3 and T Mk 5 aircraft if the air pressure relief valve malfunctions after AAR.

31. For night AAR, a probe lighting 2-position switch labelled PROBE LIGHT — ON is provided. There is no power supply to the probe lighting unless the NAV LTS switch is set to ALL ON or TIPS (F Mk 3 and F Mk 6) — STEADY or HI FLASH (T Mk 5).

Ground Refuelling

32. A pressure refuelling point, under a panel on the left side of the fuselage, permits simultaneous refuelling of all tanks including the ventral tank and, in the F Mk 6, the overwing tanks when fitted. Opening the panel operates a microswitch which changes the fuel electrical circuit from its flight condition to the ground refuelling condition. The microswitch, together with the fuel level switches in the tanks, controls the operation of the refuelling valves and the tank indicator lights.

33. In the F Mk 6, refuelling of the ventral tank is via a Mk 39 refuel/emergency transfer valve which is energised open when the refuelling panel microswitch operates.

34. All tanks are depressurised prior to refuelling by setting the BATTERY switch on and selecting FL REFUEL on the AAR switch for at least 30 seconds. The switch is returned to NORMAL when depressurisation is complete.

35. Above the refuelling panel there are seven 'tank full' indicator lights which come on when the panel is removed and go out individually when the associated tank-full float switch operates.

36. In the F Mk 6, if the aircraft is partially refuelled with overwing tanks fitted, the fuel is usually distributed fairly evenly amongst all tanks. In this condition the fuel feeds in the normal sequence and the CG should remain within limits.

Ventral Tank Jettison (F Mk 3 and T Mk 5 Only)

37. When pulled, the ventral tank jettison handle (see Tables 1 and 2 for cockpit position) releases the ventral tank. When the ventral tank is jettisoned, the VENTRAL fuel gauge freezes at the value indicated at the time of jettison.

Ventral Tank Emergency Transfer (F Mk 6 Only)

38. In the F Mk 6, a ventral tank emergency transfer three-position switch, with positions marked NORMAL/EMERG TRANSFER/OFF, is on the left console. It is guarded against inadvertant selection from NORMAL to EMERG TRANSFER; a second guard prevents accidental selection from EMERG TRANSFER to OFF.

39. When overwing tanks are fitted, if either of their low-level float switches fails to operate as the overwing tanks empty, ventral fuel does not transfer. By selecting the ventral tank emergency transfer switch to EMERG TRANSFER, the AC pump in the ventral tank is started, the Mk 47 (normal transfer) and Mk 39 (emergency transfer) valves are opened and fuel then transfers to the main tanks. However, with a failed overwing tank low-level float switch, ventral fuel may feed into one or both overwing tanks when EMERG TRANSFER is selected, whence it feeds normally into the main tanks.

40. When overwing tanks are not fitted, selecting EMERG TRANSFER opens the Mk 39 valve only, and fuel transfers to the main tanks at a reduced rate.

41. The OFF position of the switch prevents operation of the ventral tank pump during servicing with AC ground power connected.

Overwing Fuel Dumping (F Mk 6)

42. A guarded, two-position OFF/FUEL DUMP switch is on the left console of the F Mk 6. Fuel is dumped through a pipe running from the bottom of the centre compartment to the aft end of each overwing tank. The pipes are sealed by a blanking cap held in position by a hinged lever connected by two explosive bolts. When FUEL DUMP is selected, the explosive bolts of both tanks fire to free the lever which hinges open under the influence of a spring. Air pressure then dumps the fuel overboard, the transfer in the tank to its centre compartment following the normal sequence. From full, the tanks take approximately two minutes to empty, and a further two minutes for residual fuel and vapour to clear.

43. If a malfunction occurs, it is possible for dumping to continue from the ventral tank via the overwing tanks. In this situation set the AAR switch to FL REFUEL on the approach to land thus stopping ventral transfer and safeguarding against fuel spillage on hot brakes after landing.

MANAGEMENT OF THE SYSTEM

Before Engine Start

44. Before engine start note the fuel contents, particularly the ventral contents and, in the F Mk 6, the overwing tank contents (if fitted). Press the FUEL TANKS T/E button and check the MAIN gauges increase appropriately showing the contents of the flap tanks. Select the fuel gauge test switch to EMPTY noting datum readings for each gauge. It is important to note any error during the EMPTY check and apply it to the indicated fuel amounts when checking the fuel transfer sequence in flight.

Starting and After Starting Checks

45. Start the engines with both LP cocks and both DC pumps switches on (up). Check that the FUEL 1 and FUEL 2 captions go out by 38% RPM.

46. *Ventral Tank Pressure Check* (*F Mk* 6). A fuel pressure gauge is fitted at the left side of the centre compartment of the ventral tank in the F Mk 6 to allow groundcrew to check the serviceability of the ventral AC pump and tank pressure before flight. During the checks after starting, with AC on line, the groundcrew make a check of the ventral transfer pressure *before* fuel starts to transfer into the main tanks. Note that if overwing tanks are fitted, EMERG TRANSFER is selected to start the AC pump during the check. With the pump running the pressure gauge should read a minimum of 38 PSI.

47. Before take-off, carefully note the ventral (or overwing tanks, if fitted) gauge reading and compare with that noted during the internal checks. Under normal operating conditions the ventral (or overwing) contents should have decreased by 200 to 400 lb.

In Flight

48. Out-of-balance main tank contents are corrected by selective switching of the wing-to-wing TRANSFER switch to the low side, ie, selecting P (PORT) decreases right main tank contents. When an engine is shut down, consider carefully whether or not transferring

fuel is wise, depending on the emergency which caused the engine shutdown and the fuel available to the remaining engine without transfer. If it is considered necessary to transfer fuel, select the TRANSFER switch towards the side feeding the live engine. Leave the FUEL PUMPS switch of the shut-down engine ON so that the DC pumps on that side continue to run to provide wing-to-wing transfer pressure when the fueldraulic booster pump has stopped or is at a low output level. Engine and fuel management during low level diversion is discussed in Part 4, Chapter 2.

49. With the aircraft in straight and level flight, both DC pumps are uncovered when the fuel level in the main tank of the shut-down engine has fallen to approximately 400 lb gauged fuel. This fuel transfers only if the LP cock on the failed side is open and the fueldraulic booster pump is being driven by the windmilling engine.

50. *Flight with Low Fuel Contents.* When landing with indicated fuel less than 400 lb/side, avoid side-slip since this can result in an increase in unusable fuel.

After Flight

51. If the wing-to-wing transfer system has not been used in flight, it is checked after landing as follows:

a. After No 1 engine shut-down, note the fuel contents and select the TRANSFER switch to P (PORT).

b. When the fuel gauges confirm that fuel has transferred to the left tanks, select the switch off for 5 seconds and then select S (STB).

c. After No 2 engine shut-down, check that fuel has transferred to the right tanks and then select the TRANSFER switch off.

MALFUNCTIONS OF THE SYSTEM

Fuel Pressure Warnings

52. *FUEL 1 or FUEL 2 Caption.* A FUEL 1 or FUEL 2 caption indicates either failure of the fueldraulic booster pump or lack of fuel in the collector tank on the associated side.

a. *Fueldraulic Booster Pump Failure.* After booster pump failure the DC pumps are capable of supporting engine operation via the shuttle valve up to 40,000 feet, 0·9M and 85% RPM. If it is necessary to transfer fuel from the side having only DC pumps, set the corresponding engine to idle before transfer begins.

b. *Empty Collector Box.* The collector box remains topped-up under gravity feed as long as the aircraft is in a nose-up attitude. In nose-down attitudes, the collector box is emptied at a rate corresponding to engine demand unless output from the DC pumps (and, in particular, the leading-edge tank pump in a nose-down attitude) is sufficient to replenish it.

53. *PUMPS P or PUMPS S Caption.* A steady PUMPS P or PUMPS S warning signifies a pressure drop in the combined DC pumps output pipe. While this could indicate the simultaneous failure of both pumps, it is more likely to indicate the uncovering of one pump owing to fuel movement in the tanks following the failure of the other pump. The situation may be diagnosed as follows:

Flight Condition	*Probable Situation*
1. Level acceleration, *or* High nose attitude without acceleration	Front pump uncovered, rear pump failed
2. Nose-down attitude with no acceleration, *or* Rapid deceleration	Front pump failed, rear pump uncovered

a. *Condition* 1. With the front pump serviceable as diagnosed in Condition 1, no special action is required; stopping the acceleration or re-adopting a nose-down attitude re-immerses the serviceable pump to provide a continuous, if reduced, supply of fuel to the collector box. In any event, the collector box is being supplied by gravity feed.

b. *Condition* 2. With the front pump failed, as diagnosed in Condition 2, if the nose-down attitude or rapid deceleration is maintained, the collector tank empties and, since there is no DC pump pressure or gravity feed to provide an alternative fuel supply, the associated FUEL caption comes on and the engine flames out. Therefore, immediately a Condition 2 failure is diagnosed, throttle the affected engine to idle and adopt a 7° nose-up attitude for at least 15 seconds to allow the collector tank to refill under gravity. This action extinguishes the PUMPS warning if the rear pump is working but it must be repeated at intervals during recovery if the risk of flame extinction on that engine is to be avoided.

54. *Wing-to-Wing Transfer.* The output of a single DC pump is limited. It is incapable of sustaining simultaneous collector tank replenishment and wing-to-wing transfer. If a PUMPS warning appears whilst fuel transfer is in progress from the affected side, transfer should be stopped. Any fuel remaining on the side with a PUMPS warning may not be recoverable.

55. *Shuttle Valve Malfunction.* After fueldraulic booster pump failure the low pressure fuel system is supplied directly by the two DC pumps via the shuttle valve (Fig 3). If one DC pump fails in this situation, the remaining pump may provide enough pressure to

hold the shuttle valve over instead of allowing it to close and permit the engine to be fed from the collector box by HP pump suction. In this event, if the collector box has previously emptied and the fueldraulic pump system has not been reprimed by DC pump output, the engine will flame out if the supply to the DC pump is interrupted (eg by a change of aircraft attitude or velocity). This situation is resolved by deliberately shutting down and relighting the engine.

56. *Combined FUEL and PUMPS Warnings.* There is an immediate danger of engine flame out when the FUEL and PUMPS captions on one side come on together. Pressure in the delivery line to the engine has dropped below 5·75±0·75 PSI and the DC pumps are not replenishing the collector box or supplying fuel directly to the low pressure fuel system via the shuttle valve. Move the throttle to idle and adopt a 7° nose-up attitude for at least 15 seconds to replenish the collector box. If the PUMPS warning goes out the failed DC pump can be diagnosed in the method described in para 53. However, it is advisable after a combined warning to recover with the affected throttle at idle, and at an altitude below 12,000 feet if possible. If the engine flames out it may be relit at low altitude for landing. The combined failure drill and the cold relight drill are given in the FRC.

Wing-to-Wing Transfer Cock Failure

57. *Indicator Light.* After any malfunction of the wing-to-wing transfer system the transfer indicator light should be ignored. Fuel gauge readings are the only reliable inications of whether or not transfer is taking place.

58. *Cock Failed Open.* If a wing-to-wing transfer cock fails in the open position, constant cross transfer occurs and undemanded fuel asymmetry results. Stop the increasing asymmetry by selecting cross transfer in the opposite direction and balance the fuel by use of differential throttle.

59. *Cock Failed Closed.* If a cock fails in the closed position, cross transfer from that side is impossible. If the fuel contents on the side with the failed cock are high, balance can only be corrected by use of differential throttle.

Fuel Contents Gauge Failure

60. *Power Failure.* If the electrical power supply to a gauge fails, the pointer freezes at the reading indicated at the moment of failure. Operating the GAUGE TEST switch (FUEL TEST switch in T Mk 5) brings no response from the failed gauge(s).

61. Other types of failure, such as an internal short circuit in a tank sensor unit, may result in a gauge reading incorrectly or falling to zero or below, even though it indicates correctly when tested.

Ventral/Flap Transfer Failure (F Mk 3 and T Mk 5)

62. Failure of the ventral and flap tanks to transfer results in an aft movement of the CG and progressively worsening longitudinal stability as fuel is used from the wing tanks. As soon as the failure is recognised, check that the AAR switch is to NORMAL (OFF, T Mk 5) and restrict handling to gentle manoeuvres only. If the condition persists, land before the CG moves beyond the aft limit. The full drill and the CG limits are given in FRC.

Ventral Transfer Failures (F Mk 6)

63. *AC Pump Failure.* After AC failure, or after a mechanical failure of the ventral tank AC pump, the transfer rate of ventral tank fuel under air pressure is reduced. Select EMERG TRANSFER to open the Mk 39 valve and increase the flow. The engine demand is balanced by the transfer rate at economical cruise power settings.

64. *Ventral Transfer Failure.* If complete ventral transfer failure occurs, the fault is usually a failure of the Mk 47 valve to open. Having ensured that the AAR switch is to NORMAL, select EMERG TRANSFER to open the Mk 39 valve; the flow rate is then the same as after an AC pump failure. If the fuel fails to transfer after selecting EMERG TRANSFER the CG moves rapidly aft as fuel is used from the wing tanks. Use gentle manoeuvres only, reduce speed below 250 knots and make a precautionary landing. The full drill is in the FRC.

65. *Transfer Pressure Failure.* The failure of transfer air pressure in the F Mk 6 is noticeable only during prolonged use of reheat. Transfer rate is slightly lower than normal.

Mk 44 Valve Failure (F Mk 6)

66. If a Mk 44 valve fails to close because of high level float switch malfunction when the wing tank is full, ventral tank fuel is lost overboard through the wing tank vent (within approximately 10 minutes). If such venting occurs, set the ventral tank emergency transfer switch to OFF to stop the AC pump and close the Mk 47 valve. As the level in the wing tanks drops, select NORMAL to top up with ventral fuel.

67. If selecting the ventral tank emergency transfer switch to OFF does not close the Mk 47 valve, fuel is still transferred overboard by air pressure. In this case select the AAR switch to FL REFUEL to depressurise the tank and top up by selecting NORMAL on both switches when there is space available in the wing tanks.

Fuel Venting

68. If, during or after start-up, fuel is observed to be venting from the overwing tanks, or under pressure from any other source, or onto the wheelbrakes area, both engines are to be shut down immediately. If venting occurs from the overwing tank vents while taxying, immediately shut down the No 1 engine, raise the flaps and shut down the No 2 engine as soon as practicable. Abnormal venting from any other source while taxying is to be checked by a servicing specialist prior to flight.

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PART 1

CHAPTER 3—ENGINES AND FIRE PROTECTION SYSTEMS

Contents

CONTROLS AND INDICATORS

1. Details of the controls and indicators for the engine system in the F Mk 3 and F Mk 6 are shown in Table 1 and illustrated in Fig 1; for the T Mk 5 see Table 2 and Fig 2.

DESCRIPTION OF THE SYSTEM

General

2. The two Avon Mk 302 16-stage axial flow gas turbine engines are mounted in the fuselage, No 2 engine to the rear of and above No 1. Each engine develops approximately 12,600 lb static thrust without reheat and approximately 16,300 lb with full reheat. The main engine systems include:

- High pressure fuel system
- Reheat system
- Liquid fuel starting system
- Relighting facilities
- Engine oil system
- JPT control
- Engine anti-icing system
- Fire detection system
- Fire extinguishing system

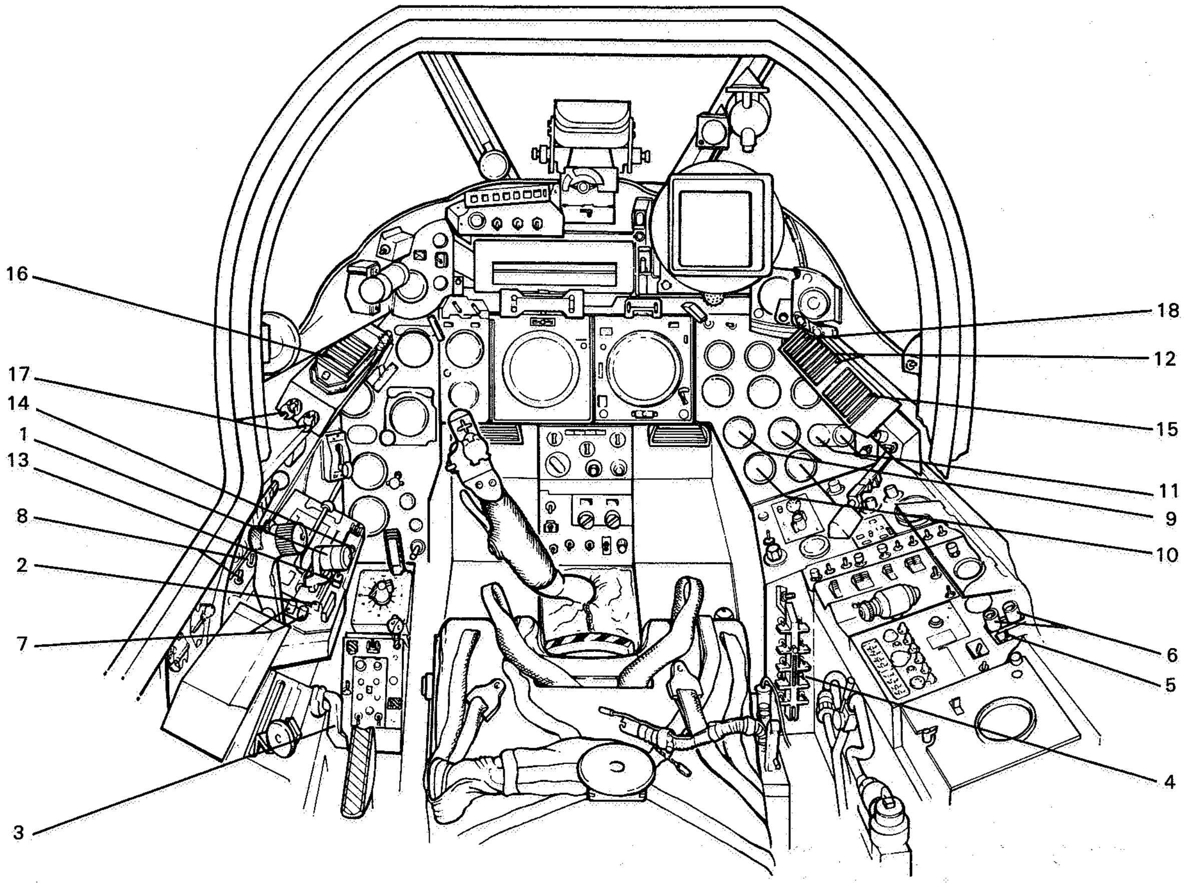
3. Each installation consists of the engine, an intermediate jet pipe and a reheat jet pipe which terminates in a variable nozzle consisting of 16 interlocking flaps. The airflow through the compressor is controlled by variable intake guide vanes and bleed valves; the intake airflow control system is fully automatic.

Table 1 — Controls and Indicators — F Mk 3 and F Mk 6

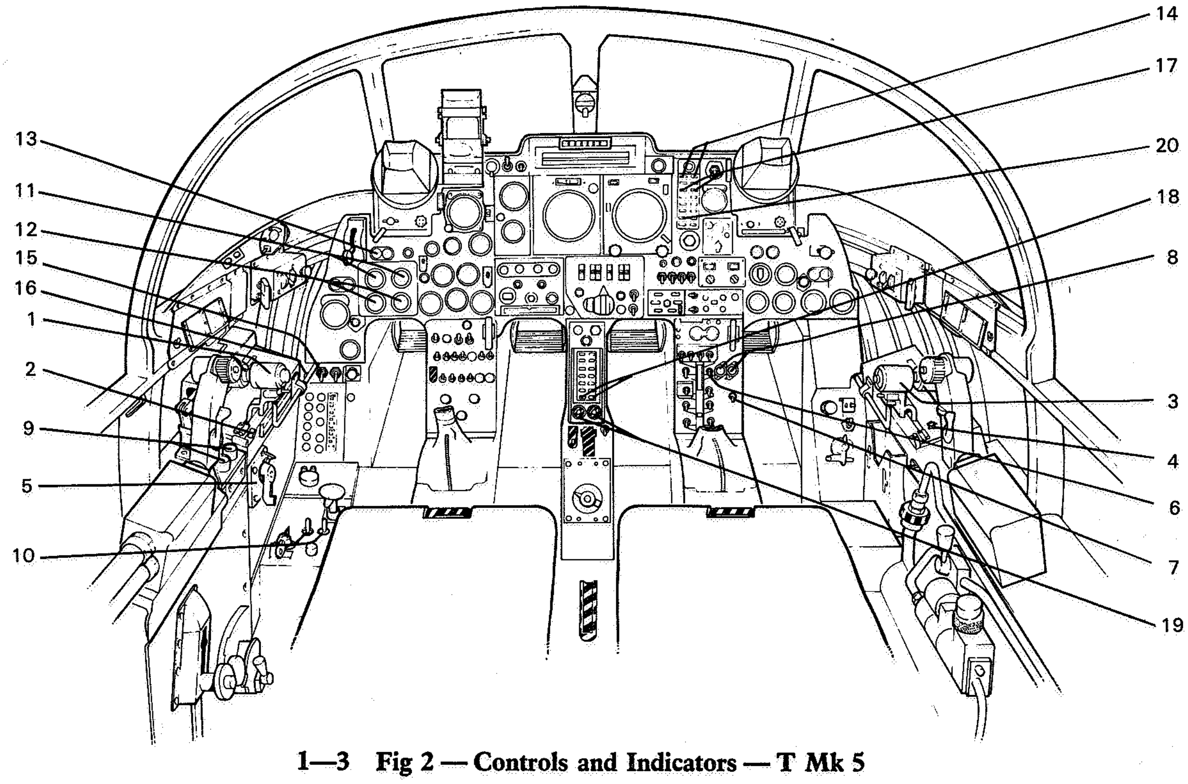
Item No	*Item*	*Markings*	*Remarks*
1	Throttles/HP cocks	HP COCKS OFF, OPEN, IDLING, THROTTLE OPEN, REHEAT. No 2 Throttle: PRESS, FAST IDLING STOP RELEASE	No 1 engine left throttle. No 2 throttle incorporates airbrake control and press-to-transmit button
2	Engine shutdown lever	SHUTDOWN	—
3	Throttle servo control	THROTTLE SERVO — ENGAGE/ DISENGAGE	See Chapter 8
4	Engine master switch	ENG MASTER	Up for on
5	Starter isolation switch	ENGINE STARTER ISOLATION	Aft to isolate
6	Engine start buttons	NO 1 — ENGINE START — NO 2	—
7	Relight buttons	NO 1 — RELIGHT — NO 2	—
8	JPT control switches	JPT CONTROL — NO 1/NO 2 — AUTO/OFF	Wire-locked to AUTO
9	RPM indicators	NO 1/NO 2 — PERCENT RPM	—
10	JPT indicators	NO 1/NO 2 — °C × 100	—
11	Nozzle position indicators	NO 1/NO 2	—
12	Oil pressure warnings	OIL 1/OIL 2	—
13	Engine anti-icing control	DE-ICING ON/OFF/RAIN DISPL	3-position switch guarded to OFF
14	Engine anti-icing MI	I/black/R	—
15	Top Temperature captions	TTC 1/TTC 2	—
16	Engine fire warnings	FIRE 1/FIRE 2	—
17	Fire extinguisher controls	F1/F2	Push buttons with integral lights
18	Ice warning caption	ICE	Inoperative

Table 2 — Controls and Indicators — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
1	Pupil's throttles/HP cocks	HP COCKS OFF, OPEN, IDLING, THROTTLE OPEN, REHEAT. No 2 throttle: PRESS, FAST IDLING STOP RELEASE	No 1 engine left throttle. No 2 throttle incorporates airbrake control and press-to-transmit button
2	Engine shutdown lever	SHUTDOWN	—
3	Instructor's throttles	HP COCKS OFF, OPEN, IDLING, THROTTLE OPEN, REHEAT	No control of HP cocks. No 1 throttle incorporates airbrake control and press-to-transmit button
4	Instructor's fast idling stop release button	—	—
5	Throttle servo control	THROTTLE SERVO — ENGAGE/ DISENGAGE	See Chapter 8
6	Engine master switch	ENGINE MASTER	Up for on
7	Starter isolation switch	ENGINE START—START/ISOLATE	—
8	Engine start buttons	ENGINE START — NO 1/NO 2	—
9	Engine relight buttons	RELIGHT — NO 1/NO 2	—
10	JPT control switches	JPT CONTROL — NO 1/NO 2 — AUTO/OFF	Wire-locked to AUTO
11	RPM indicators	NO 1/NO 2 — PERCENT RPM	—
12	JPT indicators	°C × 100	—
13	Nozzle position indicators	NO 1/NO 2	—
14	Oil pressure warnings	OIL 1/OIL 2	—
15	Engine anti-icing control	ANTI-ICING/OFF/RAIN DISPL	—
16	Engine anti-icing MI	ENGINE AND INTAKE — I/black/R	3-position switch, guarded to OFF
17	Top temperature captions	TTC 1/TTC 2	—
18	Engine fire warnings	FIRE 1/FIRE 2	—
19	Fire extinguisher controls	F1/F2	Pushbuttons with integral lights
20	Ice warning caption	ICE	Inoperative



1—3 Fig 1 — Controls and Indicators — F Mk 3 and F Mk 6



1—3 Fig 2 — Controls and Indicators — T Mk 5

Engine Fuel System

4. *Fuel Feed System.* Fuel from the low pressure fuel system is fed through a filter to the engine-driven HP fuel pump. The pump unit consists of two variable-stroke pumps in a common housing. Either pump is capable of delivering sufficient fuel for approximately 100% RPM to be attained in cold power. Pump output is fed to the burners through a fuel-cooled oil cooler and a proportional flow control unit which incorporates the combined throttle valve and HP cock. The output of the pump unit is controlled by a servo system in response to signals from the engine speed governor and the flow control system.

5. *Fuel Control System.* The fuel control system consists of the following controls:

a. *Engine Speed Governor.* The maximum RPM of the engine is controlled automatically. The governed maximum RPM, however, varies with altitude and ambient temperature and, under extreme conditions, manual control may be needed to prevent the operating limitations being exceeded.

b. *Altitude Sensing Unit (ASU).* The ASU regulates the fuel pump delivery in response to intake air pressure which varies with aircraft speed and altitude.

c. *Altitude Idling Valve.* The altitude idling valve prevents excessively low RPM when the throttle is selected to IDLING at altitude.

d. *Acceleration Control.* The acceleration control automatically limits the rate of increase in the fuel flow to the burners during rapid throttle movements.

e. *JPT Controller.* The JPT controller automatically prevents the JPT rising above the maximum limitation of 795°C providing AUTO is selected. When the maximum JPT is reached the controller trims the fuel flow to prevent a further increase in JPT. This may affect the maximum RPM attainable depending on ambient air temperature, altitude and speed. With the switch at OFF there is no automatic JPT control. The JPT control switches are normally wire locked to AUTO.

f. *Fuel Flow Limiter.* The fuel flow limiter restricts the maximum fuel flow to an engine under high intake pressure conditions, by means of a back stop on the acceleration control unit. This reduces the maximum attainable RPM at low altitude and high speed.

Oil System

6. Each engine has its own independent integral oil system of 12·5 pints capacity. One pressure and five scavenge engine-driven pumps maintain a continuous circulation through a fuel-cooled oil cooler and filter to the engine bearings and gears.

7. *Oil Pressure Warning.* A pressure switch is fitted in the oil system of each engine. If the oil pressure drops below 20 PSI the pressure switch closes and an OIL 1 or OIL 2 warning appears on the AWP. The oil warning light should go out by 45% RPM after starting.

Throttles/HP Cocks

8. In the F Mk 3 and F Mk 6 there is one throttle box on the left console. In the T Mk 5 the pupil's throttle box is similar in operation and position to the controls in the single-seat aircraft and a second throttle box is provided for the instructor on the right console. The instructor's throttle box in the T Mk 5 is slaved mechanically to the pupil's throttle box except that two solenoids in the pupil's unit are electrically connected to microswitches in the instructor's unit to permit reheat control and right throttle movement below the fast idle stop from the instructor's controls. The differences in operation of the instructor's throttle box are given in para 10.

9. *Normal Throttle Box.* The throttle lever and HP cock for each engine are combined in one control. The left throttle controls the No 1 engine and the right the No. 2.

a. *HP Cock.* When the throttle is fully back the HP cock is closed; when the lever is set forward to the IDLING position the HP cock is open. A stop at the IDLING position prevents rearward movement of the throttle lever; to select HP COCKS OFF the SHUTDOWN lever at the rear of the throttle box must first be pressed forward.

Note: When flying with No 2 engine shut down, forward movement of the throttle in the HP cock range could cause the idling stop to be depressed which would allow the No 1 throttle lever unrestricted movement through IDLING to HP COCKS OFF. To prevent this an additional stop ensures that the No 2 throttle is held positively at the HP COCKS OFF position until cleared by the operation of the PRESS FAST IDLING STOP RELEASE.

b. *Fast Idle.* On the No 2 throttle a fast idling stop prevents the No 2 engine being throttled back below approximately 58% RPM until the PRESS FAST IDLING STOP RELEASE is operated.

c. *Reheat.* Reheat power is obtained by first selecting maximum cold power and then rocking the throttle to the left and moving it forward to maximum reheat position. Once the reheat is lit, the throttle may be moved back from maximum reheat through the maximum cold power position to a mechanical stop at approximately 96% RPM. Reheat is cancelled by rocking the throttle to the right at any point between the maximum cold power position and the mechanical stop.

10. *Instructor's Throttle Box.* On the instructor's throttle box in the T Mk 5 the left throttle lever controls the No 1 engine and the right the No 2. The instructor's throttle box differs in operation from the normal throttle box in the following respects:

a. *HP Cock.* Although the throttles can be moved forward from HP COCKS OFF, it is not possible to select HP COCKS OFF from IDLING.

b. *Fast Idle Stop.* To reduce the No 2 throttle below the fast idle position, the button on the inboard side of the throttle box is pressed while continuing to throttle back. The system is electro-mechanical and requires a 28 volt DC supply to operate.

c. *Reheat.* To select reheat, the lever on the front of the throttle conrol lever must be 'lifted' whilst continuing to move the throttle forward into the reheat range. Reheat is cancelled by throttling back to the minimum reheat mechanical stop (approximately 96% RPM) and lifting the lever, which then allows further throttle movement into the cold power range.

Note: Using the instructor's controls, it is only possible to cancel reheat from the minimum reheat mechanical stop position.

Engine Starting System

11. Each engine has a separate iso-propyl-nitrate (Avpin) liquid fuel starter. A common 3-gallon fuel tank is fitted in the fuselage spine which supplies both starters with sufficient Avpin for a total of six starts. The gases drive the starter turbine which is connected to the engine through a reduction gearbox. Pressing the starter button with the starter isolation switch in the START position initiates a timed sequence of operations as follows:

a. The starter motor combustion chamber is scavenged by compressed air which is supplied by a combined fuel/air pump.

b. A fuel charge is pumped into the combustion chamber.

c. The mixture of fuel and air is ignited by two high frequency igniter plugs and combustion is sustained by the decomposition of the injected fuel.

d. The starter turbine turns the engine and at the same time the engine ignition plugs are energised to light up the engine.

e. When the engine reaches self-sustaining RPM, a switch operates to shut down the starter system.

12. *Failures to Start.* If an engine fails to start, limitations are imposed on subsequent attempts to start depending on the type of failure. The limitations are as follows:

a. *Starter Motor Failure.* If starter combustion does not occur ('A' failure) or if combustion occurs for less then one second ('B' failure) there is no indication of engine rotation on the RPM gauge. Wait at least one minute before the next attempt to start to allow the Avpin fuel to drain from the starter combustion chamber. A maximum of three attempts may be made after 'A' or 'B' failures.

b. *Engine Rotates but Fails to Light.* If, after a normal starter combustion cycle, the engine fails to reach self-sustaining speed, the engine is to be allowed to stop turning before a further starting attempt is made. Close the HP cock immediately the failure is certain and in any case before the RPM have reduced to 10%. After this failure, heat soakage of the starter may prejudice the next start attempt. Therefore, the interval between the first and second attempts should be as close as possible to one minute. A maximum of two such attempts are to be made, after which a cooling period of 60 minutes is to be allowed before investigation or a further starting attempt is made. The cooling requirement is considered satisfied if the second permitted starting cycle results in an engine start and the engine is allowed to run for 15 minutes.

c. *No Rotation.* If the engine fails to rotate after a normal starter combustion cycle, a further attempt to start is not to be made. Examination or investigation is not to be made in the vicinity of the engine starter until a cooling period of 60 minutes has elapsed.

WARNING: An engine starting button is not to be pressed when the engine is rotating (either in the air or on the ground).

13. *Starter Isolation Switch.* A starter isolation switch renders both starter buttons inoperative when ISOLATE is selected. The engine relight system is not affected by the position of the starter isolation switch.

Relighting System

14. With the ENG MASTER switch on, pressing the relight button bypasses the normal starting sequence to energise the ignition unit and operate the high energy igniter plugs of the associated engine. Pressing the relight button for two seconds also energises a time switch which allows the ignition system to run for

approximately 30 seconds after the relight button is released. Providing the undercarriage is selected up, both relighting circuits are energised whenever the armament firing trigger is pressed.

Jet Pipe Nozzle

15. The variable position nozzle is controlled by eight screw jacks which are driven and synchronised by an annular gear. An air motor, powered by engine compressor bleed air, drives the annular gear in response to mechanical inputs from an air motor control unit (AMCU). Gas stream pressure provides the nozzle opening force and the nozzle is closed or held fixed by the annular gear. One part of the AMCU controls nozzle position in the cold power range; the remainder is associated with reheat operation.

16. *Cold Power.* To improve engine handling and to give a lower SFC in the cruise range, the nozzle area is slightly increased at lower RPM under the automatic control of an engine-mounted, RPM-sensitive switch operated from the engine speed governor. The nozzle is partly opened in the cruise position from IDLING up to 97% RPM when it closes and remains closed up to maximum cold power. When throttling back, the nozzle remains closed until 89% RPM. It is therefore possible to be in cruise or closed nozzle between 89% and 97% RPM. These RPM values are sea level figures; the changeover RPM tend to increase directly with an increase in altitude.

17. *Reheat.* With reheat engaged, the nozzle area varies with throttle lever movement from part open at minimum reheat to fully open at maximum reheat.

18. *Nozzle Position Indicator.* Each nozzle position indicator displays two arcs, the lower for the cold power range and the upper for the reheat range of nozzle operation. A specific mark at the end of each arc indicates the maximum cold power and maximum reheat position, ie nozzles closed and fully open respectively.

Reheat System

19. Reheat augments engine thrust by injecting fuel to burn surplus air aft of the turbine in the reheat jet pipe. Combustion of the injected fuel raises the temperature and velocity of the exhaust gases, increasing the thrust. Fuel consumption with reheat in operation, especially at medium and low altitude, is extremely high; it is more than double the consumption at maximum cold power.

20. Fuel for the reheat system is taken from the aircraft low pressure fuel system and fed to the reheat burners by an air turbine pump which is driven by compressor bleed air. The reheat burners form three concentric rings. The two inner rings are fed from one pipe which supplies the fuel required at low reheat selections. At high reheat power, fuel is supplied to all three rings of the burner.

21. *Reheat Selection.* Reheat is always to be selected from the maximum cold power position by moving the throttles smoothly and quickly forward to the maximum reheat position. Below 35,000 feet the nozzles open fully with a momentary pause at an intermediate position. Above 35,000 feet, reheat lighting reliability is improved by automatically delaying the full opening of the nozzles until the reheat is lit and stable. After selecting maximum reheat the nozzles open to the intermediate position, the reheat lights and the nozzles hold the intermediate position for 15 seconds, after which the nozzles open to the maximum reheat position. Monitor JPT during reheat selection since a low JPT is the most reliable indication of reheat failure to light. During reheat light-up (or cancellation), there may be a transient RPM overswing (5-second limit) to 106%.

22. *Reheat Ignition.* Reheat is ignited by the 'hot streak' method. A metered quantity of fuel is injected into one of the engine flame tubes where it ignites, passes through the turbine and then ignites a further quantity of fuel injected into the intermediate jet pipe. This streak of burning fuel continues aft and lights the fuel spray from the reheat burners.

23. *Throttle Handling.* In the reheat range, movement of the throttles is to be made slowly and smoothly apart from the initial selection. Reheat is fully variable between the maximum and minimum available. Movement of the throttle lever changes the nozzle area and thus the pressure ratio across the turbine. This change of pressure ratio is sensed by the reheat fuel control unit which positions a throttle valve to increase or decrease reheat fuel flow to restore the pressure ratio.

24. *Top Temperature Control (TTC) Captions.* The TTC 1 and TTC 2 captions on the AWP indicate the correct working or malfunction of the reheat system. When reheat is selected the TTC captions come on, indicating initiation of the reheat systems, and go out when the 'hot streak' starts.

25. *Reheat Cancellation.* If the nozzles remain open after reheat cancellation a substantial loss of thrust in cold power occurs.

Note: The instructor's throttles in the T Mk 5 differ in some aspects; see para 10.

Reheat Malfunctions

26. The TTC caption comes on after hot streak initiation if reheat fails to light or if reheat is lit and automatic cancellation occurs. The following faults cause automatic cancellation:

Failure to light

Reheat extinction

Maximum JPT exceeded by 60°C (JPT controller in AUTO)

FUEL 1 or FUEL 2 caption

27. When reheat is tripped the appropriate TTC caption comes on and the nozzle closes. The TTC caption is extinguished by moving the associated throttle into the cold power range. Reheat may be re-selected after automatic cancellation but, if the system trips again, no further reheat selection is to be made. If automatic cancellation does not occur after a TTC caption comes on, select the throttle of the affected engine to full cold power to close the nozzle and regain full cold thrust.

28. If a TTC caption comes on when reheat is not selected, a DC power supply failure to the reheat system is indicated and the nozzle moves automatically to the cruise position. Reheat cannot be initiated on an engine which has a lit TTC caption.

29. When reheat is selected, a time switch is started so that, if reheat fails to light, a time delay of between 3·5 and 7 seconds occurs (depending on the cause of failure) before automatic cancellation and closure of the nozzle. If reheat fails to light within 5 seconds, cancel the selection, wait 2 seconds and re-select. If reheat again fails to light and the aircraft is within the recommended lighting envelope (Part 3, Chapter 3), further attempts are unlikely to be successful and the reheat system should be considered unserviceable.

30. If a fault other than failure to light occurs, the TTC caption appears 2 seconds before the reheat is tripped. This delay was introduced to prevent reheat extinction when firing missiles. If a TTC caption comes on and normal conditions are restored within 2 seconds, the reheat remains lit and the TTC caption goes out.

31. *Throttle Seizure in Reheat.* If a throttle seizes in the reheat range, apply force to the throttle lever. This force stretches a telescopic rod in the reheat control run allowing the gate switch to be reached; reheat then cancels and the nozzle closes. The throttle lever then operates normally in the cold power range but it is recommended that reheat is not used again during that flight.

Anti-Icing Systems

32. *General.* Protection against icing is provided by three systems. They are all controlled by one switch which operates a DC relay common to all systems. Operation of the systems is confirmed by a magnetic indicator. Two hot air systems protect the engine and intake duct lip, and an electrically-powered Spraymat system protects the leading edges of the upper and lower radome struts and areas about the engine duct bifurcation. When the engine anti-icing switch is selected to DE-ICING ON (ANTI-ICING, T Mk 5), the DC relay operates to power both engine systems, the intake duct lip protection and the Spraymat systems.

33. *Engine Anti-Icing.* On each engine, hot air tapped from the compressor is directed via an electrically-operated gate valve to flow into the front bearing support struts, the intake guide vanes, the starter fairing and the starter exhaust pipe. The air then passes into the engine.

34. *Duct Lip Anti-Icing.* Compressor bleed air from each engine, controlled by an electrically-operated butterfly valve, is fed to a manifold and divided to flow through sections of the duct lip and escape through small vents into the duct.

35. *Spraymat Anti-Icing.* The leading edges of the upper and lower radome struts and the areas about the engine duct bifurcation are protected by the Spraymat system. Power for the heating is provided from the 200V, 3-phase, 400 Hz AC supply which is controlled by the anti-icing switch and by an automatic temperature controller within the system.

WARNING: The temperature controller in the Spraymat system is ineffective when the engines are not running. To prevent damage, an AC supply is not to be connected to the aircraft with the DE-ICING ON (ANTI-ICING, T Mk 5) position selected whilst the engines are at rest.

36. *Temperature and Pressure Switches.* Downstream of the duct lip butterfly valve are two switches which protect the system against excessive temperatures and pressures. Operation of either switch trips the DC relay common to all three anti-ice systems and they stop operating. The temperature-sensing switch is self-resetting and the systems are regained when the temperature drops. However, the pressure-sensing switch is not self-resetting and, if the switch operates, no anti-ice protection is available until the switch is reset on the ground.

37. *Magnetic Indicator (MI).* A switch in the duct lip butterfly valve controls the indication of the engine anti-icing MI. The switch operates in the last few degrees of the valve's opening or closing movement, indicating I when the systems are on and black when the systems are off or automatically shut down. When the engine anti-icing control switch is moved to the RAIN DISPL position, the MI shows R to indicate that the rain dispersal system is in operation (see Chapter 11). It is therefore not possible to have the rain dispersal and anti-icing systems working concurrently.

Ice Warning System

38. The ice warning system is inoperative and the ICE caption of the AWP is therefore redundant.

Engine Fire Protection System

39. *Fire Zones.* Each engine bay is divided into two fire zones by a fire-wall between the engine compressor section (zone 1) and the turbine and exhaust section (zone 2). The space surrounding the jet pipes of both engines is zone 3 and it is separated from the other zones by vertical and horizontal fire-walls. Each fire zone has a separate ventilating system. The diagram at Fig 3 shows the T Mk 5 engine fire protection system which is similar to the F Mk 3 and F Mk 6 systems.

40. *Fire Extinguishers.* Two dual-headed methyl bromide fire extinguishers are installed in the fuselage. The left extinguisher serves each zone 2 and the right extinguisher each zone 1. There is no extinguisher for zone 3. Extinguisher operation is effected by pressing either of two indicator/extinguisher buttons on the SWP. When either button is pressed, both extinguishers are completely discharged into zones 1 and 2 of the appropriate engine bay. Telltale indicators, one on each side of the ventral tank refuelling light on the left side of the fuselage, show a reddish-brown colour if the extinguishers have been discharged electrically.

41. *Extinguisher Discharge.* Each extinguisher is fitted with an over-temperature safety device which causes the contents to discharge overboard should the temperature in the vicinity of the bottle exceed approximately 175°C. Two indicators, one left and one right, located just aft of the No 1 engine longeron, show green when no discharge has occurred. If the contents of a bottle are released overboard, the green indicator cover is blown off and a bright red bowl under the cover is disclosed.

42. *Fire Detection.* An FFFD fire detection system is fitted in all three fire zones. There is a separate firewire circuit for each engine bay and two circuits, one to each jet pipe, in zone 3. The elements are connected to the input channels of a relay unit which controls the relevant warnings on the SWP. The INSTRUMENT MASTER switch must be on for the detection circuits to be operative.

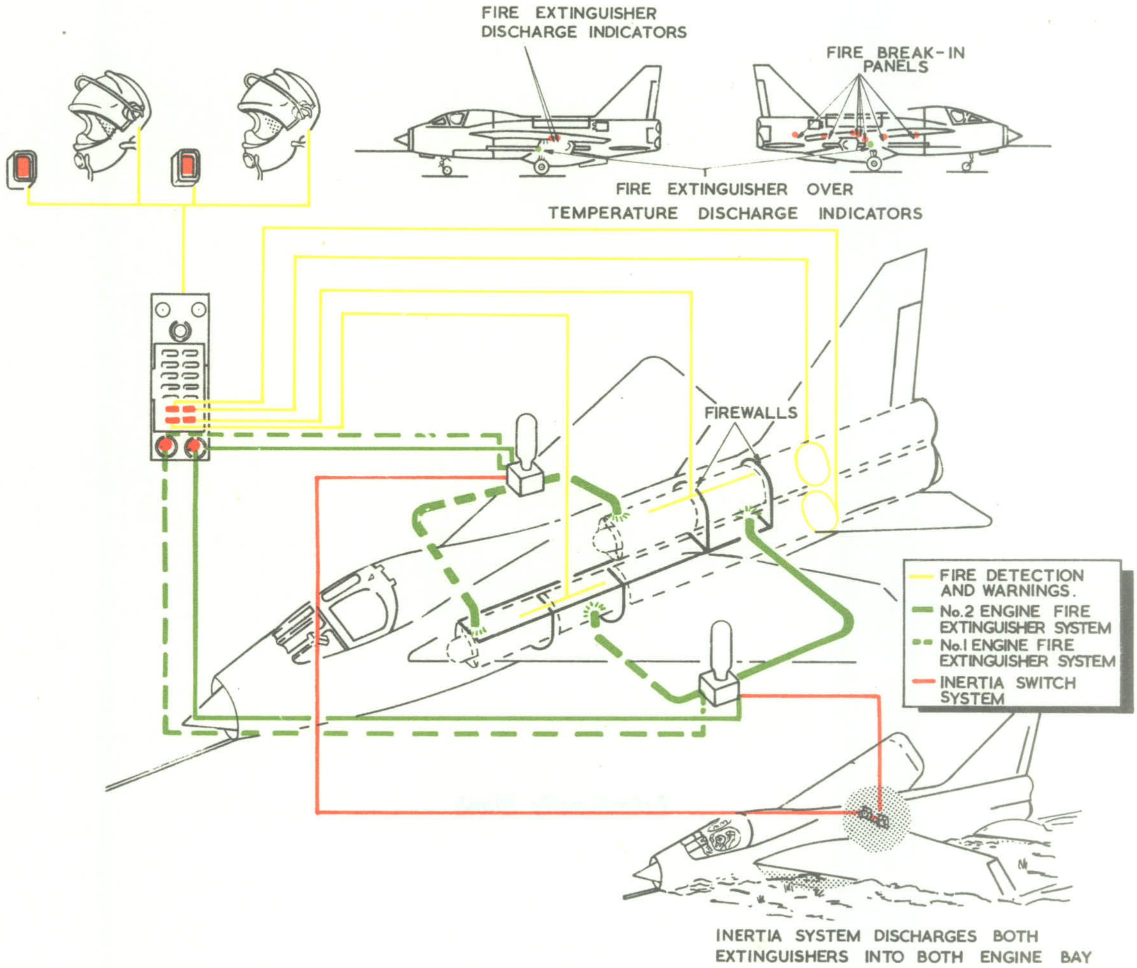
43. *Electrical Power Sources.* The system is supplied with 115V, 3-phase, 400 Hz AC from the Essential Instruments busbar which has a standby supply from the type 100A inverter. Thus, a warning initiated on one AC source is continued if changeover to the other source occurs, with a momentary interruption at the instant of changeover. Because of this interruption, cancelled attention-getters are reactivated if their originating warning is still present at the time of changeover.

44. *Fire System Testing.* The system is tested by pressing the T button on the SWP. Unserviceability is shown by the warning captions failing to come on or failing to go out when the T button is released. The system should not be tested in the air owing to the possibility that a fire warning, triggered by the test facility, may remain on when the T button is released even though the system is serviceable. Testing is done before engine start (with AC on line) and immediately after landing when optimum conditions for moisture contamination of the firewire are experienced.

45. *Fire Warnings.* Warning of fire in zone 1 or 2 of the No 1 engine is given by a FIRE 1 warning on the SWP, the operation of the F1 light in the fire extinguisher button and the operation of the attention-getters. Warning of a fire in zone 1 or 2 of No 2 engine is given by a FIRE 2 warning on the SWP, the operation of the F2 light in the fire extinguisher button and the operation of the attention-getters. Warning of excessive temperature or fire in zone 3 is given by the illumination of a RHT 1 and/or RHT 2 warning on the SWP and by the operation of the attention-getters.

46. *Inertia Crash Switches.* Two inertia crash switches are in circuit with the fire extinguisher system. If both crash switches operate, both extinguishers are discharged into zones 1 and 2 of each engine. The crash switches also isolate certain electrical supplies (see Part 1, Chapter 1).

47. *Fire Drills.* Part 4, Chapter 2 discusses in detail the procedures to be followed after fire in the air, and the FRC contain the drills.



1—3 **Fig 3 — Fire Protection System**

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PART 1

CHAPTER 4—HYDRAULICS

Contents

DESCRIPTION OF THE SYSTEMS

General

1. There are three separate hydraulic systems in the aircraft: the Services system, the No 1 Controls system and the No 2 Controls system. The systems operate the services listed in Table 1. Diagrams of the systems are shown at Fig 1 and 2.

Table 1 — Hydraulically Operated Services

Services System	*No 1 Controls*	*No 2 Controls*
Undercarriage	Aileron PFCU (outboard)	Aileron PFCU (inboard)
Wheelbrakes	Tailplane PFCU (right)	Tailplane PFCU (left)
Airbrakes	Rudder PFCU (forward piston)	Rudder PFCU (aft piston)
Flaps	Brake parachute doors	
Feel system	Undercarriage emergency lowering	
Canopy		
Nosewheel centring and anti-shimmy		
Autostabiliser actuators		
Guided weapons pack		

Pumps

2. Hydraulic power is provided by four engine-driven pumps, two being mounted on each engine wheel case. The forward pumps on each engine jointly power the Services system; the aft pumps supply the Controls systems: the No 1 engine pump and the No 2 engine pump serving the No 1 and No 2 Controls systems respectively. A hand pump for ground operation of the Services system is behind an access panel on the left side of the fuselage. A stowage for the hand pump handle is in the left wheel well.

Reservoirs

3. The pumps draw hydraulic fluid from three main reservoirs, one to supply the Services system and one each for the No 1 and No 2 Controls systems. The reservoirs are pressurised by engine compressor bleed air. An auxiliary reservoir in the No 1 Controls system provides additional fluid for emergency undercarriage lowering; it operates in parallel with the main No 1 Controls reservoir. The reservoirs are fitted with anti-g valves to prevent air from entering the hydraulic pumps under negative-g conditions.

Accumulators

4. *Services System.* The Services system has four accumulators (see Fig 1). The services not provided with hydraulic accumulator protection are the airbrakes, undercarriage raising and lowering, and the guided weapons pack. The wheelbrakes have an accumulator solely for the wheelbrake system and can also use pressure from a second accumulator which also supplies the nosewheel centring and canopy systems.

5. *Controls Systems.* Each Controls system has two accumulators (see Fig 2) which allow for high rates of normal operation of the control surfaces and for limited emergency operation.

6. The nitrogen pressures for all eight hydraulic accumulators are shown on skin gauges. The correct pressure values are listed in FRC under **External Checks.**

Services System Pressure Gauge

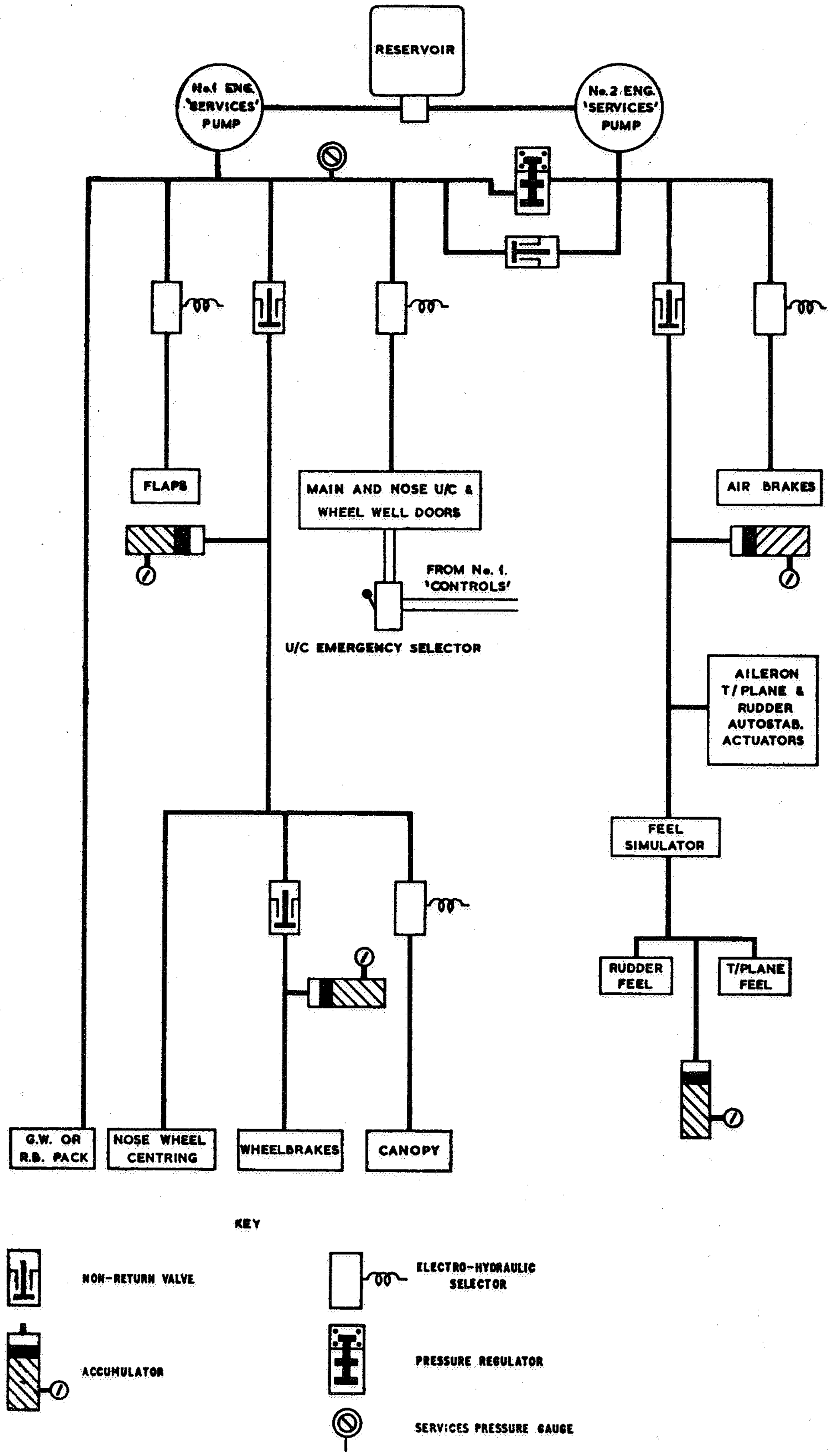
7. In the F Mk 3 and F Mk 6 a HYD pressure gauge on the left cockpit shroud indicates Services system pressure; in the T Mk 5 the gauge is marked SERVICES PRESSURE and is positioned to the right of the strip speed display. The normal pressure reading is 3000±250 PSI. When a service is selected which has a high fluid demand, the reading falls rapidly and then gradually recovers.

8. *Electrical Supply.* The gauge is powered from the 28V, single-phase, AC busbar. If the power supply fails, eg after AC failure, the reading falls below zero into the white sector of the gauge.

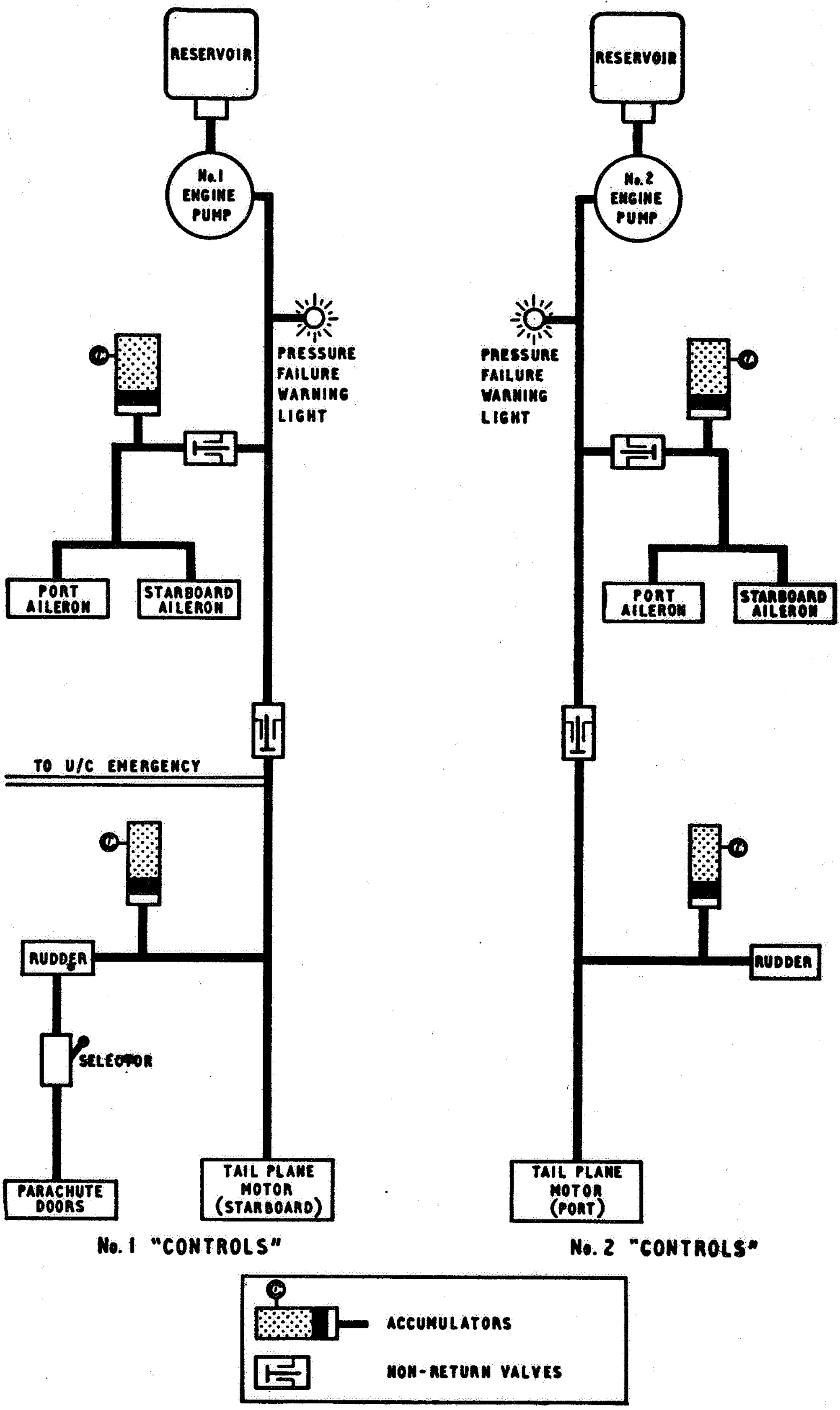
Pressure Regulator

9. The guided weapons pack alternator is driven by Services hydraulic pressure when ARM (ARMED, T Mk 5) is selected. It is necessary to maintain a minimum pressure of 2700 PSI in the system to sustain the alternator. To prevent a drop in pressure below 2700 PSI during airbrake operation, a pressure regulator and non-return valve are interposed between the delivery lines of the No 1 and No 2 Services system pumps. If airbrakes are selected during an arming sequence, the pressure regulator and non-return valve ensure that the No 1 Services pump delivery pressure is not reduced and the arming sequence is not interrupted.

10. One engine must be running at or above fast idling speed to supply sufficient Services hydraulic pressure for the missile pack alternator, and this must



1—4 **Fig 1 — Services Hydraulic System**



1—4 **Fig 2 — Controls Hydraulic Systems** be the No 1 engine if the airbrakes are to be used. The guided weapons pack alternator is interrupted when:

a. Flaps or undercarriage are cycled.

b. Airbrakes are operated when flying on No 2 engine only.

c. Airbrakes are operated after No 1 services pump has failed.

Pressure Failure

11. *Services System.* Failure of the Services system is indicated when the gauge falls to, and remains at, zero in the red sector of the gauge.

12. *Controls Systems.* A pressure switch is fitted in the delivery lines of both the No 1 and No 2 Controls systems. If line pressure falls below 1750 PSI the switch closes and a HYD 1 or HYD 2 warning, as appropriate, is lit on the AWP. If both switches close an additional HYD warning on the SWP comes on and the attention-getters operate.

MANAGEMENT OF THE SYSTEMS

External Checks

13. During the external inspection, check that the hydraulic pump handle is securely stowed and that the eight accumulator skin gauges are showing the correct nitrogen pressures.

Before Take-Off

14. After starting No 1 engine, check the Services pressure is 3000±250 PSI and the flying controls for full and free movement. Before take-off again check that the Services pressure is correct and make another full and free controls check, ensuring that the HYD, HYD1 and HYD2 warnings are all out.

In Flight

15. During flight, periodically check the Services pressure and that no hydraulic captions are lit.

After Landing

16. When No 1 engine has been shut down and its RPM are below 10%:

a. Raise the flaps and retract the airbrakes and check that the Services pressure recovers to 3000 ±250 PSI.

b. Check the flying controls for full and free movement.

MALFUNCTIONS OF THE SYSTEMS

17. Malfunctions of the hydraulic systems are dealt with in Chapter 5 (Powered Flying Controls and Trimmers) and Chapter 6 (Other Aircraft Controls). The associated drills are in FRC.

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PART 1

CHAPTER 5—POWERED FLYING CONTROLS AND TRIMMERS

Contents

CONTROLS AND INDICATORS

1. Details of the controls and indicators for the F Mk 3 and F Mk 6 are listed in Table 1, and for the T Mk 5 in Table 2. They are illustrated in Fig 1 and Fig 2 respectively.

Table 1 — Controls and Indicators — F Mk 3 and F Mk 6

Item No	*Item*	*Markings*	*Remarks*
1	Control column	—	—
2	Rudder bar	—	—
3	Aileron/tailplane trim	—	4-way, dual ganged switch, spring-loaded to the central, off, position
4	Rudder trim	RUDDER TRIM	Twin, ganged, 3-position switches, spring-loaded to central position
5	Trim indication	TRIM INDICATOR — RUD/TAIL/ AIL/AIR BRAKE	—
6	Feel selector	FEEL — ON/OFF	Guarded to ON
7	Power control failure warnings	HYD 1/HYD 2 (AWP) HYD (SWP)	— —
8	Rudder bar adjustment	PULL TO ADJUST RUDDER BAR	—

Table 2 — Controls and Indicators — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
1	Control columns	—	—
2	Rudder bars	—	—
3	Aileron/tailplane trim (2)	—	4-way dual ganged switches, spring-loaded to the central, off, position. Not illustrated
4	Rudder trim (2)	RUDDER TRIM	Twin, ganged, 3-position switches spring-loaded to the central, off, position
5	Trim indication	TRIM INDICATOR — RUD/TAIL/ AIL/AIR BRAKE	—
6	Feel selector	FEEL UNIT — ON/OFF	Guarded to ON
7	Power control failure warnings	HYD 1/HYD 2 (AWP) HYD (SWP)	— —
8	Rudder bar adjustment (2)	RUDDER BAR ADJUST	a. Pupil b. Instructor

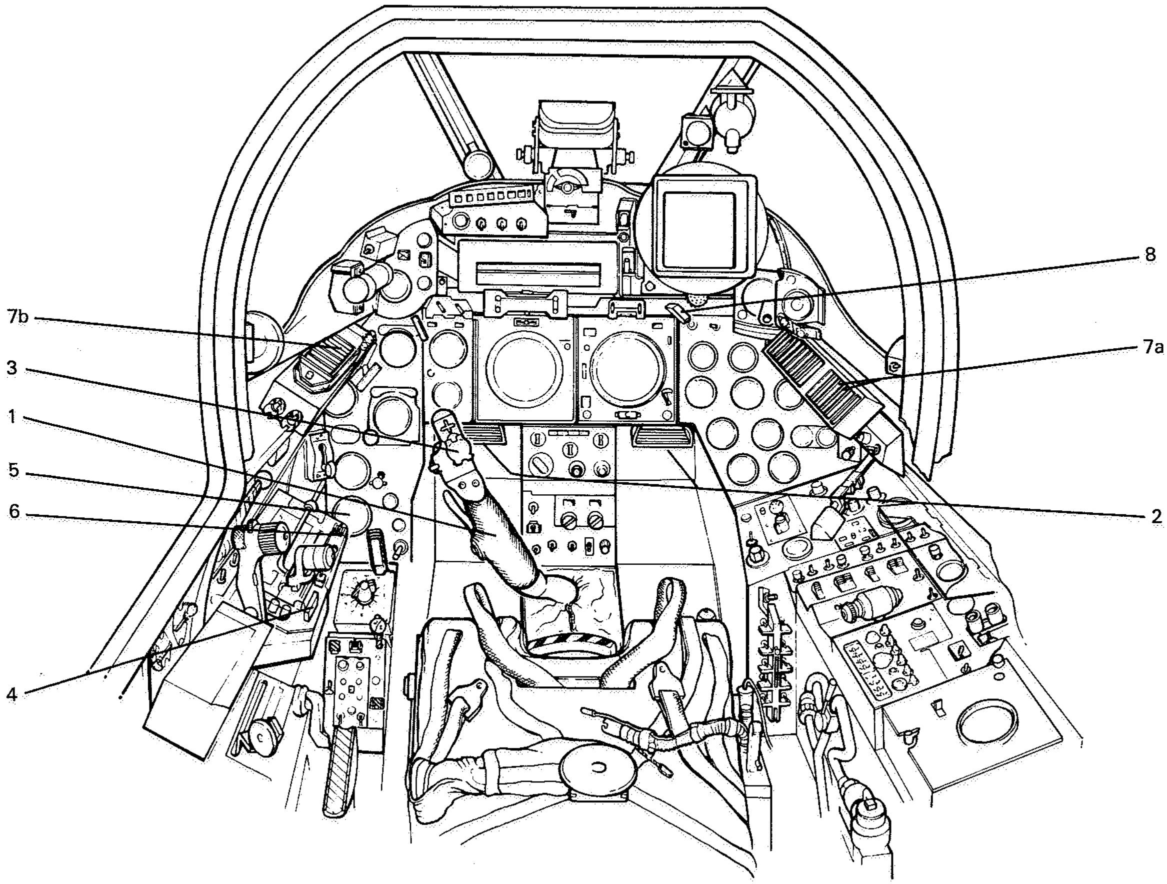
DESCRIPTION OF THE SYSTEM

General

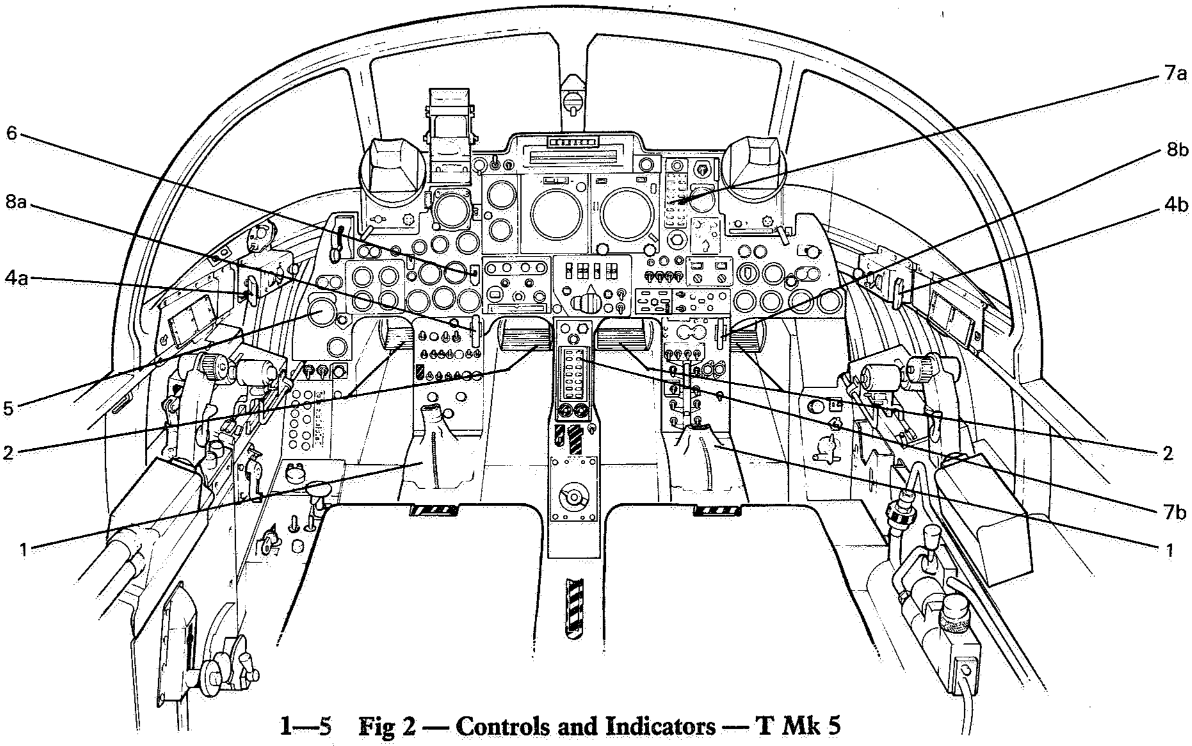
2. The ailerons, tailplane and rudder systems are fully power-operated flying controls. Each system is connected to two separate Controls hydraulic systems driven by hydraulic pumps on No 1 and No 2 engines. This gives mutual protection to the Controls systems in case one engine is shut down or if one hydraulic system fails, but there is no manual reversion to mechanical flying controls if both systems should fail. The ailerons and rudder are moved by jack-type powered flying control units (PFCU) and the tailplane by a twin screw-jack PFCU. The PFCU are mechanically actuated from conventional pistol grip control column(s) and rudder bar(s). Artificial feel is provided in each circuit. Trimming is effected by electrically-operated actuators which, by moving the control runs, displace the PFCU and adjust the cockpit controls to a new neutral position.

Ailerons

3. Each aileron is moved by two PFCU. The outboard PFCU are powered by the No 1 Controls system and the inboard by the No 2 Controls system. If the hydraulic supply fails to one PFCU, the aileron is moved by the other PFCU, resulting in a slight reduction in the maximum operating rate.



1—5 **Fig 1 — Controls and Indicators — F Mk 3 and F Mk 6**



1—5 **Fig 2 — Controls and Indicators — T Mk 5**

4. Aileron movement is limited to approximately half travel (±10°) whenever the undercarriage is up. A restrictor in the control run in the left wing engages with the undercarriage wheel well door as it closes.

Rudder

5. The rudder PFCU incorporates twin piston assemblies in tandem. The forward piston is operated by the No 1 Controls system and the rear by the No 2 Controls system. Failure of one Controls system does not affect the rate of operation.

Tailplane

6. The slab tailplane is moved by a twin screw-jack PFCU powered by two independent, reversible hydraulic motors through a common gearbox. The right hydraulic motor is supplied by the No 1 Controls system and the left from the No 2 Controls system. Failure of the hydraulic supply to one of the motors reduces the rate of tailplane operation; for this reason manoeuvre is limited to 2g following such a failure.

Aileron Feel System

7. Artificial feel in the aileron system is provided by a torsion bar connecting the control column to the control run. Feel force is directly proportional to control column movement and does not vary with speed and altitude.

Tailplane and Rudder Feel

8. Artificial feel in the rudder and tailplane control systems is provided primarily by hydraulic feel units, supplied by the *Services* hydraulic system, in each control run. Hydraulic feel may be cancelled by selecting the FEEL (FEEL UNIT, T Mk 5) switch to OFF, but the switch is normally left guarded to ON. Spring feel is also provided to supplement the hydraulic feel and to act as a standby system in the event of hydraulic feel failure.

9. *Operation.* When the control column or rudder bar is moved, a piston in the feel unit is displaced against hydraulic pressure. Relaxing the force on the control allows the piston to move the control column or rudder bar back to its trimmed position.

10. *Hydraulic Feel Units.* The hydraulic feel units give a linear increase in feel force with control movement and an increasing feel force with increase in pitot/static differential pressure through the action of a feel simulator control unit which meters hydraulic pressure to the feel unit pistons. If the pitot/static differential pressure is increased by increasing airspeed, the feel simulator control unit increases the pressure at the pistons until the speed reaches 0·9M, above which speed feel is maintained at a constant value for a given altitude. However, differences in static pressure continue to affect feel force at speeds greater than 0·9M.

11. *Accumulators.* There are two accumulators in the hydraulic feel system:

a. A small accumulator acts as a damper between the rudder and tailplane units during rapid operation of the controls and also prevents reaction on the feel simulator valve which would otherwise cause the flight instruments to fluctuate.

b. A large accumulator prevents changes in feel occurring when the general services are being operated. It also provides continued operation of the feel system for a limited period after Services system failure.

12. *Rudder Loading.* To reduce the foot load on the rudder bar in the landing configuration, hydraulic feel to the rudder is disengaged when the undercarriage is selected DOWN and is restored when an UP selection is made.

Trimmers

13. The flying controls are trimmed by an electric motor in each system. In the tailplane and rudder systems the motors are connected to the hydraulic feel units and in the aileron system to the torsion bar. Operation of the appropriate motor displaces the feel unit or aileron torsion bar which in turn displaces the control column or rudder bar to a new neutral position.

Rudder Bar Adjustment

14. *F Mk 3 and F Mk 6.* When the PULL TO ADJUST RUDDER BAR handle is pulled out, a toothed plunger is withdrawn from the rudder bar rack allowing the rudder bar to move aft under the action of a compression spring or to be pushed forward against the spring pressure. When the desired leg reach position is attained, releasing the handle allows the toothed plunger to re-engage the rack.

15. *T Mk 5.* The rudder bars at each station in the T Mk 5 are adjusted independently by pulling out the RUDDER BAR ADJUST handles and then turning the handles anti-clockwise to shorten leg reach and vice versa. After adjustment, turning the handles to the vertical position and pushing them in locks the adjustment gear.

MANAGEMENT OF THE SYSTEM

Pre-Flight Checks

16. *Failure Warnings.* Check the HYD 1 and HYD 2 captions on the AWP and the HYD caption on the SWP are on before starting, the HYD and HYD 1

warnings go out after starting No 1 engine, and the HYD 2 warning goes out after starting No 2. Re-check the warnings are all out before take-off.

17. *Rudder Trim.* On the first sortie of the day, test the rudder trim for a live circuit by disconnecting the ganging bar and operating each of the two rudder trim switches separately. If any movement of the rudder trim actuator occurs, the aircraft is not to be flown. Test the rudder trim over its full range by operating both switches together and then set neutral trim. Replace the ganging bar. On subsequent sorties test the rudder trim for correct operation.

18. *Tailplane and Aileron Trim.* On the first sortie of the day, test the tailplane and aileron trims for a live circuit by raising the ganging bar and operating each switch separately. If any movement of either tailplane or aileron trim occurs, the aircraft is not to be flown. Replace the ganging bar and check it is locked by attempting to lift it. Test the aileron and tailplane trims over their full range and then set the ailerons to neutral and the tailplane to TO. On subsequent sorties test the tailplane and aileron trim for correct operation.

19. *Controls Checks.* Adjust the rudder bars. After starting No 1 engine and before take-off, make full and free movement control checks ensuring that the appropriate failure warning captions do not come on. If an excessive movement of the tailplane control is made, it is possible to 'bottom' the control valve in the PFCU. This is made apparent by an increase in feel force; no mechanical damage should occur.

In Flight

20. Make routine periodic checks of the AWP to ensure the HYD 1 and HYD 2 captions are out during flight.

21. *Limitations.* The limitations on the use of ailerons are to be found in Part 2, Chapter 1 (**Rolling Manoeuvres**).

After Landing

22. Follow the **Checks After Landing** and **Shutdown Checks** in FRC.

MALFUNCTION OF THE SYSTEMS

General

23. The drills for power controls, trim and feel systems failures are to be found in FRC.

Double Controls Systems Failure

24. After double Controls systems failure the HYD warning on the SWP comes on together with the attention-getters, in addition to the HYD 1 and HYD 2 warnings on the AWP. The accumulators in the systems provide for limited operation for a short period before the controls freeze solid. If the failure is caused by a double flame-out, the accumulator supply may be supplemented by the Controls systems hydraulic pumps if the speed is kept at 250 knots or above to give a sufficient engine windmilling speed.

25. The most probable cause of a double Controls systems warning, other than a double flame-out, is aeration of the system followed by pump cavitation after negative-g flight. A period of straight and level flight is likely to allow the restoration of hydraulic power. The drill in the FRC recommends engagement of the autopilot for the following reasons:

a. The autopilot detects deviations from the flight path quickly and compensates economically whilst accumulator pressure is available.

b. When the controls eventually freeze it is essential that the aircraft is in stabilised flight. Having the autopilot engaged ensures that the aircraft remains straight and level long enough for the pressure to recover after aeration. This has been known to take up to eight minutes.

Trim Malfunctions

26. If the aileron trim fails or runs away, the control forces can be held even if the system has failed at the extreme end of its authority. Prolonged flight in this condition is tiring and there is reduced aileron control against the trim. Land as soon as practicable.

27. After tailplane trim runaway, switch OFF the autopilot master switch.

28. If the rudder or tailplane trim runs away or fails to function, control forces are reduced by switching OFF the FEEL (FEEL UNIT, T Mk 5) switch. If the tailplane trim seizes in a nose-down position, switch OFF the feel system for the approach and landing.

WARNING: When flying with the feel system switched off, the control forces are light and care must be taken not to exceed the airframe limitations. Speed is to be limited to 400 knots.

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PART 1

CHAPTER 6—OTHER AIRCRAFT CONTROLS

Contents

UNDERCARRIAGE, FLAPS AND AIRBRAKES
CONTROLS AND INDICATORS

1. Details concerning the controls and indicators in the F Mk 3 and F Mk 6 for the undercarriage, flaps and airbrakes systems are listed in Table 1. Fig 1 and Fig 2 illustrate, for the single-seat and two-seat aircraft respectively, the controls and indicators for all systems discussed in this Chapter.

Table 1 — Controls and Indicators — F Mk 3 and F Mk 6

Item No	*Item*	*Markings*	*Remarks*
1	Undercarriage lever	UP/DOWN	—
2	Undercarriage position indicator	—	—
3	Undercarriage emergency lowering control	U/C	Yellow and black striped
4	Flap control lever	FLAPS — UP/DOWN	—
5	Flap position indicator	FLAPS — UP/DOWN	—
6	Airbrakes control switch	IN/off/OUT	—
7	Airbrake position indicator	AIRBRAKE — IN/OUT	—

Table 2 — Controls and Indicators — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
1	Undercarriage lever	UP/DOWN	—
2	Undercarriage position indicators (2)	—	—
3	Undercarriage emergency lowering control	U/C	Yellow and black striped
4	Flap control levers (2)	a. Pupil: FLAPS — UP/DOWN b. Instructor: FLAPS — UP/centre/DOWN	—
5	Flap position indicators (2)	FLAPS — UP/DOWN	—
6	Airbrakes control switches (2)	AIRBRAKES — IN/off/OUT	—
7	Airbrakes position indicator	AIRBRAKES — IN/OUT	One indicator

DESCRIPTION OF THE SYSTEMS

General

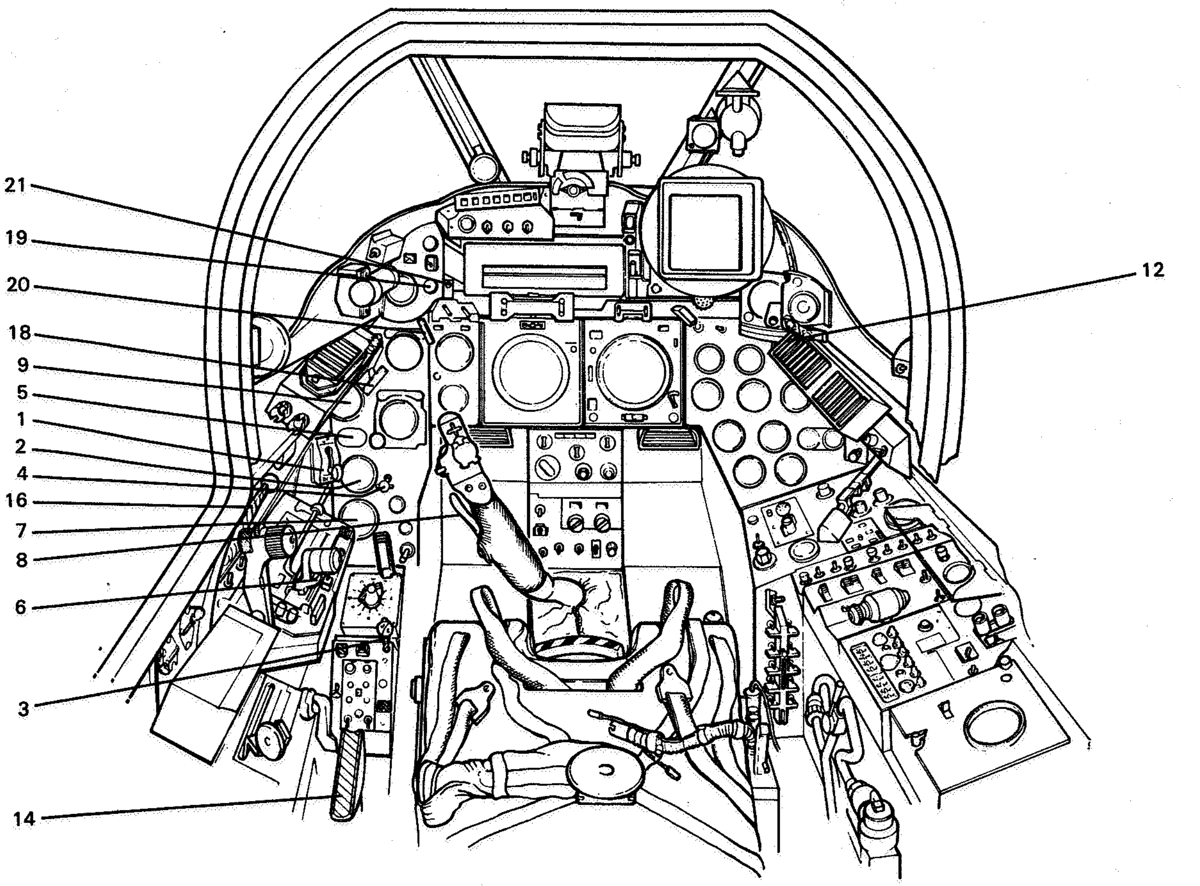
2. All three systems are electrically actuated by 28V DC and hydraulically operated by the Services hydraulic system except for the undercarriage *emergency* lowering system, which is mechanically actuated and hydraulically operated by the No 1 Controls system. After a complete DC failure or a Services system failure, the flaps and airbrakes cannot be operated and they remain in the position at which the failure occurred.

Undercarriage

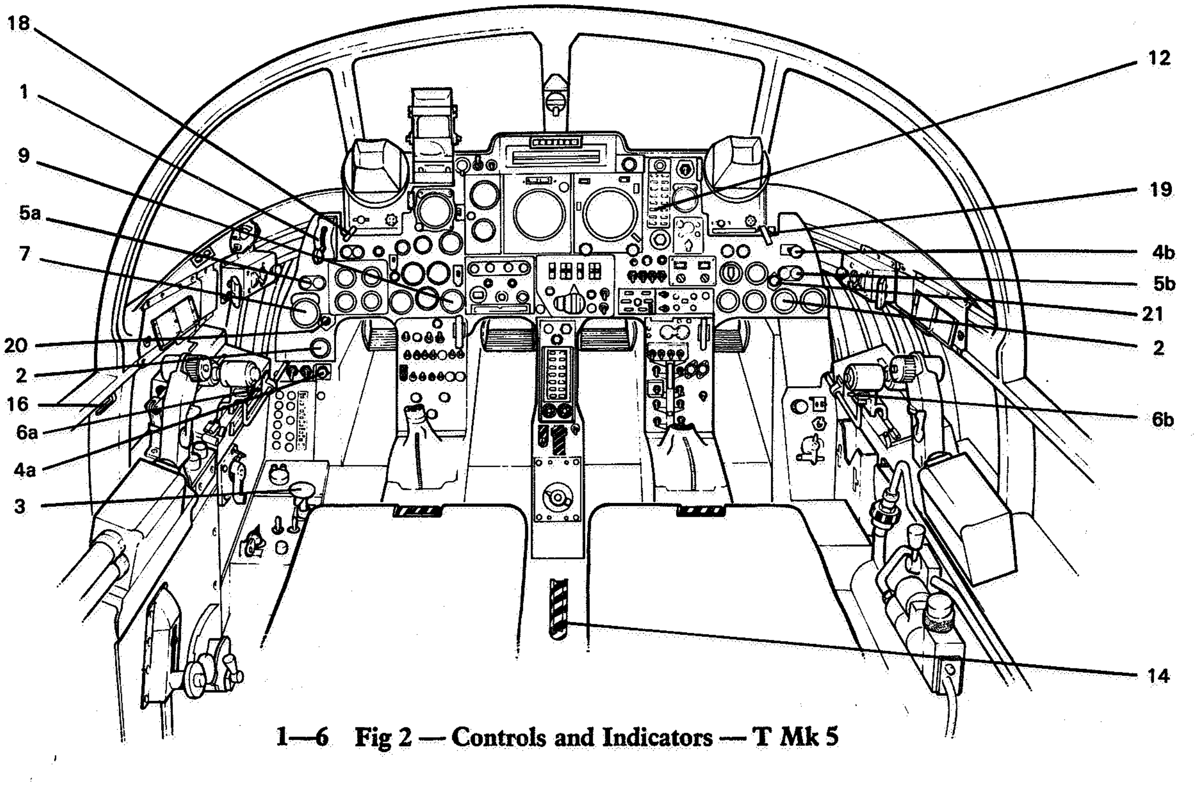
3. The undercarriage consists of two main wheels retracting rearward and outward into the wings, and a nosewheel retracting forward into a well in the fuselage nose.

4. *Undercarriage Lever.* A 2-position lever controls the operation of the undercarriage. It carries a spring-loaded cup, in effect a locking collar, which enters a gate in both the UP and DOWN positions to prevent inadvertent operation. Moving the lever to the UP or DOWN position energises either an up or down solenoid, both of which are integral with the undercarriage selector. The solenoids operate valves to direct fluid to the appropriate ends of the jacks and open the opposite lines to return. A pitot switch electrically prevents an UP selection being made below 165 knots.

5. *Emergency UP Selection.* In an emergency the pitot switch is overridden by turning the undercarriage lever clockwise through 45° and selecting UP. Normally this facility is only to be used on the ground. An emergency retraction is not to be used as a means of stopping the aircraft in a high-speed ground emergency because there is a strong likelihood of asymmetric retraction of the main wheels with the consequent danger of the aircraft cartwheeling. It is recommended that emergency retraction is restricted to normal taxying speeds.



1—6 Fig 1 — Controls and Indicators — F Mk 3 and F Mk 6



1—6 Fig 2 — Controls and Indicators — T Mk 5

6. *Undercarriage Position Indicator.* The undercarriage indicator (two indicators, T Mk 5) has three red and three green lights corresponding to the three undercarriage legs. When the undercarriage legs are all down and locked the three green lights are lit, and when locked up, all lights are out. The red lights come on to indicate that the corresponding legs are neither locked up nor down. The indicator has an alternative bulb selector and can be dimmed for night operation.

7. *Emergency Lowering.* The emergency lowering system is mechanical/hydraulic, taking hydraulic power from the No 1 Controls system. The button on top of the emergency lowering control T-handle is pressed down to release the T-handle. To ensure operation, the T-handle must then be pulled to its full extent; just prior to full travel it falls away on its cable as it clears its guide. Once the emergency system has been used it is not possible to raise the undercarriage until the system has been serviced on the ground. When the T-handle is operated, No 1 Controls system pressure is directed to:

a. Close a valve in a protection unit to isolate Services pressure from the normal selector.

b. Open a valve in the protection unit to connect all the up lines to return, irrespective of the position of the undercarriage lever.

c. Operate shuttle valves and relay valves to direct the No 1 Controls system pressure to lower the undercarriage.

8. *Nosewheel.* The nosewheel is free to caster through a maximum of 340°. The Services system provides hydraulic pressure for shimmy damping and for automatic wheel centring during retraction.

Flaps

9. The flaps, which are utilised as fuel tanks, are hydraulically operated by the Services hydraulic system and electrically actuated by the 2-position FLAPS switch in the F Mk 3 and F Mk 6. In the T Mk 5 the pupil has a similar switch but the instructor's switch is 3-position, UP/centre/DOWN. In the centre position the pupil's switch controls the flaps; if the instructor's switch is moved to UP or DOWN it overrides the selection on the pupil's switch.

10. The maximum speed for flap operation or flight with the flaps lowered is 250 knots. Pitot pressure is applied to a pressure-sensitive switch in the flaps electrical circuit. The switch automatically selects the flaps up as the speed is increased above 250 knots with DOWN selected. When automatic flap retraction occurs, the FLAPS switch is to be set to UP.

11. Asymmetric operation of the flaps in hydraulic failure conditions is prevented by hydraulic locking. If hydraulic failure occurs during lowering, the flaps are held at the position reached when the failure occurs; if the flaps are fully extended, they are held in that position. However, transient asymmetry can occur with certain flap system defects. The flap jacks incorporate a mechanical lock in the up position which automatically disengages when DOWN is selected.

12. *Flap Position Indicator.* The flap position indicator (two indicators, T Mk 5) has two pointers indicating the position of its respective flap.

Airbrakes

13. The airbrakes are hydraulically operated by the Services system and electrically selected by a 3-position switch on the No 2 throttle lever in the F Mk 3 and F Mk 6. In the T Mk 5, the pupil's airbrake switch is similar in operation and position; the instructor's switch is on his No 1 throttle and selecions on this switch override the pupil's switch positions.

14. Synchronous operation of the two airbrakes, which are forward-opening doors fitted one each side of the fuselage just forward of the fin, is achieved by a valve in the hydraulic lines to the airbrake actuators which throttles the supply of fluid to either door should it tend to lead the other during operation. The airbrakes can only be selected fully out or fully in. When closed, the airbrakes are locked mechanically.

15. *Mach Switch.* The limiting speeds for airbrake operation and for flight with the airbrakes extended are 1·3M/650 knots in the F Mk 3 and F Mk 6, and 1·2/650 knots in the T Mk 5. A Mach switch, set to operate before 1·3M in the single-seat aircraft or at approximately 1·2M in the T Mk 5, automatically closes the airbrakes if the limiting speed is exceeded or prevents operation if airbrakes are selected OUT above the Mach switch speed. If the airbrakes have been retracted by the operation of the Mach switch and speed is reduced below the Mach switch setting, the airbrakes remain closed until the next OUT selection is made.

16. Airbrake position is shown on the combined trim and airbrake indicator.

MANAGEMENT OF THE SYSTEMS

Undercarriage Operation

17. The speed switch prevents undercarriage retraction below a speed of 165 knots. The maximum speed for undercarriage lowering is 250 knots, and with undercarriage down, 280 knots.

18. When selecting down, ensure that:

a. Three red lights appear on the position indicator.

b. The locking collar is engaged in the gate.

c. Three green lights come on and the red lights go out.

19. *Emergency Lowering.* It is possible to lower the undercarriage on the emergency system with the normal undercarriage selector lever in the UP position, but DOWN should be selected to render the armament circuits safe. Emergency lowering may be achieved with only windmilling RPM on the No 1 engine: the rate of lowering is slow (approximately 70 seconds) and it is recommended that emergency selection is made in good time and that flying control demands are kept to a minimum; aerodynamic assistance may be necessary if the controls are used.

MALFUNCTION OF THE SYSTEMS

20. The drills for malfunction of the systems are given in FRC, and failure to obtain three green undercarriage lights is discussed in Part 4, Chapter 2.

WHEELBRAKES AND CANOPY CONTROLS AND INDICATORS

21. Details concerning the controls and indicators in the wheelbrakes and canopy systems for the F Mk 3 and F Mk 6 are listed in Table 3 and for the T Mk 5 in Table 4. The items are illustrated in Fig 1 and Fig 2 respectively.

DESCRIPTION OF THE SYSTEMS

General

22. The wheelbrakes and canopy operate from the Services hydraulic system. Although the brake actuation is mechanical, both the brake pressure gauge and the canopy system are operated by 28V DC current, the brake gauge being connected to the main DC busbar and the canopy and canopy audio warning to the battery busbar.

Wheelbrakes

23. The main wheels have disc brakes fitted with maxaret anti-skid units which are controlled by the brake lever(s). The nosewheel has no braking system. The maxaret units cannot be switched off.

Table 3 — Controls and Indicators — F Mk 3 and F Mk 6

Item No	*Item*	*Markings*	*Remarks*
8	Brake operating lever	—	On control column. Embodies a parking catch
9	Brake pressure gauge (post-mod 4212, F Mk 6)	BRAKES PSI × 1000 — P/S	Triple pressure gauge
10	Canopy operating control	CANOPY — OPEN/CLOSED	Not illustrated: left of seat pan. Lever and 3-position toggle switch
11	External canopy control	CANOPY EXTERNAL RELEASE HANDLE — CLOSE/off/OPEN	Not illustrated: under panel left of fuselage spine
12	Canopy unlocked warning	CANOPY caption (AWP)	—
13	Mechanical indicators	CANOPY — FREE/LOCKED	Not illustrated: left and right lower canopy frame
14	Canopy jettison handle	CANOPY JETTISON	Yellow and black striped handle
15	External canopy jettison handle	EMERGENCY CANOPY JETTISON	Not illustrated: left fuselage below cockpit — yellow and black striped
16	Canopy jack release control	EMERGENCY CANOPY JACK RELEASE	—
17	External canopy jack release control	CANOPY EXTERNAL RELEASE	Not illustrated: adjacent to normal external canopy control

Table 4 — Controls and Indicators — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
8	Brake operating levers (2)	—	On control columns. Pupil's lever has parking catch
9	Brake pressure gauge	PSI × 1000	—
10	Canopy operating control	CANOPY — OPEN/CLOSED	Not illustrated: left of pupil's seat pan. Lever and 3-position toggle switch
11	External canopy control	CANOPY LOCKS PULL — CLOSE/off/OPEN	Not illustrated: under panel left of fuselage spine
12	Canopy unlocked warning	CAN caption (AWP)	—
13	Mechanical indicators	CANOPY — LOCKED/UNLOCKED	Not illustrated: lower canopy frame
14	Canopy jettison handle	CANOPY JETTISON	Yellow and black striped
15	External canopy jettison handle	EMERGENCY CANOPY JETTISON	Not illustrated: left fuselage below cockpit — yellow and black striped
16	Canopy jack release control	EMERGENCY CANOPY JACK RELEASE	—
17	External canopy jack release control	CANOPY EXTERNAL RELEASE	Not illustrated: adjacent to external canopy control

24. The brake lever(s) is connected to a differential control valve which is mechanically linked to the rudder bar to give differential braking. Full differential is achieved when half rudder travel is applied, ie with half left rudder or more, operating the brake lever applies braking pressure to the left main wheel, according to the amount of brake lever movement, and no braking pressure to the right main wheel.

25. In F Mk 3 and T Mk 5 aircraft, and in the F Mk 6 pre-mod 4212, a single-pointer gauge displays accumulator pressure, which has a normal reading of 3000±100 PSI. In flight the pressure may build up to as much as 3600 PSI; if the pressure reaches this figure, operate the wheel brakes to relieve the pressure. Post-mod 4212 in F Mk 6 aircraft, a triple pointer gauge is fitted on which the main (lowest) pointer shows accumulator pressure and the left and right pointers indicate hydraulic pressure in the lines to the left and right brake units. The maximum left and right brake unit pressure indications are 1500 $^{+150}_{-50}$ PSI, but when the maxaret anti-skid units are operating the indications fluctuate.

Canopy

26. The canopy system controls and indicator locations are listed in Tables 3 and 4. The canopy is normally opened and closed by the CANOPY operating control. To open the canopy, pull up the control; this unlocks the canopy and exposes a 3-position toggle switch in the control handle. Selecting the spring-loaded switch to OPEN enables the application of hydraulic pressure to the canopy jack to open the canopy. To close the canopy, select the toggle switch to CLOSED; when the canopy is fully lowered, push down the operating handle to engage the canopy locks. During canopy operation an electric buzzer sounds to give audible warning of canopy movement. Canopy operation may be stopped at any intermediate position by releasing the toggle switch to the central, off, position during operation.

27. After closing the canopy, correct locking of the system is confirmed by the CANOPY (CAN, T Mk 5) caption going out and by two mechanical indicators marked CANOPY — FREE/LOCKED (CANOPY — LOCKED/UNLOCKED, T Mk 5) which show the position of the canopy shoot bolts.

28. When locking the canopy, the last few degrees of downward movement of the CANOPY operating control inflates the canopy seal.

29. *External Operation.* To operate the canopy externally in the F Mk 3 and F Mk 6, a CANOPY EXTERNAL RELEASE HANDLE and CLOSE/off/OPEN spring-loaded toggle switch are provided. The canopy is opened by rotating the handle and selecting OPEN. The reverse procedure closes the canopy. In the T Mk 5, a CANOPY LOCKS PULL

handle and similar toggle switch are provided. The canopy is opened by pulling the handle outboard and selecting OPEN on the switch. The reverse procedure closes and locks the canopy.

Canopy Emergency Operation

30. A wire-locked EMERGENCY CANOPY JACK RELEASE (CANOPY JACK RELEASE, T Mk 5) lever may be used *on the ground* to open the canopy if the normal system fails. The cockpit lever is operated by pulling it inboard to free the jack head and then pulling up the normal CANOPY operating control; the canopy is then free to be opened manually, usually with outside assistance. The canopy jack may also be released externally by operating the CANOPY EXTERNAL RELEASE handle.

Canopy Jettison

31. The canopy is jettisoned by pulling up the CANOPY JETTISON handle, by operating either ejection seat handle (on either seat in the T Mk 5), or by operating the external EMERGENCY CANOPY JETTISON handle. Operating any one of these controls withdraws the sear of the jettison firing unit which then fires a charge to unlock the canopy, free the hinges and hydraulic jack-end fitting, and jettison the canopy by means of two jettison jacks. The ejection seat cannot fire until the canopy is jettisoned; a restrictor cable inhibits ejection seat operation until the canopy has gone.

MANAGEMENT OF THE SYSTEMS

Wheelbrakes

32. A full description of the recommended braking techniques under various runway conditions is in Part 3, Chapter 5.

Canopy

33. After starting, check the CANOPY (CAN, T Mk 5) caption is on before closing the canopy. After closing and locking the canopy check the restrictor cable is in position, the caption is out, the shoot bolts are LOCKED and the seal is inflated.

34. If it is vital to vacate the aircraft quickly on the ground, do not attempt to open the canopy on the normal system but use the CANOPY JETTISON handle.

WARNING: If the nosewheel has collapsed and the canopy is jettisoned, there is a probability that the canopy will fall back on the cockpit.

MALFUNCTION OF THE SYSTEMS

Services Pressure Failure

35. After Services pressure failure, both the canopy and wheelbrakes systems are protected by accumulators. When landing, avoid 'maxaretting' to conserve accumulator pressure.

Canopy Malfunction

36. If, in hydraulic or electrical failure conditions, the canopy opens only slightly after a normal selection, it may not be possible to free the jack end by use of the EMERGENCY CANOPY JACK RELEASE or by the canopy jettison system because of the canopy position. To open the canopy in this situation, adopt the following procedure:

a. Close the canopy by selecting CLOSED on the toggle switch (manual assistance may be necessary from outside).

b. Push down the CANOPY handle to lock the system.

c. Operate the EMERGENCY CANOPY JACK RELEASE.

d. Pull up the CANOPY normal operating handle taking care not to operate the OPEN/CLOSED toggle switch.

e. With outside assistance, physically lift the canopy.

BRAKING PARACHUTE AND ARRESTER HOOK CONTROLS AND INDICATORS

Braking Parachute

37. In the F Mk 3 and F Mk 6 the parachute is streamed by pulling to its full extent a handle marked TAIL CHUTE PULL (item 18, Fig 1) on the left instrument panel and is jettisoned by pressing a CHUTE JETT button (item 19, Fig 1) on the left coaming.

38. In the T Mk 5, two white-painted parachute streaming handles are positioned towards the left and right ends of panel A1 (items 18 and 19, Fig 2). There is also a CHUTE JETT button adjacent to and below each streaming handle (items 20 and 21, Fig 2).

Arrester Hook (F Mk 6 Only)

39. The F Mk 6 controls and indicators for the arrester hook consist of a HOOK release handle (item 20, Fig 1) on the left instrument panel and a green HOOK DOWN light (item 21, Fig 1) to the left of the speed display.

DESCRIPTION OF THE SYSTEMS

Braking Parachute

40. A ribbon-type braking parachute is housed in a compartment on the underside of the rear fuselage. The cable of the parachute fitted to the F Mk 6 is stressed to five tons and of that fitted to the F Mk 3 and T Mk 5 to four tons. The different cables are identified by paint marks at the aircraft attachment bullet. Pulling the TAIL CHUTE PULL, or either white-painted handle in the T Mk 5, mechanically operates a selector which hydraulically opens the housing doors, and the parachute streams. Hydraulic power is taken from the No 1 Controls system.

41. Pressing the CHUTE JETT button operates an electro-magnetic release unit which opens to jettison the parachute. The release unit can be operated only after the parachute has been streamed.

42. A shear pin in the parachute cable acts as a weak link to detach the parachute after an inadvertent streaming at an excessive speed.

Arrester Hook (F Mk 6 Only)

43. The arrester hook on the F Mk 6 aircraft, which is fitted under the rear fuselage, is retained in the up position by a mechanically-operated release unit. When the HOOK handle is pulled the hook is released to fall down to the runway under the action of a spring, and the HOOK DOWN light comes on. The light has a press-to-test facility to check the filament. A stowage for the hook ground lock is on the left wheel well.

44. The hook may be used, within the limits given in Part 2, Chapter 1, for approach-end or overshoot-end cable engagements. The hook is not to be lowered until the aircraft is on the ground; however, once lowered, it is permissible to overshoot from the ground and fly with the hook down at speeds up to 250 knots.

MANAGEMENT OF THE SYSTEMS

Braking Parachute

45. During the internal checks, ensure that the brake parachute handle is fully in.

46. When streaming the parachute, ensure that the speed is within the limits given in Table 5 and then pull the handle to its fullest extent.

47. If the handle is reset after landing it should be returned carefully to its fully in position to avoid damage to the operating cable.

Table 5 — Braking Parachute Limiting Speeds

	Speed — Knots	
	F Mk 3 & T Mk 5	*F Mk 6*
Normal	150	170
Emergency	170	190

Note: If the braking parachute is streamed at speeds in excess of the *Normal* speed, this fact is to be reported so that the brake parachute may be inspected for serviceability.

MALFUNCTION OF THE SYSTEMS

Braking Parachute

48. If the No 1 engine is shut down but windmilling, the hydraulic pressure in the system is usually sufficient to operate the parachute doors. However, a no-parachute landing is to be anticipated in this situation.

49. Failure of the braking parachute is discussed in detail in Part 3, Chapter 5.

PART 1

CHAPTER 7—INSTRUMENTS

Contents

CONTROLS AND INDICATORS

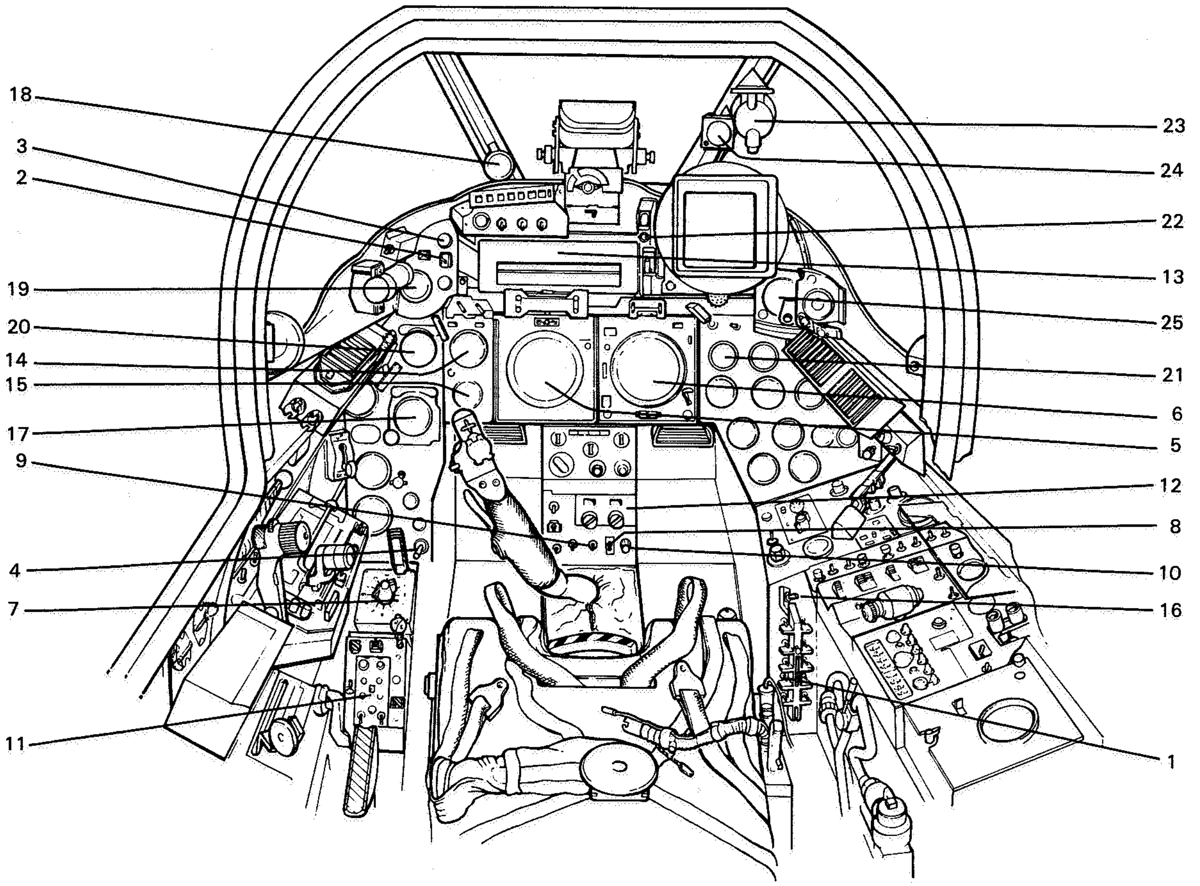
1. The controls and indicators of the integrated flight instrument system (IFIS), the standby flight instruments and the miscellaneous instruments are listed in Table 1 for the F Mk 3 and F Mk 6, and in Table 2 for the T Mk 5. Fig 1 shows the position of items in the F Mk 3 and F Mk 6; Fig 2 shows the positions in the T Mk 5.

Table 1 — Controls and Indicators — F Mk 3 and F Mk 6

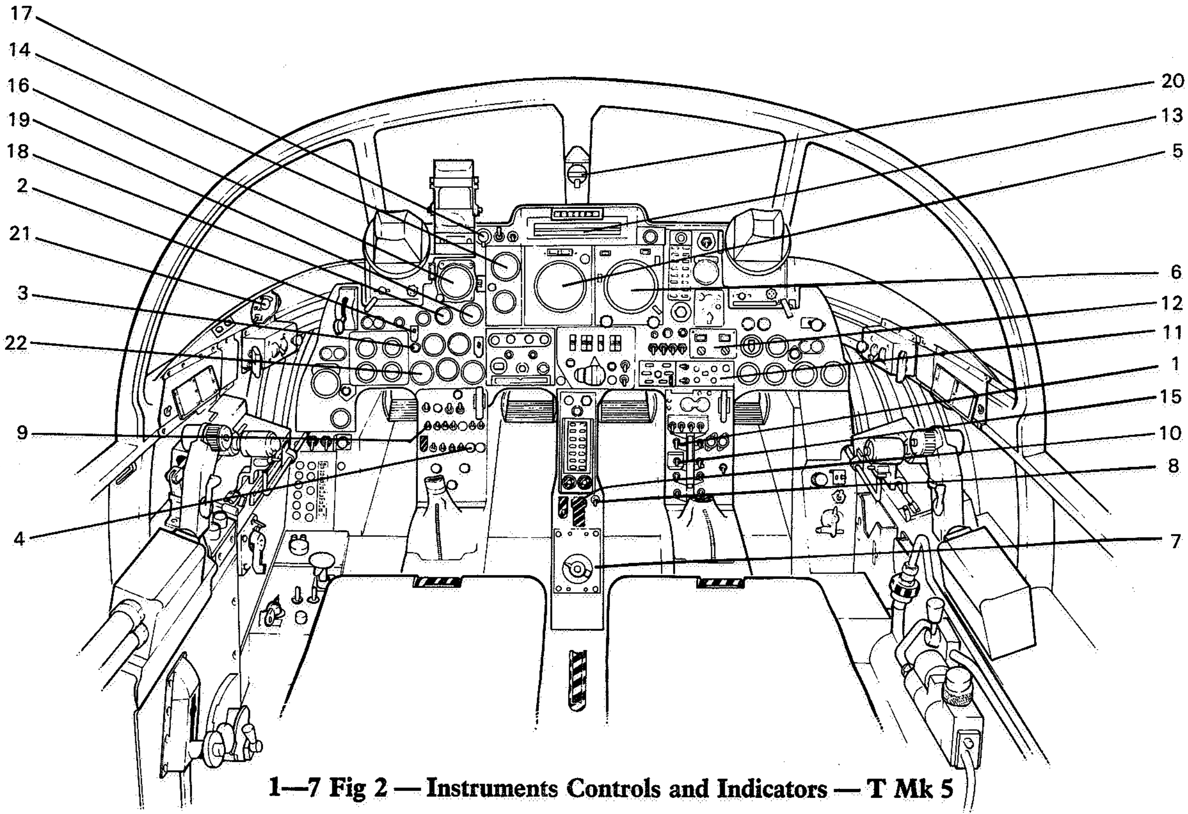
Item No	*Item*	*Markings*	*Remarks*
1	Instrument master switch	INST MASTER	Down for off
2	Standby inverter switch	INVERTER — NORMAL/STANDBY	Guarded to NORMAL
3	Standby inverter MI	Black/ON, white	—
4	Master reference gyro (MRG) switch	MRG — ON	Lock toggle switch; lift and move down to switch off
5	Attitude indicator F4C	—	—
6	Navigation display	See text	—
7	ILS control unit	Channels marked A to L	—
8	ILS master switch	ILS MASTER — ON	—
9	ILS/VP changeover switch	VP/ILS INDR	—
10	ILS volume control	ILS VOLUME	—
11	Tacan control unit	See text	—
12	Tacan offset computer	BEARING/RANGE NM	—
13	Speed display	See text	—
14	Altimeter	See text	—
15	RCDI	See text	—
16	Pitot heaters switch	PITOT HEATER — NORMAL/OFF/ STANDBY	—
17	Standby artificial horizon	—	—
18	Direction indicator (DI)	—	—
19	Standby ASI	—	—
20	Standby altimeter	—	—
21	Radar altimeter (post-mod 4846)	—	—
22	Low height warning light	—	—
23	E2B compass	—	—
24	Accelerometer	—	—
25	Ram air temperature gauge	—	—

Table 2 — Controls and Indicators — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
1	Instrument master switch	INSTRUMENT MASTER — ON	Down for off
2	Standby inverter switch	INV — NORMAL/STANDBY	Guarded to NORMAL
3	Standby inverter MI	Black/ON, white	—
4	Master reference gyro (MRG) switch	MRG — PULL OFF	Integral light
5	Attitude indicator F4C	—	—
6	Navigation display	See text	—
7	ILS control unit	Channels marked A to L	—
8	ILS master switch	ILS MASTER — ON	—
9	ILS/VP changeover switch	ILS/VP INDR	—
10	ILS volume control	ILS VOL	—
11	Tacan control unit	See text	—
12	Tacan offset computer	BEARING/RANGE NM	—
13	Speed display	See text	—
14	Altimeter	See text	—
15	Pitot heaters switch	PITOT — ON/OFF/STANDBY	—
16	Standby artificial horizon	—	—
17	Direction indicator (DI)	—	—
18	Standby ASI	—	—
19	Standby altimeter	—	—
20	E2B compass	—	—
21	Accelerometer	—	—
22	Ram air temperature gauge	—	—



1—7 Fig 1 — Instruments Controls and Indicators — F Mk 3 and F Mk 6



1—7 Fig 2 — Instruments Controls and Indicators — T Mk 5

DESCRIPTION OF THE SYSTEMS

General

2. The integrated flight instrument system (IFIS) derives its information from the following sources:

Dynamic reference system

Air data system

Tacan, ILS and UHF coupling units

3. The derived information is presented in the cockpit on the following instruments:

Attitude indicator

Navigation display unit

Speed display

Altimeter

Rate of climb and descent indicator (RCDI)

4. If the dynamic reference system fails, attitude and heading information is provided by the standby artificial horizon and direction indicator (DI). A pressure-operated ASI and standby altimeter are fitted as standby reference instruments to cater for air data system failure, but there is no standby RCDI.

Electrical Supplies

5. The IFIS requires 28V DC and 115V, 3-phase, 400 Hz AC current. The 28V DC is taken from the main 28V DC busbar. A 115V, 3-phase transformer, fed from the aircraft 200V supply, normally supplies two separate instrument busbars, one of which has an alternative AC power source from a DC-powered Type 100A inverter. The INST MASTER (INSTRUMENT MASTER, T Mk 5) switch controls the selection of AC power to the two instrument busbars and of DC power to the Type 100A inverter. The transformer output is monitored by an undervoltage/phase sequence unit.

6. When a transformer output fault is detected by the undervoltage/phase sequence unit or when AC supply fails, the Type 100A inverter supplies one instrument busbar with AC current but the other instrument busbar is dead. The services lost and the services sustained are listed in Table 3. The inverter comes on line automatically after a fault is detected or when, with the switch to NORMAL, transformer output fails. The inverter may also be started manually by selecting the switch to STANDBY.

Table 3 — Instrument Services Sustained and Lost after AC Failure

Services Sustained	*Services Lost*
MRG and attitude indicator	Air data computer:
Navigation display	Altimeter
Fire detection system	RCDI
Cockpit temp control (auto)	Speed display
Fuel contents gauges	FCS
	AI 23
	JPT control

Note: The standby artificial horizon and DI, which start and normally run on AC power, automatically continue to run on DC if the AC supply fails.

Dynamic Reference System

7. The dynamic reference system uses a master reference gyro (MRG) to provide continuous flight attitude and heading information which is supplied to the following items of equipment:

Attitude indicator

Gyro magnetic compass

Flight control system (FCS)

AI 23

Master Reference Gyro (MRG)

8. The MRG consists of a gyro-stabilised reference platform and an electronics unit mounted in the equipment bay. Its power supplies are controlled by the INST MASTER (INSTRUMENT MASTER, T Mk 5) switch. In the F Mk 3 and F Mk 6, control of the MRG is provided by an MRG toggle switch. In the T Mk 5 the MRG is controlled by an MRG PULL OFF push/pull switch which has an integral lamp which comes on when the switch is pulled out and the INSTRUMENT MASTER switch is on. After AC failure the system takes power from the standby inverter, provided the MRG is already erect. However, the standby inverter may not function normally if it is fed by battery voltage only, thus precipitating MRG failure; this may be noticed after landing when the main AC supplies go off line and generator output is low.

9. To start the MRG, AC power from an external source or from the alternator must be used. An electrical interlock prevents MRG start up from inverter power when NORMAL is selected at the INVERTER (INV, T Mk 5) switch, but when the switch is set to STANDBY the interlock is ineffective

and damage to the inverter occurs if MRG erection is attempted. The correct switching sequence when starting the MRG is therefore important and is as follows:

a. *F Mk* 3 *and F Mk* 6:

MRG switch	Off (down)
AC power (external or alternator)	On
INVERTER switch ...	NORMAL
INST MASTER switch	ON
Standby inverter MI	Black
MRG switch	ON (up), locked

b. *T Mk* 5:

MRG PULL OFF switch	Out, integral light out
AC power (external or alternator)	On
INV switch	NORMAL
INSTRUMENT MASTER	ON
Standby inverter MI	Black
MRG PULL OFF switch	Light on. Push in, light out

10. When the MRG is switched on, the roller blind on the attitude indicator rotates for about 50 seconds; full erection is complete after approximately two to three minutes and is indicated by the orange disc on the attitude indicator being masked by a black disc. The gyro takes approximately 25 minutes to run down after switching off; during this period the MRG may be switched on again but, if a break of more than 30 seconds has occurred between switching off and on, the erection cycle could take as long as five minutes.

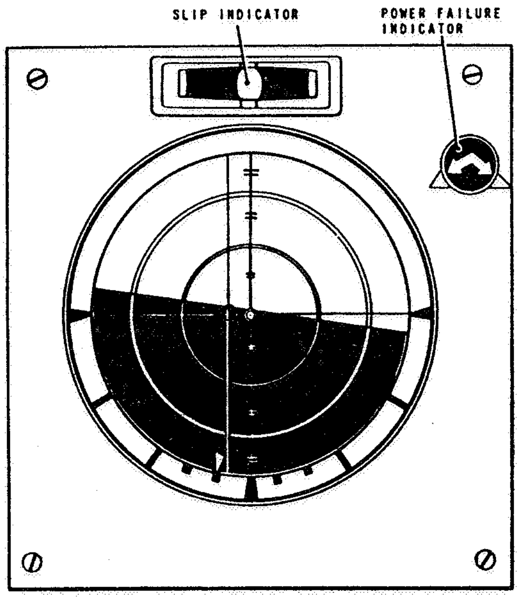
11. Vertical errors in the system, indicated on the attitude indicator, are removed at the rate of approximately 15°/minute by pressing and holding the spring-loaded MRG FAST ERECT button. Fast erection is only to be selected when gross errors are obvious and should only be made in straight and level flight when good external reference exists for levelling the aircraft. The MRG FAST ERECT button is not to be used during the normal erection cycle.

12. The MRG provides gyro-stabilized magnetic heading information on the navigation display in the compass (COMP) mode. Compass monitoring of the indicated heading is cut off when the directional gyro (DG) mode is selected or when flight accelerations and attitudes could cause errors in compass detection. In the COMP mode, no indication of compass monitoring cut-off is given and the annunciator is free to move as the aircraft moves in azimuth; no attempt is to be made, therefore, to use the synchronising control (SYN knob on the navigation display) during accelerating, decelerating, banking or turning flight.

13. If, while operating on standby inverter supplies, the MRG is switched off, no attempt to restart the MRG is to be made unless main AC supplies are available and the inverter switch is to NORMAL.

Attitude Indicator F4C

14. The attitude indicator, which is controlled by signals from the MRG, gives a continuous indication of pitch and roll by roller blind presentation, the lower (black) half indicating nose-down attitude and the upper (white) half, nose up. Aircraft pitch angle is indicated by 20° circles and bisecting 10° marks around the central, zero, datum. Angles of bank are indicated in 10° steps up to 30°, and then in 30° steps up to 90° of bank. A flight director bead for use in conjunction with the flight control system is co-incident with the central datum when not in use. The attitude indicator is shown at Fig 3.



1—7 Fig 3 — Altitude Indicator Type F4C

15. To the right of the instrument face a translucent orange disc, bearing two arrows, indicates power failure to the attitude indicator and the navigation display. The orange disc is normally covered by a black disc which lifts if power is removed. One arrow points to the attitude indicator, and the other to the navigation display for which no separate warning device is fitted.

16. Partial failure of signals from the MRG is shown by the roller blind either changing to all black or rotating continuously at a steady rate, indicating elevation or bank signal failure respectively.

17. A slip indicator, with a slip indicator datum at the top of the attitude indicator face, is fitted above the instrument.

Navigation Display

18. The navigation display combines the function of either a gyro-magnetic compass or a directional gyro together with displays selected by a 4-position mode switch on the instrument, as follows:

COMP — Gyro-magnetic compass or directional gyro
ILS — Instrument landing system display or UHF homing display
TAC — Off-set Tacan display
DL — Direct or air-to-air Tacan (data link is inoperative)

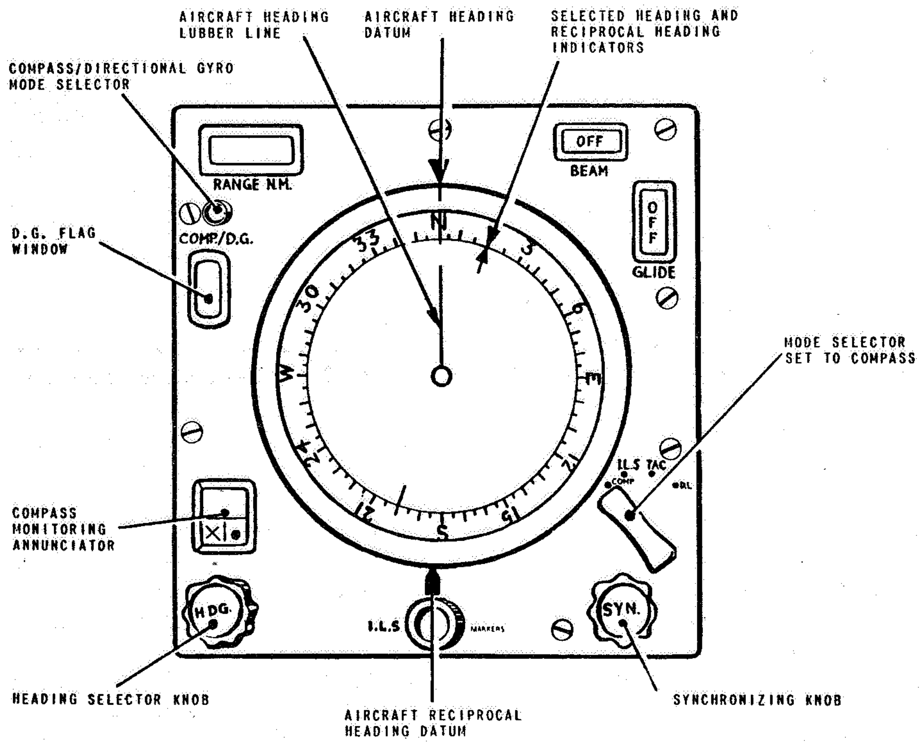
Compass Mode

19. With COMP selected at the mode switch, the display shows only the compass card. It may be used as a magnetic compass or directional gyro as selected on the COMP/DG push on/push off button to the left of the display. If DG is selected, the window beneath the button shows DG; with COMP selected it remains black. See Fig 4.

20. *Compass Synchronisation.* A compass monitoring annunciator window is on the face of the instrument. With magnetic compass selected and synchronised, a dot/cross annunciator slowly oscillates in the window. Fast heading synchronisation is achieved by using the SYN knob at the bottom right of the instrument. To synchronise, the knob is pressed and turned until the annunciator shows an oscillating dot/cross. If resistance to turning is felt, the knob is being turned in the wrong direction. If DG is selected, the annunciator is fixed in the de-energised, central position.

21. *Heading Selection Pointer.* At the bottom left of the instrument is a HDG knob which, when pressed in and turned, moves a heading selection pointer on the instrument. Any divergence between the aircraft heading and the selected heading is transmitted to the flight control computer for use with the flight director or autopilot modes.

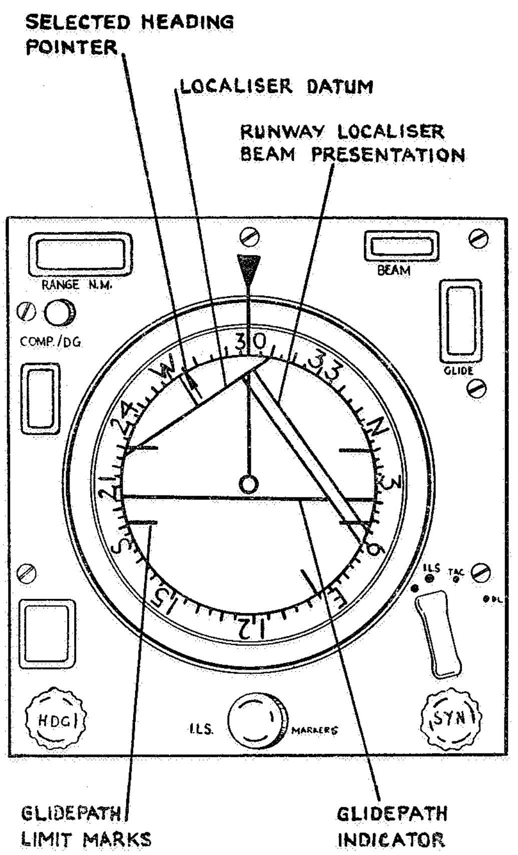
22. *MRG Failure.* With the MRG switch off, the compass card does not rotate to indicate aircraft heading changes. However, provided AC power is available to the navigation display, it is possible to synchronise the compass card by use of the SYN knob to allow for correct ILS or Tacan display orientation. The SYN knob is turned to achieve correct dot/cross annunciation. If resistance to turning is felt, select DG until the indicated heading is approximately the same as the actual aircraft heading and make the final synchronisation with the COMP/DG button selected to COMP.



1—7 Fig 4 — Navigation Display Unit — Compass Mode

ILS Mode

23. To operate in the ILS mode, the mode selector on the navigation display is set to ILS, the ILS control unit is set to the correct channel, the ILS MASTER switch is placed ON, the VP/ILS INDR changeover switch is set to ILS and the ILS VOL control is set as desired. For control positions consult Tables 1 and 2. The ILS display is shown at Fig 5.



1—7 Fig 5 — Navigation Display Unit — ILS Mode

24. Having made the correct selections and provided the signal strength is sufficient for reliability, the BEAM and GLIDE amber lights in the windows at the top right of the display unit are covered by black shutters. The display appears, framed by the compass card, as a pair of parallel lines representing the runway or localiser beam. To orientate the localiser beam presentation a datum marker, which is visible through an aperture in the display and which represents the centre of the beam, is set to the appropriate QDM by pulling *out* and turning the HDG knob and, for auto-ILS approaches, the heading selection pointer is also rotated to the QDM by pressing *in* and turning the HDG knob. The glide path position is indicated by a horizontal bar across the display which moves up and down relative to the fixed central index.

25. A blue flashing ILS MARKERS light (the operation of which is difficult to detect in daylight) is at the bottom of the display. The light has a day/night screen.

26. The ILS VOL control attenuates the volume of the beacon identification signal. It has no effect on the volume of the marker signals which operate in conjunction with the ILS MARKERS light.

Violet Picture

27. The Violet Picture UHF homing system utilises the ILS localiser indicator on the navigation display to indicate relative bearings of received UHF transmissions. To operate the system, set the correct UHF frequency and ADF on the function switch of the V/UHF control panel. Set the VP/ILS INDR switch to VP and the mode selector on the navigation display to ILS. The system operates on UHF frequencies only.

Tacan

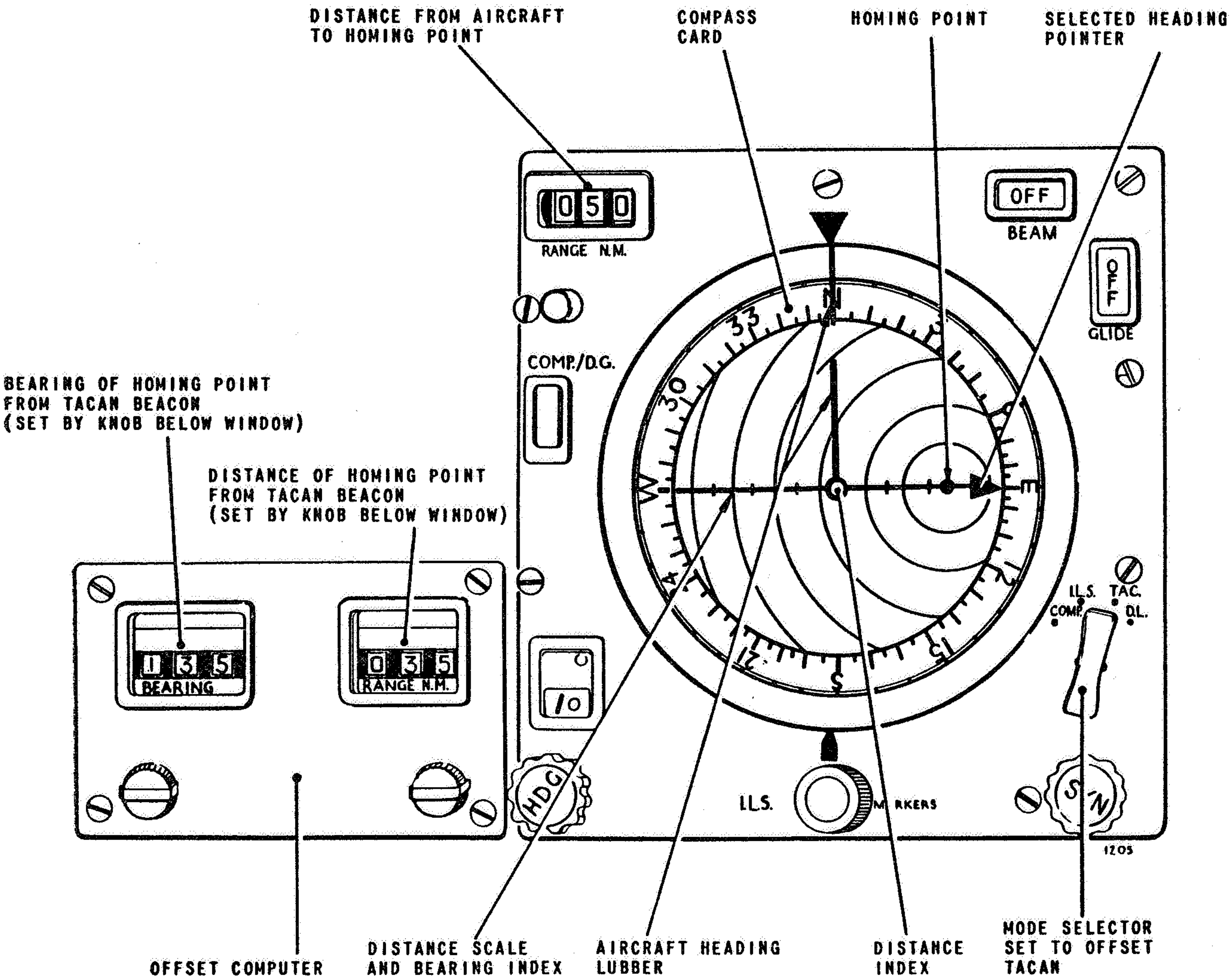
28. The Tacan navigation system gives magnetic bearing and slant distance information at ranges up to 300 NM (depending on aircraft altitude) from a fixed ground beacon. However, the maximum distance from the ground beacon at which reliable signals can be obtained depends on the protected range of the beacon. There is an offset computer fitted to facilitate direct homing to a position other than the fixed ground beacon, provided the offset position is within Tacan range of the beacon at the height flown. The system uses 28V DC and 115V, single-phase AC and is therefore inoperative after AC failure. The Tacan display is shown at Fig 6.

29. The 4-position mode switch on the navigation display utilises the DL position for direct Tacan or air-to-air Tacan; the TAC position is used when offset Tacan information is required. (Offset Tacan becomes direct Tacan when the offset computer range is set to zero.)

30. *Tacan Control Unit.* The Tacan control unit has the following controls:

a. *ON/OFF Switch.* Power on or off.

b. *VOLume Control.* The volume control is used to attenuate the beacon identification signal.



1—7 Fig 6 — Navigation Display Unit — Tacan Mode

c. *A/G—A/A Switch.* The air-to-ground (A/G) position is used when utilising a ground beacon in either direct Tacan or offset Tacan modes, and the air-to-air (A/A) position when working with another aircraft.

d. *Channel Selector Buttons.* Four buttons control channel selection, the two upper buttons increasing and the two lower buttons decreasing the digits shown in the adjacent channel indicator. The right-hand pair of buttons control the 'units' indicated and the left-hand pair, the 'tens'. 126 channels are available.

31. *Offset Computer.* The offset computer has two controls and two veeder counters by which range and bearing of the offset homing point from the Tacan beacon are selected.

32. *Tacan Display.* In the direct or offset Tacan mode the navigation display shows a series of concentric arcs, each representing 20 NM distance from the beacon or offset position. Distance is read off at the centre of the display. A line bisecting the range arcs indicates the magnetic bearing of the beacon or offset position when read against the compass card. With DL selected the display shows direct slant range and magnetic bearing to the Tacan beacon; with TAC selected the display indicates range and magnetic bearing to the offset homing point.

33. *Air-to-Air Tacan.* With DL selected on the navigation display and A/A set on the Tacan control unit, the system is in the air-to-air mode. When working with another aircraft with a similar capability and with channels set 63 apart, slant range information

is displayed in the RANGE NM window. No bearing information is available in the air-to-air mode, and the navigation display roller blind rotates.

Note: When DL is selected on the navigation display, the redundant positions DL and DL/T on the V/UHF controller are not to be selected. Data link is inoperative.

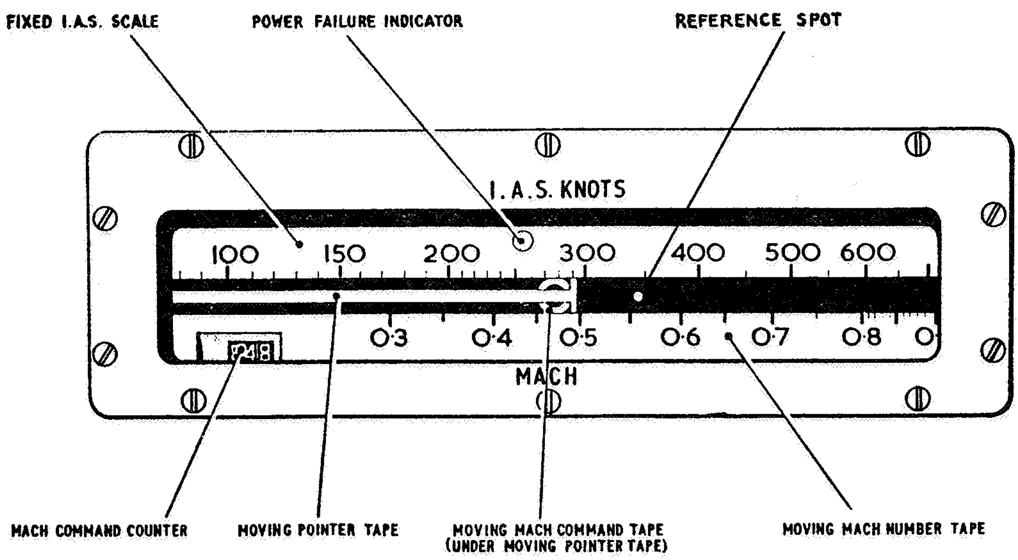
Air Data System

34. The air data system measures pitot and static pressure signals, converts them into electrical signals via transducers and passes the signals to the air data computer. The computer transforms the signals into suitable outputs for the speed display, the altimeter, the vertical speed display (RCDI), the AI 23 radar and the flight control system computer. The system is powered by 115V, 3-phase AC controlled by the INST MASTER (INSTRUMENT MASTER, T Mk 5) switch. There is no standby supply if AC failure occurs.

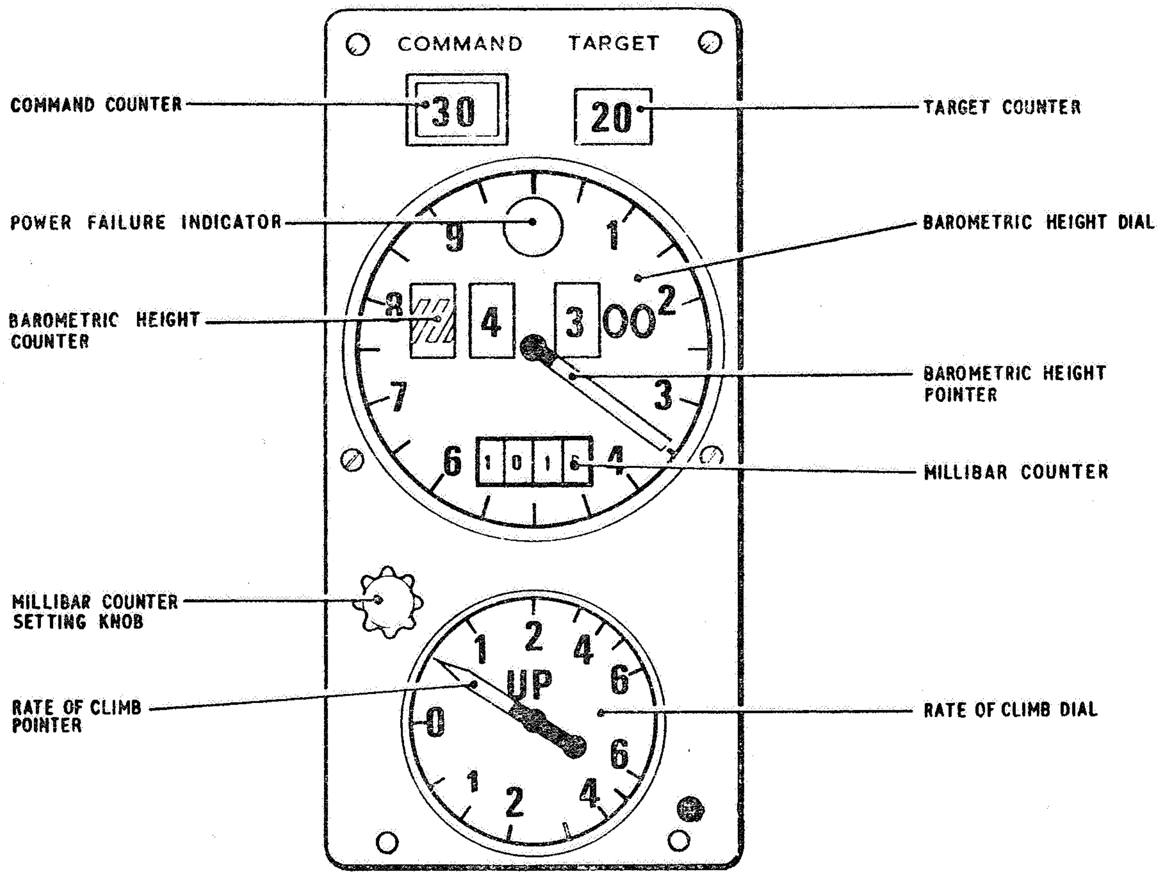
35. *Speed Display.* See Fig 7. The speed display unit presents Mach number and IAS from the outputs of the air data computer. The upper IAS scale is fixed and shows speeds between 80 and 700 knots. The lower Mach number scale moves as necessary so that a white strip, which moves horizontally between the two scales, gives simultaneous indication of IAS and Mach number. The white strip is not visible at speeds below 80 knots, but a white spot ahead of the strip should be located between two white reference bars on the left of the display when the aircraft is at rest with the instrument master switch on. The appearance of an orange disc above the centre of the IAS scale denotes power failure to the display. A transparent tape behind the white strip carries a circular indicator to show data link command Mach number, and this is repeated on a counter at the bottom left of the display. Both the data link Mach number indications are inoperative.

36. *Altimeter.* See Fig 8. The altimeter is electrically operated by signals from the air data computer. The altimeter dial is marked from zero to 1000 feet in 50 feet intervals; it is swept by a single pointer. Three digital counters set into the dial indicate altitude in 100 feet intervals. The 10,000 feet counter is marked with black and white hatching at altitudes below 10,000 feet. A setting knob, at the bottom left of the dial, enables altitude to be displayed relative to the selected barometric pressure which is displayed on a millibar counter near the bottom of the dial. If power to the instrument fails, an orange disc appears at the zero scale mark on the dial. Two windows at the top of the display, labelled COMMAND and TARGET, show data link command altitude and target altitude respectively. Data link is inoperative.

37. *RCDI.* See Fig 8. The RCDI, positioned below the altimeter, is electrically operated by signals from the air data computer and shows the rate of climb or descent in feet per minute. Both halves of the instrument are graduated on a non-linear scale in units of 1000 feet, from zero to 6000 feet, with scale divisions between zero and 1000 feet to indicate 500 feet per minute rate of climb or descent. Power failure to the RCDI is indicated by the orange disc on the altimeter.



1—7 Fig 7 — Speed Display



1—7 Fig 8 — Altimeter and RCDI

Pitot/Static Systems

38. There are two pitot heads. The main pitot head, positioned ahead of the nose intake, supplies pitot and static pressure to the air data system. The secondary pitot head, on the upper radome strut, supplies pitot pressure to the standby ASI, and two fuselage static vents supply the standby ASI, the standby altimeter and the cockpit pressure controller. (The T Mk 5 cockpit pressure controller takes static pressure from the main system.)

39. *Pitot Heating.* A PITOT HEATER—NORMAL /OFF/STANDBY switch (labelled ON/OFF/ STANDBY in the T Mk 5) controls the heating of both pressure heads. When NORMAL (ON) is selected, a 28V single-phase AC supply is used: if the AC supply fails, selecting STANDBY connects a DC supply to the heaters.

Standby Instruments

40. A standby artificial horizon and direction indicator (DI) are fitted. The power supplies are controlled by the INST MASTER (INSTRUMENT MASTER, T Mk 5) switch and the instruments are started and normally run on 115V, 3-phase AC; they are automatically sustained by 28V DC from the DC busbar after AC failure and continue to run on main battery power after AC and double generator failure provided the BATTERY switch is left on. In the T Mk 5 only, after AC failure and power failure of the DC busbar, the emergency battery automatically supplies the standby instruments. In all marks, the standby instruments, although sustained by DC power after AC failure, cannot be started by DC power and no attempt is to be made to test the system on the ground unless power is supplied from an AC source.

41. *Standby Artificial Horizon.* The Mk 6H standby artificial horizon incorporates a fast erection button and an orange and black striped off flag. The off flag disappears approximately 10 seconds after switch-on and the instrument is ready for use after 50 seconds. To correct pitch or bank errors, the FAST ERECTion button on the instrument is pressed until the errors are removed. When airborne, the fast erection button is only to be used in unaccelerated, straight and level flight.

Note: It is possible for the FAST ERECTion button to stick in intermittently against the return spring; ensure it returns out after use.

42. *Direction Indicator (DI).* The DI, which is positioned above the other standby instruments, has a dual purpose synchronisation/fast erection button. When rotated, the button changes the heading indication; when pressed, fast erection of the DI takes place. When the button is pressed a blue indicator light in the centre of the instrument comes on to indicate that fast erection is in progress. If the light goes out when the button is released, the DI is ready for use. If the light stays on, automatic fast erection is proceeding and the light goes out when the instrument is erect.

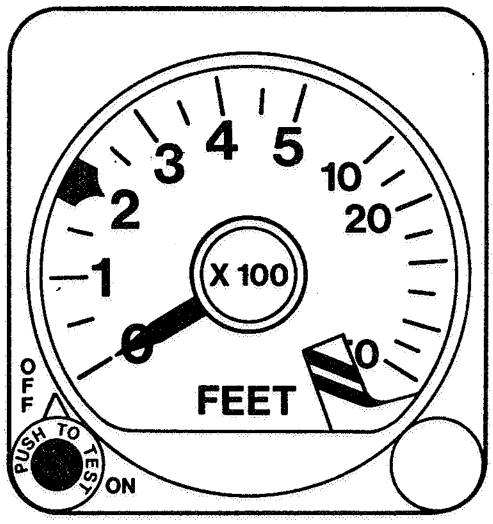
43. *Standby ASI.* A single-pointer Mk 14 ASI is provided to cater for speed display unit failure. The dial is calibrated from 80 to 700 knots. It takes its pitot and static pressures from the secondary pitot/static system.

44. *Standby Altimeter.* A three-pointer Mk 26 standby altimeter is fitted in case of main altimeter failure. The three pointers indicate hundreds, thousands and tens-of-thousands of feet. There is a millibar setting knob which adjusts the millibar scale let into the face of the instrument.

Note: Both the standby ASI and standby altimeter are subject to large errors at supersonic speeds.

Radar Altimeter (F Mk 3 and F Mk 6)

45. Post-mod 4846, a radar altimeter (ARI 23232/8) is fitted to F Mk 3 and F Mk 6 aircraft. It derives aircraft height from leading edge reflection principles. This information is displayed by the radar altimeter indicator which shows height above flight path terrain when below 5000 feet. To obtain a valid display, roll angles must be limited to 60° over good reflective surfaces such as sea, especially when flying close to the upper height limit; for terrain with poorer reflectivity, such as sandy surfaces, lower manoeuvre angles may be necessary to maintain valid signals.



1—7 Fig 9 — Radar Altimeter

46. *System Equipment.* The system consists of a transmitter/receiver in the spine bay, transmitter and receiver aerials flush with the undersides of the aircraft wings, an indicator unit incorporating a low height warning light on the instrument panel, and a repeater low height warning light above the centre instrument panel coaming.

47. *Indicator Unit.* See Fig 9. The indicator unit displays height by a single pointer traversing a non-linear graduated scale of zero to 5000 feet. The scale is expanded between zero and 500 feet to allow easier interpretation at low heights. Controls and indications are as follows:

a. *ON/OFF/Test Switch.* A 2-position ON/OFF rotary switch with a PUSH TO TEST facility and an integral warning light is at the bottom left of the indicator. The PUSH TO TEST facility provides a check of all except the aerial and transmitter circuits. When the switch is pressed with ON selected, the pointer should read 100±15 feet.

b. *Height Index Control.* The height index control knob on the bottom right of the indicator positions the index on the outer edge of the scale to set a datum height.

c. *Integral Warning Light.* An integral red warning light in the ON/OFF rotary switch comes on when the pointer indicates a height less than the datum set by the height index control. Post SEM/LTG/031 a dimmer switch is fitted to the right console to control the intensity of the warning light.

d. *Failure Warning Flag.* A striped failure warning flag appears when the power supply fails, when the pointer reads above 5000 feet, or when no reflected signals are received for over 0·3 second.

48. *Low Height Warning Light.* An amber low height warning light is fitted above the centre instrument panel coaming. The light is wired in parallel with the integral warning light on the indicator unit; its brightness is adjusted by rotating its cap.

49. *Power Supplies.* The ON/OFF switch controls the supply of 115V, single-phase AC current. The system is inoperative after AC failure. The system requires approximately 3 minutes to warm up after switching ON.

50. *Pre-Flight Checks.* Set the control switch to ON and set a height datum of 50 feet. When the system has warmed up and the failure flag has cleared, operate the PUSH TO TEST: check that the pointer indicates

100±15 feet, the warning flag remains retracted and that the warning lights are out. Release the PUSH TO TEST and check that the height display reverts to approximately 10 feet and that the low height warning lights come on. On the ground, especially whilst taxying, the height indication may frequently break lock, bringing the warning flag into view, owing to the widely separated aerial positions. This does not occur in the air.

Miscellaneous Instruments

51. *E2B Compass.* An E2B compass is fitted on the windscreen right frame in the F Mk 3 and F Mk 6; in the T Mk 5 it is on the windscreen centre strut.

52. *Accelerometer.* In the F Mk 3 and F Mk 6, an accelerometer is fitted in a head-up position on the right windscreen strut. In the T Mk 5, the accelerometer is positioned on a quarter panel on the left shroud or on the windscreen centre strut.

53. *Ram Air Temperature Gauge.* The ram air temperature gauge is fitted on the right shroud panel in the F Mk 3 and F Mk 6, and on the left centre of panel A1 in the T Mk 5. Its power is supplied from the DC busbar. The instrument is connected to a thermal sensing probe mounted on the rear spine. The gauge is graduated zero to 150°C. The equipment ram air temperature/time limitations are given in Part 2, Chapter 1.

54. *Monte Carlo Stopwatch (F Mk* 3 *and F Mk* 6 *Only*). A Monte Carlo stopwatch is mounted on the left canopy arch.

PART 1

CHAPTER 8—FLIGHT CONTROL SYSTEM

Contents

CONTROLS AND INDICATORS

General

1. The controls and indicators in the flight control system (FCS) for the F Mk 3 and F Mk 6 are listed in Table 1 and illustrated in Fig 1; the controls and indicators for the T Mk 5 are listed in Table 2 and illustrated in Fig 2. Fig 3 shows the detail on the FCS control unit in all marks.

Table 1 — Controls and Indicators — F Mk 3 and F Mk 6

Item No	*Item*	*Markings*	*Remarks*
1	FCS engage switch	FD/OFF/AP	Known as the 'stick switch'
2	FCS control unit	See text	—
3	Heading control knob	HDG	Navigation display
4	Flight director bead	—	Not illustrated. Attitude indicator
5	Autopilot trim indicator	—	—
6	Mode indicator	See text	Repeater from control unit
7	Throttle servo control	THROTTLE SERVO— ENGAGE/DISENGAGE	—

Table 2 — Controls and Indicators — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
1	FCS engage switch	FD/OFF/AP	Not illustrated. One on each control column. Known as 'stick switches'
2	FCS control unit	See text	—
3	Heading control knob	HDG	Navigation display
4	Flight director bead	—	Not illustrated. Attitude indicator
5	Autopilot trim indicator	—	—
6	Throttle servo control	THROTTLE SERVO— ENGAGE/DISENGAGE	Pupil's throttle only
7	Autopilot cutout changeover switch	AUTOPILOT CUTOUT CHANGEOVER SWITCH — POS 1/POS 2	Not illustrated. On bulkhead behind instructor's seat

FCS Control Unit

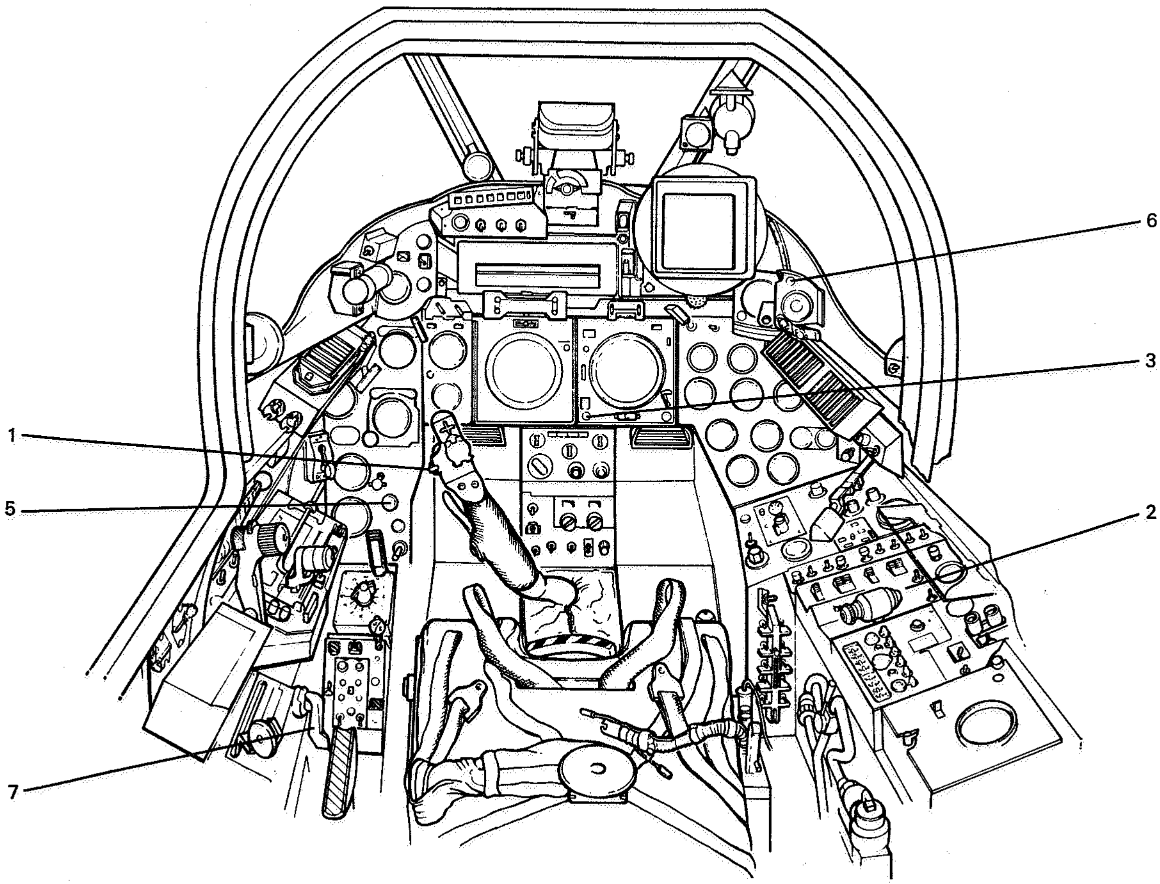
2. The FCS control unit has the following controls and indicators:

a. *MASTER Switch.* When the 2-position MASTER/OFF switch is selected to MASTER, the AC and DC power is connected to the flight control computer (FCC) and to three rate gyros; in addition the pitch autostabiliser actuator is centralised.

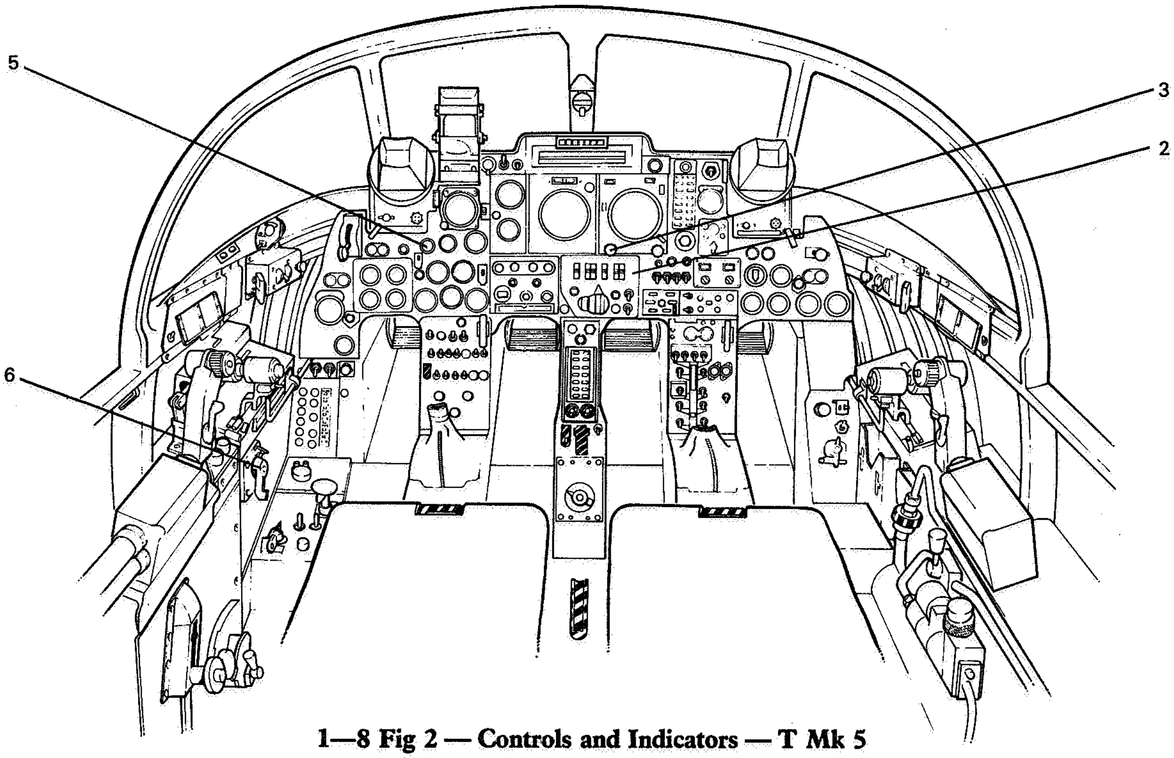
b. *SUPPLIES Indicator.* The SUPPLIES MI shows white/OFF when the MASTER switch is OFF and shows black when DC is available and the instrument master and FCS MASTER switches are on. The MI changes to white/OFF whenever the failure interlocks operate. After AC failure, the MI does not change to white/OFF unless the STAB/OFF switch is selected to STAB.

c. *Mode Indicators.* In the F Mk 3 and F Mk 6 there are two mode indicators, one on the FCS control unit and another above the voltmeter on the right cockpit shroud. The T Mk 5 has one mode indicator on the FCS control unit. When the FCS is in the autopilot or flight director mode the indicator(s) shows AUTO or DIR respectively. The indicator(s) shows white/OFF when no mode is selected on the FCS engage switch or if the CLIMB key is selected and AP engaged. The indicator changes to white/OFF after AC failure, DC failure or g-switch trip.

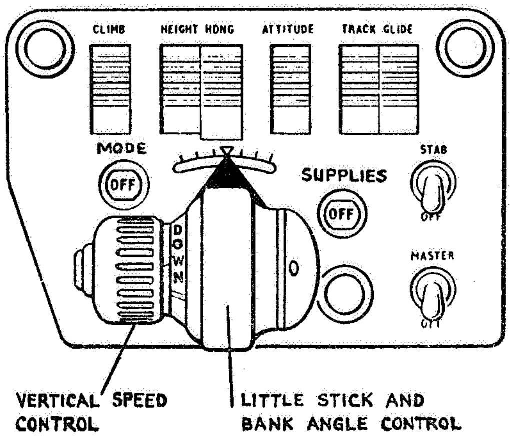
d. *STAB Switch.* Selecting the STAB/OFF switch to STAB with the instrument master and FCS MASTER switches on removes the aileron and rudder stroke restrictors and connects the autostabilisers to the FCC.



1—8 Fig 1 — Controls and Indicators — F Mk 3 and F Mk 6



1—8 Fig 2 — Controls and Indicators — T Mk 5



1—8 Fig 3 — FCS Control Unit

e. *Mode Selector Keys.* The following modes are selected by the mode selector keys:

CLIMB	— Programmed climb
HEIGHT	— Height (attitude) lock
HDNG	— Heading lock
ATTITUDE	— Pitch and bank attitude hold
TRACK	— Combined height and heading lock which can be coupled to the ILS localiser signals
GLIDE	— Couples ILS glidepath signals to the FCS provided TRACK is also selected

f. *Direct Mode Changes.* The direct mode changes which are possible with AP or FD selected on the stick switch are shown in Table 3. For all other mode key selections the FCS engage switch is to be OFF.

Table 3 — Direct Mode Changes

Selected Mode	*Possible Direct Mode Change*
HEIGHT	HEIGHT and HDNG
HEIGHT and HDNG	HEIGHT (by pressing tail of HDNG key)
HEIGHT	TRACK
HEIGHT and HDNG	TRACK
TRACK	TRACK and GLIDE

g. *Little Stick.* The little stick overrides the height and heading hold in certain modes. The vertical speed control (VSC) knob on the top of the little stick must first be centred before a rotation to UP or DOWN is effective. The rate of turn onto a new heading may be varied by use of the bank angle control (BAC) which has three click stops either side of central, corresponding to increasing changes in bank angle. The angular authority of each click stop of the BAC depends upon the mode in use. The little stick operates with AP selected on the control column stick switch in the following modes only:

HEIGHT
HEIGHT and HDNG
ATTITUDE

DESCRIPTION OF THE SYSTEM

General

3. The flight control system (FCS) is a combined autopilot and flight director system. The autopilot provides automatic flight control while the flight director provides information on the attitude indicator during manually-controlled flight. When the autopilot is engaged, the pilot can override the system manually in all three axes. The auto-throttle may also be overridden by using sufficient force on the throttles. The following facilities are provided by the system:

Autostabilisation (in three axes)
Programmed climb (flight director mode only)
Height (attitude) lock
Height and heading lock
Pitch and bank attitude hold
Auto and flight director ILS
Auto-throttle speed control

4. *Limitations.* The limitations on the use of the FCS are given in Part 2, Chapter 1.

System Characteristics

5. The automatic flight control system is essentially a control surface position demand system of limited authority operating through the autostabilisers. Each control surface in the system is operated by its own autostabiliser amplifier and electro-hydraulic actuator.

6. The principal unit of the system is the flight control computer (FCC) which is actuated by the selector keys on the control unit. The control computer's function is to effect data storage, computation and the switching required by the system. The computer receives signals from:

a. Three rate gyros (pitch, roll and yaw)
b. MRG (pitch and bank data)
c. The navigation display (heading error)
d. The air data system (altitude, vertical speed, Mach number, IAS and switching signals for system gearing changes)
e. ILS (displacement from centreline and glidepath)
f. The tailplane trim motor (tailplane trim position)

7. Output demands from the FCC are transmitted either to the flight director diplay on the attitude indicator (with FD selected on the FCS stick switch), or to both the flight director display and the autostabiliser actuators (with AP selected on the FCS stick switch). The FCC also produces outputs for the autothrottle actuator.

8. The autostabiliser actuators move their respective control runs to act on the control valves of the PFCU. Therefore there is no feedback to the flying controls in the autostabilisation mode. However, in ATTITUDE hold or HEIGHT lock modes with AP engaged, an autotrim facility transfers any FCC demand on the tailplane greater than 0·5° to the tailplane trim actuator which moves to ensure that the autostabiliser actuator is kept roughly central. This allows larger changes of tailplane angle than would otherwise be possible with the limited authority of the autostabilisers. In these modes, therefore, the control column follows up any autotrim movement via the feel units.

9. The full control surface authority of the aileron and rudder actuators is ±3°, and of the tailplane actuator 3°18′. However, full authority of the tailplane actuator is only available with TRACK engaged and the undercarriage down. In all other modes the tailplane actuator's authority is limited to ±1°.

Safety Devices

10. To prevent structural damage to the aircraft in the event of an autostabiliser runaway, each control has a solenoid-operated stroke restrictor which must be energised to obtain full authority. The DC current to the solenoid is supplied via an AC relay. Therefore, with the power off, or with failure of AC or DC, or after operation of the g-trip, the actuator stroke is restricted. The aileron and rudder actuators centralise (restricted stroke zero), but the tailplane actuator may drift to either end of its restricted stroke of ±1°.

11. *Hydraulic Failure.* In the event of Services hydraulic failure, the actuators remain in their position at the time of failure. Some out-of-trim rudder force may have to be held, but aileron and tailplane forces can be trimmed out.

12. *Acceleration Cutout.* When AP is engaged, a g-switch automatically trips the autopilot at normal accelerations outside the range of +3g to zero g. In addition to disengaging automatic control, the autostabiliser stroke restrictors centralise.

Note: When the autopilot is disengaged by AC or DC failure, or by a g-switch trip, a series of electrical interlocks prevent the re-engagement of AP unless the correct engaging sequence is followed.

13. *'No Mode' Condition.* Unless a mode is selected on the control unit, autopilot and flight director cannot be engaged. Failure to engage may occur when a mode key is not properly made although the key is apparently selected. Moving the FCS engage switch to OFF and reselecting the mode key more deliberately may cure the 'no mode' condition.

14. *AP Caption.* The AP caption on the SWP is triggered when any one of the following occurs:

Acceleration cutout
AC failure (aircraft or autopilot)
DC failure to autopilot
Incorrect engaging sequence used

Autostabilisation

15. The autostabilisers provide damping in pitch, roll and yaw. A rate gyro in each axis senses changes in angular rates and feeds correcting signals to the appropriate actuator/flying control. To compensate for changes in control effectiveness with changes in altitude, IAS and Mach number, the gearings of the pitch and yaw channels are automatically switched at pre-set values of height and speed, derived from the air data system. Autostabilisation in all three axes is selected by the STAB switch on the FCS control unit, and it must be on before any autopilot mode of the FCS can be engaged.

Programmed Climb

16. The programmed climb mode is a flight director mode only. Selecting the CLIMB mode key and FD on the stick switch provides demands on the attitude indicator's flight director bead for the initial climb, a turn onto a selected heading, and the maintenance of the optimum subsonic climb schedule in maximum cold power. Although satisfactory for reheat take-offs, the mode is not programmed for reheat climbs. The mode is designed to be engaged before take-off; the indicated demands are incorrect if engaged after take-off.

Height or Height and Heading Modes

17. With HEIGHT selected and AP engaged, the aircraft flies at the altitude at which AP was selected, with the wings level. The height datum used by the FCC is the altitude at the moment of engagement, and deviations from this datum result in corrective tailplane demands until the datum altitude is restored. In the transonic region between 0·98M and 1·06M, the

height hold is automatically replaced by pitch attitude hold. When accelerating or decelerating out of this speed band, the height hold re-locks automatically to the pressure altitude at the moment of changeover from pitch attitude hold to height hold.

18. The heading datum used with HEIGHT, HDNG and AP engaged is that indicated by the selected heading marker on the navigation display. Errors from the datum result in corrective turn demands until the aircraft takes up the datum heading. The HDG knob on the navigation display controls the setting of the selected heading marker and therefore the heading maintained by the system. However, with AP engaged and ALIGN selected on the E/F band homer, the heading selector is free to turn without causing a heading change demand through the FCS.

Attitude Hold

19. With ATTITUDE selected and AP engaged, the aircraft is locked to the pitch and bank data signalled by the MRG to the FCC at the time of engagement. Any error from the locked position causes corrective control movements.

ILS Modes

20. The TRACK and GLIDE keys on the control unit are used in conjunction with the ILS localiser and glidepath respectively. The two modes may be used either with FD selected, when the flight director bead of the attitude indicator gives steering dmands, or with AP engaged for automatic ILS. The TRACK mode selects a combined height and heading lock which enables the aircraft to be flown in FD or AP to intercept and hold the ILS localiser centreline. The GLIDE mode, which cannot be selected unless the TRACK key has previously been made, demands or produces a 3° nose-down change of attitude and couples the ILS glidepath to the FCC. The little stick is inoperative in these modes.

Auto-Throttle

21. With any mode selected, the THROTTLE SERVO control can be selected to ENGAGE thus coupling both throttles to the FCC. An actuator, operative in the speed range 166 to 188 knots (162 to 182 knots in GLIDE), moves the throttles to maintain a constant speed. With a mode selected and the FCS engage switch OFF, the actuator moves the throttles in response to airspeed alone; with a mode and AP selected, the actuator responds to both airspeed and attitude changes. The auto-throttle facility is inhibited above 275 knots.

22. If the THROTTLE SERVO is selected to ENGAGE at a speed above the operative speed range, the actuator reduces power until the speed reduces to within the range and then holds a datum speed (eg 175 knots). Adjustments to the datum speed are made by slipping the clutches: with ENGAGE still selected, moving the throttles to a new RPM reprogrammes the datum speed.

23. The THROTTLE SERVO lever is spring-loaded to the DISENGAGE position. When the lever is moved to ENGAGE against the spring, a catch retains the selection. To disengage, downward pressure on the catch releases the lever, which then returns to the DISENGAGE position.

Autopilot Trim Indicator

24. The autopilot trim indicator shows any out-of-trim condition opposed by the tailplane autostabiliser actuator. The model aircraft indication shows how the aircraft will pitch when the FCS engage switch is moved to OFF:

Indication down — nose-down pitch on disengagement; trim nose up

Indication up — nose-up pitch on disengagement; trim nose down

25. If, prior to selecting AP on the FCS engage switch, an out-of-trim indication is given after the selection of any mode except CLIMB, a latent malfunction of the FCC should be suspected and the mode should not be engaged. When CLIMB is selected, the indicator moves down.

26. In the HEIGHT, HDNG and TRACK modes it is normal for an out-of-trim indication to be present in a turn.

27. When only the autostabilisers are in use, the indicator fluctuates about the central position. In the HEIGHT and ATTITUDE modes with AP engaged, the instrument provides an indication of the aircraft's trim condition.

28. When the FCS control unit MASTER is OFF, the indication is off the scale.

FCS Engage Switches — T Mk 5

29. An FCS engage switch is fitted to both control columns in the T Mk 5. Their use to engage autopilot or flight director varies depending upon the position of the AUTOPILOT CUTOUT CHANGEOVER SWITCH.

30. The AUTOPILOT CUTOUT CHANGE-OVER SWITCH is normally wire-locked to position 2. When set at this position the instructor's FCS engage switch becomes an FCS master switch. The switching arrangements are as follows:

Instructor's Stick Switch	*Pupil's Stick Switch*	*Effect*
OFF	OFF or FD or AP	No preselected mode engaged
FD	OFF or FD or AP	Flight director engaged through instructor's switch
AP	OFF	No preselected mode engaged
	FD	Any preselected mode engaged in flight director
	AP	Any selected mode engaged in autopilot

31. When the T Mk 5 is flown solo and the FCS is to be used in other than the STAB mode, the instructor's FCS engage switch is pre-selected to AP and the cutout switch left set and wired to position 2.

32. When the aircraft is flown with the instructor's control column removed, the cutout switch is moved to position 1 to allow the pupil's FCS engage switch to operate.

Flight Director

33. The flight director bead on the attitude indicator is controlled by the FCC when AP or FD is engaged on the FCS engage switch. When in the FD mode, to follow the flight director, 'fly' the centre reference circle of the attitude indicator onto the bead.

34. The bead parks in the 2 o'clock position when the FCS engage switch is to OFF (with the instrument master switch on). If a g-switch trip, an AC failure or a DC failure occurs with FD or AP selected, the bead moves to its parked position.

MANAGEMENT OF THE SYSTEM

Pre-Flight Checks

35. A limited pre-flight check is given in FRC. If a comprehensive pre-flight check is necessary, proceed as given below. The check assumes that the cutout switch in the T Mk 5 is set to position 2.

Preliminary Checks

Throttle servo ...	DISENGAGE
FCS engage switch(es)	OFF
MASTER switch ...	OFF
STAB switch ...	OFF
Mode	ATTITUDE (cancels previous selections)

Switch-On Checks

AC and DC power ...	On line
Instrument master ...	On: FD bead should park
MASTER switch ...	MASTER: SUPPLIES indicator black, autopilot trim indicator 'in trim'
STAB switch ...	STAB: SUPPLIES indicator remains black

CLIMB Checks (F Mk 3 and F Mk 6)

Mode	CLIMB: Check that auto-pilot trim indicator shows hard nose down
FCS engage switch	AP: MODE indicators remain white/OFF, FD bead remains parked FD: MODE indicators change to DIR, FD bead demands climb (10° approx) OFF: MODE indicators change to white/OFF, FD bead parks

CLIMB Checks (T Mk 5)

Mode	CLIMB: Check that auto-pilot trim indicator shows hard nose down
Instructor's engage switch	AP: MODE indicator remains white/OFF, FD bead remains parked
Pupil's engage switch	FD: MODE indicator changes to DIR, FD bead demands climb (10° approx) OFF: MODE indicator white/OFF, FD bead parks

Note: In the remaining checks in the T Mk 5, the instructor's engage switch is left at AP and 'FCS engage switch' refers to the pupil's engage switch.

ATTITUDE Checks

Mode	ATTITUDE
FCS engage switch	FD: MODE indicator(s) changes to DIR, FD bead moves to centre, autopilot trim indicator shows 'in trim'. Operate BAC and VSC and check that FD bead moves in sympathy AP: MODE indicator(s) changes to AUTO; check as for FD OFF: MODE indicator(s) changes to OFF, FD bead parks

HEIGHT and HDNG Checks

Modes	HEIGHT and HDNG
Navigation display	Set HDG pointer to aircraft heading
FCS engage switch	FD: Check as for ATTITUDE checks. Move HDG pointer and check FD bead moves in sympathy AP: MODE indicator(s) changes to AUTO; checks as for FD OFF: MODE indicator(s) changes to OFF, FD bead parks

Cancellation Checks

MASTER switch ...	OFF: SUPPLIES indicator changes to white/OFF, trim indicator off scale
STAB switch ...	OFF
Mode	ATTITUDE
Instructor's engage switch (T Mk 5) ...	OFF

Mode Engagement Sequence

36. Interlocks prevent the engagement of the system unless the correct switching sequence is followed. To engage the FCS in flight:

FCS engage switch(es)	OFF
MASTER switch ...	MASTER: SUPPLIES indicator black (see Notes 1 and 2)
STAB switch ...	STAB
VSC	Central
Navigation display	HDG pointer to required heading
Mode	Select required mode
Trim	Straight and level
Autopilot trim indicator	Centre
FCS engage switch(es)	Engage AP or FD (see Note 3)

Note 1: If MASTER is selected in flight, an undemanded pitch increment of $\pm 2 \cdot 8$g can be experienced under the worst conditions unless corrective action is taken within two seconds.

Note 2: In flight, allow one minute between the selection of MASTER and STAB to allow the rate gyros to spin up.

Note 3: Wait a minimum of six seconds between mode selection and engagement to allow the FCC to collate the new data and compute the new demands.

Autostabilisation

37. The autostabilisers operate when, with AC on line, the instrument master, FCS MASTER and STAB switches are on. Allow one minute between selecting the FCS MASTER switch on and the STAB switch on. The autostabilisation mode is always engaged during flight under normal conditions.

38. *Jury Struts.* When jury struts are fitted in place of autostabiliser actuators, the MASTER switch is to be selected on (to retain full tailplane) but the STAB switch is to be selected OFF.

Programmed Climb

39. Select CLIMB and engage FD before take-off. Set the desired climb-out heading on the navigation display, but this setting must not be greater than 175° from the runway heading to ensure the turn is made in the required direction.

40. Because the initial climb demand is too steep, do not attempt to follow the bead on the attitude indicator until a speed of 300 knots has been attained. Above 275 knots the bead deflects left or right, demanding a turn onto the pre-set heading. Turns are limited to 45° of bank.

41. Transition from the climbing IAS to the climbing Mach number starts at about 0·85M at 9000 feet. It is important to follow the bead very closely during this transition to avoid overshooting the Mach datum of 0·89 ±0·01M, which is attained at about 14,000 feet and held until 32,000 feet. Above 32,000 feet, Mach number decreases slowly to approximately 0·85M but recovers if the climb is continued above 38,000 feet.

42. When approaching the desired altitude, switch OFF the stick switch and level the aircraft normally. The FCC is not programmed for a reheat climb.

HEIGHT or HEIGHT and HDNG Lock

43. *Use of Mode Keys.* Heading lock cannot be engaged without height lock and the keys are paired so that pressing the HDNG key also selects HEIGHT. HEIGHT may be selected independently, and HDNG can be de-selected separately without disengaging HEIGHT. With HEIGHT selected and AP engaged, a new heading can be pre-selected and the turn initiated when required by operating the HDNG key.

44. *Use of Heading Pointer.* When HEIGHT and HDG are selected and AP is engaged, turning the heading pointer on the navigation display immediately banks the aircraft towards the new heading. Since the aircraft always turns the shorter way to the new heading demanded, the applied bank is reversed if the pointer is turned through the reciprocal of the aircraft's heading. Therefore, heading changes through more than 180° are selected in sectors of 90° approximately. With the BAC on the little stick centred, bank angle is limited to 28° below 400 knots/1·06M and to 50° above those speeds.

45. *Use of the Little Stick.* The bank angle control (BAC) and vertical speed control (VSC) on the little stick are used as follows:

a. *BAC.* The rate of turn onto a new heading may be varied by use of the BAC which, in this mode, increases or decreases the autopilot bank demand by up to 12° in steps of 4°, defined by the three click stops either side of central. Centralise the control manually after use to prevent a standing heading error of up to 2½°. The BAC is spring-loaded to the nearest click stop but automatically centres when the stick switch is moved to OFF, the failure interlocks operate or a g-trip is experienced.

b. *VSC.* The VSC may be used in this mode as a climb rate demand system, having an authority of ±7500 feet per minute. The control must first be centred before a rotation to UP or DOWN is effective. The control remains in any position selected. On both sides of the central detent position there is a small dead band. On centring after use, the system reverts to height lock and the new datum is the altitude at the moment of centring. If the VSC is used at speeds over approximately 375 knots below 25,000 feet, g-switch trips are likely to occur.

46. *Automatic Height Control.* A gearing system which varies automatically with height is incorporated to compensate for changes in control effectiveness with changes in altitude and Mach number. The effect is to decrease the tailplane/height error ratio at high subsonic speeds at low altitude, and to increase the ratio at high altitudes at supersonic speeds. The quality of automatic height control varies with height and speed as follows:

a. *Subsonic Performance.* In subsonic flight, the height control performance varies significantly with IAS and, to a lesser extent, with altitude. The flight conditions which give the most satisfactory control are in the speed band 300 to 350 knots at altitudes between 20,000 and 30,000 feet. At speeds above 350 knots, especially below 20,000 feet, control is oversensitive to such an extent that large or rapid throttle movement may produce pitch disturbances which, if severe, lead to g-switch trip. Conversely, as speed is reduced below 300 knots and/or altitude increased above 30,000 feet, height hold becomes increasingly less precise. During turns at altitudes near the tropopause, up to 500 feet may be lost if speed variation is allowed to occur.

b. *Supersonic Performance.* In supersonic flight, height control varies with altitude but is virtually independent of speed changes. The most satisfactory altitude band is between 20,000 and 40,000 feet. Above 40,000 feet height control deteriorates rapidly, especially in turns. Below 20,000 feet, height control becomes increasingly sensitive. Pitch oscillations may occur with a combination of high altitude (above 36,000 feet) and high bank angle (greater than 50°); this oscillation is alleviated by reducing the bank angle.

c. *Transonic Performance.* When accelerating in the transonic region, the aircraft climbs and, in the worst circumstances, acceleration may cease. During decelerations there is also a tendency to climb, particularly when the deceleration is rapid. Below 25,000 feet, during both acceleration and deceleration, the pitch disturbances induced by the change from height hold to pitch attitude hold and vice versa, may trip the g-switch. For this reason the HEIGHT mode is not to be used during transonic accelerations and decelerations between 15,000 and 25,000 feet.

47. *Tailplane Trim Changes.* Any change in flight conditions requiring large and rapid tailplane trim changes produces temporary height variations. These variations are normally greatest in the climb sense but, during rapid deceleration from high speed at low level, the aircraft tends to descend.

48. *Lateral and Directional Trim.* Lateral and directional trim changes which occur and which are

not corrected manually on the normal trim controls produce heading errors or, in HEIGHT lock alone, bank errors. An out-of-trim condition causes a partial inhibition of autopilot authority in roll, giving a slow roll rate in response to a heading demand.

49. *Asymmetric Loads.* Careful trimming is essential when carrying asymmetric loads (eg single missile or AAR probe).

Attitude Hold Mode

50. Pitch and bank attitude hold is satisfactory in the ATTITUDE mode throughout the flight envelope. However, pitch errors occur if the mode is used in conditions requiring rapid trim changes (eg a high rate of climb). Bank errors also occur if lateral trim changes are required.

51. The little stick may be used in this mode to vary the pitch and bank datum. Its authority in this mode is $\pm 6 \cdot 6°$ in pitch and 30° in bank (10° per click stop).

ILS Modes

52. An ILS approach may be flown down to decision height in autopilot with AP selected, or manually in FD, by engaging TRACK and GLIDE at the appropriate positions. The aircraft is landed manually after selecting OFF on the stick switch. Auto-ILS procedure is described in detail in Part 3, Chapter 5.

53. *Bank Angle.* In the ILS modes the bank angle with TRACK selected is limited to 28°. With GLIDE selected, bank angle is limited to 15°.

TRACK Mode

54. In steady cruise conditions the TRACK mode may be used as a height and heading lock. Check that the ILS master switch is off and engage the mode in the normal way. Owing to variations between aircraft and production tolerances on equipment, some aircraft may perform a small pitching oscillation in this mode. Turns are made by rotating the HDG selector on the navigation display, but heading changes in excess of 40° are prohibited because there may be insufficient tailplane authority to maintain height in the turn. Height corrections in turns can be reduced by applying direct control column corrections or by trimming.

Auto-Throttle

55. Auto-throttle may be used on manual and auto-ILS approaches, and on PAR or visual approaches. Its characteristics are described in para 21 to 23.

PAR Approaches

56. The FCS, including auto-throttle, may be used as an aid during PAR approaches. With the ILS MASTER switch off and TRACK selected, engage AP to provide height and heading lock for the initial phase of the PAR approach. Ensure the autopilot trim indicator shows an 'in-trim' situation and start the descent by selecting GLIDE; this pitches the aircraft nose down through 3°, giving a rate of descent of approximately 900 feet per minute at 175 to 180 knots. Adjust the rate of descent manually by re-trimming. Pitch changes take place slowly: make only small trim adjustments and pause between each change.

MALFUNCTIONS OF THE SYSTEM

General

57. The malfunctions possible in the FCS depend on the settings of the MASTER and STAB switches as follows:

a. With the MASTER and STAB switches both OFF there can be no malfunction in any channel, but the tailplane autostabiliser actuator is likely to drift and to remain at one end of its restricted stroke (±1°).

b. With the MASTER switch on and the STAB switch OFF, a malfunction is possible only in the tailplane channel within the restricted stroke of the autostabiliser actuator.

c. With both MASTER and STAB switches on, with or without a mode engaged, hard-over or oscillatory autostabiliser actuator malfunctions are possible in all three axes. In the case of the tailplane, the malfunction is limited to ±1° except when in TRACK with the undercarriage down, when the limit increases to ±3°18′.

58. *Failure Indications.* The attention-getters operate and the AP caption on the SWP comes on after a g-switch trip, after AC or DC failure to the FCS, or when an incorrect selection sequence is made. The MODE and SUPPLIES indicators change to white/OFF and the FD bead parks after a g-switch trip, after AC or DC failure to the FCS, or after an FCS malfunction. If an FCS malfunction occurs which does not bring on the AP caption, it may not be obvious that the system has tripped if the aircraft is in trim, although the MODE and/or SUPPLIES indicators may be showing white/OFF.

Aircraft Response to FCS Malfunctions

59. *Hard-Over Malfunctions.* In the worst cases, without immediate corrective action, the effects of a hard-over (runaway) malfunction are as follows:

a. *Tailplane.* In the autostabilisation mode the maximum normal acceleration increment is ±2·8g, and in the height and heading or attitude hold modes, ±4·5g. At subsonic speeds above 40,000 feet, pre-stall buffet may be experienced after a tailplane hard-over, the buffet increasing in severity with increase in altitude. Except in the autostabilisation mode, the autopilot disengages automatically if less than zero g or more than +3g is experienced. After certain tailplane malfunctions when the hard-over is opposed by the pilot, the push or pull force required progressively increases until the autotrim reaches its limit stop or the FCS MASTER is switched OFF.

b. *Ailerons.* After an aileron hard-over at high subsonic or supersonic speeds, 90° of bank can be applied in two seconds.

c. *Rudder.* After a rudder hard-over, 2° of side-slip and 20° per second peak roll rate can be experienced. Care should be taken during recovery to avoid large sideslip values caused by abrupt rudder correction.

d. *Auto-ILS.* With TRACK and AP engaged and the undercarriage down, the peak hard-over increments are as follows:

Tailplane	— ±0·85g
Aileron	— 15° of bank in two seconds
Rudder	— 1·6° sideslip and 10° per second peak roll rate

60. *Oscillatory Malfunctions.* The aircraft response to oscillatory malfunctions is as follows:

Tailplane	— ±½g increment at one to two cycles per second
Aileron	— Negligible effect
Rudder	— Large oscillatory sideslip

Actions Following Malfunctions

61. After an FCS malfunction, take corrective action on the controls, but do not chase an oscillatory malfunction. Then cancel the FCS in the following sequence:

MASTER switch ...	OFF (anticipate a change in tailplane trim)
STAB switch ...	OFF
Stick switch ...	OFF
Retrim	

62. If the trip indications are not accompanied by an obvious malfunction, make an FD re-engagement. If the indications are satisfactory in FD, AP may be re-engaged with caution. The FCS is not to be re-engaged after an obvious malfunction.

Instrument Power Supply Changeover

63. Whenever the standby inverter MI changes to white/ON, whether accompanied by an aircraft oscillation or not, the FCS is to be cancelled in the correct sequence.

Intentionally Blank

PART 1

CHAPTER 9—WARNING SYSTEMS AND LIGHTING

Contents

WARNING SYSTEMS

CONTROLS AND INDICATORS

1. The controls and indicators for the warning systems in the F Mk 3 and F Mk 6 are listed in Table 1, and for the T Mk 5 in Table 2; illustrations are Fig 1 and 2 respectively. The standard warning panel (SWP) and auxiliary warning panel (AWP) in the F Mk 3 and F Mk 6 are shown in Fig 3 and 4. The panels in the T Mk 5 are shown in Fig 5.

Table 1 — Controls and Indicators — F Mk 3 and F Mk 6

Item No	*Item*	*Markings*	*Remarks*
1	Standard warning panel	See text	—
2	Fire extinguisher buttons (2) (SWP)	F1, F2	Integral fire warning lights
3	Cancel button (SWP)	C	Integral flashing light
4	Mute switch (SWP)	M	Integral light comes on when muted (up)
5	Test button (SWP)	T	Not illustrated
6	Audio mute button	AUDIO WARNING — PULL TO MUTE	—
7	Day/night screen (SWP)	DAY/NIGHT	—
8	Auxiliary warning panel	See text	—
9	Test button (AWP)	TEST	—
10	Day/night switch (AWP)	NIGHT/DAY	—
11	Mute button (AWP)	—	Not illustrated. Integral light on when muted (up)

Table 2 — Controls and Indicators — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
1	Standard warning panel	See text	—
2	Fire extinguisher buttons (2) (SWP)	F1, F2	Integral fire warning lights
3	Cancel button (SWP)	C	Integral flashing light
4	Mute button (SWP)	M	Integral light on when muted (up)
5	Test button (SWP)	T	—
6	Audio mute button	AUDIO MUTE	Up for mute
7	Day/night screen (SWP)	See text	—
8	Auxiliary warning panel	See text	—
9	Test button (AWP)	T	—
10	Day/night screen (AWP)	—	Not illustrated. Translucent screen

DESCRIPTION OF THE SYSTEMS

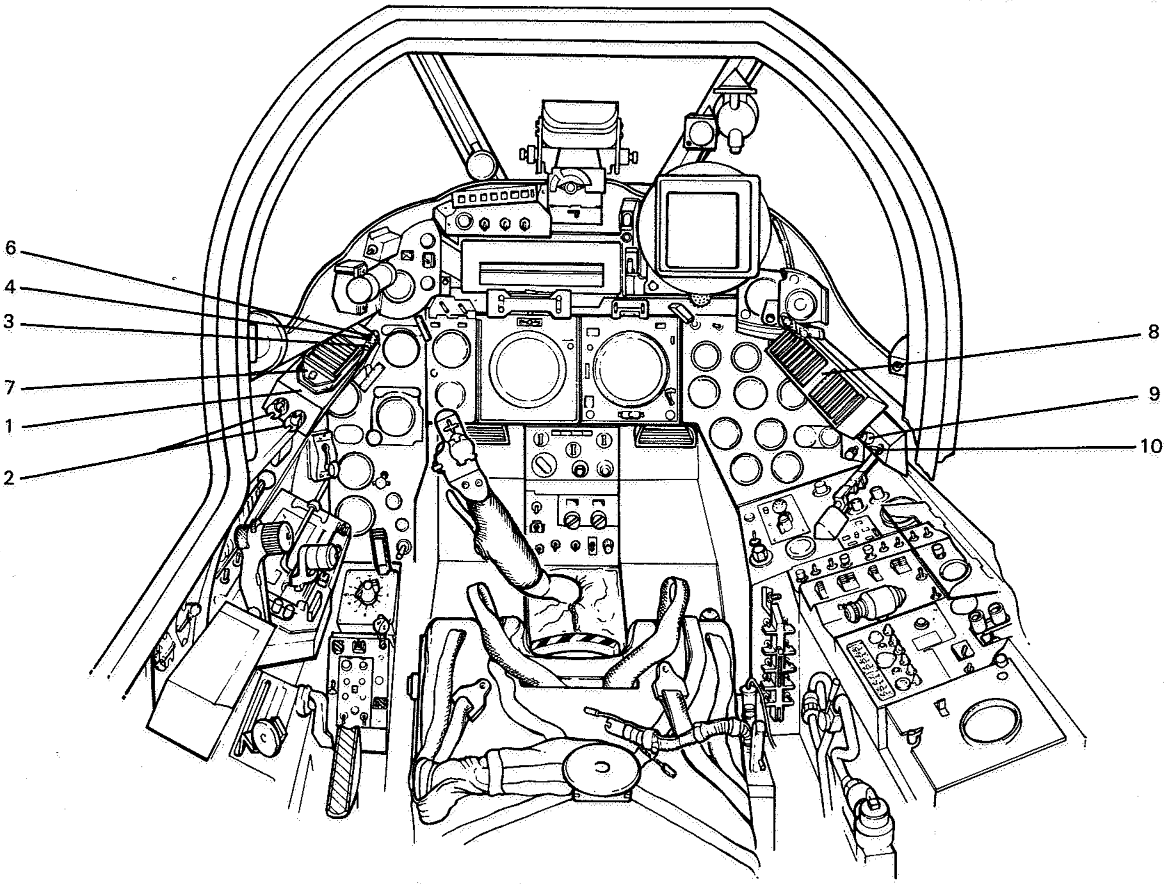
General

2. The standard warning system and the auxiliary warning system ensure that malfunctions in aircraft systems are easily identified. The standard warning panel (SWP) displays captions relating to the more important failures while the auxiliary warning panel (AWP) deals with less important warnings. Audio warning and flashing attention-getters operate when an SWP caption is triggered.

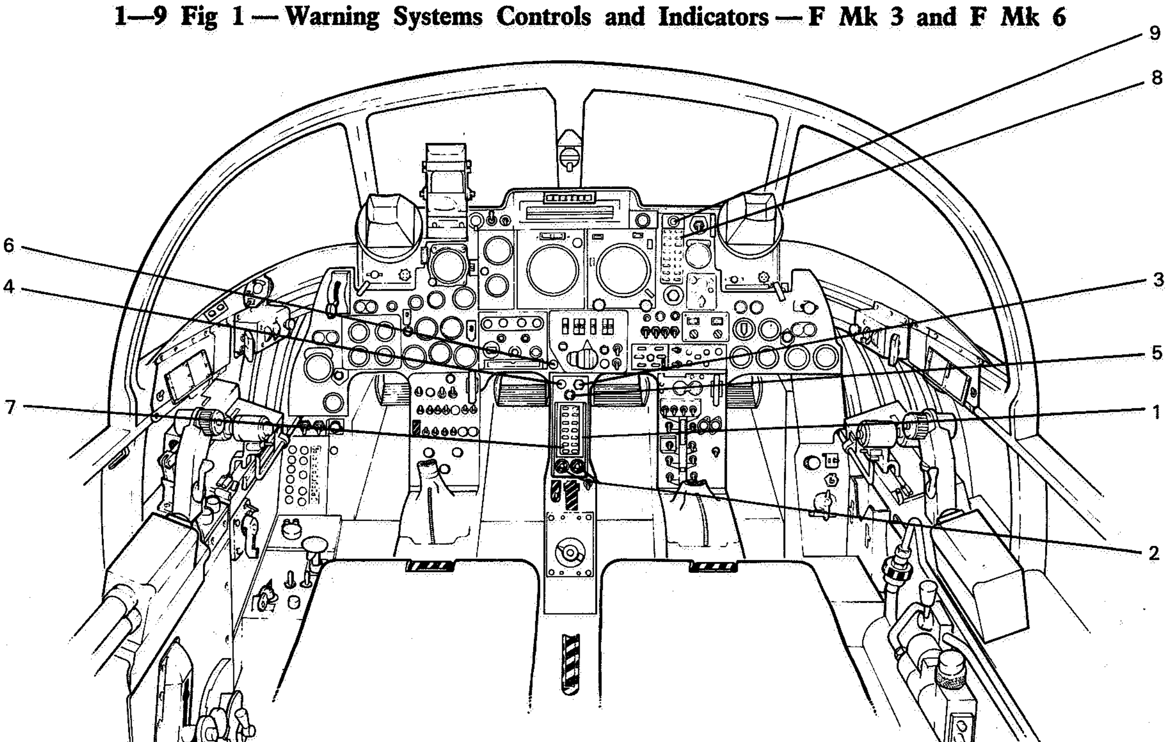
Standard Warning System

3. The warnings on the SWP are ready to operate when AC and DC supplies are available, and the ENG MASTER (ENGINE MASTER, T Mk 5) and INST MASTER (INSTRUMENT MASTER, T Mk 5) switches are on. The fire captions, however, operate with the engine master switch off providing the instrument master switch is on.

4. The captions on the SWP, together with their meanings, are listed in Table 3. A fuller description



1—9 Fig 1 — Warning Systems Controls and Indicators — F Mk 3 and F Mk 6



1—9 Fig 2 — Warning Systems Controls and Indicators — T Mk 5 of the cause and the associated action for each caption is given in the Chapter dealing with the appropriate system.

Table 3 — SWP Captions

Caption	*Cause*
FIRE 1	Fire in No 1 engine bay (zones 1 and 2)
FIRE 2	Fire in No 2 engine bay (zones 1 and 2)
RHT 1	Fire in No 1 jetpipe area (zone 3)
RHT 2	Fire in No 2 jetpipe area (zone 3)
GEN	Both generators off line
HYD	No 1 and No 2 Controls hydraulic systems failed
AP	Autopilot trip
CPR	Cockpit pressurisation failure
OXY	Oxygen supply failure (there are two OXY captions in the T Mk 5)

5. In addition to the captions, the SWP incorporates two fire extinguisher push buttons (F1/F2) which have integral lights; the appropriate light in an extinguisher button comes on when a FIRE 1 or FIRE 2 caption on the panel is lit.

6. *Attention-Getters.* When any caption on the SWP comes on, a red attention light (two lights, T Mk 5) flashes and an audio alarm is heard. If a caption comes on and then goes out, the audio alarm and attention-getters also stop.

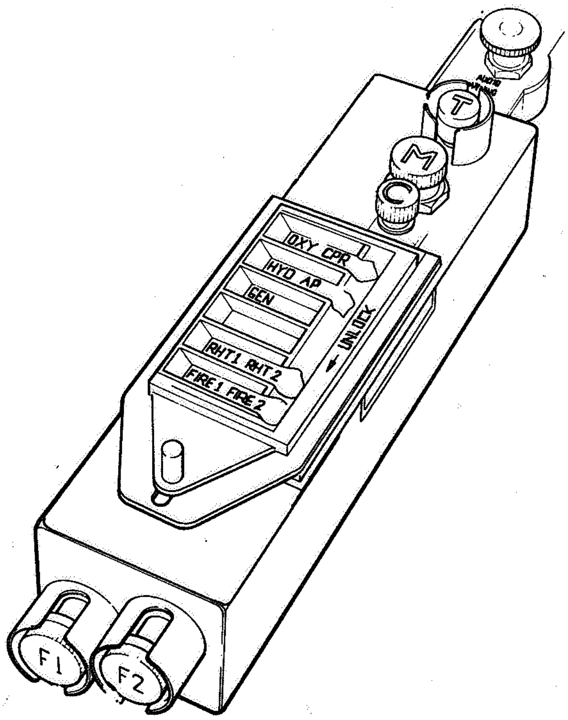
7. *Associated Controls.* In addition to the two fire extinguisher buttons, there are four other buttons associated with the SWP either on, or adjacent to, the panel:

a. *Cancel Button.* The spring-loaded C button has an integral light which flashes when a caption on the panel comes on. Pressing and releasing the button cancels the audio alarm, attention-getters and the flashing integral light, leaving the attention-getters ready to signify any subsequent warning. The C button does not extinguish any captions nor the lights in the fire extinguisher buttons.

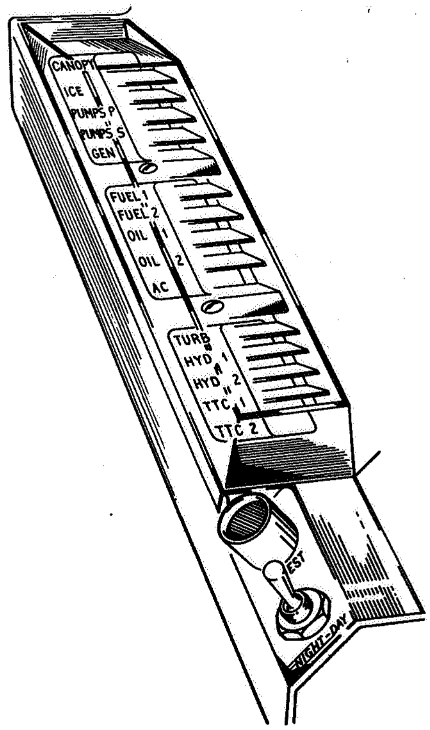
b. *Mute Switch.* When the M button is pulled, its integral light comes on and all captions except the fire warnings are rendered inoperative. The M button is always to be pressed down (light out) in flight.

c. *Test Button.* Pressing the spring-loaded T button causes all captions, the F1 and F2 lights, and the audio and flashing alarms to operate. After releasing the T button, all captions go out (unless they were previously lit); the C button is pressed to cancel the audio and flashing alarms.

d. *AUDIO MUTE.* The AUDIO MUTE button, when pulled out, attenuates the audio alarm.



1—9 Fig 3 — Standard Warning Panel — F Mk 3 and F Mk 6



1—9 Fig 4 — Auxiliary Warning Panel — F Mk 3 and F Mk 6

8. *Day/Night Screens.* In the F Mk 3 and F Mk 6 a screen covers the captions when the DAY/NIGHT selector is moved to NIGHT. In the T Mk 5 a translucent screen is moved over the captions for night operation.

9. *AC Changeover.* If a FIRE or RHT caption is lit and the attention-getters have been cancelled, the attention-getters are re-activated if AC changeover from alternator to inverter (or vice versa) takes place.

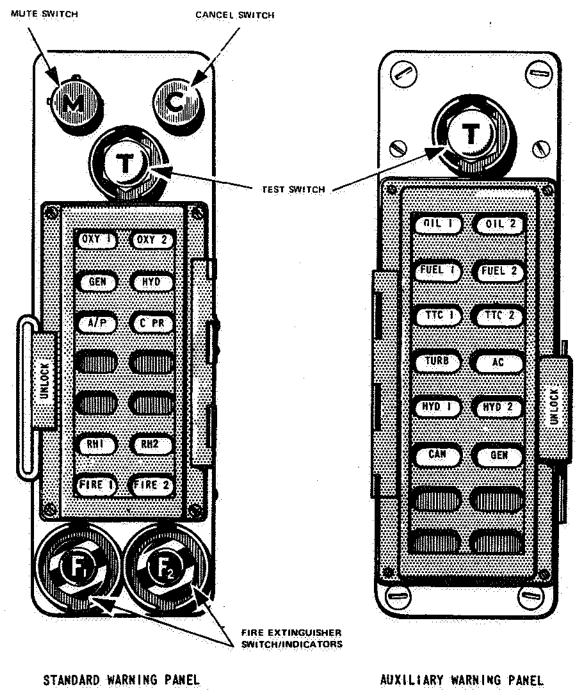
10. *Indications Summary.* When a warning occurs on the SWP, the following indications are given:

- Attention light(s) flashes
- Audio alarm sounds
- Caption lit
- C button light flashes
- If a FIRE caption is on, the appropriate extinguisher button comes on

Auxiliary Warning System

11. The warning captions on the AWP are DC operated. There are no audio or visual attention-getters in the auxiliary warning system.

12. The single-seat aircraft have a panel different in shape from that in the T Mk 5, but both types of panel contain the same warning captions. In the F Mk 3 and F Mk 6 the panel has an 'open' list of warning captions down its left side for night use and a duplicated list of 'shuttered' captions down the right side for day use. The T Mk 5 has one set of captions for both day and night.



1—9 Fig 5 — Warning Panels — T Mk 5

13. The captions on the AWP, together with their meanings, are listed in Table 4. A fuller description of the causes and the associated action for each caption is given in the Chapter dealing with the appropriate system.

Table 4 — AWP Captions

Caption	*Cause*
GEN	Main generator failure
TURB	Air turbine stall
AC	Alternator failure
PUMPS P	Fuel transfer pressure low (left)
PUMPS S	Fuel transfer pressure low (right)
FUEL 1	Fueldraulic pump output failure (left)
FUEL 2	Fueldraulic pump output failure (right)
OIL 1	No 1 engine oil pressure low
OIL 2	No 2 engine oil pressure low
HYD 1	No 1 Controls system failure
HYD 2	No 2 Controls system failure
TTC 1	No 1 engine reheat trip
TTC 2	No 2 engine reheat trip
CANOPY*	Canopy unlocked
ICE	Inoperative

*In the T Mk 5, the canopy warning reads CAN.

14. *Test Button.* The filaments of all the lamps are tested by pressing the spring-loaded TEST button (marked T in the T Mk 5).

15. *Day/Night Systems.* In the T Mk 5 a translucent screen is moved over the captions for night use. In the F Mk 3 and F Mk 6 a DAY/NIGHT switch is fitted. When DAY is selected, two lamps under each right-hand 'shuttered' window are in circuit; when NIGHT is selected, two lamps under each 'open' left-hand caption are in circuit:

16. *Mute Button.* In the F Mk 3 and F Mk 6, a push/pull mute button is mounted at the forward end of the AWP to prevent overheating during long periods of servicing with DC power on line. With the button pulled out an integral lamp in the switch comes on and all warnings on the AWP are extinguished. A positive check that the switch is pushed in (lamp out) is to be made prior to starting.

INTERNAL LIGHTING — F MK 3 AND F MK 6

CONTROLS AND INDICATORS

17. The controls and indicators for the internal lighting system for the F Mk 3 and F Mk 6 are listed in Table 5 and illustrated in Fig 6. All lighting is supplied from the DC system except for the 4-volt instrument lighting circuit which is fed, via a transformer, from the AC system.

Table 5 — Internal Lighting Controls — F Mk 3 and F Mk 6

Item No	*Item*	*Markings*	*Remarks*
1	Console lighting switches (2)	PORT, STBD	Rotary dimmer switches
2	Instrument lighting switches (2)	FWD PORT, FWD STBD	
3	IFIS lighting	CENTRE	Rotary dimmer switches
4	Standby instrument lighting	STBY E2B — ON	
5	Frequency card lighting	FREQ CARD LIGHT	—
6	Floodlamp	—	—
7	Emergency lighting switch	EMERGENCY LIGHTS — ON	—
8	Anti-dazzle lamps switch	BRIGHT/OFF/DIM	—

DESCRIPTION OF THE SYSTEM

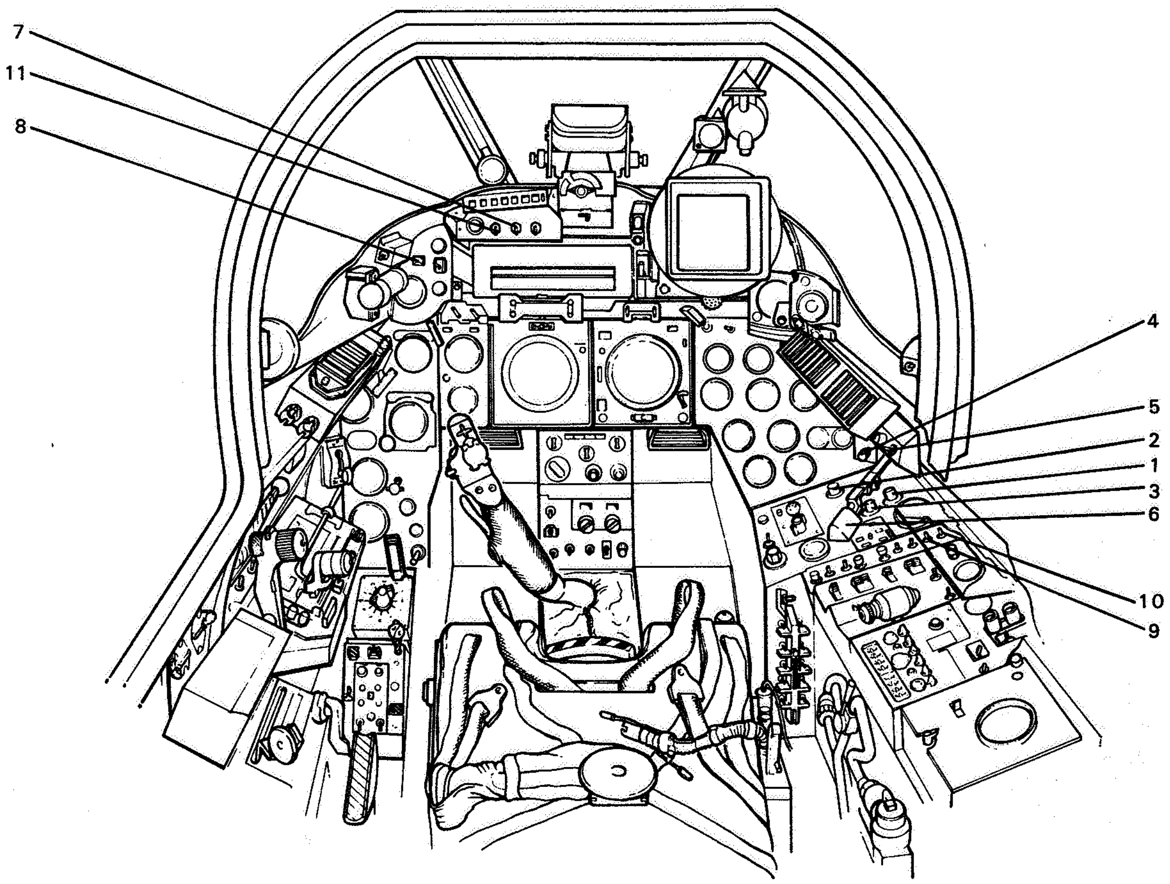
Normal Lighting

18. The following five rotary/dimmer switches control the normal cockpit lighting:

a. *Console Lighting.* Two switches, PORT and STBD, control the pillar lamps and flood lamps for the left and right consoles respectively.

b. *Instrument Lighting.* The FWD PORT switch controls the pillar lamps and floodlamps for the left instrument and coaming panels, and the hydraulic pressure gauge. The FWD STBD switch dims the attention-getter lamp when cockpit lighting is on and controls the pillar and flood lighting in the following areas:

Right instrument panel



1—9 Fig 6 — Lighting Controls — F Mk 3 and F Mk 6

Starter panel
V/UHF controller
Voltmeter
Accelerometer

c. *IFIS Lighting.* The CENTRE switch controls the integral 4-volt lighting for the IFIS display.

19. *Standby Instruments.* The STBY E2B rotary dimmer switch controls the integral lamps in the standby DI and the E2B compass.

20. *Frequency Card Lighting.* The frequency card switch, marked FREQ CARD LIGHT, is a toggle switch which controls supplies to the frequency card lamp.

21. *Floodlamp.* A floodlamp on a swinging arm is below the AWP. The lamp, which may be used to illuminate a knee pad, is controlled by a toggle switch under the arm.

Emergency Lighting

22. If the normal cockpit lighting fails, emergency lighting is selected by switching ON the EMERGENCY LIGHTS switch on the left coaming panel to illuminate the instrument panel and the consoles. The electrical supply is taken from the emergency battery. With the switch at ON, the E2B compass and the standby DI lighting supply is transferred from the DC busbar to the emergency battery, but the STBY E2B switch continues to control the brilliance at these two instruments.

23. *Anti-Dazzle Lamps.* Two high-intensity white anti-dazzle lamps are fitted to the windscreen arch; they are controlled by a three-position BRIGHT/OFF/DIM switch on the left instrument panel.

INTERNAL LIGHTING — T MK 5 CONTROLS AND INDICATORS

24. The controls for the internal lighting in the T Mk 5 are listed in Table 6 and illustrated at Fig 7. All lighting is supplied from the DC system except for the 4-volt instrument circuit which is fed, via a transformer, from the AC system.

DESCRIPTION OF THE SYSTEM

Normal Lighting

25. The following five rotary dimmer switches control the normal cockpit lighting:

a. *Left Console Lighting.* A SILL FLOODLIGHT DIM switch on panel A2 controls the floodlamps on the left console, a bank of floodlamps on the left sill and the pillar lighting of the brake pressure gauge and voltmeter.

b. *Instrument Lighting.* Three switches on panel A3 control the instrument lighting:

(1) A DIM PORT switch controls a bank of floodlamps on the left sill, the engine instruments panel and standby artificial horizon pillar lamps, the IFF/SSR control panel, panel A3 lighting, the relight buttons and the left 100%/AIRMIX control lighting.

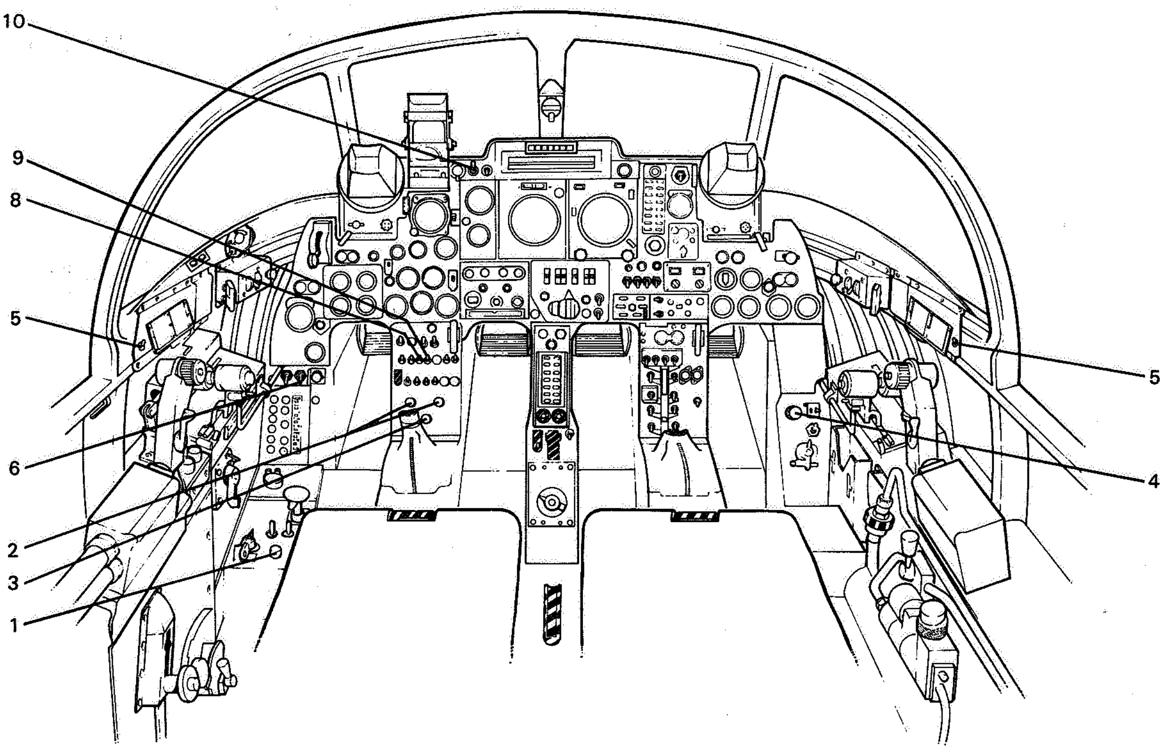
(2) A DIM STBD switch controls one bank of floodlamps on the right sill, pillar lights on panel A1 (excluding the engine instruments), the FCS, Tacan and E/F band homer control units' lighting, and panels A4 and A5 lighting together with the right 100%/AIRMIX control lighting.

(3) A DIM CENTRE switch controls the 4-volt instrument lighting to the IFIS display.

c. *Right Console Lighting.* The SILL FLOODLIGHT DIM switch on panel A6 controls the floodlights under the right sill.

Table 6 — Internal Lighting Controls — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
1	Left console lighting switch	SILL FLOODLIGHT DIM	Rotary dimmer switches
2	Instrument lighting switches (2)	DIM PORT, DIM STBD	
3	IFIS lighting switch	DIM CENTRE	
4	Right console lighting switch	SILL FLOODLIGHT DIM	
5	Frequency card lighting switches	ON/OFF	Beside frequency cards, left and right
6	Emergency lighting switch	EMERG LIGHTS — ON	—
7	Anti-dazzle lamps switch	BRIGHT/OFF/DIM	On canopy centre member. Not illustrated



1—9 Fig 7 — Lighting Controls — T Mk 5

26. *Frequency Card Lighting.* The lighting of the frequency cards on the left and right sills is controlled by adjacent ON/OFF switches.

Emergency Lighting

27. If the normal cockpit lighting fails, emergency cockpit lighting is selected by switching ON the EMERG LIGHTS switch on panel A2 to illuminate the instrument panels and consoles. The power supply is taken from the emergency battery. With the switch ON, the E2B compass and standby DI lighting is transferred from the DC busbar to the emergency battery but the DIM PORT switch continues to control the brilliance at these two instruments.

28. *Anti-Dazzle Lamps.* Two high-intensity white anti-dazzle lamps are fitted to the canopy centre member; they are controlled by an adjacent BRIGHT/OFF/DIM switch.

EXTERNAL LIGHTING — F MK 3 AND F MK 6

CONTROLS AND INDICATORS

29. The controls for the external lights in the F Mk 3 and F Mk 6 are listed in Table 7 and illustrated in Fig 6.

DESCRIPTION OF THE SYSTEM

30. The external lighting is supplied from the 28V DC busbar. The following switches control the external lights:

a. *Navigation Lights.* Setting the NAV LTS switch to ALL ON brings on the left, right and dual tail navigation lights together with the flashing anti-collision lights. With TIPS selected, only the navigation lights are lit.

b. *Taxy Lights.* The two taxy lights, fitted on each main undercarriage leg, are controlled by the TAXI LTS — ON/OFF switch.

Table 7 — External Lighting Controls — F Mk 3 and F Mk 6

Item No	*Item*	*Markings*	*Remarks*
9	Navigation lights switch	NAV LTS — ALL ON/OFF/TIPS	—
10	Taxy lighting switch	TAXI LTS — ON/OFF	—
11	AAR probe lighting switch	PROBE LIGHT — ON	—

c. *Probe Light.* When the AAR probe is fitted, it is illuminated by selecting the PROBE LIGHT switch to ON. There is no electrical supply to the two probe lights unless the NAV LTS switch is set to ALL ON or TIPS.

EXTERNAL LIGHTING — T MK 5 CONTROLS AND INDICATORS

31. The controls for the external lights in the T Mk 5 are listed in Table 8 and illustrated on Fig 7.

DESCRIPTION OF THE SYSTEM

32. The external lighting is supplied from the 28V DC busbar. The following switches control the external lights:

a. *Navigation Lights.* The 3-position NAV LIGHT switch, when set to HI FLASH, brings on steady navigation lights and flashing anti-collision lights. When set to STEADY, only the navigation lights are lit.

b. *Taxy Lights.* Two taxy lights, one fitted on each main undercarriage leg, are controlled by the TAXI LIGHT — ON switch.

c. *Probe Lights.* When the AAR probe is fitted, it is illuminated by selecting the PROBE LIGHT switch to ON. There is no electrical supply to the two probe lights unless the NAV LIGHT switch is set to STEADY or HI FLASH.

Table 8 — External Lighting Controls — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
8	Navigation lights switch	NAV LIGHT — STEADY/off/ HI FLASH	—
9	Taxy lighting switch	TAXI LIGHT — ON	—
10	AAR probe lighting switch	PROBE LIGHT — ON	—

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PART 1

CHAPTER 10—AIR SYSTEMS

Contents

INTRODUCTION

Sources of Air

1. With the exception of some cooling air, the main air system takes air from two 15th-stage engine compressor tappings, one from each engine. Non-return valves close to each tapping ensure that an air supply is maintained after an engine fails or is shut down. After passing the non-return valves, the compressor air from both engines enters a common duct which feeds the main air system.

2. Compressor tappings, separate from the main air system, supply the reheat pumps (Chapter 3), the guided weapons pack (Aircrew Manual, Weapon System), the hydraulic reservoirs (Chapter 4) and the fuel system (Chapter 2). Ram air is used for equipment cooling and, when selected by the pilot, for cockpit ventilation.

Air Systems

3. The air systems described in this Chapter are:

Cockpit pressurisation and air conditioning

Canopy sealing

4. The location of information on other systems supplied from the main air system is as follows:

Subject	*Location*
Main air turbine	Chapter 1
Standby generator turbine	Chapter 1
Reheat nozzle system	Chapters 1 and 3
Anti-icing systems	Chapter 3
Hot air demisting	Chapter 11
Canopy demisting	Chapter 11
Rain dispersal	Chapter 11
Anti-g system	Chapter 12
Air ventilated suit	Chapter 12
Radar head pressurisation	Aircrew Manual, Weapon System (AP 101B-1003, 5 & 6-15B)

PRESSURISATION AND AIR CONDITIONING

CONTROLS AND INDICATORS

5. The controls and indicators in the cabin pressurisation and air conditioning system for all marks are listed in Table 1. The locations of controls in the F Mk 3 and F Mk 6 are shown in Fig 1, and for the T Mk 5 in Fig 2.

DESCRIPTION OF THE SYSTEM

General

6. Air tapped from the 15th-stage of both engine compressors is used to pressurise the cockpit and regulate the cockpit temperature. An electrically-operated shut-off valve in the main hot air supply duct, controlled by the CABIN AIR switch on the starter panel, controls the supply of air. It takes its power from the 28V DC busbar.

7. With the shut-off valve open, temperature control is effected by passing the bulk of the airflow through a refrigeration system and routeing the remainder to by-pass the refrigeration system, the latter flow being controlled by a variable-position, electrically-operated valve connected to the cockpit temperature controller. The regulated hot air from the by-pass is then mixed with the refrigerated air and delivered to the cockpit via a water extractor.

8. In the F Mk 3 and F Mk 6, conditioned air is delivered to the cockpit through two perforated spray nozzles and two ducts on either side of the control column pedestal. In the T Mk 5, conditioned air is delivered to the cockpit through a perforated spray nozzle and two diffusers on panels A3 and A5. Cockpit differential pressure is controlled by the pressure controller (para 15).

9. Partially-cooled air from the cabin pressurisation and air conditioning system is used for the anti-g and AVS systems, and to pressurise the radar head.

10. A manually-operated RAM AIR valve in the left cockpit wall allows air at ambient temperature and pressure into the cockpit when OPEN is selected. The valve is normally in the CLOSED position.

Refrigeration System

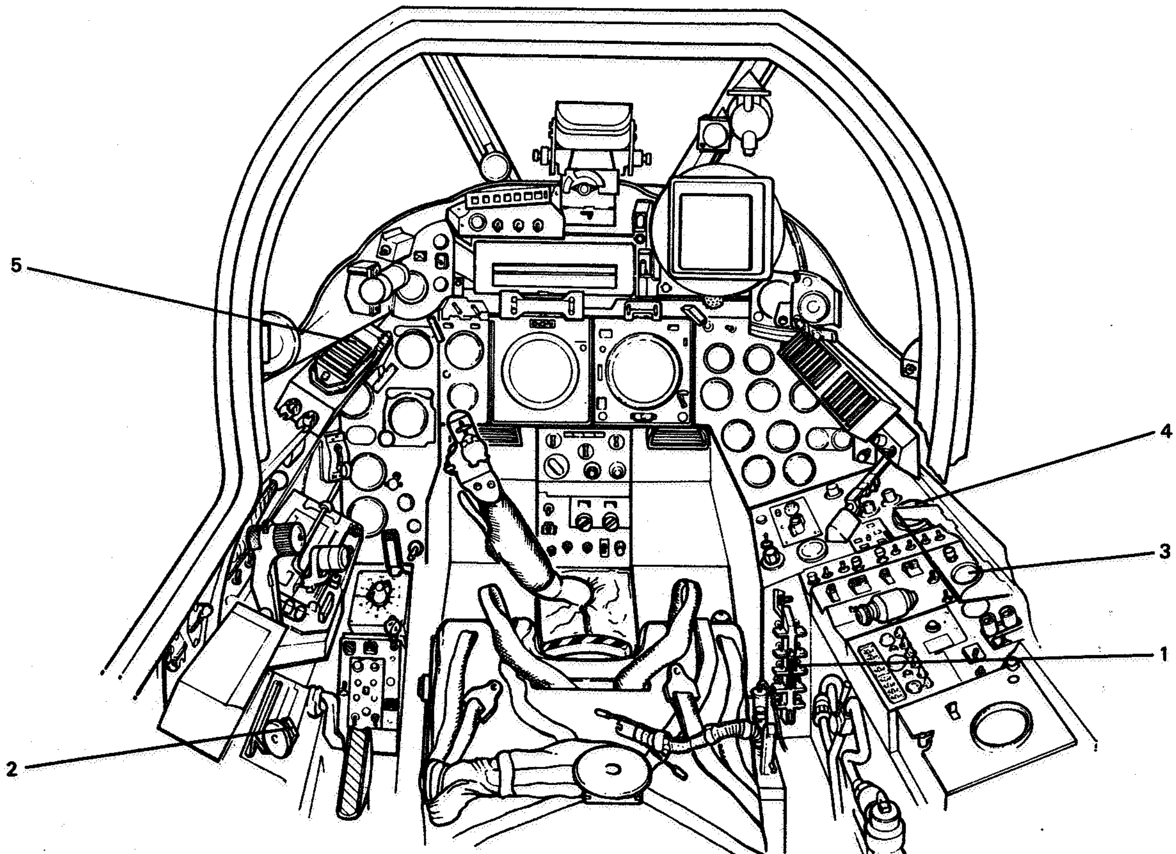
11. The refrigeration system consists of a pre-cooler which uses ram air as a cooling medium, a water boiler and a cold air unit.

Cabin Altimeter

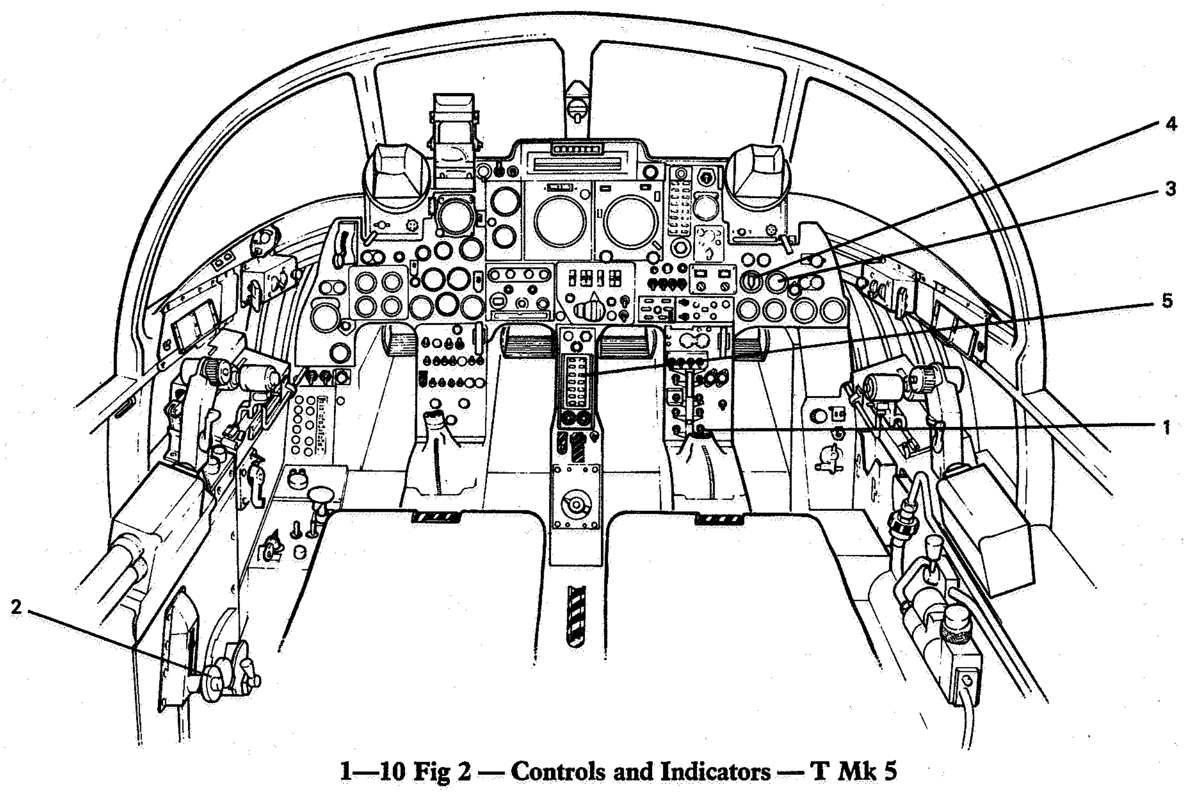
12. The Mk 21A cabin altimeter indicates the cockpit pressure in terms of altitude.

Table 1 — Controls and Indicators

Item No	*Item*	*Markings*	*Remarks*
1	Cabin air switch	CABIN AIR	Up for on
2	Ram air selector	RAM AIR — OPEN/CLOSED	—
3	Cabin altimeter	—	—
4	Cockpit temperature controller	MANUAL/AUTO — COOL/FIXED/WARM	—
5	Pressurisation failure warning	CPR caption (SWP)	—



1—10 Fig 1 — Controls and Indicators — F Mk 3 and F Mk 6



1—10 Fig 2 — Controls and Indicators — T Mk 5

Temperature Controller

13. The temperature controller regulates the by-pass airflow to allow the adjustment of the temperature of pressurised air. The controller is divided into two sectors, AUTO (black) and MANUAL (red). In the AUTO sector the temperature control valve is operated by 115V, 3-phase AC from the Essential instrument busbar and it therefore takes standby inverter power after AC failure; in the manual sector the valve is operated by 28V DC.

14. When the temperature controller is in the AUTO sector, the knob remains at the position selected and the cockpit temperature is automatically regulated by the temperature control valve. In the MANUAL sector, the control is self-centring to a FIXED position. The control is held against a spring to either WARM or COOL until the desired temperature is attained. In MANUAL the valve takes approximately 20 seconds to move from fully WARM to fully COOL (and vice versa) and a time delay of approximately one minute elapses before the full effect of a temperature change is felt.

Pressure Controller

15. A pressure controller on the forward pressure bulkhead automatically controls cockpit pressure by regulating the action of an air discharge valve. When the aircraft climbs through approximately 7500 feet the unit starts to control the discharge of air from the cockpit and, as altitude increases, the cockpit pressure in relation to ambient pressure builds up until the full differential of 4 PSI is reached at approximately 32,000 feet, above which altitude the differential remains constant.

16. Severe overpressurisation is normally prevented by relief valves, built into the discharge valve, which open if the cabin pressure/ambient pressure differential exceeds approximately 4·5 PSI. Aircraft operation is limited if differential pressure approaches or exceeds 6 PSI (para 24). Corresponding values of aircraft altitude and cabin altitude are as follows:

Aircraft Altitude (feet)	*Cabin Altitude (feet) at 4 PSI*	*Cabin Altitude (feet) at 6 PSI*
35,000	17,750	11,500
45,000	22,500	15,500
55,000	26,500	18,000

Note: The cabin altitude above 32,000 feet at 4 PSI differential is approximately half the aircraft altitude; at 6 PSI differential the cabin altitude is approximately one-third of the aircraft altitude.

Canopy Seal

17. When the canopy is closed, the final movement of either the internal or external canopy locking handle mechanically operates a pneumatic valve to allow air at a reduced pressure from the main 15th-stage air system to inflate the canopy seal. Similarly, the initial movement of either handle when unlocking, deflates the seal. If the canopy handle is not fully home after locking, the canopy seal may not inflate fully, causing loss of cockpit pressurisation.

18. In the canopy seal system there is an air storage bottle which is charged either from the main air system or from a ground charging point. The storage bottle holds sufficient air to inflate the seal several times and it also compensates for slight leakages in the system.

Pressure Failure Warning

19. A serious failure of cockpit pressurisation is indicated by the CPR caption on the SWP.

MANAGEMENT OF THE SYSTEM

Cabin Pressurisation and Temperature Control

20. Set the CABIN AIR switch to on (up) before engine start, using the starter bar. The switch is normally left in this position for the duration of the flight.

21. Before take-off ensure that the RAM AIR valve is CLOSED and the canopy seal is inflated.

22. Set the temperature controller into the AUTO sector as required. Although automatically controlled, variations in the selected temperature can be expected with large changes of speed or altitude. If a new temperature datum is selected, there is a delay of approximately one minute before it is attained.

23. The MANUAL sector of the temperature controller is not normally used. However, if the AUTO facility fails, move the control to the MANUAL sector, hold it momentarily to COOL or WARM as desired and then release it to the FIXED position. Again there is a delay of approximately one minute between selecting and experiencing a new temperature.

MALFUNCTIONS OF THE SYSTEM

Overpressurisation

24. If the cabin altimeter indicates that the differential pressure is between 4 and 6 PSI, restrict speed to a maximum of 500 knots/1·3M. If the differential is greater than 6 PSI, restrict speed to 500 knots/1·3M and land as soon as practicable.

Pressurisation Failure

25. *Indications.* Pressurisation failure is indicated by the CPR caption on the SWP accompanied by the attention-getters; the failure is confirmed by the cabin altimeter indication.

26. *Actions.* If the failure occurs at high altitude, make an immediate descent to 40,000 feet cabin altitude having set the oxygen mask toggle down. Set the oxygen regulator to 100% and EMERGENCY, and the DEMIST lever to ALL ON (OPEN, T Mk 5). To avoid decompression sickness continue the descent to below 25,000 feet cabin altitude and fly as low as practicable. Use ram air ventilation as necessary.

Temperature Control Failure

27. If overheating or overcooling occurs, select the temperature controller to MANUAL and hold at COOL or WARM, as appropriate, for 10 to 15 seconds. If the temperature responds, leave the controller in the FIXED position but make manual adjustments as necessary. If the overheating or overcooling persists, select the CABIN AIR switch off (down) and proceed as for a pressurisation failure.

Smoke in Cockpit

28. If smoke enters the cockpit through the diffusers, select the CABIN AIR switch off until the smoke disappears. If the smoke is coming from any other source, select the RAM AIR valve OPEN. Select 100% and EMERGENCY on the oxygen regulator while the smoke persists. In both cases cockpit pressurisation is lost; take pressurisation failure actions.

Emergency Decompression

29. If it is necessary to depressurise the cockpit, set the CABIN AIR switch to off (down) and set the RAM AIR valve OPEN.

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PART 1

CHAPTER 11—WINDSCREEN DEMISTING AND RAIN DISPERSAL

Contents

CONTROLS AND INDICATORS

1. The controls and indicators for the windscreen demisting and rain removal systems are listed in Table 1 for the F Mk 3 and F Mk 6 and in Table 2 for the T Mk 5.

Table 1 — Controls and Indicators — F Mk 3 and F Mk 6

Item	*Location*	*Markings*	*Remarks*
Front windscreen heating switch	Starter panel	W/SCR FRONT	—
Left quarter panel heating switch	Starter panel	W/SCR SIDE	Also controls canopy interspace demisting
Demist control handle	Left cockpit wall	DEMIST — ALL ON/ TOP ON/OFF	—
Rain dispersal control switch	Left console	DE-ICE/OFF/ RAIN DISPL	De-ice function explained in Chapter 3
De-ice/rain dispersal MI	Left console	R/off (black)/I	—

Table 2 — Controls and Indicators — T Mk 5

Item	*Location*	*Markings*	*Remarks*
Left windscreen heating switch	Starter panel	WSCREEN PORT — ON	—
Right windscreen heating switch	Starter panel	WSCREEN STARBOARD — ON	—
Left quarter panel heating switch	Starter panel	WSCREEN SIDE — ON	Also controls canopy interspace demisting
Demist control handle	Left cockpit wall	DEMISTER — OFF/ BLEED/ON	—
Rain dispersal control switch	Panel A2	ANTI-ICING/OFF/ RAIN DISPL	Anti-icing function explained in Chapter 3
Anti-ice/rain dispersal MI	Panel A2	R/off (black)/I	—

WINDSCREEN DEMISTING

DESCRIPTION OF THE SYSTEM

Windscreen Heating

2. In the F Mk 3 and F Mk 6, the windscreen and left quarter are electrically heated. Similarly, the two windscreen panels and the left quarter panel are electrically heated in the T Mk 5.

3. The system keeps the windscreen(s) and quarter panel free from mist and icing. The laminated panels incorporate heating, control and overheat elements which are supplied from the 200V AC busbar and controlled by 28V DC current. The system is brought into operation by two switches in the F Mk 3 and F Mk 6, or by three switches in the T Mk 5.

4. *Front Windscreen(s)*. For the heating elements to the front windscreen(s) to be energised, the W/SCR FRONT (F Mk 3 and F Mk 6) switch or the WSCREEN PORT and WSCREEN STARBOARD (T Mk 5) switches are moved up (ON, T Mk 5). With the undercarriage lever selected DOWN, only half power is applied; when UP is selected, full power is fed to the elements.

5. *Quarter Panel Heating*. The left quarter panel heating is brought into operation by the W/SCR SIDE (WSCREEN SIDE, T Mk 5) switch. The heating is automatically controlled by a temperature control unit.

Hot Air Demisting

6. The left and right quarter panels and the canopy top panel are fitted with hot air sprays in the F Mk 3 and F Mk 6. In the T Mk 5, hot air sprays are fitted to the left and right quarter panels only. Hot air from the main air system is fed to the sprays via a manually-operated valve.

7. The control lever has three positions. In the T Mk 5 the quarter panels receive a full flow of hot air when ON is selected and a metered supply when at BLEED. In the F Mk 3 and F Mk 6, the ALL ON position provides a full flow to the quarter panels and canopy; TOP ON gives full flow to the canopy and a partial flow to the quarter panels. In all marks, when OFF is selected, the heating supply is shut off.

Canopy Interspace Demisting

8. Air in the canopy interspace is circulated by a AC-powered blower motor which is controlled by the W/SCR switch in the F Mk 3 and F Mk 6, and by the WSCREEN SIDE switch in the T Mk 5. The air is dried by passing it through chemical air driers.

MANAGEMENT OF THE SYSTEM

Normal Operation

9. Providing the windscreen heater switches are on, the front windscreen and quarter panel heating, and the canopy interspace demisting are all automatic, full power being applied to the windscreen(s) when the undercarriage lever is UP. Hot air demisting is not normally used unless the electrical heating proves inadequate or AC failure has occurred.

RAIN DISPERSAL SYSTEM

DESCRIPTION OF THE SYSTEM

General

10. The rain dispersal system clears rain from the front windscreen in the F Mk 3 and F Mk 6, and from

the left front windscreen in the T Mk 5. A centre strip of the whole windscreen is cleared in light rain; in heavy rain the lower part of the centre strip is completely cleared but the upper part may only be partially cleared. The limitations on the use of the system are given in Part 2, Chapter 1.

11. Air from the main air system is directed to a nozzle assembly located in the fuselage skin forward of the windscreen. The assembly has two nozzles angled away from the windscreen and a wiper nozzle directed to the base of the windscreen. The efflux from the angled nozzles creates high turbulence in the airflow to break up large rain droplets, while the jet of hot air from the wiper nozzle keeps an area of the windscreen free from moisture.

Control

12. The system is controlled by the DE-ICE/OFF/RAINDISPL switch (ANTI-ICING/OFF/RAIN DISPL switch, T Mk 5) and by two pressure-operated switches which automatically limit operation to below 10,000 feet and less than 350 knots. A magnetic indicator shows white/R when RAIN DISPL is selected and black when the system is off. Because the anti-ice and rain dispersal systems are controlled by the same three-position switch, it is not possible to have both systems operating at the same time. The engine anti-icing system is explained in Chapter 3.

MANAGEMENT OF THE SYSTEM

Before Flight

13. Check the rain dispersal system before each flight as part of the **After Starting Checks,** thus reducing the possibility of valve seizure owing to corrosion. The system may be used for take-off.

In Flight

14. With two engines running, RAIN DISPL may be selected on at any stage of the approach and left on for an unlimited number of normal overshoots. If the system is used during a single-engine approach, overshoot and landing, report the fact after landing.

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PART 1

CHAPTER 12—PILOT EQUIPMENT AND ASSOCIATED SYSTEMS

Contents

EJECTION SEAT

ANTI-g AND AVS SYSTEMS

continued

Contents — *continued*

OXYGEN SYSTEM—F Mk 3 AND F Mk 6

OXYGEN SYSTEM—T Mk 5

Illustrations **Fig**

EJECTION SEAT

CONTROLS AND INDICATORS

WARNING: The aircraft assisted escape system is a potential source of danger and inadvertent operation can cause fatal injuries. On completion of a landing and before departing from the aircraft, the pilot is to ensure that the ejection seat (and the canopy in the T Mk 5) is left in the 'Safe for Parking' condition, that is, safety pins fitted to the face-screen firing handle, to the seat pan firing handle and, in the case of the T Mk 5, to the canopy sear.

1. The features of the Type 4BSB Mk 2 and Type 4BSC Mk 2 ejection seats are shown in Fig 1 and Fig 2.

DESCRIPTION OF THE SYSTEM

General

2. In the F Mk 3 and F Mk 6, a Type 4BSC Mk 2 ejection seat is fitted. In the T Mk 5, two Type 4BSB Mk 2 ejection seats are fitted. The associated parachute assembly is a Back Type Mk 45 which embodies a horseshoe parachute pack and a combined parachute

and safety harness fastened by a quick-release fitting (QRF), the pack being held in position by two restraining straps at the upper end. A back pad and lumbar cushion are included in the harness for comfort and support. A Type V personal survival pack (PSP), complete with cushion and containing a liferaft and survival equipment, is housed in the seat pan. Two leg restraint cords are fitted to the front of the seat pan. Emergency oxygen is provided. A guillotine unit is incorporated to assist in manual separation.

3. A pack restraint spreader system is incorporated. This consists of two arms mounted just beneath the parachute support arch which swivel forward giving quicker release of the parachute pack restraining straps during separation after ejection.

4. At the rear of the seat is an 80 ft/sec ejection gun. The seat has two firing handles, both of which are provided with safety pins. One, which has an integral face screen, projects from the front of the drogue container; the other is positioned centrally on the front of the seat pan.

5. A drogue gun is mounted on the left seat beam. For high speed ejections below 10,000 feet a g-switch control is fitted. This delays operation of the barostatic time release mechanism until the forward speed of the seat and pilot has been sufficiently reduced to ensure a safe parachute deployment. The seat has a ground-level ejection capability provided the aircraft's flight path is parallel to the ground with a minimum forward speed of 90 knots.

Seat Height Adjustment

6. The seat height is adjusted by an electric motor. In the F Mk 3 and F Mk 6, the motor is operated by a switch on the left console marked SEAT—UP/off/DOWN. In the T Mk 5, the seat height is adjusted appropriately by a SEAT — RAISE / off / LOWER switch under the left and right instrument panel shroud. The switches are spring-loaded to off.

7. The seat pan moves relative to the headrest to accommodate different body lengths and to ensure the pilot's head is correctly located.

Inertia-Reel Harness

8. An inertia-reel, go-forward, shoulder harness system is fitted. It is controlled by a 3-position spring-loaded lever on the left side of the seat pan. When the lever is moved fully forward and then allowed to return to the central position under the action of the spring, the occupant may move forwards or backwards at will. An automatic inertia device locks the harness during an ejection or if more than 2·5g in the forward plane is experienced. Moving the lever to the rear position brings into action the snubbing unit in the top harness lock, thus preventing further forward movement. As the wearer leans back the harness is locked in the rearward position.

Quick Release Fitting (QRF)

9. The QRF, when fastened, secures the combined restraint and parachute harness and therefore secures the pilot to the seat in flight and to the parachute after ejection. *On no account is the QRF to be operated when carrying out a manual separation since its operation frees the pilot from both seat and parachute.*

Personal Equipment Connector (PEC)

10. A PEC on the right side of the seat pan enables main oxygen, emergency oxygen, mic-tel, the air ventilated suit and the anti-g system to be connected or disconnected in one action. It consists of three components: a seat portion which is fitted permanently to the right side of the seat pan, a man portion which is attached to the flying clothing, and an aircraft portion which disconnects automatically on ejection. The man portion is separated from the seat portion when the harness release mechanism operates.

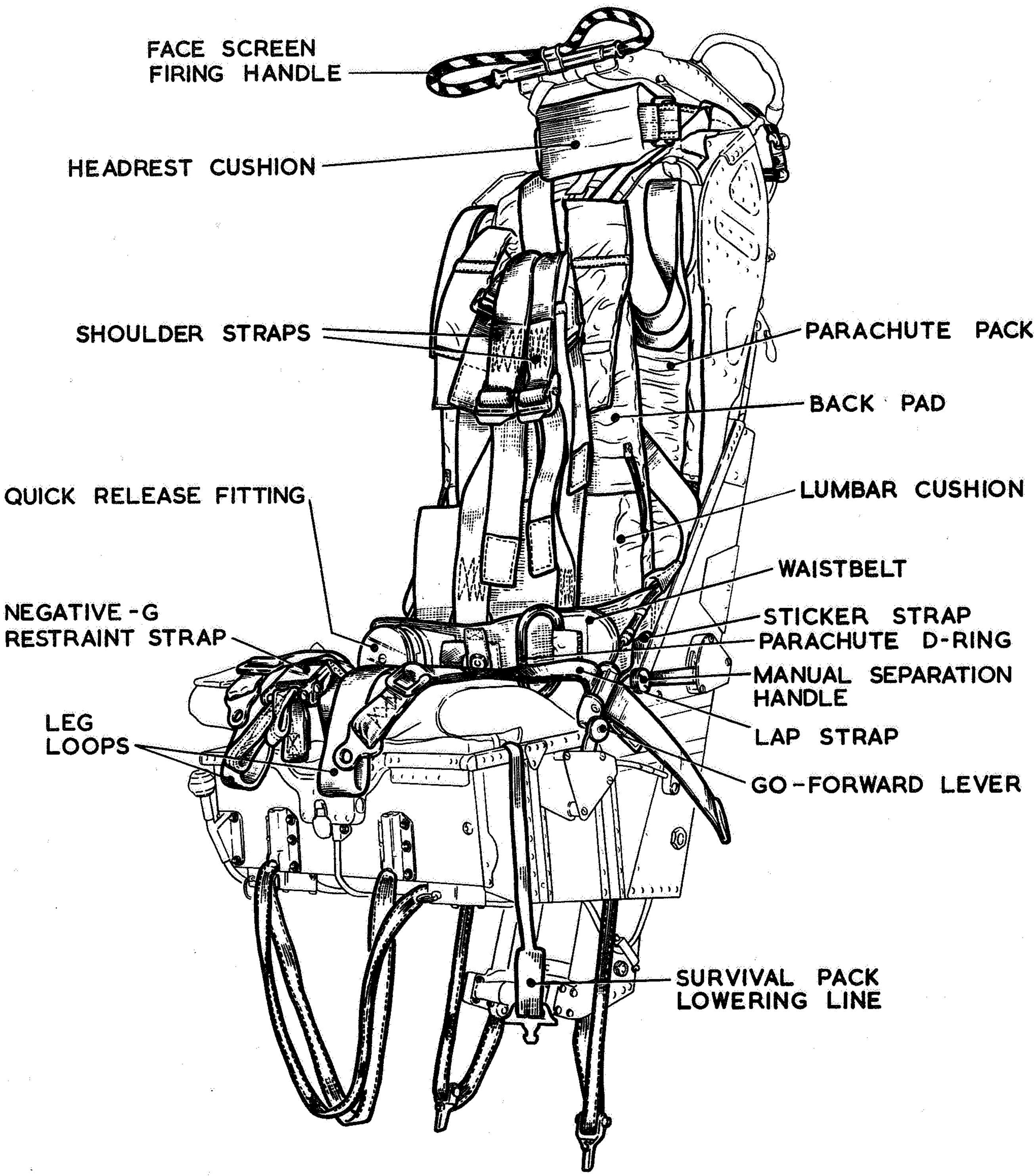
Leg Restraint System

11. The two leg restraint cords ensure that the pilot's legs are drawn back automatically and restrained close to the seat pan during ejection to prevent injury to the legs by flailing. The cords are connected to the aircraft structure at their lower ends by a shear rivet, and pass through snubbing units beneath the front of the seat pan, which allows the cords to pass freely down through the units but prevents them passing upwards. An adjusting ring on each snubbing unit, when pulled forwards, allows the pilot to adjust the cords to give sufficient leg movement for the application of full rudder. The upper ends of the cords are passed through the leg-restraint garter D-rings and plugged into units on the forward face of the seat pan.

12. During ejection the cords operate to restrain the legs until drawn tight, when the shear rivets allow the cords to separate from the aircraft structure. The legs are held in position until automatic or manual separation occurs, the cords then being free to pull through the garter D-rings.

Ripcord D-Ring

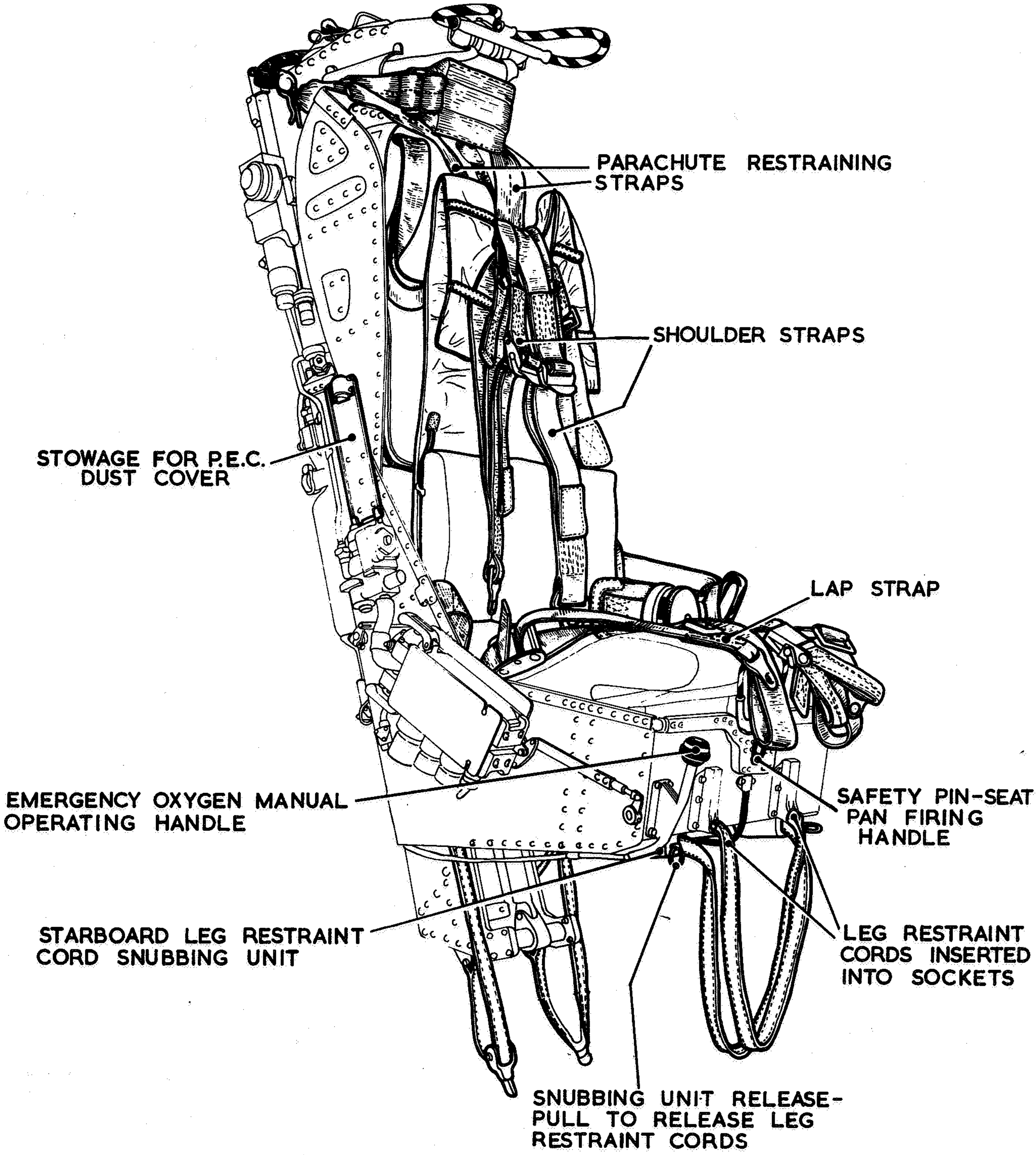
13. The ripcord D-ring, on the left lap strap, is provided for manual operation of the parachute after a manual separation or manual bale-out.



1—12 Fig 1 — 4BSB and 4BSC Mk 2 Ejection Seats—Left Side

Ejection Sequence

14. When either firing handle is pulled, the canopy immediately jettisons, thus removing an attached interdictor from the time-delay firing unit. Continued force on the firing handle is necessary, however, to remove the sear on the time-delay firing unit and start the ejection. The 'double pull' effect is unlikely to be noticed if the system operates normally. The main purpose of the interdictor system is to ensure that the seat is not in a 'live but unfired' condition if the canopy



1—12 Fig 2 — Type 4BSB and 4BSC Mk 2 Ejection Seats—Right Side

fails to jettison: the seat cannot eject while the canopy is on.

15. After the canopy has removed the interdictor a delay of 0·6 seconds occurs before the seat is fired. As the seat rises the drogue gun sear and the barostatic time-release mechanism sear are withdrawn by static rods. The aircraft portion of the PEC is disconnected, emergency oxygen is supplied to the pilot, and the IFF/SSR transponder replies with emergency codes

provided it has warmed up (see Chapter 13). The legs are restrained by the leg restraint cords.

16. The drogue gun fires 0·5 seconds after the withdrawal of its sear and the stabilising drogues are deployed. Removal of the sear from the barostatic time-release mechanism puts it into an 'armed' condition. When the seat has descended to 10,000 feet (or 5000 metres, depending on the modification state) the barostatic time-release mechanism operates to release the combined harness from the seat, to separate the man portion of the PEC and to free the leg restraint cords. The drogues are also released from the seat to allow them to deploy the main parachute. The pilot may momentarily be prevented from leaving the seat by two sticker straps until deployment of the parachute lifts him clear.

17. If ejection takes place below 10,000 feet (or 5000 metres) the barostatic time-release mechanism operates after a 1·25 second delay. However, a g-stop mechanism prevents the start of the 1·25 second sequence until the forward speed has been sufficiently reduced to permit the main parachute to be deployed without the danger of its bursting.

Manual Separation

18. A manual separation lever is on the left side of the seat pan. When pulled out of its gate and upwards, the combined harness is released from the seat, the parachute restraining straps are freed, the man portion of the PEC separates, and the leg restraint cords are released. As the occupant moves forward in the seat the guillotine operates. When clear of the seat it is necessary to pull the parachute ripcord D-ring to deploy the parachute.

19. The guillotine unit fires as a result of forward movement of the parachute pack during manual separation, to sever the parachute withdrawal line, thus making the final separation of the pilot and his parachute from the seat. The unit, positioned on the left side of the drogue container, has a sear safety pin for use during servicing.

NORMAL USE OR MANAGEMENT

Pre-Flight Checks

20. Carry out the **Aircraft Safe For Parking** and **Ejection Seat Checks** given in FRC.

Strapping-In

21. When seated, strap in using the following procedures:

a. Remove the dust cover from the seat portion of the PEC and fit into the stowage on the right-hand side of the seat pan. Connect the man portion to the seat portion, ensuring it is locked.

b. Connect the survival pack lanyard to life preserver or pressure jerkin ensuring that it passes outside the left leg.

c. Pass the left-hand leg restraint cord through the right leg garter D-ring and plug into the socket above left-hand snubbing unit. Pass the right-hand leg restraint cord through the left leg garter D-ring and plug into the socket above the right-hand snubbing unit. It is not important which cord is secured first provided they are not interlaced. Pull sharply on each cord to ensure it is securely locked (the leg restraint cords cannot be secured unless the PEC is locked to the seat portion). If the cords are too short, pull the ring of each snubbing unit and ease the cord forward. Take up any slack by pulling the cords backwards through the snubbing units.

d. Pull up the parachute back pad and adjust the height of the lumbar cushion. Pass the looped ends of the blue 'Y' section of the negative-g strap over their respective lap strap lugs and connect the lugs to the harness QRF. Tighten the straps and tighten the adjustable part of the negative-g strap.

Note: The lap straps must be as tight as possible.

e. Pass the left leg loop upwards over the inside of the thigh and through the D-ring on the left strap (from the inside of the ring towards the outside of the leg). Bring the end of the leg loop over towards the QRF and pass the lug of the left shoulder strap through the leg loop (from the top downwards) and insert the lug into its appropriate slot in the QRF. Snug the loop over the lug. Repeat these operations with the right leg loop and shoulder strap.

f. Adjust the sitting height to the desired position.

g. Ensure the shoulder straps pass under the lobes of the life preserver or pressure jerkin stole. Tighten the inner (blue) straps and then the outer (khaki) straps.

Note: It is not desirable to tighten these straps excessively since this action may arch the back and lead to spinal injury if ejection becomes necessary. The inner straps should not press down unduly on the shoulders but equally there should be no slack. The outer straps should be adjusted similarly to provide a comfortable fit.

h. Operate the go-forward lever and lean forward. Move the lever fully back, lean fully back and re-tighten the khaki straps. Failure of the harness to re-engage and lock back indicates that the harness is not secure.

i. Don helmet and connect oxygen supply and mic-tel lead.

j. Check that the face screen firing handle is resting on top of the protective helmet. Check that the firing handle can be reached with both hands.

k. Have the face screen and seat pan firing handle safety pins removed and placed in their stowages.

Leaving the Aircraft After Landing

22. Proceed as follows to leave the aircraft:

a. Have the ejection seat made Safe for Parking.

b. Unlock the QRF, free the straps and return the QRF to the locked position.

c. Disconnect the man portion of the PEC and replace the dust cover.

d. Free the leg restraint cords from the garter D-rings.

e. Disconnect the PSP lanyard.

Abandoning the Aircraft in Flight

23. If a premeditated ejection is to be made, consider and plan for the area of parachute landing and aircraft impact, and complete as much of the following drill as time and conditions permit:

T Mk 5	...	Alert other crew member
Height	...	Below 40,000 feet (ideal height 9000 feet)
Speed	...	250 knots
IFF/SSR	...	EMGY
Harness	...	Tight and locked. Leg restraints, PSP and lanyard connected
Visor	...	Down
Trims	...	Pitch trim—level Roll trim—slight roll
Radio	...	Mayday call
Throttles	...	Idle/fast idle

EJECT (T Mk 5, pupil first)

24. The seat pan handle is the primary handle. Adopt the correct posture leaving the feet on the rudder pedals, grasp the firing handle and pull it to its full extent. This action jettisons the canopy and ejects the seat. When the parachute has developed and the seat has fallen away, release the PSP leaving the lowering line attached to the life preserver. If descending into water, inflate the life preserver. Once safely down, operate the QRF to free the occupant from the parachute. If in water, trace the PSP lowering line to the operating handle of the CO_2 cylinder, and pull the handle to inflate the liferaft.

Note: When the seat pan handle is used to operate the ejection system, release the handle before separation from the seat since the handle does not come free. If the face screen firing handle is used, the handle and screen fall free on separation.

MALFUNCTIONS OF THE SYSTEM

Failure to Eject

WARNING: If, in the event of a failure of the automatic ejection sequence, the canopy has to be jettisoned manually, either firing handle must be pulled again to eject the seat.

25. If the canopy fails to jettison on the automatic sequence, pull up the canopy unlock handle to remove the canopy, and then pull the firing handle again.

26. If the canopy has left the aircraft and the seat still fails to eject, operate the manual separation lever, push free of the seat and bale out. When clear of the aircraft, pull the parachute ripcord D-ring.

Failure of Auto-Separation

27. If the auto-separation fails, operate the manual separation lever, push free of the seat and then pull the parachute ripcord D-ring.

ANTI-g AND AVS SYSTEMS

CONTROLS AND INDICATORS

28. *F Mk 3 and F Mk 6.* In the single-seat aircraft, the anti-g stop valve and control lever unit is mounted on the inboard face of the right console; a spring-loaded catch retains the control lever in either the OFF (forward) or ON (aft) position. The barometric/anti-g valve, which incorporates a high (H) and low (L) gradient selector and test button, is situated aft of the anti-g stop valve. The AVS rotary control knob, which is turned counter-clockwise to OPEN, is positioned forward of the anti-g stop valve.

29. *T Mk 5.* In the T Mk 5, the instructor's anti-g and AVS controls are similar in position and operation to those in the F Mk 3 and F Mk 6. The pupil's anti-g stop valve is on the inboard face of the left console but the barometric/anti-g valve, incorporating the gradient and test functions, and the AVS rotary control knob are between the seats.

DESCRIPTION OF THE SYSTEMS

General

30. Both the anti-g and AVS systems take partially-cooled air drawn from a tapping in the refrigeration unit of the cabin pressurisation and air conditioning system. Therefore, neither system operates unless the CABIN AIR switch is on and an engine is running, although air can be fed to the systems from a break-away ground cooling connection in the fuselage skin for the AVS when the aircraft is on the ground.

31. The common, partially-refrigerated air supply passes through a heat exchanger, a water trap and a non-return valve before dividing into the separate anti-g and AVS systems. The heat exchanger adjusts the temperature of the air depending on the setting of the cockpit temperature controller. Eventually, air from the two systems is fed to the pilot's clothing through PEC connections.

Note: In the T Mk 5, the pupil's and instructor's systems are entirely separate after the original tapping from the refrigeration unit.

Anti-g System

32. With CABIN AIR selected on, the engines running and the anti-g stop valve selected ON, the barometric/anti-g valve automatically provides protection to the lower abdomen and legs under positive g and after cabin depressurisation at high altitude.

33. *Positive-g Protection.* Under positive g the barometric/anti-g valve applies pressurised air to the anti-g suit proportional to the g force experienced. With the gradient selector set to H, pressure is supplied at 1·25 PSI/g when more than +1·9g is experienced. When set to L, pressure is applied at 1·05 PSI/g when more than +2·25g is pulled.

34. *Depressurisation Protection.* If loss of cabin pressure occurs at altitudes above 35,000 feet, the barometric/anti-g valve applies pressure to the g-suit at a value approximately 0·5 PSI greater than the oxygen system applies pressure to the lungs.

35. *Test Button.* With the system selected ON and an engine running, the system is checked by pressing the test button on the barometric/anti-g valve, thus inflating the g-suit. The suit deflates when the button is released.

36. *Not used.*

AVS System

37. With CABIN AIR selected on, the engines running and the AVS rotary control knob turned to OPEN, air is supplied to the AVS via a pressure control valve which functions to maintain the air at 4·5 to 6·5 PSI above the prevailing cockpit pressure at any cabin altitude. A relief valve, set at 11·0 to 11·5 PSI, is incorporated. The temperature of the air is controlled by the cockpit temperature controller.

MANAGEMENT OF THE SYSTEMS

Anti-g System

38. Before flight, ensure that the anti-g stop valve control is to ON. The OFF position is for emergency use only and ON is normally selected at all times. If the control is left at OFF, there is no protection for the lower part of the body after depressurisation nor during positive-g accelerations.

39. Set the gradient selector to H or L as desired. The setting is decided by individual requirements; it should not be necessary to change the setting in the air.

40. When the engines are running, press the test button to check the operation of the system.

AVS System

41. Control the quantity of the air supplied to the AVS by adjusting the position of the rotary control knob. Adjust the temperature of the air by use of the cockpit temperature controller.

MALFUNCTION OF THE SYSTEMS

Anti-g System

42. In the event of failure of the barometric/anti-g valve giving an abnormal build-up in pressure in the anti-g suit, select the stop valve to OFF to deflate the suit. No further lower body protection is then available.

AVS System

43. If the temperature of the air to the AVS becomes uncontrollable because of a temperature control runaway in the pressurisation and air conditioning system, turn off the AVS rotary control knob to cut off the supply of air.

OXYGEN SYSTEM—F MK 3 AND F MK 6

CONTROLS AND INDICATORS

44. The controls and indicators of the main and emergency oxygen systems in the F Mk 3 and F Mk 6 consist of a Mk 17F regulator and an oxygen contents gauge on the right console, and the emergency oxygen knob, striped yellow and black, on the right front of the seat pan of the ejection seat. There is an oxygen flow MI at top left on the instrument coaming to repeat the flow indication on the regulator. There is an OXY warning caption on the SWP.

DESCRIPTION OF THE SYSTEM

General

45. The main oxygen system consists of a 3·5 litre liquid oxygen container and associated evaporator and stabilising system, housed in the equipment bay, and a Mk 17F pressure demand regulator. Gaseous oxygen is fed to the pilot via the regulator and the PEC. A type P or Q oxygen mask is used.

46. The system provides normal protection against hypoxia at cabin altitudes up to 42,000 feet and affords

the pilot 'get down' protection from a maximum cabin altitude of 50,000 feet without the aid of pressure garments. At cabin altitudes below approximately 11,000 feet, oxygen is delivered at cabin pressure; above this altitude and up to 40,000 feet, oxygen is delivered at a slight safety pressure to ensure that any mask leakage is outward. Between 40,000 and 50,000 feet, after depressurisation, pressure oxygen is delivered to maintain an adequate level of oxygen in the lungs to enable a safe descent to be made to a more normal environment.

Mk 17F Regulator

47. The Mk 17F pressure demand regulator has the following controls and indicators:

a. *ON/OFF Cock.* An OXYGEN SUPPLY—ON/OFF cock, wired to ON, controls the flow of oxygen entering the regulator.

b. *Pressure Gauge.* A pressure gauge, in the centre of the regulator panel, indicates the input pressure to the regulator. When the OXYGEN SUPPLY cock is ON, the gauge normally indicates 150 to 215 PSI but may increase to 270 PSI following a high demand.

c. *Flow Indication.* The OXYGEN FLOW INDICATOR is an MI which shows a white vertical bar when oxygen is being drawn from the regulator on breathing in, and black when no flow is taken on breathing out or if there is no electrical supply to the regulator. A repeater MI, marked OXY FLOW, is positioned on the upper left coaming.

d. *Air Mix.* The NORMAL OXYGEN/100% OXYGEN switch, in the NORMAL position, conserves oxygen at low cabin altitudes by mixing air and oxygen in appropriate quantities, but makes recognition of low oxygen delivery difficult. With the switch at 100% OXYGEN, neat oxygen is delivered to the mask. Above a cabin altitude of 32,000 feet, 100% oxygen is supplied irrespective of the switch position.

e. *Test Button.* A button marked EMERGENCY—PRESS TO TEST MASK is used to test delivery pressures to the mask. Moving the button to the left or right delivers oxygen at approximately safety pressure up to 11,000 feet cabin altitude and at double safety pressure above this height. Pressing the button down allows a pressure test of the oxygen mask (with the mask toggle down).

Contents Indication

48. Liquid oxygen (LOX) is stored within the inner shell of a double-walled container. The inner shell and a perforated gauging shell form the two plates of a variable capacitor in a capacitance bridge to measure the level of LOX. The capacitance is converted by a gauge control unit to give a reading on the contents gauge.

49. The contents gauge is calibrated in fractions of tank capacity from 0 (zero) to F (full). The dial has two sectors which are failure arcs. When energised, the pointer reads between 0 and F depending on the contents. If the pointer remains in the red arc below 0, a power failure is indicated; if the pointer moves towards or into the arc above F, a capacitance gauging failure has occurred.

OXY Caption

50. The OXY caption on the SWP is triggered by a low pressure switch in the oxygen delivery line to the regulator when the pressure drops below 125 to 128 PSI.

Oxygen Masks

51. The Mk 17F regulator is only to be used with a type P or Q oxygen mask; other types of mask are not compatible, even at low altitudes. The masks have a harness toggle system which, when moved down, tightens the mask-to-face fit to allow pressure breathing without leaks round the sides of the masks.

Limitations

52. The protection afforded by the Mk 17F regulator and P or Q mask is subject to a limitation of 50,000 feet, provided descent is initiated within 30 seconds of depressurisation and a cabin altitude of 40,000 feet is attained within two minutes.

Note: If the canopy is lost, aerodynamic suck causes the cabin altitude to exceed aircraft altitude by up to 8000 feet.

Power Supplies

53. The two MI and the contents gauge are powered by the main 28V DC busbar.

Emergency Oxygen

54. The emergency oxygen system has a gaseous oxygen storage bottle fitted to the back of the ejection seat which feeds its supply through an emergency oxygen demand regulator to the rear of the seat portion of the PEC and thence into the oxygen mask tube. Emergency oxygen is selected manually by pulling the emergency oxygen knob, or automatically on ejection as the seat rides up the rails. When the pilot separates from the seat after ejection, the separation of the man

and seat portions of the PEC breaks the emergency oxygen supply and allows air to be breathed at ambient pressure.

55. The emergency oxygen demand regulator controls and regulates the delivery of oxygen to the pilot according to altitude. A pressure/contents gauge is fitted to the right rear of the ejection seat; the reading on the gauge should be in the white sector before flight.

MANAGEMENT OF THE SYSTEM

General

56. During the **Ejection Seat Checks** ensure that the emergency oxygen contents gauge pointer is in the white sector. Check that the OXYGEN SUPPLY cock is wired to ON.

Pre-Flight Checks

Note: Comprehensive checks of all personal equipment should be carried out on a Godfrey Test Cabinet with the assistance of a safety equipment worker, prior to flight. The following checks verify the serviceability of the aircraft equipment.

57. During the **Internal Checks:**

a. Check that the contents gauge shows sufficient oxygen is available.

b. Check that the OXYGEN SUPPLY cock is ON and wired.

c. Check that the pressure gauge indicates between 150 and 215 PSI.

d. Set the air mix control to NORMAL.

e. Check that the oxygen flow indicator and the OXY FLOW MI both annunciate during breathing.

f. Deflect the EMERGENCY—PRESS TO TEST MASK button sideways (left or right) and check that increased safety pressure is felt. Check the flow indicators show black when the breath is held. Move the mask harness toggle down and press the button: oxygen is fed to the mask under pressure; hold the breath and again check that the flow indicators show black. Return both mask toggle and button to their normal positions.

MALFUNCTIONS OF THE SYSTEM

58. The drills for pressurisation failure, toxic fumes in the cockpit, suspected hypoxia and oxygen equipment malfunctions are given in the FRC.

OXYGEN SYSTEM—T MK 5

CONTROLS AND INDICATORS

59. The controls and indicators for the oxygen system in the T Mk 5 are listed in Table 1. A schematic diagram of the T Mk 5 oxygen system is at Fig 3.

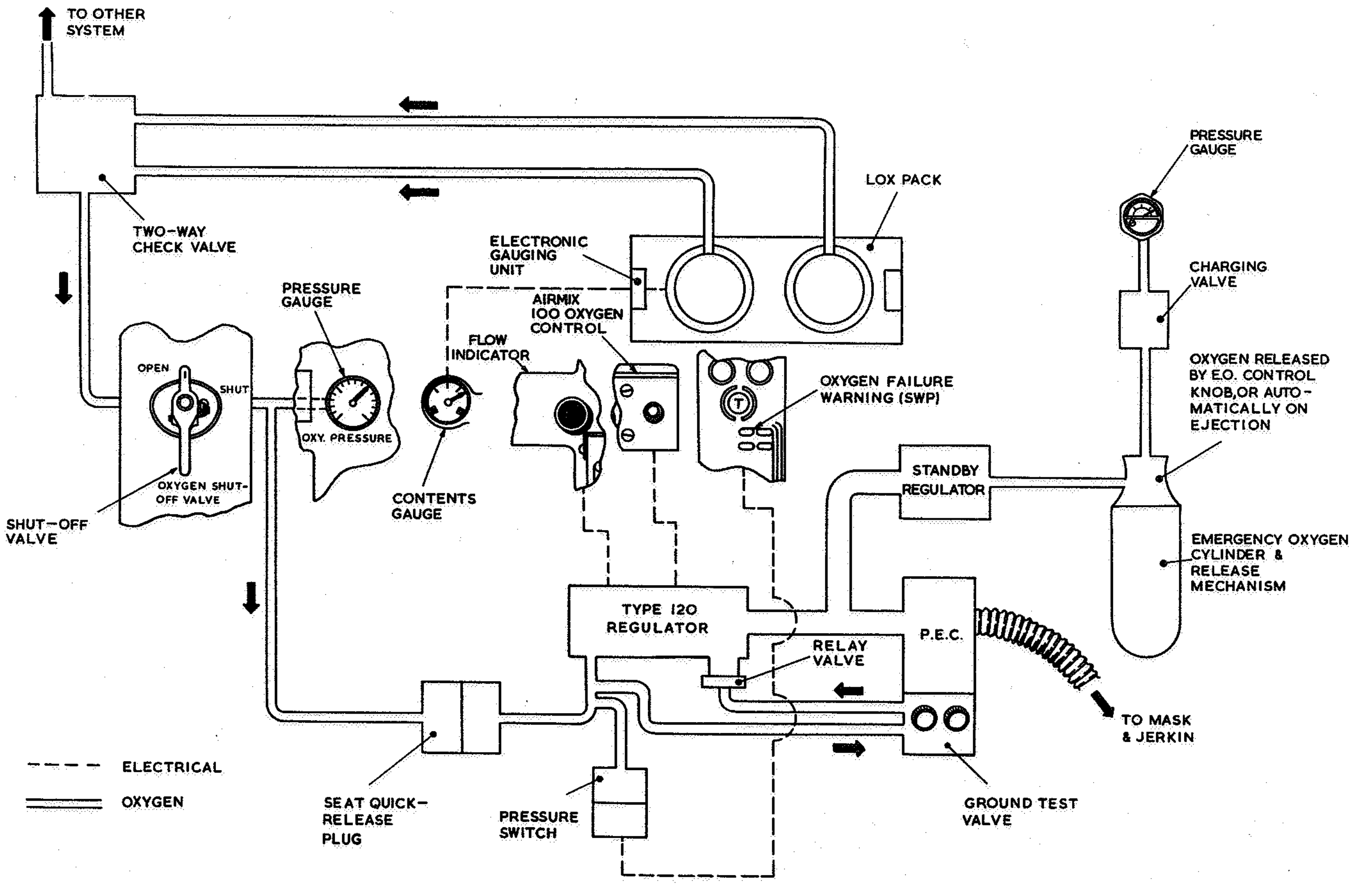
DESCRIPTION OF THE SYSTEM

General

60. In the T Mk 5 there are two separate main oxygen systems and two emergency oxygen systems. In the main systems, two 3·5 litre liquid oxygen (LOX) containers and their associated evaporators and stabilising systems are housed in the main equipment bay behind the cockpit aft pressure bulkhead. Gaseous oxygen is fed to the cockpit through the bulkhead to

Table 1—Controls and Indicators

Item	*Location*	*Markings*	*Remarks*
Contents gauges (2)	Panel A5		—
Shut-off valves (2)	a. Panel A2 extension b. Panel A6	OXYGEN SHUT OFF VALVE—OPEN/SHUT	—
Pressure gauges (2)	Panel A1	OXY PRESSURE	—
Flow indicators (2)	a. Panel A1 left b. Panel A1 right	OXY FLOW	—
Warning captions (2)	SWP	OXY 1/OXY 2	—
Airmix controls (2)	a. Left shroud b. Right shroud	PULL OXYGEN 100% AIRMIX PUSH	Integral light
Emergency oxygen knobs (2)	Right front of each seat pan	—	Black and yellow striped
Test buttons (2 for each)	Front of each PEC	—	One button guarded



1—12 Fig 3 — Oxygen System Schematic—T Mk 5

two Type 120 regulators mounted on the right side of each ejection seat whence oxygen is fed to the pilots via their PEC. A type P or Q mask is used.

61. Each main oxygen system provides normal protection against hypoxia at cabin altitudes up to 40,000 feet and affords pilots 'get down' protection from a maximum altitude of 43,000 feet without the aid of a pressure jerkin. At cabin altitudes below approximately 14,000 feet, oxygen is delivered at cabin pressure; above that altitude and up to 40,000 feet, oxygen is delivered at a slight safety pressure to ensure any mask leakage is outward. Between 40,000 feet and the limiting altitude without a pressure jerkin of 43,000 feet, oxygen is delivered under pressure to maintain an adequate level of oxygen in the lungs to enable a safe descent to be made to a more normal environment.

Two-Way Valve

62. The supply to each main system to its associated regulator passes through a two-way check valve which links the two systems. In the event of one system failing, the valve operates automatically to supply both regulators from the serviceable system; it also prevents leakage from the serviceable to the failed system.

63. In some circumstances it is possible for both crew members to be supplied from one system until it is empty and then from the other system, or be

supplied from each system alternately rather than simultaneously. This may be caused either by pressure difference between the two systems greater than 10 PSI, or by a pressure drop in a system during manoeuvring flight if the system is not fully stabilised. In these conditions no action is necessary since the oxygen from both systems is available provided all other indications are normal.

Main Oxygen Equipment

64. The Type 120 pressure demand regulators and their associated cockpit equipment have the following controls and indicators:

a. *Shut-Off Valves.* Two isolating valves, one for each system, are controlled by two switches marked OXYGEN SHUT OFF VALVE; they are held in the OPEN position by spring-loaded safety flaps. Each control enables the supply to its associated regulator to be turned off when SHUT is selected. Thereafter only emergency oxygen is available to that crew position, the shut-off valve being downstream of the two-way valve. The controls are always set to SHUT on the ground unless DC power is available, otherwise leakage of oxygen under safety pressure occurs.

b. *Pressure Gauges.* In each system, a tapping downstream of the two-way valve and shut-off valve leads to an OXY PRESSURE gauge. When the OXYGEN SHUT OFF VALVE is OPEN, each gauge normally reads 60 to 100 PSI when static or 50 to 100 PSI when working; a gauge may read up to 115 PSI for a short period following a high demand.

c. *Flow Indications.* Two diaphragm-operated microswitches in the regulators control two remote OXY FLOW MI on the left and right side of panel A1 which correspond to the left and right seat systems. Each MI shows a white vertical bar when oxygen is being drawn from the regulator, and black when no flow is taken on breathing out. The MI also shows black after electrical power failure.

d. *Oxygen Warning Captions.* Another tapping between each shut-off valve and regulator serves a pressure-operated switch. The switch makes if supply pressure falls below approximately 50 PSI, bringing on the appropriate OXY 1 or OXY 2 caption on the SWP, the warnings corresponding to the left and right systems respectively.

e. *Air Mix.* Two air dilution controls, one each for each system, are both marked PULL OXYGEN 100%/AIRMIX PUSH. When pushed in to the AIRMIX position, oxygen is conserved at low cabin altitudes by mixing air and oxygen in appropriate quantities, but recognition of low oxygen delivery is difficult. With the switch pulled out to the OXYGEN 100% position, neat oxygen is delivered and an integral light in the control comes on. Above a cabin altitude of 34,000 feet or after an electrical failure, 100% oxygen is delivered irrespective of the position of this switch.

f. *Test Buttons.* A tapping from each main supply to the regulator is fed to a ground test valve, with two buttons, fitted at the forward end of each PEC. The unguarded button is used for normal mask leak testing; the guarded button was used for testing when a pressure jerkin was worn, both buttons being pressed for a jerkin test.

Contents Indications

65. The method used in each LOX system to determine oxygen contents is described in para 48. In the T Mk 5, two contents indicators on panel A5 are calibrated in fractions of tank capacity from 0 (zero) to F (full). The dial has two sectors which are failure arcs. When energised, the pointers read between 0 and F depending on the contents of each system. If a pointer moves towards or into the arc above F, a capacitance gauging failure has occurred; if a pointer remains in the red arc below 0, a power failure is indicated.

Oxygen Masks

66. The Type 120 regulator is only to be used with a P or Q mask; other types of mask are not compatible, even at low altitudes. The masks have a harness toggle system which, when moved down, tightens the mask-to-face fit to allow pressure breathing without leaks round the sides of the masks.

Limitations

67. The protection afforded by the Type 120 regulator and P or Q mask is subject to a limitation of 43,000 feet, provided descent is initiated within 30 seconds of depressurisation and a cabin altitude of 40,000 feet is attained within two minutes. At cabin altitudes above 43,000 feet the pressure delivered by the regulator is too great for the lungs without a pressure jerkin to compensate for the high pressure.

Note: If the canopy is lost, aerodynamic suck causes the cabin altitude to exceed aircraft altitude by up to 11,000 feet.

Power Supplies

68. The oxygen contents gauges, flow indications, failure captions and the airmix valves are all powered from the 28V DC busbar.

Emergency Oxygen

69. The two separate emergency oxygen systems in the T Mk 5 are each identical to that described for the F Mk 3 and F Mk 6 in para 54 and 55.

MANAGEMENT OF THE SYSTEM

Pre-Flight Checks

Note: Comprehensive checks of all personal equipment should be carried out on a Godfrey Test Cabinet with the assistance of a safety equipment worker prior to flight. The following checks verify the serviceability of the aircraft equipment.

70. During the **Ejection Seat Checks** ensure that the emergency oxygen contents gauge pointers are in the white sectors.

71. During the **Internal Checks:**

a. Check that the contents gauges show sufficient oxygen is available.

b. Select both OXYGEN SHUT OFF VALVE switches to OPEN and guarded, and check that the OXY 1 and OXY 2 captions go out.

c. Check the pressure gauges indicate between 60 and 100 PSI.

d. Set the airmix controls to the AIRMIX position (in) and check the integral lights are out.

e. Check that both OXY FLOW indicators annunciate during breathing.

f. Press the unguarded test button and check that an increase in safety pressure is felt in the mask. Check that the flow indications show black when the breath is held.

MALFUNCTIONS OF THE SYSTEM

72. The drills for pressurisation failure, toxic fumes in the cockpit, suspected hypoxia and oxygen equipment malfunctions are given in FRC.

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PART 1

CHAPTER 13—COMMUNICATIONS EQUIPMENT

Contents

CONTROLS AND INDICATORS

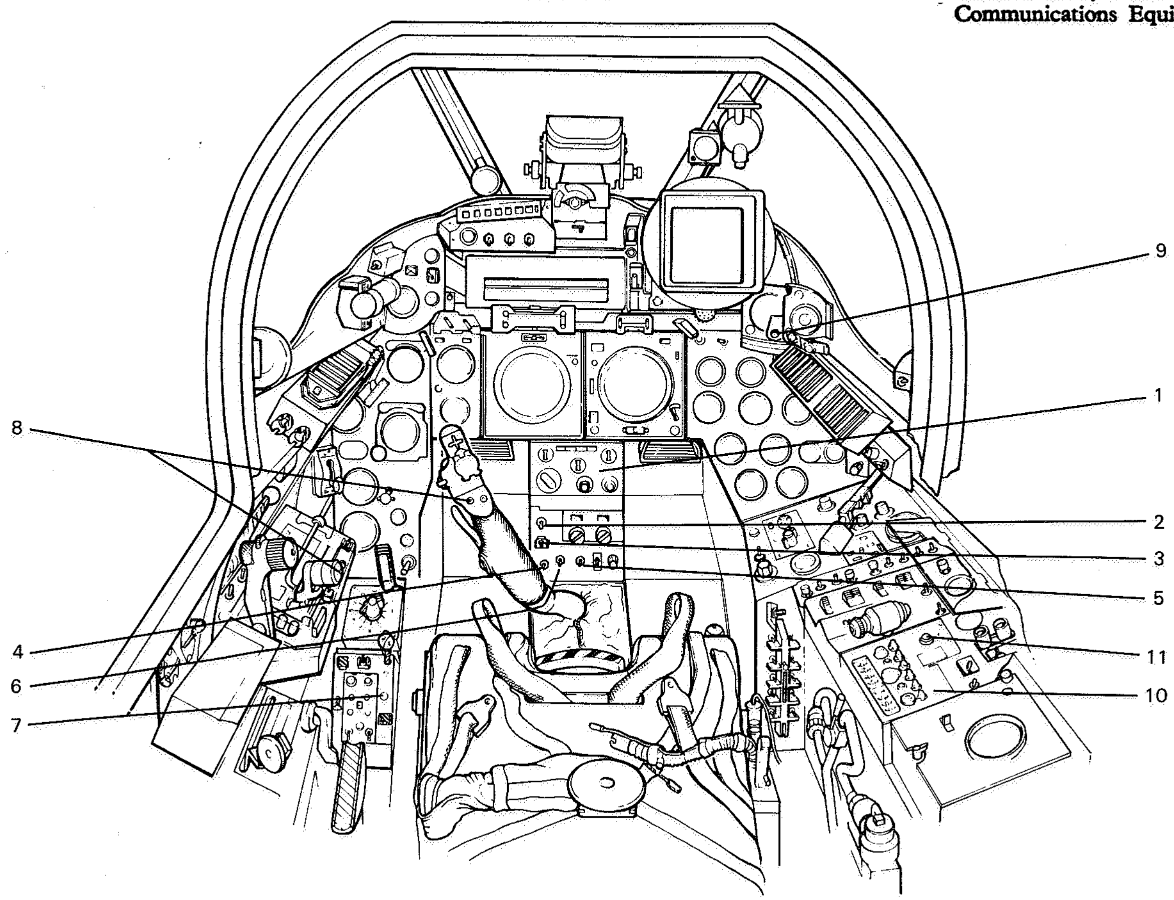
1. The controls and indicators of the communications equipment are listed in Table 1 and their locations shown in Fig 1 for the F Mk 3 and F Mk 6. For details of the T Mk 5, refer to Table 2 and Fig 2.

Table 1 — Controls and Indicators — F Mk 3 and F Mk 6

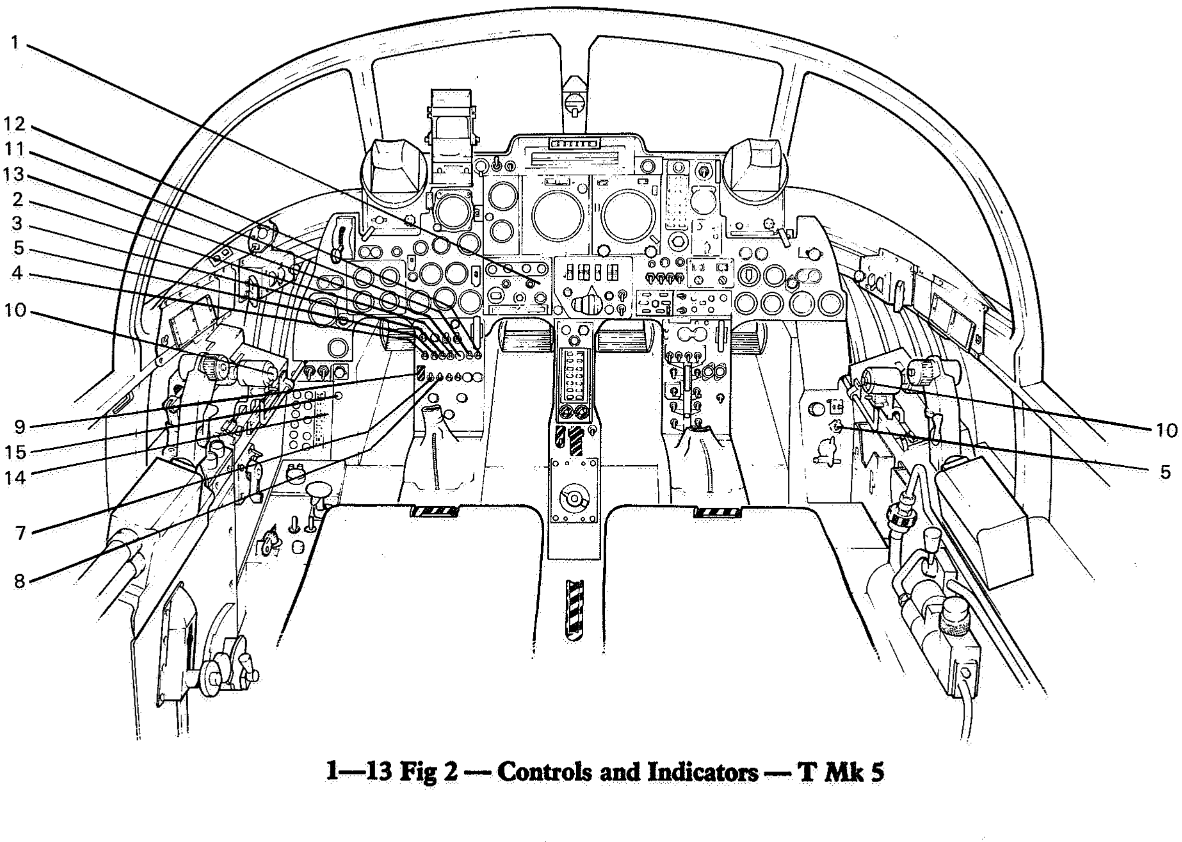
Item No	*Item*	*Markings*	*Remarks*
1	V/UHF control unit	See text	—
2	Normal/standby radio selector	UHF SET — NORMAL/STANDBY	—
3	Radio power selector switch	POWER — NORMAL/STANDBY	—
4	Aerial selector	AERIAL — UPPER/LOWER	—
5	Violet Picture/ILS selector	VP/ILS INDR	—
6	Violet Picture sensitivity switch	VP SENS — MAX/MIN	—
7	Standby radio channel selector	UHF STANDBY — GUARD/ CHANNEL A	—
8	Press-to-transmit switches (2)	—	—
9	Telebrief light/transmit button	TELEBRIEF	—
10	IFF/SSR control panel	See text	—
11	IFF fail light	IFF FAILURE	—

Table 2 — Controls and Indicators — T Mk 5

Item No	*Item*	*Markings*	*Remarks*
1	V/UHF control unit	See text	—
2	Normal/standby radio selector	UHF SET — NORMAL/STANDBY	—
3	Radio power selector switch	UHF POWER — NORMAL/STANDBY	—
4	Aerial selector	UHF AERIAL — UPPER/LOWER	—
5	UHF mute switches (2)	UHF — NORMAL/MUTE	Spring-loaded switches
6	UHF mute button (post-mod 4768)	—	On instructor's control column. Not illustrated
7	Violet Picture/ILS selector	ILS/VP IND	—
8	Violet Picture sensitivity switch	VP METER SENSITIVITY — MAX/MIN	—
9	Standby radio channel selector	UHF STBY — GUARD/ CHANNEL A	—
10	Press-to-transmit switches (4)	—	Those on control columns not illustrated
11	Intercom control switch	INTERCOM — ON/OFF	—
12	Emergency intercom switch	INTERCOM — NORMAL/EMERGY	—
13	Telebrief light/transmit button	TELEBRIEFING	—
14	IFF/SSR control panel	See text	—
15	IFF fail light	IFF FAILURE	—



1—13 Fig 1 — Controls and Indicators — F Mk 3 and F Mk 6



1—13 Fig 2 — Controls and Indicators — T Mk 5

VHF/UHF RADIO

DESCRIPTION OF THE SYSTEM

General

2. The main VHF/UHF radio provides air-to-air and air-to-ground voice communication. There is a standby UHF radio with two channels for use if the main radio fails.

3. The transmitter/receiver is located in the fuselage spine. There are two main aerials, one in the fin (UPPER) and the other below the nose (LOWER). Two UHF homing aerials are situated on the top of the fuselage behind the cockpit.

4. The main radio V/UHF control unit controls the operation of 18 pre-set channels plus a guard channel, and the manual selection of VHF frequencies between 117·5 and 135·95 MHz (at 50 kHz intervals) and UHF frequencies between 225·0 and 339·95 MHz (also at 50 kHz intervals). The standby radio has two channels which are normally set to 243·0 and 243·8 MHz.

5. The Violet Picture (VP) homing facility uses the ILS presentation on the navigation display to indicate homing information. VP homing is only possible on UHF frequencies in conjunction with the main radio. The system is described in Chapter 7.

6. Both the main and standby radios use DC power.

V/UHF Control Unit

7. The controls on the V/UHF control unit and their functions are as follows:

a. *Channel Selector.* The CHAN selector is a rotary switch with positions 1 to 18, G and M. Positions 1 to 18 permit the selection of pre-set frequency channels. Position M selects the frequency set by the manual frequency control knobs as shown on the MANUAL counters. Position G permits the main radio transmitter/receiver to operate on guard frequency (243·0 MHz) independently of the standby radio. When the CHAN selector is turned fully in either direction it stops in the G position.

b. *Mode Selector.* The mode selector is a 7-position rotary switch which has the following positions:

(1) OFF — main radio off.

(2) T/R and TR+G — power on: main radio set to transmit and receive.

(3) ADF — automatic direction finding (VP) system operates on the UHF frequency selected and normal communications are retained.

(4) DL and DL/T — these positions are inoperative because data link is not fitted.

(5) TR ON D/L OFF — inoperative.

c. *Volume Control.* The VOL control adjusts the level of incoming signals.

d. *Manual Frequency Control Knobs.* There are three manual frequency control knobs which are used to set either VHF or UHF frequencies as shown by the MANUAL counters. The knob on the left of the panel is the hundreds and tens selector, the centre knob the units selector, and the knob on the right the decimals selector. Clockwise rotation of the knobs selects higher numbers.

Associated Controls

8. *Normal/Standby Radio Selector.* The UHF SET switch controls the selection of the main radio (NORMAL) or the standby radio (STANDBY).

9. *Radio Power Selector Switch.* The POWER switch is used in conjunction with the standby radio. With the POWER switch selected to NORMAL, the 28V DC supply to the standby radio is reduced, by a dropping resistor, to the 24V DC required to operate the radio. After double generator failure, STANDBY is selected in the F Mk 3 and F Mk 6 to by-pass the resistor to allow the radio to run on battery voltage. Selecting STANDBY in the T Mk 5 connects the standby radio to the emergency battery, thus reducing the load on the main battery.

10. *Aerial Selector.* The AERIAL — UPPER / LOWER switch selects the aerial required for main UHF radio operation. When a VHF channel is selected, the upper aerial is used irrespective of the position of the switch. When the standby radio is selected, the lower aerial is in use.

11. *Violet Picture/ILS Selector.* The VP/ILS INDR switch (marked ILS/VP IND in the T Mk 5) selects the mode of operation of the ILS indicators on the navigation display.

12. *VP Sensitivity Switch.* The VP SENS (VP METER SENSITIVITY, T Mk 5) switch has positions MAX/MIN to select the sensitivity of the homing indication when VP is in use.

13. *Standby Radio Channel Selector.* The UHF STANDBY (UHF STBY, T Mk 5) 2-position switch selects the standby radio frequency. It is normally left at GUARD in flight; CHANNEL A is used for ground testing purposes.

14. *Transmit Switches.* In the F Mk 3 and F Mk 6 there are two press-to-transmit switches, one on the control column and the other on the No 2 engine throttle. In the T Mk 5 four transmit switches are provided, one on each control column and one on each inboard throttle.

15. *Muting Switches* (*T Mk 5 Only*). Two UHF—NORMAL / MUTE switches, spring-loaded to NORMAL, are on panels A3 and A6 to permit interference-free intercom. ▶◀ A spring-loaded press-to-mute button is also provided on the instructor's control column.

Intercom

16. The T Mk 5 is equipped with an intercom amplifier. The system is controlled by two INTERCOM switches labelled ON/OFF and NORMAL/EMERGY. When ON and NORMAL are selected, normal intercom is provided through the amplifier. If the power supply to the intercom amplifier fails, intercom facilities are automatically provided by the side-tone of whichever radio is in use. If the amplifier itself fails, both intercom and radio reception are lost until EMERGY is selected.

17. In all three marks, provision is made for external intercom via a socket in the right wheel well.

Telebriefing

18. A telebrief line can be connected at a socket in the right wheel well. When the connection is made, the light in the TELEBRIEF button comes on and all mic/tel circuits are transferred from the aircraft's internal circuits. The main and standby radios cannot be used when the telebrief connection is made. To transmit to the telebrief centre, the TELEBRIEF button is pressed.

19. The telebrief system takes its power from the Battery busbar.

MANAGEMENT OF THE SYSTEM

20. With external or internal power on line, check that the POWER switch is to NORMAL and, in the T Mk 5, set the INTERCOM switches to ON and NORMAL. If using the main radio on UHF frequencies, set the AERIAL switch as desired. The main and standby radios are normally tested before taxying.

MALFUNCTION OF THE SYSTEM

Transmitter Failure

21. If it becomes apparent that the transmitter has failed, try the alternative transmit button.

Main Radio Failure

22. If the main radio fails, make the following attempts to regain 2-way communications:

◀ a. Select alternative aerial (see Note).

b. If using a pre-set channel, try a manual frequency (and vice versa).

c. Check the pigtail connection from the helmet.

d. If using UHF, try a VHF frequency (and vice versa).

e. Select the standby radio; if unsuccessful, reselect the main radio on channel G.

f. Check the PEC and relock (leg restraints also have to be relocked).

Note: If both aerials are suspect, select ADF and a UHF frequency and use the VP aerials; reception range is reduced.

23. After main and standby radio failure it is possible to receive one-way voice communication from ATC by switching ON the ILS and turning up the ILS VOL control. The IFF code for radio failure on mode 3A is 7600. ▶

IFF/SSR IDENTIFICATION SYSTEM

DESCRIPTION OF THE SYSTEM

General

24. The IFF/SSR system, when operating, automatically transmits identification signals in reply to

challenge signals from surface or airborne interrogators. In addition, the equipment can be selected to transmit an identification of position (I/P) signal or an emergency signal.

25. The transponder system decodes incoming signals to ascertain the mode. If this mode is selected on the IFF control panel, a coded reply is triggered in response. The IFF/SSR modes are listed in Table 3.

Table 3 — IFF/SSR Modes

Mode	*Use*	*Control*
1	General military control and Command identification. Airways crossing under ATCRU control	Military radar or ATCRU
2	Identification of specific aircraft	Air Defence Radar stations
3/A	ATC purposes and airways crossing	Military, civil and joint ATC centres
B	An extension of mode A to give increased cover in confined spaces which have a dense flow of traffic	As mode 3/A
C	Automatic altitude reporting	As mode 3/A
D	Not used	—

Control Panel

26. The control panel switches and their functions are listed in Table 4.

IFF Fail Light

27. A green IFF FAILURE light is adjacent to the control panel. It has a press-to-test facility which also tests the blue or amber TEST light on the control panel. The IFF FAILURE light comes on if the TEST button/light has been pressed and the equipment has failed the test, or as a result of the signal being low or non-existent. It also comes on when:

a. The rotary function switch on the control panel is set at OFF.

b. The rotary function switch is set to SBY and the transponder is being interrogated but cannot reply (flashing light).

c. Transponder is unserviceable when under interrogation.

d. Rotary function switch is set at LOW during self-test procedure.

Power Supplies

28. The IFF/SSR system uses 115V, single-phase, 400 Hz AC and 28V DC. The system is inoperative after AC failure.

MANAGEMENT OF THE SYSTEM

29. With power supplies available, set the rotary function switch to SBY and, after a 50-second warm-up period, the IFF/SSR is ready for use. Set the required codes and modes and, when appropriate, select NORM and test the system. Re-select SBY until required for use.

30. The operating modes and codes to be used are normally established before flight, but ground radar stations may request particular codes or the de-selection of particular modes.

31. *Emergency Mode.* When the rotary function switch is pressed and turned fully clockwise to the EMGY position, emergency replies are transmitted in response to interrogation in modes 1, 2, 3A and B, irrespective of other control settings. Emergency replies are also transmitted automatically after ejection (either seat in the T Mk 5) providing the set has had a 50-second warm-up period.

MALFUNCTION OF THE SYSTEM

IFF Fail Light

32. If the IFF FAILURE light comes on with the function switch to NORM, press the TEST button. If the light remains on, it is recommended that the equipment be switched OFF as there is a possibility that overheating and internal damage may occur.

Table 4 — IFF/SSR Control Panel

Control: Markings	*Function*	
Five-position rotary function switch: OFF/SBY/LOW/NORM/EMGY	OFF	Power supply disconnected. IFF FAILURE light on steady
	SBY	Power to equipment. After 50-second warm-up, transponder accepts interrogations but cannot reply. If interrogated on a selected mode, IFF FAILURE light flashes
	LOW	Equipment functioning but with reduced sensitivity. Used only when requested by ground station to reduce clutter
	NORM	Equipment functioning normally, accepting interrogations and responding on selected modes
	EMGY	When pushed in and turned to EMGY, transponder transmits emergency coding on modes 1, 2, 3A or B (see also CIVIL/MIL switch) irrespective of mode switch positions
Four on/off MODE switches (up for on): 1/2/C/D	MODE 1	Transponder replies to mode 1 interrogations using selected mode 1 code
	MODE 2	Transponder replies to mode 2 interrogations using a pre-set code unique to aircraft
	MODE C	Not in use
	MODE D	Not in use
Three-position rotary switch: 3A/OFF/B	OFF	Transponder isolated from mode 3A or B interrogations
	MODE 3A	Transponder replies to mode 3A interrogations using the mode 3 code set
	MODE B	Transponder replies to mode B interrogations using the mode 3 code set
Code number selectors and indicators for MODE 1 and MODE 3A/B transponder replies	Four selectors and indicators for each. Indicators show 0000 to 7777. 4096 codes may be set	
Two-position emergency coding switch: CIVIL/MIL	Used in conjunction with EMGY position to establish emergency reply codes for mode 3A/B only:	
	MIL	Normally used. Selected mode 3A/B code is transmitted in emergency form in reply to interrogation
	CIVIL	Code 7700 is automatically selected for response to mode 3A/B interrogation
Two-position switch (spring-loaded to off): I/P	When operated momentarily and released, an identification pulse is transmitted, added to selected codes in modes 1, 2 and 3A/B	
Self-test facility, a push-button incorporating a double-filament green light: TEST	When pressed with equipment switched on, the facility carries out a check of receiver sensitivity, transmitter power output and mode serviceability. Select NORM, press TEST button: if check satisfactory, green TEST light comes on, IFF FAILURE light out. Unsatisfactory test indicated by IFF FAILURE light and no TEST light	

Intentionally Blank

PART 2

LIMITATIONS

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LIMITATIONS

PART 2

CHAPTER 1—AIRFRAME LIMITATIONS

Contents

The Limitations in this Part are taken from the Release to Service Documents (F Mk 3 & 5, Issue 5, AL2; F Mk 6, Issue 4, AL3). The Release to Service Documents are to be consulted to ascertain the latest release standard.

General

1. The F Mk 3 and F Mk 6 aircraft are designed for duties appropriate to an interceptor fighter and the T Mk 5 as an interceptor trainer. Intentional stalling and spinning are prohibited. The aircraft are cleared for use in temperate and tropical conditions, by day and night.

Altitude

2. Although the aircraft are cleared to fly at up to 60,000 feet, the oxygen systems and the pilots' personal equipment impose altitude limits as follows:

F Mk 3 and F Mk 6 — 50,000 feet
T Mk 5 — 43,000 feet

Note: If the canopy is lost, aerodynamic suck causes cockpit altitude to exceed aircraft altitude by up to 8000 feet in the F Mk 3 and F Mk 6, and by up to 11,000 feet in the T Mk 5.

Airspeed

3. *Maximum Speeds.* The following are the max IAS/Mach number for the configurations listed. When IAS/Mach number is quoted, the first attained is the limiting speed.

Maximum permissible:	650 knots/2·0M
Single missile (F Mk 3/T Mk 5):	650 knots/1·8M
F Mk 6 with overwing tanks:	525 knots/0·98M (525 knots/0·9M with single missile)
With AAR probe fitted:	625 knots
When Red Top operational missiles are carried below 10,000 feet in peace time:	550 knots
Airbrakes operation and extended:	
F Mk 3 and F Mk 6:	650 knots/1·3M
T Mk 5:	650 knots/1·2M
UC selection:	250 knots
Flight with UC down:	280 knots
Flaps:	250 knots
Brake parachute:	
F Mk 3 and T Mk 5:	150 knots (normal) 170 knots (emergency)
F Mk 6:	170 knots (normal) 190 knots (emergency)

Note: Brake parachute streaming above the normal speed is to be reported.

4. *Minimum Speeds.* The minimum speeds are as follows:

Flaps and UC up 180 knots
Flaps and UC down 140 knots

Note 1: In all configurations, higher minimum speeds are to be maintained with g applied

Note 2: In the F Mk 6, add 4 knots to the minimum speeds for every 2000 lb increase in AUW above 36,000 lb.

Normal Acceleration

5. *Negative g.* The maximum negative acceleration is minus 3g. Negative g is not to be applied for more than 15 seconds. Use of the ejection system is to be avoided in negative-g conditions.

6. *Positive g — F Mk 3 and T Mk 5*

Speed	*Ventral Empty*	*Fuel in Ventral*	*Single Missile*
Up to 0·9M	6g	6g	4g
0·9M to 1·8M	6g	5·5g	4g
Above 1·8M	4g	4g	—

Note 1: When winged Red Top missiles are carried, the limit is +4g except in operational necessity.

Note 2: Above 1·8M with two wingless Red Top missiles fitted, the limit is +3g.

7. *Positive g — F Mk 6*

a. *Without Overwing Tanks:*

Speed	*Ventral Empty*	*Ventral Tank Fuel*			*Single Missile*
		Up to 1000 *lb*	1000 *to* 3500 *lb*	*More than* 3500 *lb*	
Up to 0·9M	6g	6g	5·5g	5g	4g
0·9 to 1·8M	6g	5·5g	5g	4·5g	4g
Above 1·8M	4g	4g	4g	4g	4g

Note 1: When winged Red Top missiles are carried, the limit is +4g except in operational necessity.

Note 2: Above 1·8M with two wingless Red Top missiles fitted, the limit is +3g at all fuel states.

b. *With Overwing Tanks:*

Speed (kt)	*Overwing Tanks*		*Single Missile*
	With Fuel	*Empty*	
Below 475	3·5g	4g	2g
Above 475	3g	3·5g	2g

Maximum Weight

8. *Take-Off.* The maximum AUW for take-off are:

F Mk 3 — 36,000 lb
T Mk 5 — 37,000 lb
F Mk 6 — 45,750 lb

Note: In the F Mk 6, the mainwheel tyres are to be used only once at take-off weights in excess of 45,000 lb.

9. *Landing.* The maximum permissible landing weights are:

F Mk 3 and T Mk 5 — 34,500 lb (except in emergency)

F Mk 6 — Normal 34,500 lb
— Emergency 40,500 lb

Centre of Gravity (CG)

10. The take-off CG limits are contained in the Release to Service, Annex A.

Approach Criteria

11. *Aircraft Category.* The aircraft category for approaches is E.

12. *Visual Committal Height (VCH).* The VCH are as follows:

a. *F Mk 3 and T Mk 5.* In the F Mk 3 and T Mk 5, the VCH for weights up to the maximum landing weight is zero.

b. *F Mk 6.* In the F Mk 6 without overwing tanks, the VCH is zero for weights up to 38,000 lb and 250 feet above that weight. With overwing tanks fitted, the VCH is zero for weights up to 34,000 lb and 700 feet above that weight.

13. *Engine Out Allowance (EOA).* The EOA are as follows:

a. *F Mk 3 and T Mk 5.* In the F Mk 3 and T Mk 5, the EOA for weights up to the maximum landing weight is zero.

b. *F Mk 6.* Without overwing tanks in the F Mk 6, the EOA is zero for weights up to 38,000 lb and 150 feet above this weight. With overwing tanks fitted, the EOA is zero for weights up to 34,000 lb and 600 feet above this weight.

13A. *Standby Pressure Instrument Allowance.* The standby pressure instrument allowance is 300 feet. When using the standby altimeter, add 300 feet to the true height of DH/MDH.

Crosswind Limitations

14. *Take-Off.* The maximum crosswind component for take-off is 25 knots except in the F Mk 6 with overwing tanks, when the limit is 20 knots.

15. *Landing.* The maximum crosswind component for landing on dry runways is 25 knots, on wet runways 20 knots, and on flooded runways 15 knots. In the F Mk 6 with overwing tanks fitted, the figures are the same except that, on a dry runway, the limit is 20 knots.

Runway Restrictions

16. In the F Mk 3 and T Mk 5, the LCN is 27 at 36,000 lb AUW and, in the F Mk 6, the LCN is 30 at 39,000 lb AUW. For further information refer to the appropriate ODM.

Rolling Manoeuvre Limitations

17. *General.* The following general rolling limits apply:

a. *Negative g.* At accelerations less than +1g, the use of aileron should be kept to a minimum although the transient use of aileron is permitted for target tracking.

b. *Buffet.* In moderate buffet or other signs of the approach of the stall, particularly above 20,000 feet or at high subsonic speed, rapid application of full available aileron is not to be made.

c. *Airbrakes.* The position of the airbrakes is not to be varied during rapid rolling.

d. *Sideslip.* Before rolling, care is to be taken to minimise sideslip by the use of rudder. Greater care is to be taken to minimise sideslip when carrying a single missile or when two missiles are carried and the AAR probe is fitted. It is essential to counteract sideslip when the AAR probe is fitted and one missile is carried on the left station.

e. *High Positive g.* Above +4g, only co-ordinated turns using low roll rates are permitted.

f. *Overwing Tanks.* When overwing tanks are fitted, change in bank angle is to be limited to normal heading change manoeuvres only.

18. *Rapid Rolling.* Rapid rolling is prohibited:

a. When the AAR probe is fitted.

b. Above 1·8M when wingless Red Top are fitted.

c. Above +3g or the onset of moderate buffet, whichever occurs first, when drill Red Top fitted with Luneberg lens are carried.

19. *Rolls up to* 180°. Rapid rolling through not more than 180° is permitted, using full aileron, between +1g and the lesser of +4g or the onset of moderate buffet provided there is no other overriding limitation.

20. *Rolls Between* 180° *and* 360°. For all rolls between 180° and 360°:

a. Either two or no missiles are to be carried.

b. The manoeuvre is to be executed smoothly from an upright attitude in 1g flight and is to be completed before any other manoeuvre is started.

c. 1g aileron rolls are permitted above 300 knots using low rates of roll.

21. *Rolls in Excess of* 360°. Rolls in excess of 360° are prohibited.

22. *Aerobatic Manoeuvres.* For training and display purposes, aerobatic manoeuvres are permitted below 15,000 feet and between 300 knots and the lesser of 550 knots/0·9M with the following restrictions:

a. During rapid rolls, only aileron is to be used.

b. Derry turns and hesitation rolls are prohibited.

c. Winged Red Top missiles are not to be carried.

d. The missile load is to be symmetrical.

Note: Co-ordinated slow rolls involving less than 1g are permitted.

Carriage of Missiles

23. The aircraft are cleared to carry Firestreak or Red Top live, acquisition or drill missiles in pairs except that flight with one wingless Red Top is prohibited. To conserve missile wing life, Red Top missiles are to be flown wingless whenever possible. Red Top missiles are cleared for flight with or without Luneberg lenses.

24. When winged Red Top are fitted, aerobatic type manoeuvres may be performed in operational circumstances only.

Missile Firing — AAR Probe Not Fitted

25. When the AAR probe is *not* fitted, one or both missiles may be fired subject to the following limitations:

a. *Firestreak.* Firestreak missiles may be fired:

(1) At speeds between 300 knots or 0·6M, whichever is the lesser, and the maximum IAS stated in para 3, but not exceeding 1·7M.

(2) At heights up to 55,000 feet.

(3) At normal accelerations up to +3g or the onset of moderate buffet.

(4) At low level targets, but to allow for possible vertical dispersion, if the target is below 300 feet the fighter is to be at or above 300 feet at launch, and if the target is at or above 300 feet, the fighter may be below 300 feet at launch.

(5) The breakaway manoeuvre is not to exceed +4g (subsonic) or +3g (supersonic) and is strictly to adhere to the rolling limitations in para 17 to 22.

b. *Red Top.* Red Top missiles may be fired:

(1) At speeds between 0·5M and the maximum IAS stated in para 3, but not exceeding 1·8M.

WARNING: Reheat extinction may occur if Red Top missiles are fired below 300 knots at heights above 20,000 feet.

(2) At heights up to 55,000 feet.

(3) At normal accelerations up to +4g or the onset of moderate buffet, whichever occurs first.

(4) At low level targets, but to allow for possible vertical dispersion, if the target is below 300 feet the fighter is to be at or above 300 feet at launch, and if the target is at or above 300 feet the fighter may be below 300 feet at launch.

(5) The breakaway manoeuvre is not to exceed +4g (subsonic) or +3g (supersonic) and is strictly to adhere to the rolling limitations in para 17 to 22.

26. *Overwing Tanks.* When overwing tanks are fitted, missile firing is permitted within the above limits as modified by the speed and normal acceleration limitations for overwing tanks.

Missile Firing — AAR Probe Fitted

27. When the AAR probe *is* fitted, one or both missiles may be fired subject to the following limitations:

a. At heights up to 55,000 feet.

b. At normal accelerations between +1g and +2g or the onset of moderate buffet, whichever occurs first.

c. *Firestreak.* Firestreak missiles may be fired at speeds between 300 knots or 0·6M, whichever is the lesser, and 475 knots, but not exceeding 0·95M (0·9M with overwing tanks).

d. *Red Top.* Red Top missiles may be fired at speeds between 300 knots or 0·7M, whichever is the lesser, and 475 knots, but not exceeding 0·95M (0·9M with overwing tanks).

28. *Sideslip.* Excessive sideslip overloads the aircraft fin. Therefore, when one missile is fired, the resultant sideslip is to be counteracted immediately by use of rudder. The breakaway manoeuvre may then be initiated and is to be limited to +4g (or the onset of moderate buffet) and half aileron. The development of sideslip during the breakaway is to be counteracted by use of rudder.

Gun Firing (F Mk 6)

29. Gun firing is permitted at all heights and at accelerations between +0·5g and +4·5g, above the following minimum speeds:

Below 10,000 feet:	180 knots	2-second bursts max
10,000 to 20,000 feet:	200 knots	
20,000 to 30,000 feet:	240 knots	
Above 30,000 feet:	260 knots	— unlimited bursts

30. Gun firing is prohibited when any missiles are fitted.

31. When overwing tanks are fitted, the normal acceleration limits are modified by para 7b.

32. *Ammunition.* The following ammunition may be fired:

Practice, Mk 4Z

HE Mk 5Z and 6 star Z

Armour-piercing Mk 1Z

Light Fighter Sight (LFS)

33. The LFS is cleared for use by day only.

Carriage and Jettison of Ventral Tank (F Mk 3 and T Mk 5)

34. The F Mk 3 and T Mk 5 aircraft may be flown with or without the ventral tank. The tank may be jettisoned, but because of the severe nose-down trim change which may occur in certain conditions, the tank should not be jettisoned above 500 knots.

Overwing Tank Jettison

35. Empty overwing tanks may be jettisoned between 200 and 250 knots and up to 0·75M at heights up to 40,000 feet in straight and level flight. Overwing tanks containing fuel are not to be jettisoned.

Overwing Tank Fuel Dumping

36. Overwing tank fuel may be dumped at speeds between 220 knots and the maximum carriage speed at heights up to 36,000 feet. Dumping is normally to be performed in straight and level flight but turns at not more than +2g may be made if necessary.

Canopy Jettison

37. A speed of 300 knots should not be exceeded when jettisoning the canopy. The canopy may also be jettisoned when the aircraft is stationary on the ground but, if the nosewheel has collapsed, there is a danger that the canopy will fall back onto the cockpit.

Flight Control System (FCS)

38. In all autopilot modes when flying below 10,000 feet, the pilot is to hold the control column and monitor the aircraft's behaviour continuously, particularly the dolls-eye indicators, in case of a malfunction.

39. *Autostabilisation.* The FCS may be used in the autostabilisation mode subject to the following restrictions:

a. The autostabilisation system may be in operation throughout flight from before take-off to landing, but it is recommended that with the autostabilisers engaged, speed should be less than 400 knots below 1000 feet AGL.

b. When STAB is selected in flight, the aircraft should not be in close proximity to the ground or another aircraft in case of a system malfunction.

40. *Pitch and Bank ATTITUDE Hold.* The FCS may be used in the ATTITUDE hold mode, including the use of the 'little stick', subject to the following limits and restrictions:

a. Speed is limited to between 250 and 400 knots between 1000 and 5000 feet, and to between 250 knots and 650 knots/2·0M between 5000 and 50,000 feet.

b. Before selection, autostabilisers are to be engaged and operating.

c. Bank angle is not to exceed 65°.

41. *Height, Height and Heading Lock Modes.* The FCS may be used in the HEIGHT and HEIGHT and HDNG lock modes, including the use of the 'little stick', subject to the following limits:

a. From 1000 feet AGL to 15,000 feet:

Without overwing tanks:

200 knots to 550 knots/0·92M

With overwing tanks:

250 knots to 525 knots/0·92M

b. From 15,000 feet to 45,000 feet, without overwing tanks: 200 knots to maximum permissible speed.

c. From 15,000 feet to 40,000 feet, with overwing tanks: 250 knots to maximum permissible speed.

d. Large power changes are to be made gently when below 10,000 feet and above 450 knots.

e. During transonic accelerations or decelerations between 15,000 feet and 25,000 feet, these modes are not to be engaged, thus preventing possible g-switch operation and automatic disconnection.

f. With a single missile fitted, turns are not permitted at supersonic speeds.

42. *FD/ILS and Auto-ILS Modes.* The system is cleared for use up to 40,000 feet in the FD/ILS and auto-ILS modes subject to the following restrictions:

a. All approaches should be PAR-monitored.

b. The approach limitations are to be observed.

43. *TRACK Mode.* The use of the TRACK mode of the auto-ILS as a height and heading lock is permissible within the following limits:

Indicated airspeed: 250 to 350 knots

Mach number limit: 0·95M

Height limit: 1000 feet AGL to 40,000 feet

Heading change demands: maximum 40°

Undercarriage: undercarriage up

44. *Programmed Climb.* The system is cleared for use in the FD programmed climb mode except when overwing tanks are fitted.

Formation Flying

45. The limitations on high speed formation flying are to be found in Part 3, Chapter 3.

Anti-Ice and Rain Dispersal Systems

46. *Anti-Ice System*

a. Engine and duct lip anti-icing are cleared for use.

b. The Spraymat system is cleared for use only when the engines are running.

47. *Rain Dispersal*

a. The rain dispersal system may be used for take-off.

b. Rain dispersal may be selected on at any stage of the approach and left on for any subsequent overshoot, circuit and landing. With two engines operating, the number of normal overshoots with rain dispersal switched on is unlimited.

c. If the system is used during a single-engine approach, overshoot and landing, the fact is to be reported after landing (inspection of vinyl layer).

ILS

48. The ILS may be used at speeds up to 400 knots and at heights up to 30,000 feet, but erroneous indications may be expected when the ram air temperature exceeds 70°C for more than 20 minutes.

Arresting Barriers

49. All aircraft marks, with or without the AAR probe fitted, are clear to engage the Mk 6, 12 and 12A, and Types A and B, aircraft arresting barriers. Aircraft with overwing tanks fitted may engage the Mk 12A, Type A and Type B barriers only but the tanks should be empty to reduce fire hazards.

Arrester Hook (F Mk 6)

50. The arrester hook fitted to the F Mk 6 is cleared for use at all aircraft weights.

51. The arrester hook is not to be released in flight. However, provided the hook is released while the aircraft is on the runway, it is then safe to overshoot and fly with the hook lowered at speeds up to 250 knots.

52. Whenever possible, the cable should be engaged within 40 feet of the centre of the runway. However, discontinuities on the runway surface (as little as one-sixteenth of an inch step-up eg, centreline lighting) before the cable may cause the hook to bounce over the cable.

53. *Use with RHAG Mk* 1. Safe engagement with the RHAG Mk 1 system is possible at speeds up to 170 knots. After engagement at speeds above 170 knots there is a risk of structural failure and the pilot should be prepared to eject. At speeds up to 115 knots, the aircraft is to be visually inspected for damage and the hook blade changed. If engagement occurs at speeds above 140 knots, the integrity of the aircraft's structure is to be checked before further flight.

54. *Use with Other Arresting Gear.* The arrester hook may be used with other types of arresting gear provided they have normal performance characteristics similar to those of the RHAG Mk 1, subject to the following conditions:

a. At engagement speeds above 140 knots there is a risk of structural failure and the pilot should be prepared to eject.

b. After engagement at speeds above 95 knots the aircraft is to be visually inspected for damage and the hook blade changed. If engagement occurs at speeds above 115 knots, the integrity of the aircraft's structure is to be checked before further flight.

Trampling of Arresting Cables

55. The aircraft are clear to trample, at any speed, the rigged and supported centre span of the following arresting cable systems: RHAG, SPRAG, CHAG, PUAG, BLISS BAK 9, BAK 12 and 500S.

Note: The fins under the ventral tank may occasionally be struck by a cable.

Equipment Temperatures

56. The performance of certain equipment may become unreliable or give false indications in sustained high speed, low altitude flight at high ambient temperatures. Normally, therefore, speed should be restricted within the ram air temperature/height/time limits as follows:

Airframe structure — 117°C max

Cabin conditioning system — 80°C max above 10,000 feet

Firestreak missile (armed) — 70°C max

ILS — accuracy degraded after 20 minutes above 70°C

Red Top with Luneberg lens — 70°C

HE Ammunition (F Mk 6) — 10 minutes max above 70°C

Air-to-Air Refuelling (AAR)

57. Sorties of up to nine hours duration (11 hours, F Mk 6) may be undertaken provided that losses of engine/airframe fluids and oxygen are small. AAR is permitted as follows:

a. From Victor K2 tankers up to 43,000 feet within the following restraints:

(1) *Minimum Speed.* The minimum speed for making contact and in contact is 250 knots.

(2) *Maximum Speeds.* The maximum speeds for making contact and in contact are:

Mk 20B drogue on wing stations:

Stainless steel hose — 280 knots/0·88M

Carbon steel hose — 290 knots/0·88M

Mk 17 HDU on centre station — 320 knots/0·88M

b. From Buccaneer Mk 2 tankers using Mk 20C or Mk 20E refuelling pods at speeds between 250 and 290 knots.

c. From KC 135 tankers between 250 and 270 knots.

d. From VC10 K2 tankers up to 35,000 feet, between 260 and 300 knots. Optimum speed is 280 knots. AAR without autostabilisers is to be in emergency circumstances only. Bank angle in contact is to be not greater than 30° and gentle manoeuvres only are to be used.

e. If autostabilisers are required, they are to be engaged before contact.

f. If it is necessary to use reheat, it is to be engaged prior to contact.

Radar Altimeter

58. The F Mk 3 and F Mk 6 are cleared to use the radar altimeter (ARI 23232, Type 48 or 49 AMR). Momentary loss of lock occurs during taxying and during roll and pitch manoeuvres over land, especially towards the top of the radar altimeter range.

WARNING: It is possible for the Type 48 AMR indicator to show a withdrawal of the failure warning flag after a failure, when subjected to normal acceleration greater than +2.5g. The flag reappears when the acceleration reduces below +2.1g. This limitation does not apply to the Type 49 AMR which has an improved failure flag motor solenoid.

AI 23 C/D

59. AI 23 C/D is cleared for use, including the homer, subject to the following conditions:

a. Fast mode attacks are not to be made below 20,000 feet.

b. Practice attacks against targets may be made provided aircraft safety can be maintained without reliance on kinematic ranging.

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PART 2

CHAPTER 2—ENGINE LIMITATIONS

Contents

Engine Limitations

1. The Avon 302 engine is cleared for use subject to the limitations in Table 1 and the relevant Notes.

Table 1 — Avon 302 Engine Limitations

Power Rating	*Time Limit per Flight or per Hour*	*RPM (per cent)*	*Max JPT °C*
Maximum cold power (or any degree of reheat — see Note 3)	15 min (combined)	102·5 max (see Note 1)	795 (see Note 2)
Intermediate	30 min	98·0 max	755
Max continuous	Unrestricted	97·0 max	720
Approach	Unrestricted	60·0 min	—
Slow idle	Unrestricted	31·0 to 34·0	750 (see Note 4)
Ground fast idle	Unrestricted	58·0 min	750 (see Note 4)
During starting	—	—	800

Note 1: During climbs at maximum power conditions the governed speed may be permitted to rise to 104% RPM but the maximum JPT is not to be exceeded. During reheat selections and cancellations, transient overswings (5 seconds) are permitted up to 106% RPM.

Note 2: During certain engine accelerations, temperatures in excess of the limiting JPT may be experienced. Full control should be established by the JPT controller within 5 seconds. If, owing to a malfunction, control is not established within this period, temperatures up to 850°C may be tolerated for a further period of 10 seconds while manual control is being taken.

Note 3: The maximum continuous reheat running time is 15 minutes; if further time is required, the reheat is to be cancelled and re-selected. This limitation applies to all degrees of reheat and included in this period is any time spent with maximum cold power selected.

Note 4: Under adverse conditions of high ambient temperature and/or tailwind while at slow idle or ground fast idle, the JPT may be allowed to exceed the limit of 750°C but is not to exceed 800°C.

Oil Pressure

2. The oil pressure warning captions are to be out at 45% RPM and above.

Minimum Starting Temperature

3. The minimum ambient temperature for engine starting is minus 20°C. In temperatures below this value, the engine is to be heated as necessary before starting.

Approved Fuels

4. The following fuels are approved for use:

NATO Code	*UK Joint Service Desig*	*UK Specification*	*US Designation*
F34	AVTUR/FSII	DERD 2453	JP-8
F40	AVTAG/FSII	DERD 2454	JP-4
F44	AVCAT/FSII	DERD 2452	JP-5
F35	AVTUR	DERD 2494	—
—	AVTAG	DERD 2486	—
F43	AVCAT	DERD 2498	—

Note: FSII (DERD 2451) may be added to the fuels above which are not designated with FSII, in the proportion 0·10% to 0·15% by volume. A corrosion inhibitor/lubricity improving additive (DERD 2461) should be used with any of the fuels listed.

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PART 3

HANDLING

List of Chapters

PART 3 HANDLING

PART 3

CHAPTER 1—PREPARATION FOR FLIGHT

Contents

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 face screen firing handle(s), the seat pan firing handle(s) and, in the T Mk 5 only, the canopy jettison sear.

**Safe for Servicing — Safety pins also fitted to the main gun sear(s) and the guillotine unit sear(s).

WARNING 2: The armament safety break key is to be removed by the groundcrew on instruction from the pilot immediately prior to the aircraft taxying, and re-inserted on the pilot's instruction during the **Shutdown Checks.**

External and Internal Checks

1. Carry out the **External, Ejection Seat** and **Internal Checks** as laid down in the FRC, together with the additional **T Mk 5 Checks** where appropriate.

Starting Procedure

2. Start the engines in accordance with the drills in the FRC. The following considerations should be borne in mind:

a. It is preferable that the aircraft is facing into wind.

b. The engine running danger zones are to be clear of ground equipment.

c. If, during starting, the JPT limit is rapidly approached and appears likely to be exceeded, move the throttle to the HP COCK OFF position.

DC Start

3. The aircraft may be started without the use of an external AC electrical supply. If such a start is made, those items in the **Internal Checks** requiring AC power (including the MRG) are to be switched off wherever appropriate. Delay the selection and testing of these items (including the SWP) until the main generator and alternator are on line. Do not test the inverter until the MRG is fully run up.

4. Do not start the aircraft without an external DC supply because the subsequent re-charging of the main battery following an internal start is liable to cause battery boiling with consequent acid spillage.

Failure to Start

5. There are three types of failure to start an engine identifiable by:

a. Failure of combustion of the Avpin starter motor.

b. Normal starter combustion and engine rotation, but failure to achieve engine light-up.

c. Normal starter combustion but failure of the engine to rotate.

6. Having identified the type of failure, carry out the appropriate drill in accordance with the FRC.

WARNING: When normal starter combustion takes place but the engine fails to rotate, no further start is to be attempted, and 60 minutes are to elapse before examination or investigation takes place.

Checks After Starting

7. Carry out the **After Starting Checks** listed in the FRC.

8. After the first engine start of the day, set No 1 engine to 65% RPM and No 2 engine to idle while checking the standby generator.

9. Having closed the canopy, the pilot is to obtain a positive check from the groundcrew that the ejection seat restrictor cable is properly positioned. If prior to take-off or after an intermediate landing the canopy is opened, the restrictor cable is to be checked again by the groundcrew before take-off.

10. On the ground, with one engine at maximum RPM, 80% RPM or above is to be maintained on the other engine to prevent overheating of the slower running engine.

Anti-Icing Procedures

11. If the runways are wet or visible moisture reduces visibility to 1000 metres or less and the OAT is below +5°C, anti-icing is to be switched on immediately after engine start and left on for taxying.

12. Before selecting anti-icing, increase No 2 engine RPM to 70% to ensure that AC remains on line during selection. Once the anti-icing is operating, RPM may be reduced, but AC is likely to come off line at engine speeds below 65% RPM.

Taxying

13. Have the chocks removed and release the wheel-brakes parking catch. Idle/fast idle usually provides sufficient power to start the aircraft moving. Check the brakes as the aircraft moves off. At taxying speed, the aircraft tends to continue accelerating at idle/fast idle and frequent light braking is necessary to prevent excessive speed. Avoid harsh braking and sharp turns, otherwise vented fuel may enter the auxiliary air intakes. High AUW necessitates extra caution during taxying.

14. In conditions of high ambient temperature and/or tailwind, maintain the slower running engine at a minimum of 40% RPM in order to avoid excessive JPT. Whenever an engine is accelerated from idle care is to be taken to avoid exceeding the JPT limitation.

15. The canopy may be left open, but off the top stop, provided the airstream against the canopy does not exceed 65 knots (ie taxying speed plus wind component). If canopy vibration occurs, either close the canopy or reduce speed until the vibration stops. Ensure the ejection seat restrictor cable is re-checked before take-off.

16. Fuel consumption at idle/fast idle is approximately 55 lb/minute.

PART 3

CHAPTER 2—TAKE-OFF

Contents

Performance Considerations

1. Vstop and Vgo speeds are given in Part 2 of the ODM.

2. If speed is at or below Vstop, the take-off may be aborted and the aircraft brought to rest by the use of the maximum braking technique in the remaining length of the runway. Therefore, when an engine failure occurs at or below Vstop, the take-off is to be aborted.

3. If speed is at or above Vgo, take-off may be continued after failure of an engine; the aircraft will become airborne within the remaining distance.

4. Provided Vstop is greater than Vgo, only Vstop need be considered. If Vgo is greater than Vstop however, a speed band occurs between the two speeds in which engine failure results in the aircraft running into the overshoot area irrespective of whether the take-off is continued or not.

Reheat

5. *F Mk* 3 *and T Mk* 5. Normally, if Vstop exceeds Vgo, use maximum cold power for take-off but, if reheat is used and one reheat fails during take-off, cancel the failed reheat and continue the take-off. However, when Vgo is greater than Vstop in cold power, use reheat from the start of the take-off run and, if either reheat fails to light, abort the take-off.

6. *F Mk* 6. In the F Mk 6, all take-offs are to be carried out using maximum reheat. If full overwing tanks are carried and either reheat fails to light, abort the take-off. In other configurations, if either reheat fails to light at the first attempt, a second selection is permissible provided the speed is below 90 knots. If this procedure is unsuccessful, abort the take-off.

Note: F Mk 6 aircraft fitted with overwing tanks containing fuel are only permitted to take-off when the runway in use has a serviceable and rigged upwind arresting gear. If no upwind arresting gear is available, the overwing tanks are to be empty.

Flap

7. *F Mk* 3 *and T Mk* 5. Although in the F Mk 3 and T Mk 5 the use of flap improves the unstick characteristics of the aircraft, flap should not be used for take-off because:

a. In cold power, single-engine climb-out performance is marginal with flaps down.

b. The nose-down pitching forces caused by the failure of No 1 engine with No 2 in reheat in the flap-down configuration may prejudice a safe take-off.

8. *F Mk* 6. In the F Mk 6, normal take-off is with full reheat and flaps down.

Engine Failure

9. If a cold power take-off is continued after an engine failure, reheat is not to be selected because a successful engagement of reheat is of little benefit in shortening the take-off run. Furthermore, if the nozzle opens but the reheat fails to light, the resultant thrust reduction aggravates the emergency.

10. Following an engine failure on a take-off that is not aborted, leave both throttles at the position selected for take-off because there is no yaw to assist the pilot in determining which engine has failed. When the aircraft is safely airborne, raise the undercarriage, identify the failed engine and then shut it down.

11. Details of climb-out performance with one engine windmilling are given in the ODM.

Icing Conditions

12. The use of anti-icing adversely affects the take-off performance by approximately 5%.

13. In icing conditions, anti-icing is to be used for take-off unless runway length is limiting, in which case run the engines at 85% RPM for not less than 30 seconds with the anti-icing on and then make an immediate take-off with the anti-icing switched off. This procedure removes any ice already formed but affords no subsequent protection; therefore, switch on the anti-icing again as soon as practicable after take-off.

14. If an engine fails when anti-icing is in operation, the net thrust on the remaining engine is reduced by 8·5%; this reduces Vstop by 5 knots and increases Vgo by 25 knots. Adjust take-off calculations accordingly.

Take-Off

15. Carry out the **Checks Before Take-Off** listed in the FRC.

16. Align the aircraft on the runway with the nose-wheel straight and apply the brakes. Parallel No 1 throttle with No 2 and then open both throttles to 92% (85% in F Mk 3 or T Mk 5 pre-mod 4682) and check that the brakes hold at this setting. Release the brakes and increase both throttles to maximum cold thrust checking:

a. The nozzles have moved to the closed position.

b. Both JPT have increased to at least 650°C.

If either of these conditions is not satisfied, abort the take-off.

17. If reheat is to be used, rock the throttles through the gate and move them smoothly and quickly to maximum reheat. The TTC lights come on momentarily. Check that the nozzles are fully open, that the JPT is above 700°C but below 795°C, and that the TTC lights are out.

18. Take-off RPM may stabilise at any figure between 97% and 102·5%, depending on the ambient temperature, use of reheat, use of anti-icing, JPT controller operation and intake effects.

19. Speed increases quickly during the take-off run and there is no difficulty in keeping straight even in strong crosswinds. At 90 knots cross-check the IAS shown on the strip speed display with that of the standby ASI. Differential braking may be necessary until the rudder becomes effective at 100 knots.

20. In the F Mk 3 or T Mk 5 at 145 knots (135 knots without missiles), progressively move the control column rearwards to raise the nosewheel, avoiding an excessive attitude. In the F Mk 3 the nosewheel comes off cleanly at the recommended speed and care is to be taken not to attain a high nose attitude. In the T Mk 5, during a clean take-off, the nosewheel is reluctant to come off at the recommended speed. In both marks, once the nosewheel is raised, care is to be taken not to over-rotate otherwise there is a danger of the tail bumper striking the ground. At 150 knots, move the control column smoothly back, aiming to unstick at 175 knots.

21. In the F Mk 6 with flaps down, raise the nose-wheel at 150 knots (165 knots with full overwing tanks). The nosewheel is reluctant to come off; a moderate pull force and nearly full rearward movement of the control column is required. Maintain this control position and the aircraft leaves the ground cleanly at the recommended speed of 170 to 180 knots (185 to 190 knots with full overwing tanks).

WARNING: In all marks, the undercarriage oleos extend appreciably before the aircraft finally unsticks; undercarriage retraction at this stage, when there is still some weight on the wheels, causes the aircraft to sink back on to the ground. To prevent this, establish a positive rate of climb before retracting the wheels.

22. During a take-off using full reheat and flaps down when carrying Red Top missiles without wings, the nosewheel raising speed and unstick speed are increased by up to 10 knots with an associated increase in ground roll of up to 600 feet. Be prepared to use more aft stick to lift the nosewheel.

23. In a strong crosswind, the up-wind wing may rise slightly and, when the aircraft unsticks, the down-wind wing may drop. The wing-drop is easily corrected by use of aileron.

24. As soon as the aircraft is safely airborne, apply the brakes and retract the undercarriage, keeping the speed below 250 knots and the brakes applied until the wheels are locked up. The nosewheel locks up with a distinct thud. Raise the flaps (if used) at not less than 190 knots (200 knots with full overwing tanks) and cancel reheat (if used) when no longer required (but not below 250 knots with fuel in the overwing tanks).

25. Carry out the **Checks After Take-Off.**

26. If a 'rotation' is to be performed after a reheat take-off, it is to be started at a minimum speed of 260 knots and acceleration is not to exceed +3g.

Aborting Take-Off

27. If an emergency occurs during the take-off run that makes it unwise to become airborne, abort the take-off even if Vstop has been exceeded. If there are no arresting facilities available, the decision whether or not to eject from the aircraft will depend upon the circumstances.

28. To abort the take-off:

a. Move the throttles to idle/idle.

b. Stream the brake parachute (which may not deploy if the speed is below 100 knots).

c. Employ the maximum wheel braking technique (Part 3, Chapter 5, para 16).

d. In the F Mk 6, if an arresting cable is available, lower the arrester hook and aim to engage the centre of the arresting cable at 90° (avoid hook bounce on centreline runway lighting, if installed, by aiming slightly left or right of centre). Release the brakes before entry. Any pull-back as the aircraft stops should be checked by the application of engine power, not the use of wheelbrakes.

e. All marks of aircraft are cleared to engage Mk 6, 12 and 12A, and Types A and B arresting barriers. F Mk 6 aircraft with overwing tanks fitted may only engage Mk 12A and Type A and B barriers; the overwing tanks must be empty.

29. Failure of the Services hydraulic system pumps is not indicated to the pilot during an abort since AC is off line. If a double pump failure has occurred, the wheelbrakes accumulator meets the normal braking requirements, but frequent maxaretting or differential braking could exhaust the system.

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PART 3

CHAPTER 3—HANDLING IN FLIGHT

Contents

CLIMBING

General

1. The aircraft accelerates rapidly after take-off if the climb angle is shallow. Allow the speed to increase to 430 knots and then increase the climb angle to about 14° (F Mk 3, 16°) to establish the recommended speed of 450 knots.

2. The optimum climb in the troposphere is obtained at 450 knots/0·87M. If a climb to a greater height is required, the recommended technique is to accelerate the aircraft near the tropopause and then carry out an energy climb. For specific details of climb profiles and the best altitudes for accelerating to supersonic flight, refer to the ODM.

ENGINE HANDLING IN FLIGHT

General Operation

3. The JPT CONTROL switches are wire-locked to AUTO, thereby providing maximum JPT limiting and automatic reheat cancellation if the maximum allowable JPT is exceeded by 60°C. Maximum RPM varies according to the ambient air temperature, altitude and airspeed. Throttle back if necessary to keep within the RPM limitations. If the JPT control malfunctions, switch off the JPT CONTROL switch and control the JPT manually.

4. Make smooth throttle movements. At low altitude, acceleration from 60% RPM to maximum cold power can be achieved in five seconds.

5. To conserve fuel, operate the engines in the cruise nozzle position whenever practicable.

6. Maintain at least one engine above 58% RPM to ensure continuous AC electrical supplies. Below 15,000 feet and 250 knots IAS, the RPM with the throttle at idle is less than 58%.

7. At about 60,000 feet and 1·1M to 1·2M with maximum cold power selected, RPM fluctuations with or without audible rumbling may occur; bangs may also be experienced. Throttle back the engines until the fluctuations cease. Engine characteristics at high Mach numbers are described in para 41.

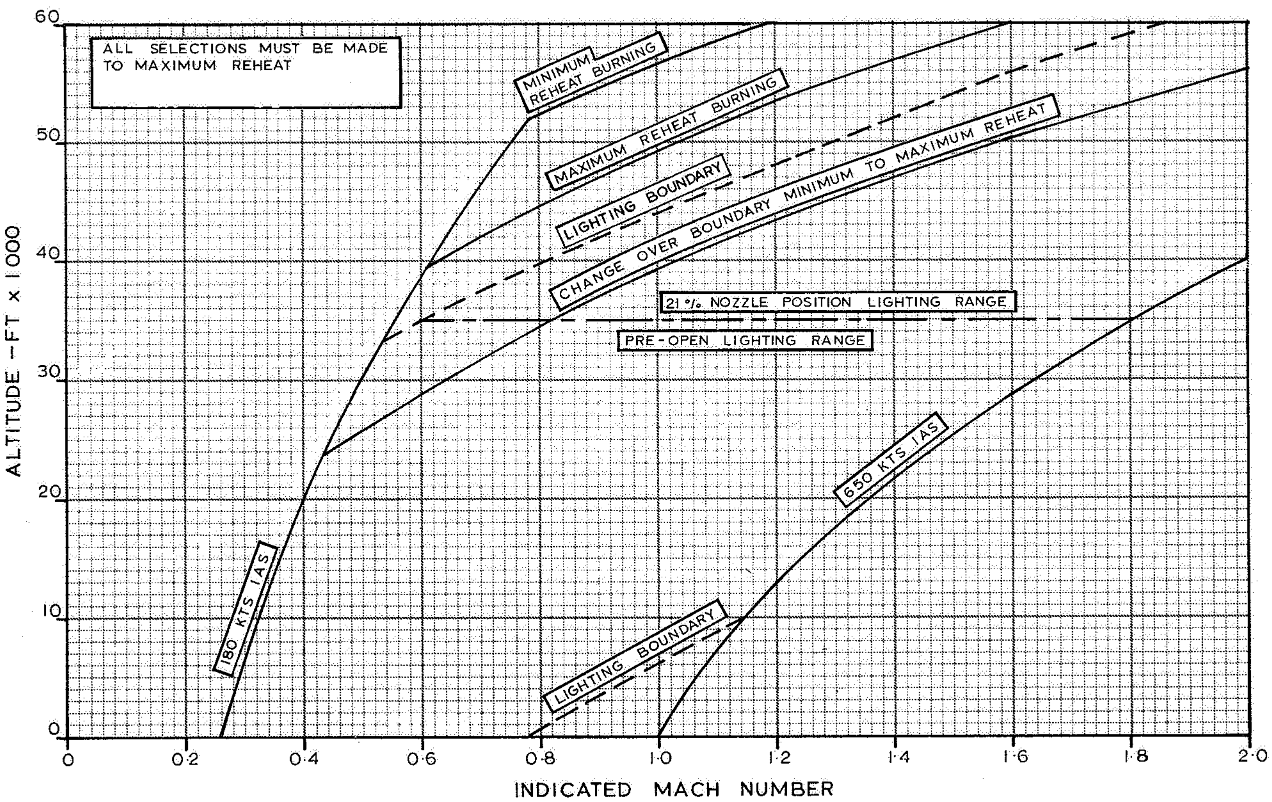
WARNING: At airspeeds in excess of 500 knots there is a risk of engine surge if the engine is throttled back rapidly, especially at altitudes below 5000 feet. Therefore, avoid slam or rapid throttle movements above this speed. Similarly, care is to be exercised when using reheat, and especially in cancelling reheat, when at a high IAS. It is preferable before cancelling reheat at high IAS to reduce airspeed to below 500 knots by the use of airbrakes or by climbing.

Reheat

8. All selections of reheat are to be maximum and should be made within the reheat lighting boundary shown in Fig 1. When selection is made in a shallow climb or dive through 35,000 feet, it is possible for operation of the altitude switch to cause transient nozzle staging which could be misinterpreted as a system malfunction. In such cases, provided a successful light-up results, the system may be regarded as serviceable.

9. In addition to the reheat lighting range, Fig 1 also shows the boundaries for minimum and maximum reheat burning and the limit for successful change from minimum to maximum reheat. After light-up, unrestricted throttle movements may be made throughout the reheat range anywhere within the reheat burning boundaries. The limit for successful change from minimum to maximum reheat shown on the graph is not a handling restriction; however, when minimum reheat has been maintained for more than 20 seconds above the change-over boundary line and maximum reheat is selected, successful change to maximum reheat power is unlikely. If reheat extinction occurs in these circumstances, an immediate cancellation of reheat followed by a re-selection to maximum reheat is often successful, provided the aircraft is within the reheat lighting boundaries.

10. If, when within the recommended lighting range, reheat fails to light in five seconds, cancel the selection and wait two seconds; ensure that the TTC lights are out and then re-select. If reheat again fails to light, further attempts are unlikely to be successful and the system should be regarded as unserviceable.



3—3 Fig 1 Reheat Lighting and Burning Envelope

11. If automatic cancellation occurs through any cause, one re-selection or reheat may be made. If automatic cancellation occurs again, make no further attempt to light the reheat.

12. The possibility of reheat cancellation through flame extinction increases at higher altitudes. Successful re-selection of reheat under these circumstances is affected by altitude and Mach number.

13. If, after manual cancellation of reheat, the nozzle remains fully open, there is a thrust loss of approximately 40% at maximum cold power. However, a subsequent selection of reheat is permissible.

Icing Conditions

14. If icing conditions are met in level flight, select DE-ICE and climb or descend out of the icing because continued flight in these conditions may result in flame extinction. If climbing, employ the maximum practicable rate of climb.

15. When anti-icing is switched on, there is usually a rise in JPT of approximately 20°C and, at full throttle, RPM falls if the JPT controller comes into operation.

16. When a power adjustment is necessary, move the throttles slowly. If an engine flames out, attempt an immediate hot relight. If this is unsuccessful, make a cold relight attempt within three minutes of the flame-out; any attempt after this interval may damage the engine.

17. The maximum anti-icing protection is obtained with the highest practicable RPM. Therefore, prior to descending through icing conditions, ensure that DE-ICE has been selected, descend at the maximum practicable rate, and maintain at least 70% RPM (75% if the descent in icing conditions is expected to take more than five minutes).

18. If icing persists down to airfield level, check the engine response before approaching to land and maintain at least 70% RPM, if possible, until finally committed to a landing. If it is necessary to overshoot, open the throttles smoothly.

19. After leaving icing conditions, wait at least one minute before switching the anti-icing OFF.

WARNING: There is a risk that unnecessary and prolonged use of the engine anti-icing may cause an explosion in the AVPIN fuel system; therefore, it is essential that the anti-icing is switched OFF when sufficiently clear of icing conditions.

IN-FLIGHT HANDLING

General Handling

20. *Harmonisation.* The aileron and tailplane controls are well harmonised at subsonic speed. Manoeuvres at supersonic speed require large tailplane movements in comparison with aileron movements. Rudder deflections to co-ordinate manoeuvres are necessary only at low indicated airspeeds and at supersonic speeds, particularly in the region 1·2M to 1·4M.

21. *Ailerons.* The ailerons are effective and the control forces are light throughout the speed range. Aircraft response to aileron increases with speed and, at high subsonic speeds, high rates of roll can be achieved. Care is to be taken to observe the rolling limitations (see Part 2, Chapter 1) in order to avoid inertia coupling. Large, rapid aileron movements cause adverse yaw, which is more pronounced at low indicated airspeeds and in high speed flight (see para 30 to 34). When the undercarriage is down, the aileron stops are removed and available travel is doubled, thus improving lateral control.

22. *Tailplane.* Below 200 knots, longitudinal response is slow and relatively large control movements are necessary during the round-out to land. At higher airspeeds, the tailplane is more effective and response is good. At supersonic speeds, the response to tailplane movement again decreases and relatively large control movements are required for manoeuvre.

23. *Rudder.* Rudder foot loads are heavy at all speeds with the undercarriage up, but, when the undercarriage is down, the hydraulic component of feel is automatically removed and the rudder forces are moderate. At circuit speed, relatively small applications of rudder induce a marked roll. At supersonic speeds, rudder response reduces and this, combined with a reduction in aerodynamic damping, necessitates larger deflections to co-ordinate manoeuvres or to trim out any asymmetry.

24. *Airbrakes.* The deceleration obtained with airbrakes extended is moderate over the speed range. Extension causes slight buffet at all speeds, and at high speed, directional stability is reduced. This reduction is more marked in the T Mk 5 and results in a lower Mach limitation for airbrake use.

25. *Trims and Changes of Trim.* The rates of trim operation, especially of the tailplane trimmer, are slow. Increase in power or raising the flaps both cause a slight nose-up trim change, whilst lowering the undercarriage or extension of airbrakes at high speed, cause

a slight nose-down change. Lowering flap results initially in a slight nose-up change followed by a slight nose-down change.

26. *Armament.* Stick forces per g at all speeds are higher for an aircraft without missiles than for an aircraft with missiles. The carriage of a ventral gun pack (with or without ammunition) in place of the ventral tank has no appreciable stick force effect.

27. *Refuelling Probe.* The AAR probe causes a marked directional trim change at speeds above 500 knots. At Mach numbers between 1·7 and 1·8 the probe may oscillate, imparting a slight variation to the airframe.

28. *Overwing Tanks.* The handling of the aircraft is not noticeably affected by the carriage of overwing tanks. It is easy to exceed the overwing tank carriage limitations, imposed mainly for structural reasons, especially at low fuel states and when flying below 10,000 feet and above 400 knots.

Manoeuvrability

29. *General.* In order to avoid excessive airframe fatigue caused by manoeuvres involving high structural loads, particular care is required in the configurations and flight conditions as specified in the following paragraphs.

30. *Aircraft with Two or No Missiles.* During rapid rolls at high g, roll-yaw inertia coupling tends to produce higher than normal loads. This is particularly true at the speed/height combination of 0·8M to 0·95M and 20,000 to 35,000 feet where the high angle of attack, signified by buffet, produces sideslip and hence fin load; the amount of sideslip increases with higher rates of roll and higher g. In the region of 1·2M to 1·4M, adverse yaw due to aileron application becomes pronounced, particularly at high IAS (500 to 600 knots) and under applied g. This produces sideslip and, therefore, high fin loads, and appreciably reduces the normal rolling capability of the aircraft. Extension of the airbrakes aggravates the situation; their use (within the limitations) is to be kept to a minimum in these circumstances. Use rudder to decrease the sideslip and fin loads. If g is also reduced, rolling response is improved and fin loads further reduced.

31. *Aircraft with Single Missile.* The regions of high loading, and the corrective actions, are similar to those in para 30; however, the problem is exacerbated by further fin loading owing to the yawing moment caused by the single missile, which is additive when rolling away from the missile. Indications that asymmetry effect is becoming excessive are:

a. The inability to correct yaw, despite a large rudder pedal force.

b. A marked change in lateral trim.

32. *Firing and Breakaway.* If only one of two missiles is fired and then a rapid breakaway is performed, high fin loads are produced. The aircraft yaws and, owing to the sweep-back, has a strong rolling tendency. If aileron is applied to oppose this roll even higher fin loads result. Minimise loads by reducing normal acceleration to between +1 and +3g and correcting sideslip with rudder; this also improves rolling response.

33. *Autorotation.* Unless low roll rates are used, rolls at less than +1g can produce autorotation. Therefore, it is essential that only aileron control be used when rolling rapidly through 360°. Should autorotation occur, only the minimum amount of aileron is to be used to stop the rotation with the rudder kept central and the control column in the position for 1g flight.

34. *Transonic Yaw Divergence.* Supersonic manoeuvrability is restricted by the g limitations but, at high altitudes, the use of full tailplane may be insufficient to achieve these limits. If full, or nearly full, tailplane is applied or maintained at supersonic speeds below 1·3M above 30,000 feet, there is a danger of achieving a large angle of attack with little or no pre-stall buffet warning. In this situation the reduced lateral and/or directional stability may cause the aircraft to roll and/or yaw; if this occurs, g should be relaxed *immediately*. These conditions must be avoided because the yaw may be severe and can induce high fin loads. Furthermore, the high angle of attack causes a rapid loss of speed which, combined with the yaw, may induce a spin as the aircraft becomes subsonic. Accordingly, when decelerating transonically above 30,000 feet, avoid the application of large tailplane angles until the aircraft is subsonic, when buffet will provide stall warning. However, because of the large stick travel and the heavy force required, a determined effort is required to sustain these large tailplane angles, and the g increases markedly when decelerating through 1·0M.

Note 1: Airbrakes aggravate the reduced stability.

Note 2: With a single missile, the additional yawing and rolling effects may conceal the onset of the symptoms.

Flight in Turbulence

35. The recommended speed for flight in severe turbulence is 350 knots/0·9M, whichever is the lesser.

Aerobatics

36. The IAS, g and rolling limitations given in Part 2 are to be strictly observed. Within these limitations, aerobatics are easy and pleasant to perform.

37. *Rolling Manoeuvres*. The recommended speed for rolling manoeuvres is 350 knots which, below 15,000 feet, affords the greatest scope within the rolling limitations.

38. *Looping Manoeuvres*. Considerable height is covered in looping manoeuvres and small variations in technique significantly affect recovery. Use reheat or maximum cold power for loops. If reheat is to be used, select it before entry, thereby avoiding the thrust loss associated with nozzle opening prior to light up during the manoeuvre. The recommended minimum entry speed for loops is 400 knots though, until experience is gained, 450 knots should be used, starting at 7000 to 12,000 feet. Apply 4g initially, anticipating slight buffet during part of the loop. For a half-roll off the top of a loop, an initial speed of 500 knots is recommended.

39. *Inverted Flying*. The recommended speed for inverted flying is 350 knots. Negative g is not to be sustained for longer than 15 seconds. Fuel starvation does not occur but the oil pressure reduces causing the oil lights to come on, and, in addition, the air turbine gearbox suffers oil starvation. During successive prolonged negative-g manoeuvres, a minimum period of 10 seconds positive-g flight is to be established between each manoeuvre to prevent oil starvation of the air turbine gearbox.

High Speed Flying

40. *General*. The aircraft is capable of exceeding its airspeed and Mach number limitations (Part 2, Chapter 1), especially in reheat power.

41. *Intake Vibration and Buzz*. The aircraft is subject to intake vibration and intake buzz. Vibration occurs with the engines at full power at speeds above 1·88M and may also occur in the range 1·35M to 1·60M; this is due to turbulence of the airflow behind the intake bullet. It is felt as a low amplitude vibration similar to aerodynamic buffet and is structurally acceptable. Intake buzz is caused by a more violent disruption of the airflow in the intake and occurs if the engines are throttled back rapidly at speeds above 1·85M. With increased g, buzz occurs at a lower Mach number and a higher RPM. It is indicated by a series of loud and rapidly recurrent bangs. The condition does not persist because, with the application of g or on throttling back, the aircraft decelerates rapidly below the buzz boundary. Intake buzz causes no damage but should be avoided if possible.

42. *Trim Changes*

a. *F Mk 3*. In the F Mk 3, as speed is increased beyond 0·9M there is a slight nose-up trim change; beyond 0·96M the trim change is slight nose-down and the aircraft is back in trim at 1·0M. These trim changes are accompanied by slight buffet which becomes more pronounced under increased g and/or with a ventral tank fitted. A slight nose-down trim change continues progressively, up to 1·3M, then remains constant up to 1·6M and continues slightly nose-down above 1·6M.

b. *T Mk 5*. As speed is increased beyond 0·9M there is a slight nose-up trim change which becomes slight nose-down beyond 1·1M; at 1·25M the aircraft is back in trim. Buffet effects are as for the F Mk 3. The slight nose-down trim change continues progressively up to 1·6M; there is little trim change above this speed.

c. *F Mk 6*. As speed is increased beyond 0·9M there is a slight nose-down trim change; between 0·98M and 1·1M there is no trim change. Above 1·1M there is a slight nose-up trim change, continuing until 1·4M is reached; there is little trim change above this speed.

d. *All Marks*. In the transonic range, a reduction in damping causes a slight deterioration in stability. Above 1·0M control improves and application of g, within the limitations, is restricted only by the gradual decrease in tailplane effectiveness with increase in Mach number.

43. *Directional Control*

a. *F Mk 3 and T Mk 5*. In the F Mk 3 and T Mk 5, the handling charcteristics change appreciably in the region 1·2M to 1·4M above 550 knots, particularly when missiles are fitted and when g is applied. In this region, application of aileron induces pronounced adverse yaw, causing reduced roll response and a feeling of control heaviness. In the lateral plane, difficulty may be experienced in accurate trimming. Therefore, close rudder coordination is important during all manoeuvres. On some aircraft, and especially in the F Mk 3 at supersonic speed, repeated applications of rudder trim may be needed as Mach number is increased.

b. *F Mk 6*. With only one missile fitted, there is a pronounced directional change of trim with change of speed. At 10,000 feet the rudder trimmer authority is adequate but at 40,000 feet an increasing pedal force may be required above 1·7M.

Formation Flying

44. *General*. There is a possibility of the structural limitations of the aircraft being exceeded during formation flying due to airflow interference between

aircraft. The following speed and manoeuvre limitations are to be observed.

45. *Normal Close Formation Procedures*. During formation flying, speeds should normally be restricted to less than 450 knots or 0·92M, whichever is the lesser, and accelerations limited to +2g. Lateral clear separation should be not less than half wing-span and is never to be less than a quarter span. The wing man's overtake speed is to be slow enough to allow correction for any lateral disturbances due to the other aircraft's airflow pattern. When higher speeds or greater normal accelerations are required, a minimum lateral separation of two wing-spans is to be maintained. One aircraft is not to fly directly behind another at speeds greater than 0·7M. Below this Mach number, the fin tip is to be kept clear of the leading aircraft's jet stream.

46. *Formation Aerobatics and Display Flying*. During formation aerobatics, 0·87M is not to be exceeded. Between 0·7M and 0·87M, 3g is not to be exceeded and clear lateral separation should be at least one half wing-span, and is not to be less than a quarter span. The 'line astern' limitations are as given in para 45. High subsonic speed low level runs in formation are to be in echelon only with a minimum lateral separation of two wing-spans.

47. *Supersonic Manoeuvres*. Special care is necessary to avoid the pressure field of an aircraft flying at supersonic speed. In any passing manoeuvre between aircraft, one or both of which are travelling supersonically, a clear separation of at least two spans is to be allowed in any direction normal to the line of flight.

Range and Endurance

48. Full details of the cruise performance are given in the ODM. In general, the maximum range and endurance are obtained at approximately the following heights:

a. *On Two Engines*: Range 36,000 feet
Endurance 30,000 feet

b. *On One Engine*: Range 30,000 feet
Endurance 20,000 feet

DESCENDING

Types of Descent

49. *Fast Descent*: Speed 0·95M/550 knots
Airbrakes Out
Throttles Idle/idle
(see Note)

50. *Normal Descent*: Speed 0·9M/375 knots
Airbrakes Out
Throttles Idle/fast idle

51. *Slow Descent*: Speed 0·9M/250 knots
Airbrakes In
Throttles Idle/idle
(see Note)

Note: Set No 2 engine at fast idle before RPM falls to 58% to keep AC power on line.

52. *Single-Engine Descent*. Set the live engine throttle to fast idle and use any 2-engine descent profile. Half-way down the descent, increase the attitude to 7° nose-up for at least 15 seconds to ensure that fuel pressure is maintained.

PART 3

CHAPTER 4—STALLING AND SPINNING

Contents

Stalling

WARNING: Intentional stalling is prohibited and speed is not to be reduced below the minimum speed limitations (Part 2, Chapter 1). During any manoeuvres below 200 knots, maintain engine RPM above 60% to ensure rapid acceleration to full power.

1. *Characteristics.* The following sequence applies on aircraft carrying two missiles and with undercarriage and flaps up:

220 knots — Slight buffet begins

180 knots — Gentle wing rock may occur

170 knots — Buffet increases in intensity. In the F Mk 6, the aircraft will probably sink straight ahead, even with the control column fully back

140 knots — In the F Mk 3 and T Mk 5 the aircraft begins to wander in roll, yaw and pitch. The wander becomes more pronounced as speed is reduced

115 knots — In all marks, the aircraft yaws rapidly followed by wing drop and entry to a spin

Note: In all marks, the rate of descent can increase to over 6000 ft/min as the stall is approached. The IAS at which sink commences varies according to the rate at which the control column is moved aft.

2. *No Missiles Carried.* With missiles off, the buffet level is higher and there is some stick force lightening as speed is reduced below 125 knots, which gives a 'knife edge' feeling.

3. *Overwing Tanks Carried.* With overwing tanks fitted, *moderate* buffet is felt at 220 knots which reduces to *mild* buffet as the speed falls to 150 knots.

4. *Recovery.* Recovery from the stall is immediate upon centralising the control column and increasing IAS. However, coarse use of aileron or rudder could easily result in a spin. If the aircraft has already reached the stage of yawing rapidly, centralising the control column may not prevent a spin developing.

5. *g-Stalling.* Speed can be lost rapidly as g is applied. With a gradual application of g, the onset of moderate buffet occurs before the stall. Further evidence may be provided in the form of gentle wing rocking and directional wandering. If the aircraft fails to respond normally to control movements or starts to deviate from its flight path without pilot action, centralise the controls immediately or the aircraft is likely to flick roll. Instinctive use of aileron to oppose any roll aggravates the situation and will probably cause the aircraft to roll and yaw in the opposite direction to the applied aileron. (With missiles removed, the flick manoeuvre is less predictable and usually more severe.) If g is applied suddenly by harsh control movement, the aircraft may pass rapidly through the buffet zone into the flick manoeuvre. Avoid coarse use of the controls when manoeuvring in the buffet zone.

Spinning

WARNING: Intentional spinning is prohibited. The following information is to acquaint pilots with spin characteristics and the recovery from inadvertent spins.

6. *General.* The characteristics of the incipient spin vary considerably and depend on the type of manoeuvre and control positions at the moment the aircraft departs

from controlled flight. If control is lost during manoeuvre, the fully developed spin may be preceded by one or more rapid rolls; if the control column and rudder are centralised at this stage, the aircraft may recover. Spin characteristics differ with the various missile configurations but the recovery behaviour is not affected.

7. *Spin Characteristics.* Generally, at stalling incidence the aircraft yaws rapidly and then begins to roll, the higher the g on departure, the greater the rate of roll. In the spin the nose tends to drop after the first half turn and then rise towards the end of the first turn. The second and subsequent turns are steeper and the spin remains oscillatory in roll, yaw and pitch. The fully developed erect spin is fairly steep, with the aircraft nose 40° to 60° below the horizon. The rate of rotation is quite slow, being one turn every six to eight seconds. The rate of descent is approximately 20,000 feet/min (2000 to 2500 feet/turn). The ASI fluctuates between off-scale and 140 knots once per turn.

8. *Recovery.* The spin recovery actions and considerations are listed in Table 1.

WARNING: If the aircraft is not under control by 10,000 feet AGL (ie responding normally to control inputs and accelerating through 200 knots) — *Eject.*

Table 1 — Spin Recovery

Actions	*Considerations*
Centralise the controls	Recovery may result. If not, maintain the controls central during the next two actions
Positively confirm that the aircraft is spinning	Indications: Sustained rotation in yaw and ASI fluctuating between off-scale and 140 knots
Positively assess the direction of rotation	External references only are available. Do not apply rudder unless the direction of spin is definitely established. If in doubt, maintain rudder and control column central; there is a high probability that this action will achieve recovery within three to four turns (8000 feet)
Apply full rudder against direction of rotation	A force of 200 lb is required to apply full rudder
Monitor height and speed	The aircraft is slow to respond initially but recovers within two turns after applying full rudder
Centralise the rudder when IAS rises through 150 knots	The best indication that the aircraft is recovering is the IAS increasing through 150 knots
At 200 knots oppose any residual roll with aileron. Smoothly roll the wings level	Do not apply aileron before 200 knots otherwise the aircraft may re-enter a spin
Recover from dive	Not more than +3g below 250 knots

WARNING: It is essential that full rudder application can be achieved. Pilots are therefore to adjust their sitting positions before flight accordingly.

9. *Recovery Considerations*

a. *Disorientation.* Disorientation or confusion is likely during an unintentional spin (eg from combat manoeuvring). It is essential that the controls be centralised and maintained in that position until the direction of rotation is positively established, or the aircraft recovers of its own accord, or the decision to eject is made.

b. *Engine Effects.* The engines should not flame out or surge in a spin although reheat (if in use) may extinguish. Varying the power setting in a spin has negligible effect on recovery and therefore the throttles should be left at the pre-spin position until recovery from the dive is started.

c. *Control Column Position.* Full out-spin aileron prevents recovery. More than ½ in-spin aileron, though resulting in an extremely rapid recovery, can easily produce a reversal into a spin in the opposite direction. Neutral aileron should therefore be used; the control system 'feel' assists in achieving this position. Tailplane position has no effect on recovery rate but, with the control column fully forward, an uncomfortable bunt results after rotation ceases; a too-far aft position could result in a further stall after rotation ceases.

d. *Airbrakes.* Airbrakes have little effect on spin recovery.

e. *Overwing Tanks.* Overwing tanks, with or without fuel, have little effect on spin characteristics or recovery. Do not jettison them in a spin.

f. *Brake Parachute.* Do not attempt to stream the brake parachute as an aid to spin recovery as it is unlikely to be effective and may foul the flying controls.

g. *Instruments.* Gyro instruments may topple during a spin. Therefore the MRG and compass cannot be relied on after recovery until they have been checked and re-erected.

PART 3

CHAPTER 5—APPROACH AND LANDING

Contents

VISUAL CIRCUITS

Visual Approach and Landing

1. An overshoot followed by a circuit and landing uses up to 250 lb of fuel per side (F Mk 3, 200 lb/side). An overshoot followed by an instrument circuit and landing uses 500 lb/side. When calculating the fuel required for landing, bear in mind that up to 400 lb/side gauged fuel may be unusable. Approach, threshold and touchdown speeds are listed in the FRC.

2. In the T Mk 5 only, the wheelbrakes are not to be applied during the five minutes immediately before landing.

3. After joining the circuit, carry out the **Checks Before Landing** listed in the FRC. Ensure that the brakes are off: in the F Mk 6, post-mod 4212, check that the left and right pointers indicate zero on the triple pointer gauge; in the T Mk 5 check that the left stick parking catch is not engaged and both stick brake levers are fully off.

4. Make the initial turn on to final approach at the approach speed plus 15 knots in the F Mk 6 or at 190 knots in the F Mk 3 and T Mk 5. When converging with the runway centreline, reduce the bank angle and airspeed progressively to line up at 300 feet at the approach speed. Airbrakes are normally extended half-way round the finals turn.

5. A shallow approach is recommended, maintaining at least 60% RPM to ensure rapid engine acceleration if this becomes necessary. Avoid steep approaches owing to the danger of striking the rear fuselage on the runway at round-out.

6. Reduce speed slowly on the approach to cross the threshold at the recommended speed. Round out smoothly, with power on, to prevent the rear fuselage striking the ground. When the main wheels are on the ground, close the throttles to idle/fast idle, lower the nosewheel and pull the brake parachute handle to its full extent. To prevent damage to the parachute during streaming, hold the control column fully forward;

when the parachute has deployed, move the No 2 throttle to idle. If the brake parachute is streamed below 100 knots, there may be insufficient airflow to assist the pilot chute to deploy the main canopy.

7. The braking effect of the parachute is high and it is always to be used. The parachute normally reduces the aircraft speed to 20 knots in approximately 6000 feet without the use of wheelbrakes, irrespective of runway surface conditions. Use the wheelbrakes as necessary to supplement the effect of the parachute and to keep straight. If wheelbrakes only are used, the landing ground roll is increased by approximately 40 to 50% on a dry runway and up to 90% on a wet runway. Landing data is given in the ODM.

Roller Landing

8. Roller landings are not normally permitted owing to the possibility of overheating the tyres.

Precautionary Landing

9. When an approach is made in circumstances that preclude any further approach being made, the precautionary landing technique is to be adopted as follows. At touchdown, move the throttles to idle/idle, lower the nosewheel to the ground promptly, and employ the maximum braking technique (para 19), simultaneously pulling the brake parachute handle to its full extent.

10. If the brake parachute deploys, release the wheelbrakes and complete a normal landing run. If the brake parachute fails to deploy (or it is not available), continue with the maximum braking technique; do not taxy because damage to the brakes and tyres may have occurred.

Crosswind Landing

11. The crab landing technique is recommended for approaches in crosswind conditions. When rudder is used to eliminate drift, anticipate a rolling moment due to yaw.

12. Immediately after touchdown, lower the nosewheel and stream the brake parachute anticipating weathercocking and correcting by the use of rudder. Apply into-wind aileron to keep the wings level and equalise weight distribution on the wheels as far as possible. Use differential wheel braking only when the rudder begins to lose effectiveness, thereby minimising the chance of drift caused by loss of runway adhesion.

13. The most critical part of the landing run is between 125 and 100 knots. Below 100 knots, normal wheel braking up to maximum may be used as required without significant adverse effects on directional control. Landing distances are longer than normal.

14. If an uncontrollable drift to the downwind side of the runway occurs, the following actions are recommended:

a. Release the brakes, thereby allowing maximum use of the restoring force provided by tyre/runway friction to oppose drift.

b. Allow the weathercocking effect to yaw the aircraft nose into wind and restore tracking towards or parallel to the upwind side of the runway.

c. Delay the use of wheelbrakes until rudder control becomes insufficient or until directional control ceases to be critical.

d. Do not jettison the brake parachute to counter drift unless retaining it is likely to cause the aircraft to leave the side of the runway.

Turbulence

15. When landing in turbulent conditions, add five to 10 knots to the threshold and touchdown speeds.

Braking Technique

16. *Dry Surfaces*. On dry surfaces, the maxaret units normally prevent the wheels from locking when excessive brake pressure is applied but, unless the shortest possible run is required, more gentle use of the brakes is recommended. The aircraft is to be firmly on the ground before the brakes are applied as the maxaret units do not operate unless the wheels are rotating. As a safeguard against the wheels locking during a bounce, the maxaret units remain operative for several seconds, ie the wheels continue to rotate even though the brake lever is applied. If a slip or skid is felt, or difficulty is experienced in keeping straight, release the brakes momentarily to allow the wheels to spin up. Use brakes judiciously to minimise wheelbrake heating.

17. *Wet Surfaces*. Braking effect may be greatly reduced on wet runways, depending on runway surface and the amount of water. Generally, in wet conditions, light, continuous braking should be started after the wheels have had time to spin up. Thereafter brake application may be progressively increased as the speed falls.

18. *Flooded or Icy Runways*. Whenever possible avoid flooded or ice-covered runway conditions because of the reduced wheelbrake effectiveness. If a landing is to be made in such circumstances, employ the wet surfaces technique, using extreme caution.

19. *Maximum Braking Technique.* If maximum braking is necessary, lower the nosewheel on to the runway as soon as possible after touchdown. With the stick held fully forward, apply firm brake pressure and simultaneously stream the brake parachute. Progressively move the stick rearward and increase the brake pressure as the aircraft slows, avoiding maxaretting.

Overshoot Procedure

20. Normally 90% RPM is sufficient for an overshoot before touchdown. Open the throttles together smoothly and retract the airbrakes; when climbing away, raise the undercarriage. If required, the undercarriage may be left down; it is to be left down for a short time if the wheels have touched the runway in order to assist cooling. Delay the selection of flaps UP until a speed of 180 knots is attained.

Failure of the Brake Parachute

21. Failure of the brake parachute to stream considerably increases the landing run and places a heavy demand on the wheelbrakes. The action to be taken depends on the prevailing conditions and is to be decided on before starting the final approach.

22. If conditions permit a further approach, apply full cold power to become airborne again, raising the flaps at 180 knots. Leave the undercarriage down to cool the wheels. Make the subsequent landing using the precautionary landing technique.

23. If the parachute streams but subsequently collapses, the decision whether to become airborne again depends upon the initial deceleration obtained, the remaining length of runway available and the prevailing conditions. When it is decided to roll and make a further approach, roll as described in para 22, being sure to jettison the brake parachute. Initially the pilot will have no indication whether the parachute has jettisoned or not.

Heavy Weight Landing

24. Landing at AUW in excess of 34,500 lb should be avoided whenever possible. Before making the approach, consider the actions to be taken in the event of a brake parachute failure. If a landing at high AUW is inevitable:

a. Make a flatter than normal approach and, to avoid damaging the undercarriage, land as gently as possible.

b. As soon as the nosewheel is on the ground, employ maximum braking technique (para 19).

c. Do not stream the brake parachute until the speed has reduced to 150 knots (170 knots, F Mk 6).

d. After a successful stream, moderate wheel braking should suffice. The landing run may be reduced by closing one HP cock.

Flapless Landing

25. All stages of a flapless circuit and landing should be flown at 10 knots faster than for a normal landing. Whenever practicable, reduce AUW in order to keep the touchdown speed as low as possible. The absence of flap results in a marked nose-up attitude throughout the circuit and, unless the seat position is raised, difficulty may be experienced in retaining an unobstructed view of the runway on the final approach.

26. Make a flatter than normal approach; the high angle of attack reduces tail bumper clearance when rounding out and extra care is necessary at this stage of landing. The higher touchdown speed may cause the aircraft to bounce unless prevented by moving the control column forward as the main wheels touch the ground. The minimum landing run is approximately 600 feet longer than for a normal landing.

Checks After Flight

27. Carry out the **Checks After Landing** listed in the FRC.

28. If heavy braking has been used during the landing, the minimum braking necessary is to be used during taxying to avoid wheel overheating.

29. In dispersal carry out the **Shutdown Checks** listed in the FRC.

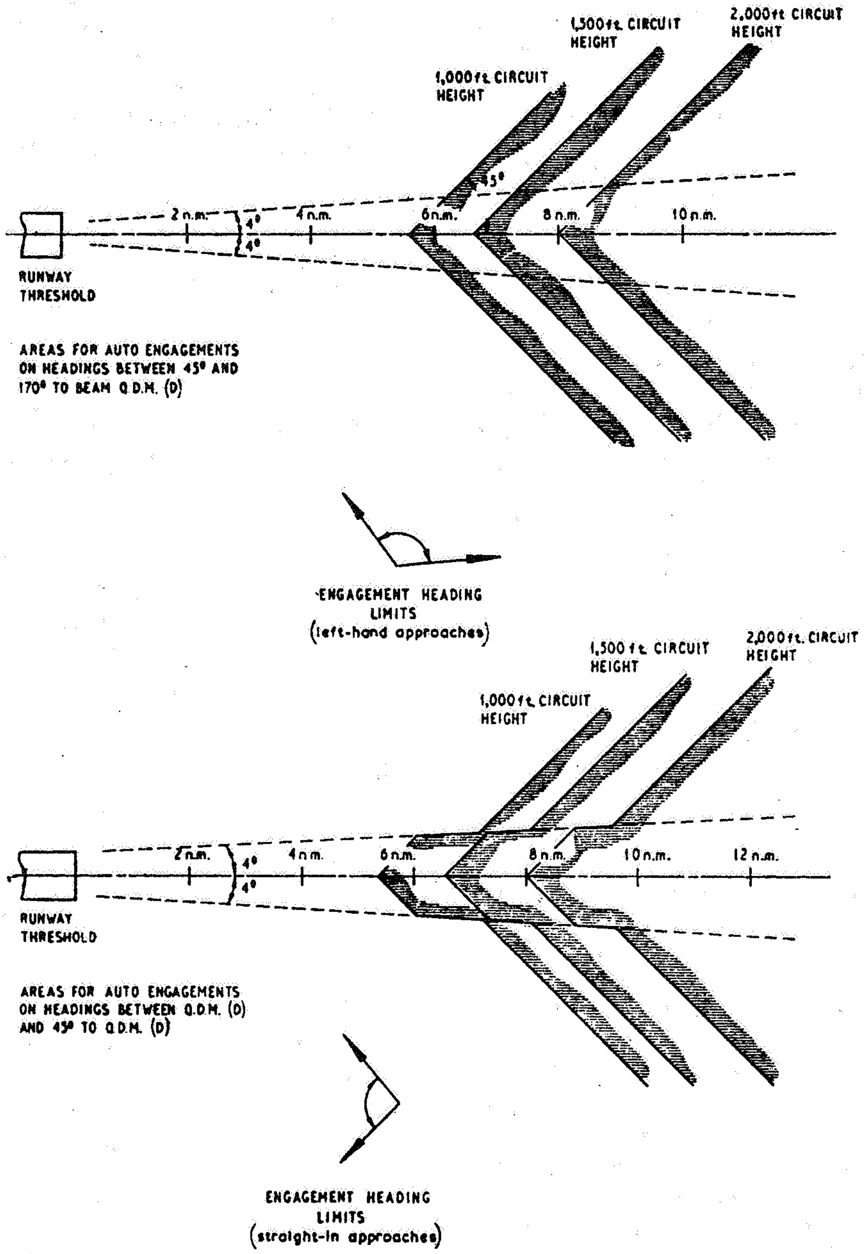
INSTRUMENT APPROACHES

PAR and ILS

30. It is recommended that ILS approaches be monitored by PAR.

31. Instrument approach power settings, speeds to fly and aircraft approach limitations are set out in the FRC.

32. In the event of a missed approach, carry out the overshoot procedure (para 20). If the fuel state is marginal for dealing with any subsequent undercarriage malfunction that might arise, leave the undercarriage down during and after the overshoot.



3—5 Fig 1 Engagement Areas for Auto-ILS Approaches

Auto-ILS

33. Plan the let-down into the ILS pattern so that on reaching check height the aircraft is suitably positioned within the ILS engagement area (Fig 1). Do not descend to less than 1000 feet AGL until the ILS glidepath is intercepted. The **Checks Before Landing** are normally completed by 12 miles from touchdown.

34. During the let-down, set or confirm:

a. Autostabilisers ON and functioning satisfactorily.

b. ILS MASTER switch ON, channel selected and beacon identified.

c. VP/ILS to ILS.

d. ILS selected on the navigation display, heading selector on QDM(D), localiser index set on beam QDM.

e. BEAM and GLIDEPATH amber lights not showing.

f. Autopilot engage switch OFF.

g. TRACK selected on the FCS control unit.

35. Below 250 knots with both engines set at 75% RPM, select throttle servo to ENGAGED. It may be

necessary to make small adjustments to the power setting to maintain the correct speed; these small movements to the throttle can be made without servo disengagement. When high AUW requires an approach speed above 180 knots, disengage the servo and control the speed manually.

36. With the aircraft trimmed out, the autopilot trim indicator should fluctuate about the central position.

37. When positioned within the ILS engagement area and on the correct heading (ie within 170° of QDM(D)), check that the ILS indications are logical and the autopilot trim indicator central. Select the stick switch to AP: the FD bead moves from its parked position.

38. The autopilot immediately applies up to 30° of bank to turn the aircraft towards the localiser beam and fly an interception heading of up to 45° to the QDM(D). During this turn the aircraft may descend by as much as 400 feet. This can be corrected by overriding the autopilot; using the trimmer to correct the error as an alternative, necessitates re-trimming when the turn is complete.

39. After passing through the localiser beam once, the autopilot aligns the aircraft on the localiser centreline. At short ranges, this overshoot through the beam may cause a full-scale deflection on the ILS indication.

40. When the glide bar begins to move down, extend the airbrakes and press the GLIDE key. The aircraft pitches down and follows the glidepath.

41. Throughout the approach, carefully monitor autopilot trim and approach speed and keep them correct by trimming and overriding the throttle servo clutch as appropriate. The small corrections that may be necessary should be followed by a delay of about 30 seconds, where practicable, to allow the system to stabilise.

42. At decision height, disengage the throttle servo, select the stick switch to OFF and land or overshoot as appropriate.

Note 1: QDM(D) is the heading required, allowing for drift, to track the beam centreline (QDM). The accuracy of the final approach depends on the accuracy of the drift allowance set.

Note 2: If the autopilot trim indicator does not indicate zero in steady flight, do not engage the autopilot.

Note 3: Do not select GLIDE with a heading error greater than 10° from QDM(D) or with a localiser error at full deflection. If necessary, selection may be delayed until half-scale 'fly-down' is indicated.

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PART 3

CHAPTER 6—AIR-TO-AIR REFUELLING

Contents

Considerations

1. The aircraft is cleared for air-to-air refuelling (AAR) from Victor K2, Buccaneer S2, VC10 K2 and KC-135 tankers. Sorties of up to nine hours (11 hours, F Mk 6) duration may be undertaken.

2. *Normal Limitations*

   a. *Victor K2*

      (1) Maximum altitude: 43,000 feet

      (2) Minimum speed for making contact and in contact: 250 knots

      (3) Maximum speed for making contact and in contact: 290 knots/0·88M or 320 knots/0·88M on centre station

   b. *Buccaneer S2*

      (1) Speed for making contact and in contact: 250 to 290 knots

   c. *KC-135*

      (1) Speed for making contact and in contact: 250 to 270 knots

   d. *VC10 K2*

      (1) Maximum altitude: 35,000 feet.

      (2) Speed is to be between 260 and 300 knots. Optimum speed is 280 knots.

3. *Reheat.* Do not use reheat unless absolutely necessary. If full cold power is not adequate, establish lateral separation from the tanker before engaging one reheat only. Do not engage reheat while in contact with the drogue.

Checks Before AAR

4. Before commencing AAR check:

   a. Autostabilisation ON and functioning correctly.

   b. Fuel contents.

   c. Weapons switches safe.

   d. Ventral tank emergency transfer switch to NORMAL (F Mk 6).

   e. AAR switch to FL REFUEL (ON, T Mk 5)

   f. 'Tanks full' indicator lights on.

   g. Probe lighting — as required.

   Note: Switch off the radar transmitter when in visual contact with the tanker.

Stabilised Position

5. When cleared astern the tanker, wait behind the appropriate drogue noting the trail angle of the hose.

Making Contact

6. When using a wing drogue the following trim adjustments are required:

   a. *Victor and KC-135*

      (1) Aileron: Two-thirds maximum away from tanker fuselage.

      (2) Rudder: a little away from the tanker may be required.

b. *Buccaneer*

(1) Aileron: ¾ maximum away from the tanker.

(2) Rudder: ¾ maximum away from the tanker.

c. *VC10 K2*

(1) Aileron: ¾ maximum away from tanker fuselage.

(2) Rudder: ¼ maximum away from tanker fuselage.

(3) Displacement inboard and/or downward from the normal refuelling position on wing stations causes rolling and yawing moments towards the tanker fuselage. Such displacements are to be avoided.

7. The procedures for making, maintaining and breaking contact are to be found in the No 1 Group AAR SOP.

Hose/Drogue Malfunctions

8. Structural failure of the hose or drogue may result in excessive fuel spillage; the fuel may enter the air intake and cause an engine flame-out. If this occurs, do *not* attempt an immediate relight. Close the appropriate HP cock and wait for as long as practicable but for at least 1½ minutes before carrying out the **Cold Relight** drill.

Probe Damage

9. If the end of the probe is damaged or lost, do not exceed 350 knots.

Checks After AAR

10. When air-to-air refuelling is complete, check:

a. AAR switch to NORMAL (OFF, T Mk 5).

b. Ventral tank feeding.

c. Probe lighting (if used), off.

WARNING: If the AAR switch is left at FL REFUEL (ON, T Mk 5), the ventral and flap tanks do not transfer.

PART 3

CHAPTER 7—SINGLE-ENGINE FLYING AND RELIGHTING

Contents

General

1. Handling procedures in the event of an engine failure during take-off are described in Chapter 2 of this Part.

Shutting Down an Engine in Flight

2. The engine is only to be shut down in flight on the following occasions:

a. During specific emergency procedures.

b. When required by an air test schedule.

c. When there is an operational necessity to conserve fuel.

3. If the situation permits the pilot to choose which engine to shut down, No 2 engine should be chosen because, if No 1 were shut down and it failed to relight, the emergency undercarriage lowering facility is lost and the brake parachute would be slow to deploy or not stream at all.

4. The **Engine Shut Down drill** is contained in the FRC. If an engine is shut down to comply with an air test schedule or to conserve fuel, the appropriate FUEL COCK switch is to be left ON to provide fuel lubrication for the engine HP fuel pump.

5. If No 2 engine has been shut down, take care to ensure that the No 1 engine remains above 58% RPM.

Single-Engine Flying

6. There are no asymmetric handling problems associated with single-engine flying. However, flight through icing conditions should be avoided owing to the lack of anti-icing protection on the shut-down engine.

7. Correct any fuel asymmetry by using the fuel transfer switch; both DC pumps switches must be on (see Part 4, Chapter 2 for engine/fuel management during low level diversion). When gauged fuel on the side with the shut-down engine falls to 400 lb, thereby uncovering the DC pumps, transfer continues at approximately 33 lb/minute if the windmilling engine is kept above 30% RPM.

Single-Engine Landing and Overshoot

8. Use the normal descent and approach procedures, listed in the FRC, when flying on one engine, but maintain the live engine at fast idle during the descent and increase attitude to 7° nose up for at least 15 seconds half-way down the descent.

9. A single-engine landing presents no difficulty; use the normal approach and landing speeds. On the approach, the live engine RPM settings required are eight to 10% higher than on a 2-engine approach.

10. At normal landing weights an overshoot with undercarriage and flaps down can be achieved in maximum cold power. Details of climb performance on one engine are given in the ODM. Raise the undercarriage when safely climbing away, and the flaps at not less than 190 knots.

Single-Engine Landing at High AUW (F Mk 6)

11. When at or close to the maximum permissible emergency landing weight in the F Mk 6 (40,500 lb), the maximum cold power available on one engine may be insufficient to enable the aircraft to maintain a normal glidepath. Without overwing tanks at weights over 38,000 lb, the VCH is 250 feet and the EOA 150 feet. With overwing tanks fitted at weights over 34,000 lb, the VCH is 700 feet and the EOA 600 feet. Overwing tanks are to be emptied before landing.

12. If an approach at a high AUW cannot be avoided, make a flapless approach at 195 knots with the airbrakes in. When certain of reaching the runway, lower flap and extend the airbrakes with caution to achieve threshold speed.

13. Make the decision to land or overshoot before the flap is lowered and the speed reduced, since the height loss during overshoot from 185 knots at this weight can be as great as 200 feet.

Simulated Single-Engine Flying

14. Single-engine flight may be simulated by throttling back either engine to idle, taking care to maintain at least 58% RPM on the other engine to ensure AC power supplies.

Relighting an Engine in Flight

15. There are two methods of relighting an engine in flight: 'hot' relight and 'cold' relight.

16. The minimum recommended windmilling RPM for relighting an engine is 15%; however, in an emergency, relighting may be attempted at any RPM.

17. *Hot Relight.* If a flame-out occurs, an immediate (hot) relight may be attempted at any height and speed. Leave the throttle at its set position (or, if in reheat, move it into the cold power range) and press the relight button for 2 seconds. A successful relight is indicated by the RPM stabilising and then starting to rise. Ensure that the maximum JPT is not exceeded by throttling back if necessary. If no relight occurs within 20 seconds, set the appropriate throttle at HP COCKS OFF and wait 1½ minutes to drain excess fuel before attempting a cold relight.

18. *Cold Relight*

WARNING: Each time an unsuccessful attempt to relight is made, a quantity of fuel is discharged into the engine and jet pipe. Repeated attempts result in a fire risk, which is greater when relighting No 2 engine. Therefore, only one cold relight is to be attempted unless:

a. *No 1 Engine.* There are overriding flight safety reasons for *not* making a single-engine recovery.

b. *No 2 Engine.* Ejection is the only alternative.

Relighting becomes progressively more certain at lower altitudes. The stated height and speed limits for a cold relight are 0·9M and 40,000 feet. However, if practicable, it is recommended that the relight attempt be made between 250 and 300 knots below 25,000 feet. Set the live engine at less than 96% RPM and try to achieve 15 to 20% RPM on the windmilling engine. Ensure that the ENGINE MASTER and fuel switches are on. When the throttle has been at HP COCKS OFF for at least 1½ minutes, press the appropriate relight button for 2 seconds and immediately set the throttle to IDLING. If a relight is not achieved within 20 seconds, select HP COCK OFF and decide upon subsequent actions in accordance with the above WARNING. It is unlikely that an engine which fails to relight during the first cold relight attempt will achieve a successful relight during a subsequent attempt.

Relighting in Icing Conditions

19. If an engine flames out when flying in icing conditions, a hot relight may be attempted. If this is unsuccessful, descend out of icing conditions, if possible, before attempting a cold relight. However, the cold relight attempt is to be made within three minutes of the flame-out; an attempt after this interval may damage the engine.

PART 4

EMERGENCIES AND MALFUNCTIONS

List of Chapters

PART 4

CHAPTER 1—EMERGENCIES INDEX

Contents

General

1. Systems malfunctions and their associated emergency handling drills are covered in the appropriate Chapters of this Manual or in the FRC as shown in Table 1 below.

Table 1 — Emergencies Index

Emergency	*Text* *Part*	*Chap*	*Para*	*FRC Tab Marking*
ABANDONING				
Abandoning the aircraft in flight	1	12	23	Ejection/U/C
Failure to eject	1	12	25	
Failure of auto-separation	1	12	27	
AIR CONDITIONING AND PRESSURISATION				
Pressurisation failure	1	10	25	Autopilot/Stabs/Fumes/Press/Oxygen
Overpressurisation	1	10	24	
Toxic fumes	1	10	28	
Temperature control failure	1	10	27	—
Emergency decompression	1	10	29	—
COCKPIT EQUIPMENT				
Canopy malfunction	1	6	36	—
Internal lighting malfunctions	1	9	22 and	—
	1	9	27	
Anti-g valve failure	1	12	42	—
AVS malfunction	1	12	43	—
EJECTION — see ABANDONING				
ELECTRICAL				
AC failure	1	1	34	Trim/Elect
Generator failure	1	1	37	Electrical/Jettison
Double generator failure	1	1	39	
Generator overvolting	1	1	43	
Air turbine malfunctions	1	1	46	—
Turbine failure	1	1	46	Trim/Elect
Burst air duct	1	1	47	Trim/Elect
Load shedding	1	1	40	Electrical/Jettison

continued

Table 1 — Emergencies Index — *continued*

Emergency	*Text* Part	Chap	Para	*FRC Tab Marking*
ENGINE				
Failure to start	1	3	12	Fail Start/Take-Off
Engine or reheat failure on take-off	3	2	1	Engine Fail
Flame out		—		Engine Fail
Engine shut-down	3	7	2	Relight/Oil/Shut Down/Fuel Leak
Hot relight	3	7	17	Engine Fail
Cold relight	3	7	18	Relight/Oil/Shut Down/Fuel Leak
Reheat malfunctions	1	3	26 and	Take-off/Limitations
	3	3	8	
Oil pressure failure	1	3	7	Relight/Oil/Shut Down/Fuel Leak
High JPT	2	2	1	—
FIRE				
Engine fire	4	2	2	Fires
Single reheat fire	4	2	16	Fires
Double reheat fire	4	2	17	Engine fail
FLIGHT CONTROLS				
Single control system failure		—		Trim/Elect
Double control system failures	1	5	24	Trim/Elect
Feel failure		—		Trim/Elect
Trim malfunctions	1	5	26	Trim/Elect
Loss of rudder in flight	4	2	25	—
Autopilot/autostab failures	1	8	57	Autopilot/Stabs/Fumes/Press/Oxygen
FUEL				
Contents gauge failure	1	2	60	—
Fuel pressure warnings	1	2	52	Fuel
Wing-to-wing transfer malfunction	1	2	57	Fuel
Ventral/flap transfer failure (F Mk 3 and T Mk 5)	1	2	62	Fuel
Ventral transfer failure (F Mk 6)	1	2	63	Fuel
Overwing transfer failure		—		Hydraulics
Overwing tank fuel dumping	1	2	42 and	Hydraulics
	2	1	36	
Tank vent valve failure	1	2	8	—
Mk 44 valve failure	1	2	66	Hydraulics
Fuel management during diversion	4	2	33	Operating Data
Fuel leak		—		Relight/Oil/Shut Down/Fuel Leak
HYDRAULICS (see also FLIGHT CONTROLS)				
Services system failure	1	4	11 and	Hydraulics
	1	6	35	
INSTRUMENTS				
Instruments sustained after AC failure	1	7	6	—
Standby instruments — power supplies	1	7	40	—
IFF fail light	1	13	32	—

continued

Table 1 — Emergencies Index — *continued*

Emergency	*Text* *Part*	*Chap*	*Para*	*FRC Tab Marking*
JETTISONING				
Canopy jettison	1	6	31 and	Electrical/Jettison
	2	1	37	
Ventral tank jettison	1	2	37 and	
(F Mk 3 and T Mk 5)	2	1	34	
LANDING EMERGENCIES				
Undercarriage fails to lower	1	6	7 and	Ejection/U/C
	1	6	19	
Two green lights only	4	2	21	Barrier/Cable
Undercarriage fails to retract		—		Ejection/U/C
Undercarriage emergency retraction	1	6	5	—
Barrier engagement	2	1	49	Barrier/Cable
Brake parachute failure	3	5	21	—
Precautionary landing	3	5	9	—
Heavy weight landing	3	5	24	Landing
Flapless landing	3	5	25	—
Arresting cable engagement	4	2	26 and	Barrier/Cable
	2	1	50	
OXYGEN				
Suspected hypoxia		—		Autopilot/Stabs/Fumes/Press/Oxygen
Difficulty breathing in		—		
Difficulty breathing out		—		
OXY caption	1	12	50 and	
	1	12	64d	
Dolls-eye black		—		
Dolls-eye white		—		
RADIO				
Transmitter failure	1	13	21	—
Main radio failure	1	13	22	Radio/Hydraulics
SPINNING AND LOSS OF CONTROL				
Stalling	3	4	1	—
Spinning	3	4	9	—
Transonic yaw divergence	3	3	34	—
Autorotation	3	3	33	—
UNDERCARRIAGE — see LANDING EMERGENCIES				

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PART 4

CHAPTER 2—EMERGENCY PROCEDURES

Contents

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General

1. Although system malfunctions are covered elsewhere in the text of this Manual and in the FRC, considerations to be borne in mind and background information in respect of certain emergencies are given in this Chapter.

ENGINE AND REHEAT FIRES

Indications

2. A FIRE 1 or FIRE 2 caption indicates an engine fire in the respective engine bay; a RHT 1 or RHT 2 warning indicates an excessive temperature or fire in the jet pipe area. These warnings are indicated on the SWP and are accompanied by the flashing attention-getters and audio warning. A FIRE 1 or FIRE 2 warning also causes the appropriate fire extinguisher button light to come on.

3. If AC changeover occurs while any of these captions is still being displayed, the audio warning and attention-getters are re-activated.

4. *Titanium Fires.* A titanium fire caused by mechanical failure in the engine compressor may not be contained within the engine casing. This could cause the FFFD firewire to be burnt through so quickly that no fire warning is given; however, a falling RPM and rapidly rising JPT would be indicated. If these symptoms are experienced in the absence of compressor stall or mechanical failure, a titanium fire must be suspected and the **Engine Fire** drill in the FRC carried out. Because of the absence of a fire warning light initially, the actions under '*If fire warning remains on*' must also be carried out.

Safe Height and Speed

5. It is essential that a safe height is achieved and maintained as soon as possible after any fire warning has occurred. Normally 5000 feet AGL should be considered the minimum safe height to fly. This height ensures that the pilot has sufficient time for a safe ejection should the aircraft adopt any sudden, uncontrollable attitude or high rate of descent.

6. Although there is no speed limitation on the use of the engine fire extinguisher, for fuel economy and ejection reasons 250 knots should be achieved and maintained as soon as practicable.

7. Use gentle manoeuvres only, avoiding negative g.

Fire Drills

8. The engine, reheat and double reheat fire drills are given in the FRC. The drills are similar in content. It is essential that the defective engine is shut down immediately, thereby cooling the engine and its surrounds quickly. The fuel supply must be cut off promptly by switching off the appropriate fuel cock and DC pumps switch and selecting the AAR switch to FL REFUEL (ON, T Mk 5). If practicable, bring the non-affected engine to idle/fast idle while carrying out the fire drill, thereby achieving optimum cooling of the external surfaces of the live engine. There is no fire extinguisher available for the reheat zone.

9. If the initial actions for a FIRE 1 or FIRE 2 cause the warning to go out and remain out, the aircraft should be landed ASAP.

10. If a RHT 1 or RHT 2 warning occurs, the aircraft is to be flown at or above the minimum safe height for as long as possible (minimum five minutes) *whether or not the warning goes out.* The same procedure applies to a persistent FIRE 1 or FIRE 2 warning. During the waiting period, a visual inspection is to be obtained if possible and the performance of the flying controls monitored carefully.

11. The time required to cool the firewire sufficiently to put out the warning caption when a fire has been extinguished depends on the type of overheating experienced and the level beyond the warning threshold to which the firewire was heated. This reset time may be up to two minutes or even more.

Persistent and Recurrent Warnings

12. If, after taking the initial actions for a fire, the warning persists, or, after a period with the warning light out the warning recurs, it must be presumed that the fire has not been extinguished. It is therefore essential to remain at a safe height until it can be ascertained whether or not the warning is spurious. The following symptoms indicate a persistent fire:

a. Tailplane control damage.

b. Fuel system warnings.

c. Total electrical failure.

d. Hydraulic malfunctions.

e. Hook lowering indication without selection (F Mk 6).

f. Loss of rudder control.

13. Although the tailplane control rods are resistant to fire, distortion of the airframe or carbonisation of the control bearing lubricant may result in:

a. Loss of tailplane effectiveness about the neutral position.

b. Loss of feel.

c. Increased friction or stiffening of the tailplane control.

14. Complete loss of tailplane effectiveness is unlikely before other malfunctions necessitate ejection. However, a persistent fire is highly likely to produce some indications of tailplane malfunction within five minutes of the fire starting. These malfunctions can be detected by making small fore and aft control column movements. Consequently, the absence of any tailplane malfunction after an elapsed period of 15 minutes strongly suggests that the fire warning was spurious unless other malfunctions are present.

15. If, after a period with a fire warning out, the warning recurs, the waiting period must be started again, since recurrence of the warning is, in itself, indicative of a persistent fire.

Single Reheat Warning

16. After a single reheat warning, complete the drill in the FRC. Even if a single reheat warning goes out, a safe height is to be maintained for at least five

minutes because a reheat fire can cause the FFFD to malfunction after the initial warning.

Double Reheat Warnings

17. Double reheat fire warnings usually result in the ultimate loss of the aircraft, although immediate ejection is not always necessary. Complete the drill in the FRC if practicable while positioning for possible ejection.

Recovery and Landing

18. Although there may be evidence of tailplane control damage, provided a minimum safe height is being maintained the aircraft is safe to fly until the extent of the fire damage has been established. The decision to land or eject depends upon the symptoms remaining at the end of the waiting period. Use the minimum power settings possible during recovery.

19. Do not attempt to land if there are positive signs of an unextinguished fire.

20. The rate at which control damage can arise is such that it may be dangerous to attempt to land even though the warning occurs when in close proximity to a suitable airfield. Therefore, unless the warning occurs during the last stages of an approach, from which position a landing is likely to be safer than an overshoot, the pilot is to overshoot and climb to the minimum safe height while carrying out the appropriate fire drill.

FAILURE TO OBTAIN THREE GREEN UC LIGHTS

Indications and Actions

21. When the undercarriage is lowered, there is a distinctive noise as each wheel locks down.

22. If a red light indication remains after an undercarriage DOWN selection, carry out the **Nosewheel Red** or **Mainwheel Red** drill in the FRC as appropriate.

23. Should one or more undercarriage lights remain out after a DOWN selection (ie no red or green indication for a particular leg), carry out the **Two Green Lights Only** drill in the FRC. The absence of a light indication for a particular leg is probably an electrical fault in the indicating circuit. Whether or not the appropriate red light came on during the lowering sequence, the undercarriage is probably down, especially if the three distinct thumps of the undercarriage locking down were noted. However, a visual inspection is to be obtained if possible.

24. If the undercarriage appears to be fully down and locked, operate the emergency undercarriage selector as an additional safeguard and land when practicable. If a part of the undercarriage appears not to be down and locked, proceed with the appropriate **Mainwheel Red** or **Nosewheel Red** drill in FRC.

Note: If the nosewheel fails to lower or unsafe indications are present and a nosewheel-up landing is to be made, carry out the **Undercarriage Fails to Lower** drill in the FRC. However, the decision to use the braking parachute must be made after considering the prevailing wind conditions. Wheelbrakes must not be used until the nose has been lowered onto the runway: therefore directional control may be lost in strong wind conditions after streaming the braking parachute.

LOSS OF RUDDER IN FLIGHT

Actions

25. If the rudder becomes detached in flight, recover to a runway with a crosswind component of less than 10 knots. However, if this is not possible, a landing in crosswind components of up to 20 knots can be made without difficulty.

ARRESTING CABLE ENGAGEMENT (F Mk 6)

General

26. Because of the likelihood of structural failure of the aircraft if a high-speed cable engagement is carried out (see Part 2, Chapter 1), and the possibility of the hook jumping over the cable owing to runway surface irregularities, do not attempt an approach-end engagement unless there are no alternative methods of stopping the aircraft safely.

Engagement Considerations

27. If centreline lighting is installed on the runway, aim to engage the cable slightly off centre, thereby minimising the risk of hook bounce causing a missed engagement.

28. The aircraft is liable to swing off-line if the cable is not engaged close to the centreline or if it is not taken at 90°. The swing caused by oblique engagement is more pronounced than that caused by off-centre engagement. Therefore, if an off-centre engagement is unavoidable, ensure that the cable is engaged at 90°.

29. The severity of any swing is likely to be greater at lower engagement speeds, down to 30 knots. If the cable is engaged more than 40 feet off centre, the aircraft may be swung off the runway.

Approach and Landing

30. Carry out the **Arresting Cable Engagement—** *Before Landing* checks in the FRC. Make a precautionary landing and delay hook lowering until the aircraft is firmly on the ground. Release the brakes just before engaging the cable.

31. If the cable is not engaged and it is necessary to become airborne again after the hook has been lowered, do not exceed 250 knots. Because of wear on the hook, anticipate possible hook failure on subsequent cable engagement.

After Engagement

32. Having released the brakes before reaching the cable, do not re-apply them until the aircraft finally comes to a halt. The deceleration after engagement is smooth and progressive. After a RHAG engagement close to the limiting speed, or when taking any other type of cable, the aircraft may be pulled backwards as the cable detensions. Do not apply the brakes at this stage because that is likely to cause the nose to lift and the tail to strike the runway. If the pull-back is violent, use engine power to check the rearward movement and apply the brakes only when the aircraft is stationary with the engines at idle/idle.

DIVERSION — ENGINE/FUEL MANAGEMENT

Fuel Transfer Technique

33. If a low level diversion is to be made when fuel reserves are critically low, the best use of available fuel is achieved by transferring as much fuel as possible to one side.

34. Therefore, fly at range speed with No 1 engine at idle while transferring fuel from the No 2 side to the No 1 side. The DC pumps of the No 2 side are likely to become uncovered when the indicated fuel on that side has dropped to 400 lb. At that stage, set No 1 engine to cruise power, set No 2 engine at idle, and switch off the No 2 engine DC pumps. This will cause a PUMPS S warning; do not carry out the PUMPS S drill. Provided nose-down attitudes and fast rates of descent are avoided, No 2 engine will continue to run and some of the remaining No 2 fuel will transfer. However, be prepared for No 2 engine to flame out subsequently since, at very low readings, the fuel gauges are unreliable.

PART 5

ILLUSTRATIONS

List of Chapters

PART 5

CHAPTER 1—COCKPIT ILLUSTRATIONS

Contents

General

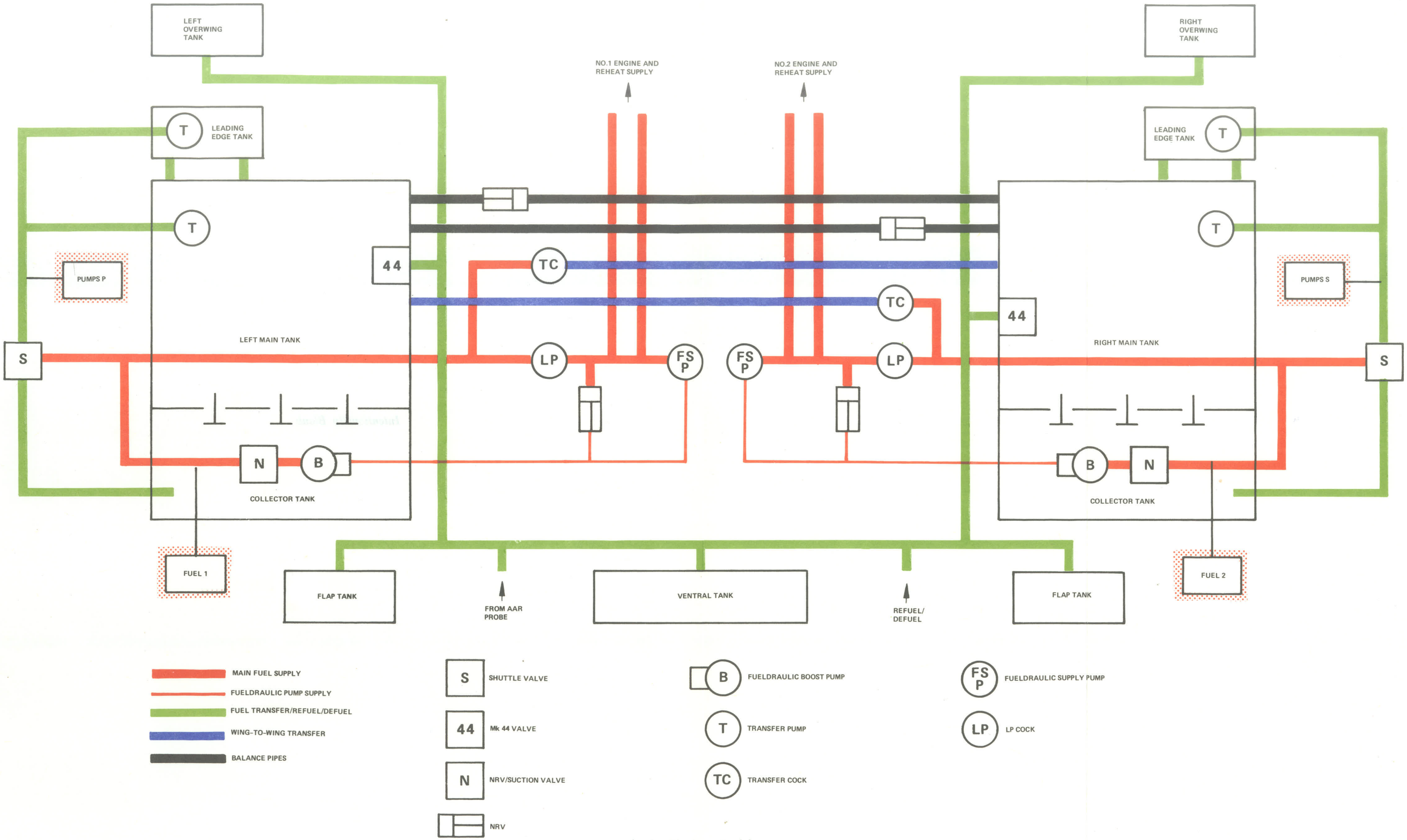
1. This Chapter contains illustrations depicting the layout of the cockpits of the F Mk 3 and F Mk 6, and the T Mk 5.

KEY TO FIG 1

1. Anti-dazzle lamp switch
2. AAR switch
3. Services pressure gauge
4. Brake parachute handle
5. Standard warning panel
6. Flap position indicator
7. Undercarriage selector
8. Emergency canopy jack release
9. Trim/airbrakes position indicator
10. Anti-ice/rain dispersal MI
11. AI hand controller
12. JPT control switches
13. Anti-ice/rain dispersal switch
14. Relight buttons
15. Engine shutdown lever
16. O'wing tank jettison switch
17. Seat adjustment switch
18. Ram air control
19. Windscreen demist control
20. Standby inverter MI
21. Standby inverter switch
22. Arrester hook down light
23. Brake parachute jettison button
24. Standby ASI
25. Arrester hook control handle
26. Standby altimeter
27. Brake pressure gauge
28. Standby attitude indicator
29. UC position indicator
30. Flap selector
31. Autopilot trim indicator
32. MRG fast erection button
33. MRG switch
34. Ventral jettison (F3)
35. No 2 throttle
36. ILS channel selector
37. Rudder trim switch
38. UC emergency lowering control
39. Ventral tank emergency transfer switch
40. Tacan controller
41. O'wing fuel dump switch
42. Canopy jettison handle
43. Standby DI
44. AAR indicator panel
45. Oxygen flow MI
46. AAR probe light switch
47. Emergency lighting switch
48. LFS/CRT switch
49. Slip indicator
50. Altimeter
51. RCDI
52. UHF NORMAL/STANDBY switch
53. UHF power switch
54. Aerial switch
55. VP sensitivity switch
56. VP/ILS switch
57. ILS master switch
58. Light fighter sight
59. SWP attention-getter
60. Low height warning light
61. Speed display
62. AI pressurisation override switch
63. Attitude indicator
64. Navigation display
65. V/UHF control unit
66. Tacan offset computer
67. ILS volume control
68. E2B compass
69. Accelerometer (post-mod 4664)
70. AI B-scope
71. Rudder pedal adjusting handle
72. Wing-to-wing transfer indicator
73. Wing-to-wing transfer switch
74. Overwing tank fuel gauges (post-mod 4846, left gauge is radar altimeter)
75. Main tank fuel gauges
76. RPM indicators
77. JPT indicators
78. E/F-band homer control
79. Flap tank contents test button
80. Fuel gauge test switch
81. Master armament selector
82. Pure air pressure gauge
83. AI recorder switch
84. GW arming switch
85. Pairs/single switch
86. GW reset button
87. Radar altimeter low height light dimmer switch (post-SEM/031)
88. Camera iris switch
89. Starter panel (see below)
90. FCS control unit
91. Anti-g lever
92. Anti-g low/high valve
93. Accelerometer (pre-mod 4664)
94. Telebrief button/light
95. Voltmeter
96. AC reset button
97. DC reset button
98. Auxiliary warning panel
99. Frequency card light switch
100. Ventral tank fuel gauge
101. Nozzle position indicators
102. AWP test button
103. AWP day/night switch
104. Cockpit lighting/dimmer switches
105. Cockpit temperature selector
106. Floodlight
107. Arming indicator
108. Taxy lamp switch
109. Navigation lights switch
110. Missile telemetry switch
111. Cockpit altimeter
112. Camera master switch
113. Oxygen contents gauge
114. Engine start buttons
115. Starter isolation switch
116. IFF failure light
117. Standby generator switch
118. IFF master switch
119. IFF control unit
120. Oxygen regulator

Starter Panel Ganged Switches

	O Pitot heaters	
O Left fuel cock		O Right fuel cock
O DC pumps left		O DC pumps right
O Battery		O Cockpit pressurisation
O Instrument master		O Engine start master
O Side w'screen heat		O Front w'screen heat



1—2 Fig 3 — Fuel System

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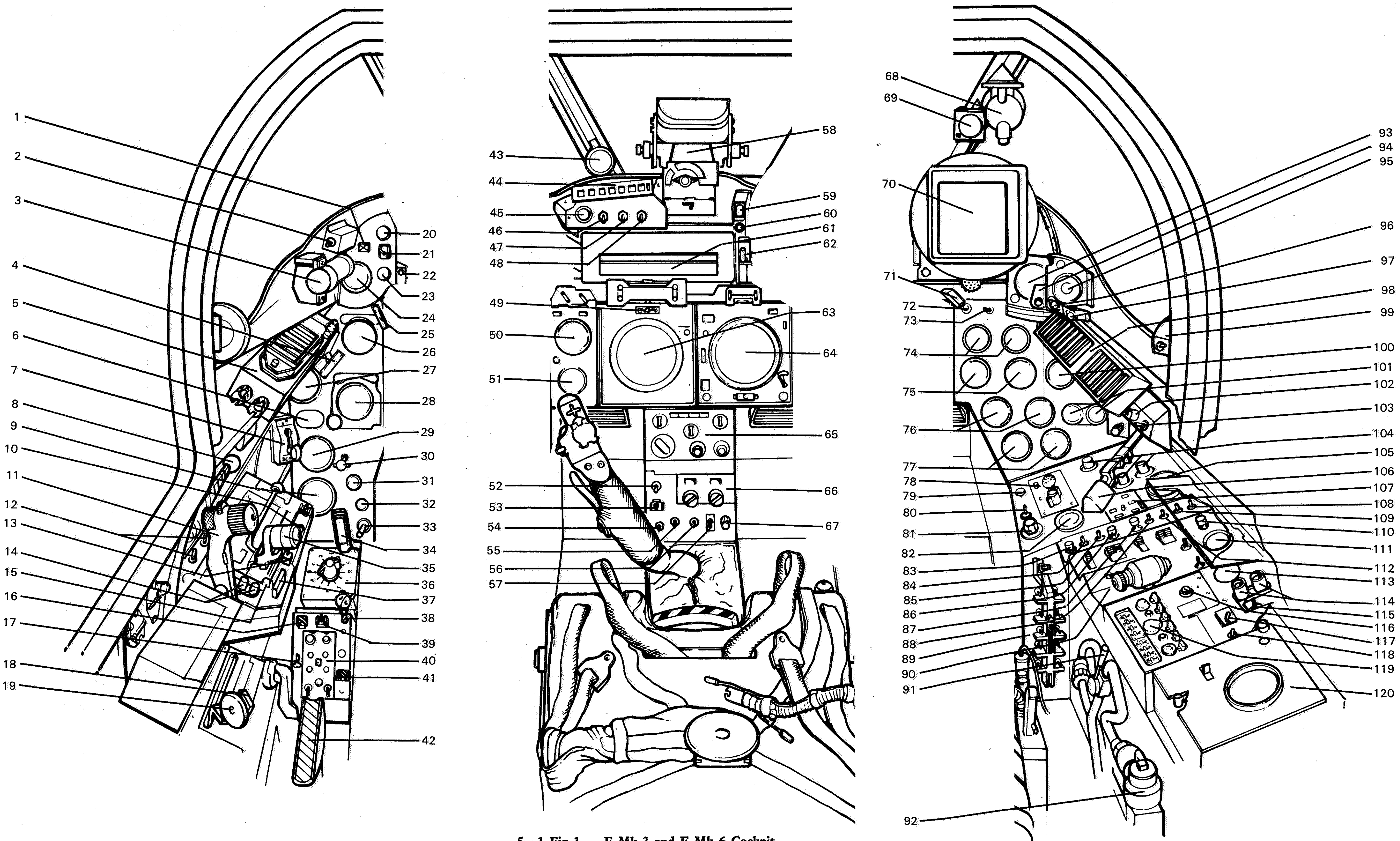
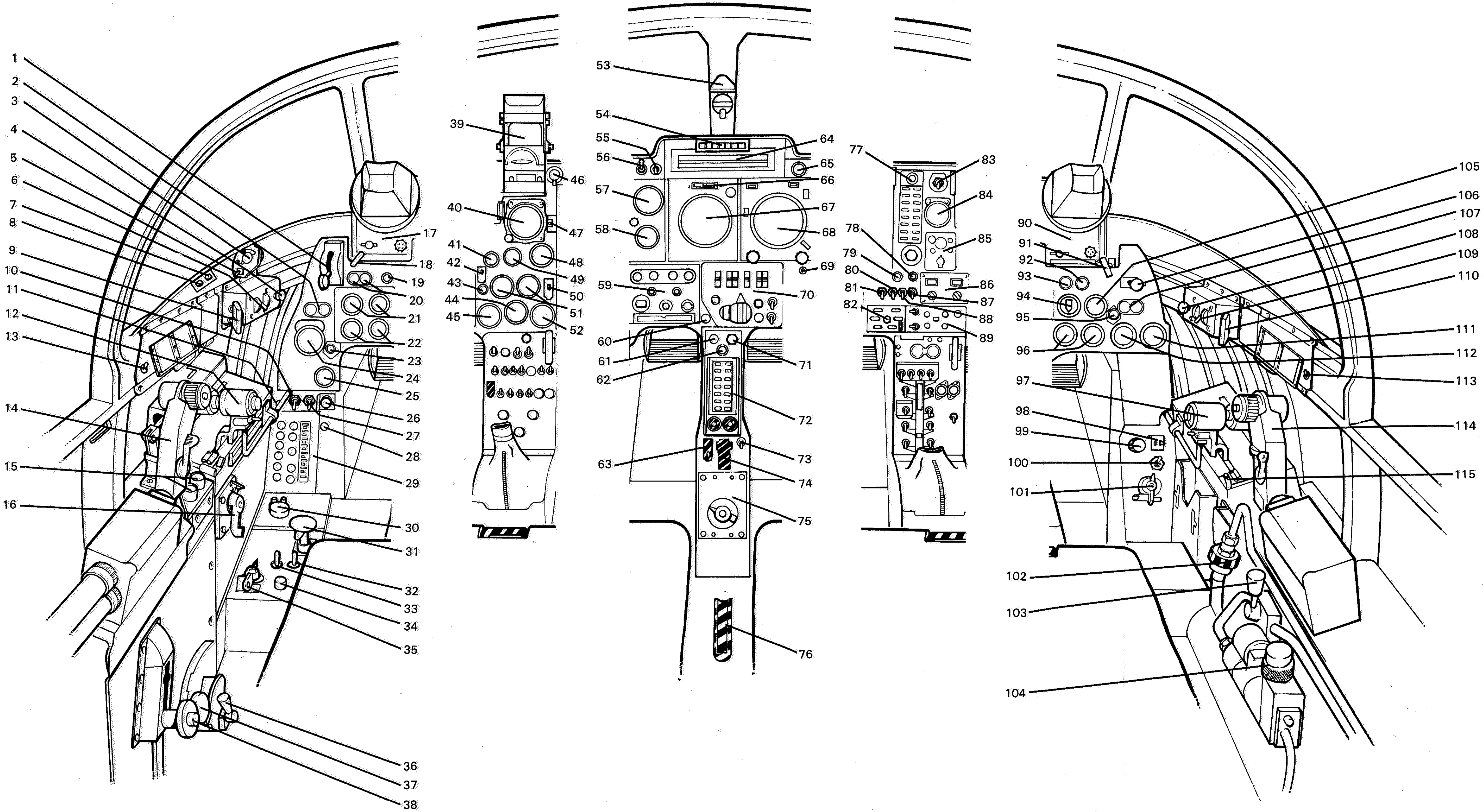


5—1 Fig 1 — F Mk 3 and F Mk 6 Cockpit

KEY TO FIG 2

1. UC lever
2. Flap position indicator (pupil)
3. Accelerometer
4. Airmix control (pupil)
5. AI pressure override
6. Seat adjust switch (pupil)
7. AC reset button
8. DC reset button
9. Rudder trim (pupil)
10. Anti-ice/rain dispersal switch
11. Anti-ice/rain dispersal MI
12. No 2 throttle (pupil)
13. Frequency card light switch
14. AI hand controller (pupil)
15. Relight buttons
16. Throttle servo control
17. AI B-scope (pupil)
18. Brake parachute handle (pupil)
19. Oxygen flow MI (pupil)
20. Nozzle position indicators
21. RPM gauges
22. JPT gauges
23. Brake para jettison button
24. Trim/airbrake position indicator
25. UC position indicator
26. Flap selector (pupil)
27. Emergency lights switch
28. IFF fail light
29. IFF control unit
30. Voltmeter (pupil)
31. Emergency UC handle
32. JPT control switch
33. JPT control switch
34. Cockpit lighting dimmer
35. Oxygen shut-off cock (pupil)
36. Anti-g control lever
37. Windscreen demist lever
38. Ram air valve
39. LFS
40. Standby artificial horizon
41. Autopilot trim indicator
42. Standby inverter switch
43. Standby inverter MI
44. Ventral fuel gauge
45. Ram air temp gauge
46. Standby DI
47. Standby generator switch
48. Standby altimeter
49. Standby ASI
50. Feel unit switch
51. Main fuel gauges
52. Brake pressure gauge
53. E2B compass
54. AAR panel
55. AAR switch
56. AAR probe light switch
57. Altimeter
58. RCDI
59. V/UHF control unit
60. SWP audio mute
61. SWP mute button
62. SWP test button
63. O'wing tank jettison
64. Speed display
65. Services pressure gauge
66. Slip indicator
67. Attitude indicator
68. Navigation display
69. Rocket launcher retract switch
70. FCS control unit
71. SWP cancel button
72. SWP
73. ILS master switch
74. Ventral/missile jettison
75. ILS channel selector
76. Canopy jettison lever
77. AWP
78. Missile telemetry button
79. GW fire control reset
80. GW pairs/single switch
81. GW arm/safe switch
82. Armament indicator panel
83. CRT/LFS switch
84. Pure air pressure gauge
85. E/F band homer control
86. Tacan offset computer
87. Camera iris switch
88. Camera master switch
89. Tacan control unit
90. AI B-scope (instructor)
91. Brake para handle (instructor)
92. AI recorder switch
93. Oxygen flow MI (instructor)
94. Cockpit temperature control
95. Brake chute jettison button
96. Oxygen pressure gauge
97. No 1 throttle (instructor)
98. AI changeover switch
99. Right sill dimmer switch
100. UHF mute switch
101. Oxygen shut-off cock (instructor)
102. AVS control
103. Anti-g control (instructor)
104. Anti-g high/low selector (instructor)
105. Cabin altimeter
106. Flap selector (instructor)
107. Flap position indicator (instructor)
108. Airmix control (instructor)
109. Seat adjust switch (instructor)
110. Rudder trim (instructor)
111. Voltmeter (instructor)
112. UC position indicator (instructor)
113. Frequency card light switch
114. AI hand controller (instructor)
115. Fast idle stop release (instructor)



5—1 Fig 2 — T Mk 5 Cockpit

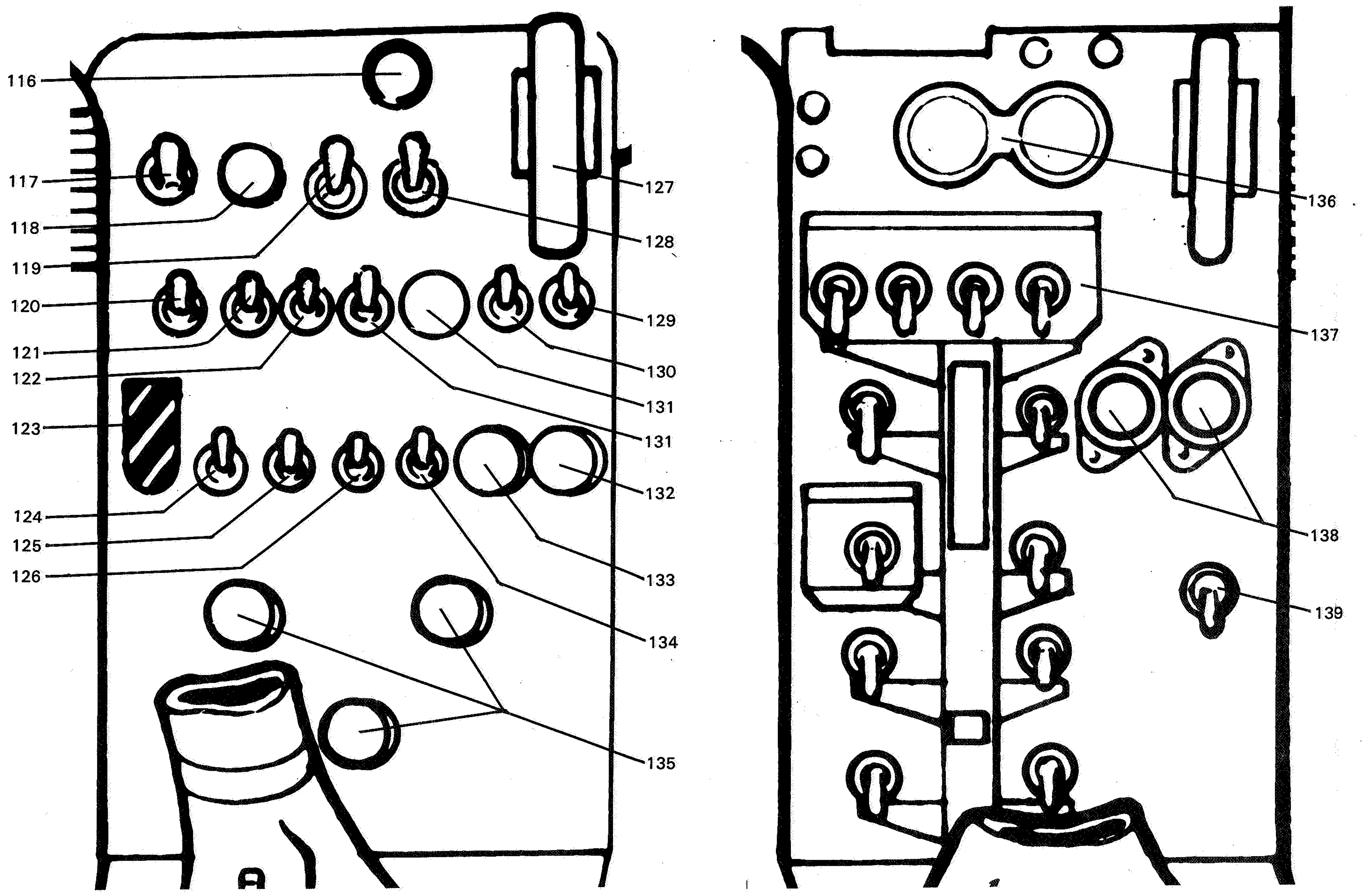
KEY TO FIG 3

116. Flap tank contents button
117. Wing-to-wing transfer switch
118. Wing-to-wing transfer MI
119. Ventral emergency transfer switch
120. Aerial switch
121. UHF mute switch
122. Fuel contents test switch
123. UHF normal/standby set selector
124. VP/ILS switch
125. VP sensitivity switch
126. Navigation lights switch
127. Rudder bar adjust (pupil)
128. Fuel contents test switch
129. Intercom normal/emergency switch
130. Intercom on/off switch
131. Telebrief light/button
132. MRG fast erection button
133. MRG pull/off switch
134. Taxy lights switch
135. Cockpit lights switches
136. Oxygen contents gauges
137. Starter panel (see below)
138. Engine start buttons
139. Starter isolation switch

Starter Panel Ganged Switches

O	O	O	O
Left fuel cock	Left DC pumps	Right DC pumps	Right fuel cock

O Instrument master	O Engine start master
O Pitot heater	O Side windscreen heat
O Left windscreen heat	O Right windscreen heat
O Battery	O Air conditioning



5—1 Fig 3 — T Mk 5 Panels A3 and A5

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