Ministry of Defence

Air Command Secretariat
Spitfire Block
Headquarters Air Command
Royal Air Force
High Wycombe
Buckinghamshire
HP14 4UE

Ref. 2020/07542

[redacted]

14 October 2020

Dear [redacted],

Thank you for your e-mail of 1 July 2020 asking for RAF documentation. Specifically, you requested the following information:

"I would be very grateful if you could send me the last editions of the following Aircrew Publications (APs):

AP101B-4401-14 Hawk T Mk 1/1A Flight Reference Cards
AP101B-4401-15 Hawk T Mk 1/1A Aircrew Manual?"

I am treating your correspondence as a request for information under the Freedom of Information Act 2000 (FOIA). A search for the information has now been completed within the Ministry of Defence, and I can confirm that information in scope of your request is held and is attached. A very small amount of information has been withheld under Section 40 (Personal Information) of the Act in accordance with the Data Protection Act 2018.

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Finally, please accept my apologies for the delay in responding to your request.

If you have any queries regarding the content of this letter, please contact this office in the first instance.

If you wish to complain about the handling of your request, or the content of this response, you can request an independent internal review by contacting the Information Rights Compliance team, Ground Floor, MOD Main Building, Whitehall, SW1A 2HB (e-mail CIO-FOI-IR@mod.gov.uk). Please note that any request for an internal review should be made within 40 working days of the date of this response.

If you remain dissatisfied following an internal review, you may raise your complaint directly to the Information Commissioner under the provisions of Section 50 of the Freedom of Information Act. Please note that the Information Commissioner will not normally investigate your case until the MOD internal review process has been completed. The Information Commissioner can be contacted at: Information Commissioner's Office, Wycliffe House, Water Lane, Wilmslow, Cheshire, SK9 5AF. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website at https://ico.org.uk/.

Yours faithfully

[redacted]
Secretariat 3a1
Air Command

HAWK T MK 1/1A

AIRCREW MANUAL

Amendment Information

Note: This is an electronic version of this publication and not a direct duplicate of the hard copy version. The hard copy is the master copy and the only one to be used in flight and for flight planning. This electronic publication represents the extant version of the publication and is to be used for reference only. Only change bars applicable to the current version will be shown.

Edition

3 (Jul 11)

AL

3 (Apr 2019)

AIL

AIL 1/20

ANA

ANA 9

ANA 10

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HAWK T MK 1 & 1A

AIRCREW MANUAL

PREPARED BY DEFENCE AIRCREW PUBLICATIONS SQN

NOTES TO USERS

1. This Manual is complementary to the Hawk T Mk 1 & Mk 1A Flight Reference Cards (AP 101B-4401-14) and the Flight Test Schedule (AP 101B-4401-5M).

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

a. Preliminaries
b. Part 1 Description and Management
c. Part 2 Handling
d. Part 3 Emergencies and Malfunctions
e. Part 4 Illustrations
f. Supplement No. 1
g. Supplement No. 2

3. Each Part is divided into Chapters as listed on the marker card. Each page is identified by a Part, Chapter, Page reference at the foot of the page. Thus, a page bearing the reference: 2-4 Page 5 is page 5 of Part 2, Chapter 4.

4. The limitations quoted in Part 2 (unless over-ridden by the Release to Service) are mandatory and are not to be exceeded except when recovering from emergency conditions, any exceedance is to be reported. The contents of the parts of the manual are mainly advisory but instructions containing the words "is to" and "are to" are also mandatory. This Manual is only valid when used in support of a current MOD RTS.

5. The manual and its associated Flight Reference Cards aim to provide the best operating instructions and advice currently available for normal and abnormal operations. They assume adequate knowledge of the pertinent volumes of AP 3456 series. Nothing in these publications removes the obligation to comply with MAA requirements. The application of sound judgement and good airmanship applies at all times and is paramount. 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. However, any deviation from the prescribed procedures or drills should be fully justifiable and users are strongly advised to record this justification to aid any subsequent inquiry or investigation.

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 new or amended matter of importance will be indicated by change bars, positioned in the outside margin alongside the amended text, to show the extent of the amended text. 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 change bars on either page forming a sheet will 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 change bars 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, where values such as airspeed, mach number, acceleration, altitude, incidence (AOA) and temperature, are quoted they are indicated values (corrected for instrument error).

c. **WARNINGS** imply possibility of death or injury; **CAUTIONS** imply possibility of damage to the aircraft or its equipment; **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 this book when it is necessary to differentiate between pre- and post-mod states. For ease of reference, a list of the modifications mentioned in the text is included in the preliminary pages of the Manual, with a cross reference to the location in the text of the modification details.

IMPORTANT

Proposals for change to the AM are to forwarded on MoD Form 765X (Aircrew) overleaf, through the Hawk User Authenticator for onward transmission to the Publications Organisation.

The User Authenticator for this manual is:
User Authenticator, 100 Sqn, RAF Leeming, Northallerton, DL7 9NJ.

The Publication Organisation for this manual is:
Defence Aircrew Publications Squadron, Boscombe Down, Salisbury Wilts, SP4 0JE.

~~OFFICIAL-SENSITIVE*~~

MOD Form 765X
(Revised Feb 19)

AIRCREW PUBLICATIONS AMENDMENT REQUEST

References MAP-01 Chapter 8.2

Originating Unit
Title/Address

Reference

Date

Air Publication / Document*
Publication / Document No.

To Amdt / Issue / Revision Date*

Title

Section / Chapter / Page / Paragraph

Part 1 - Requested Amendment and Suggested Revision
(Use continuation sheet(s) if necessary and firmly attach all diagrams etc.)

Originator's Signature	Rank and Name	Tel No.	Appointment	Date

Part 2 - User Authenticator's Comments Serial No. / /

Proposed Priority:	**Immediate***	**Rapid***	**Routine***

☐ Other publications affected have been reported at:

User Authenticator's Signature	Rank and Name	Tel No.	Appointment	Date

Send to Delivery Team:
Hawk Support Team
ADS Manager
UKMFTS
MOD Abbey Wood (North)
#7001
Bristol
BS34 8JH

Copy to:
OC Defence Aircrew Publications Squadron
Boscombe Down
Salisbury
Wiltshire
SP4 0JE
e-mail: [redacted]@hansqn.mod.uk
@hansqn.r.mil.uk

plus Copy to Release to Service Authority (RTSA)

* Delete as appropriate

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Part 3 Delivery Team Action			Serial No.	/ /		
(Please include any report/letter references)		**Approved Priority:**		**Immediate***	**Rapid***	**Routine***
☐ Other Mks affected and relevant UA notified When complete, send to Publication Organisation						
Signature	Rank/ Grade & Name		Tel No.	Appointment		Date

Part 4 – Publication Organisation/Defence Aircrew Publications Squadron (DAPS)*			
☐ Requested Amendment incorporated ☐ Requested Amendment rejected (see below) Incorporation Details: Copy to be sent to Originator, UA and DT			
Incorporated by Publication Organisation*	Name	Tel No.	Date
DAPS PO's Signature*	Rank / Grade & Name	Tel No.	Date

Instructions for Use

1. MOD Form 765X has been introduced to maintain an approval trail of changes to aircrew publications and documents to ensure that both the User Authenticator and DAPS are involved at the earliest opportunity after the form has been raised.

2. MOD Form 765X is to be raised by the individual who observed a deficiency, omission or inaccuracy in the Aircrew Manual, Flight Reference Cards, Operating Data Manual, Mission Operating Procedure cards, Flight Test Schedule or Aircrew Landaway Flight Servicing Schedule. Apart from typographic errors and/or grammatical changes, a separate MOD F765X is normally to be raised for each system deficiency, omission or inaccuracy being reported.

3. When an individual raises a MOD Form 765X (by completing the header detail and Part 1) they are to send the form to the User Authenticator, (RAF: STANEVAL; Army: A Avn Stds, HQAAC; RN: Naval Flying Standards Flight, RNAS Culdrose or RNAS Yeovilton as appropriate).

4. On receipt the User Authenticator is to complete Part 2, enter a serial number consisting of a 3-letter MOB / type designator, a 3-digit number (starting with 001 from1Jan each year) and 2 digits for the year (eg BZN/016/05), comment as appropriate and pass the form to the Delivery Team (DT), with a copy to DAPS and a copy to the appropriate Release to Service Authority (RTSA). An electronic version of the Form is available on the Defence Intranet and the Form can be submitted electronically by the UA in the first instance followed up by a signed hard copy or via the RESOLVE system.

5. The User Authenticator is to keep a register of all MOD Form 765X arisings.

6. The DT is to complete Part 3 of the MOD Form 765X and forward it to DAPS or the Publication Organisation (copy to DAPS), as appropriate, for action.

7. When the change proposed in the F765X is deemed by the UA or DT to be of an urgent flight safety or operational nature, the DT can authorize DAPS by e-mail to proceed with the appropriate amendment action in advance of the completion and signature of Part 3 of the F765X. When issue of an ANA closes a F765X, the Publication Organisation is to raise a Tech Pubs task to ensure that the change is incorporated at the next routine amendment.

8. Priorities: Immediate – within 28 days (ANA/AIL Action), Rapid –within 3 months (next AL/AIL), Routine - within a year (next AL).

* Delete as appropriate

AMENDMENT RECORD SHEET

ALNo	Amended By	Date	ALNo	Amended By	Date
1	Han Sqn	18 May 2012			
2	Han Sqn	15 Jan 2015			
3	DAPS	1 May 2019			

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AIL RECORD

AIL No	Date of Issue	Location Part/Chap	Signature	Cancelled By	Signature	Date
1/15	Feb 15	Pt 1, Ch 9	Han Sqn	AL 3	DAPS	1 May 19
2/15	Mar 15	Pt 1, Ch 9	Han Sqn	AL 3	DAPS	1 May 19
1/16	Jun 16	Pt 1, Ch 11	Han Sqn	AL 3	DAPS	1 May 19
1/20	Mar 20	Pt 2, Ch 3	DAPS			

ANA RECORD

ANA No	DTG	Location Part/Chap	Signature		Cancelled By	Signature	Date
1 to 7 incorporated							
8	Jul 18	Supplement 1	Han Sqn		AL 3	DAPS	1 May 19
9	Nov 19	Supplememt 1	DAPS				
10	Mar 20	Pt 2 Ch 2 Ch 3	DAPS				

LIST OF EFFECTIVE PAGES

This list shows all the pages which should be present after incorporating Amendment List 3 in this Manual.

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F765X	AL 3	1-4 page 21	AL 3	1-9 page 29	AL 3	1-13 page 27	AL 3	2-3 page 3	Initial
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LIST OF ASSOCIATED PUBLICATIONS

Hawk T Mk 1/T Mk 1A Aircraft Maintenance Manual AP101B-4401-1 Series

Hawk T Mk 1 & T Mk 1A Aircrew Landaway Flight Servicing Schedule AP 101B-4401-5Y

Hawk T Mk 1 & T Mk 1A Flight Reference Cards AP101B-4401-14

Hawk T Mk 1 & T Mk 1A Flight Test Schedule AP101B-4401-5M

Hawk T Mk 1 & T Mk 1A Operating Data Manual AP101B-4401-16

Hawk T Mk 1 Aircraft List of Applicable Publications AP101B-4401-1Z

Royal Air Force Manual - Flying AP 3456

UHF Communications Equipment AN/ARC 164 - Havequick - General and Technical Information AP116D-0157-1B

HAWK T MK 1

HAWK T MK 1A

INTRODUCTION

General

1. The Hawk T Mk 1 is an all-metal, low wing, tandem seat flying training and weapons training aircraft. Equipment specific to the weapons training role is fitted only when aircraft are allotted to that role. The T Mk 1A is equipped to an operational standard capable of undertaking a war role; the equipment for this role is also suitable for the weapons training role.

2. Aerodynamically, the aircraft is of conventional design. The wing has moderate sweep with 2° dihedral and trailing edge double-slotted flaps. A one-piece, all-moving tailplane is swept back and has 10° anhedral.

3. The fuselage comprises three main parts. The front fuselage accommodates two equipment bays and a pressurized cabin containing two cockpits. The centre fuselage contains the engine, a fuselage fuel tank, a Gas Turbine Starting (GTS) system and a Ram Air Turbine (RAT). The rear fuselage houses a jet pipe bay and has an airbrake hinged to its under-surface.

4. The aircraft is powered by an Adour Mk 151 turbofan engine.

Cockpits

5. A retractable step, a toe-in step and an extending step on the left side of the fuselage give access to the cockpits.

6. Each cockpit is equipped with a fully automatic Type 10B rocket-assisted ejection seat with zero speed/ zero height capability. The seats can be fired individually from each cockpit or in sequence by a command ejection system initiated from the rear cockpit. The command system is preset on or off as required.

7. A single, sideways-hinged, manually-operated cockpit canopy is fitted; it cannot be jettisoned but embodies a Miniature Detonating Cord (MDC) to shatter the canopy transparency. The MDC can be operated manually from inside or outside the cockpit to facilitate escape on the ground; on ejection, an interconnection between each ejection seat and the MDC fires the MDC to ensure that the transparency is shattered early in the ejection sequence. A dividing windscreen, integral with the canopy, protects the occupant of the rear seat if the front half of the transparency is shattered.

8. A cabin pressurization and air conditioning system uses air supplied from the engine HP compressor via heat exchangers and a cold air unit. Engine compressor air is also used to inflate the cockpit canopy seal and for inflation of anti-g suits. Ram air can be introduced to ventilate the cabin if malfunction of the system occurs. The pressurization and air conditioning system is controlled from the front cockpit.

Cockpit Controls and Equipment

9. The layout of each cockpit is similar. Full control of all systems is from the front cockpit but, for appropriate systems, monitoring or override facilities are provided in the rear cockpit. The aircraft is flown solo from the front cockpit, special preparation of the rear cockpit being unnecessary apart from the appropriate FRC checks.

10. Controls and equipment in each cockpit are grouped on consoles and panels as follows:

- Left console - Throttle, engine starting, electrical and flying control systems.
- Main panels:
    - Left - Weapon selection and UHF.
    - Centre - Flight instruments, weapon sighting and navigation displays.
    - Right - Engine instruments.
- Right console - Avionic equipment control units.

Electrical Systems

11. An engine-driven 9 kW DC generator supplies an Essential Services busbar via a Generator busbar. Two batteries provide power for engine starting and, following generator failure, for those services essential for the normal operation of the aircraft; the batteries are individually switched to the Essential Services busbar.

12. Two static inverters, supplied from the Generator busbar, provide the main AC power requirements; in addition, some equipments are supplied from individual static inverters. The T Mk 1A has an additional static inverter to provide power for the armament installation.

13. An external DC power supply can be connected for aircraft maintenance purposes and to supply power for operational readiness states.

Central Warning System

14. A Central Warning System (CWS) indicates system failures and events which require prompt action. The failures or events are classified and appear as red or amber captions on a Central Warning Panel (CWP) in each cockpit. A light in the head of an engine fire extinguisher button, on the CWP in each cockpit, illuminates an F to give an additional warning of fire in the engine bay.

15. Attention lights, either side of the centre panel in each cockpit, flash in association with the illumination of any CWP caption; the lights in both cockpits are cancelled when any one attention light is pressed. All red warnings are accompanied by an audio tone in the headphones.

Fuel System

16. All fuel is carried internally, in a flexible fuselage tank and an integral wing tank. Total fuel contents are indicated on a single gauge in each cockpit. Fuel transfers automatically from the fuselage into the wing tank and thence to a collector section of the wing tank; a negative-g compartment, at the forward part of the collector tank, houses a booster pump. The aircraft fuel system is pressurized from an engine air bleed.

17. The booster pump, which has its own electrical inverter, supplies fuel to the engine fuel system and to the fuel system of the GTS.

18. The fuel system has a single pressure refuelling/defuelling point; alternatively, the system can be replenished via a gravity refuelling point.

Engine

19. The Adour Mk 151 is a turbofan engine which has a 2-stage low pressure (LP) compressor driven by a single-stage LP turbine, and a 5-stage high pressure (HP) compressor driven by a single-stage HP turbine. In ISA sea-level conditions the engine develops 231 kN (5200 lb) static thrust.

20. The engine, installed in the aft end of the centre fuselage, has an air intake on each side of the fuselage. The engine is started by the Gas Turbine Starting (GTS) system which is operated from the aircraft batteries. The main components of the GTS are a gas turbine air producer and a starter motor. The GTS can also be used to assist in engine relighting.

21. Fire detection and warning systems are embodied for the engine bay and the air producer bay and there is an overheat detection system for the jet pipe bay. A fire extinguishing facility is provided for the engine bay only.

Hydraulic Systems

22. Two independent hydraulic systems, No 1 and No 2, each with an engine-driven pump, supply hydraulic power to tandem actuators in powered flying control units (PFCU) and for general services. A Ram Air Turbine (RAT) extends into the airstream automatically and maintains pressure in the No 2 system if the No 2 system pump fails.

23. One half of each tandem actuator is powered from the No 1 hydraulic system and the other half from the No 2 system. If either system fails, the airbrake must be selected in and, in high speed flight, airspeed must be reduced; control of the aircraft then remains satisfactory on the power supplied from the remaining system.

24. The No 1 system also supplies power for the normal operation of the landing gear, wheelbrakes, flaps and airbrake. A hand pump in the No 1 system is for maintenance operations.

25. No 2 system pump is automatically off-loaded to allow an adequate engine windmilling speed to be attained when an airborne engine relight is attempted.

Landing Gear

26. The landing gear consists of 2 main wheel units and a nosewheel unit; the main wheel units retract inward into wheelbays in the wing; the nosewheel unit retracts forward into a wheelbay in the front fuselage. Landing gear selectors and position indicators are in both cockpits, but the controlling selector depends upon the setting of a control transfer button in the rear cockpit.

27. The landing gear can be lowered by a nitrogen-operated standby system if the normal system fails.

28. The main wheels have hydraulic brakes, operated by toe pads on the rudder pedals, with differential braking action. An anti-skid facility is incorporated in the braking system.

Flying Controls

29. The ailerons and the tailplane are fully power operated by the two hydraulic systems and artificial feel is incorporated in the control circuits; there is no manual reversion facility. The rudder is manually-operated and has no artificial feel; a rudder lock is in the front cockpit. Trimming is provided for all controls but out-of-trim forces are easily held if a trimming system fails.

30. The flaps can be controlled from either cockpit. From the front cockpit, the flaps can be set to up, mid or fully down; from the rear cockpit they can only be selected to up or fully down. The flaps can be lowered by a nitrogen-operated standby system if the normal system fails.

31. The airbrake is on the underside of the rear fuselage and can be controlled from either cockpit. To prevent the airbrake from striking the ground when the aircraft is in the landing attitude, an interlock in the landing gear system prevents extension of the airbrake when the landing gear is down; the airbrake is automatically retracted when the landing gear is selected down.

Oxygen Systems

32. A gaseous main oxygen supply is provided, via a personal equipment connector (PEC) and a seat-mounted demand-type regulator, for each occupant. Each cockpit has a supply gauge and a flow indicator. Warning of low pressure in the oxygen supply is given on the CWP.

33. An emergency oxygen cylinder is on each ejection seat. The supply is available for use in an emergency by manual selection; it is selected automatically on ejection.

Flight Instrument System

34. The aircraft has an attitude and heading reference system (AHRS). Attitude information in pitch and roll is presented on a main attitude indicator in each cockpit. Gyromagnetic compass, Instrument Landing System (ILS) and Tacan range and bearing information can be displayed on a horizontal situation indicator (HSI) in each cockpit.

35. Each cockpit has a standby compass, a turn and slip indicator, a directional gyro indicator (DGI) and a standby attitude indicator.

Communications

36. Transmit and receive facilities are available in both cockpits but frequency selection can only be made from the front cockpit. UHF and VHF communications, intercom and the audio inputs from Tacan and ILS equipment are integrated and controlled by a communications control system (CCS) which has a station box in each cockpit. The Tacan and ILS installations are controlled from the front cockpit. A 2-channel standby UHF transceiver is provided, with channel selection, transmit and receive facilities in each cockpit. A sonar locator beacon (SLB) is in the ram air turbine bay (post-Mod 1029) or the forward equipment bay (pre-Mod 1029). The T Mk 1A has a telebriefing facility for use during operational readiness periods. Post-Mod 1015 an anti-jam (A/J) facility is available as an aid to electronic counter-counter-measures.

37. An IFF/SSR installation, controlled from the front cockpit, provides identification and coded flight level information to interrogating stations.

Lighting

38. The aircraft has normal and emergency cockpit lighting. The external lighting includes a landing/taxy lamp in the nosecone; an indicator light, on the nosewheel leg, comes on to confirm to a ground observer that the landing gear is down and locked.

Ice and Rain Protection

39. Engine bleed air is used to de-ice the engine LP compressor nose fairing. Ice formation in the pitot-static tube is prevented by electrically heating the probe. Curvature of the windscreen provides a measure of rain clearance of the screen.

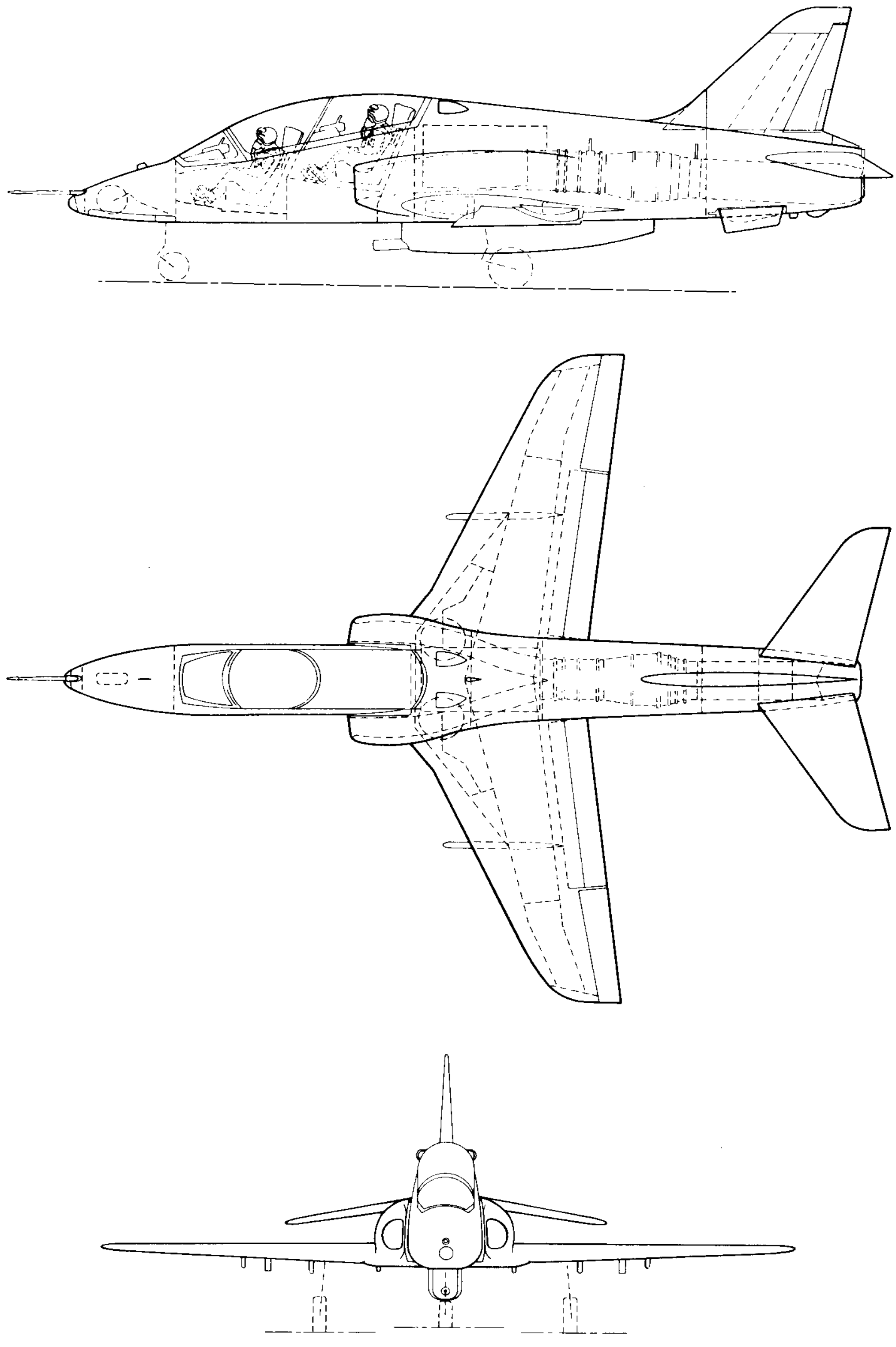
Armament Installation

40. As a weapons trainer, the aircraft armament installation provides for the carriage and release of rockets and practice bombs on two wing pylons, and for the firing of a 30 mm gun carried in an under-wing pod mounted on the fuselage centreline. The T Mk 1A is additionally equipped for the carriage and release of AIM-9 Sidewinder air-to-air missiles on the wing pylons.

41. A weapon control panel (WCP) is in the front cockpit and a weapon monitor panel (WMP) is in the rear cockpit. A Sidewinder missile control panel (MCP) and a bomb spacing intervalometer are in the front cockpit of the T Mk 1A. Weapon aiming is by means of an ISIS D-195R optical sighting system in each cockpit; ranging information is not provided. Post MOD 5141 a video camera can be fitted to the sight head in the front cockpit. A gun firing trigger and a bomb/RP release/missile launch button are on the handgrip of each control column. A master armament safety switch (MASS) is in the front cockpit.

Accident Data Recorder

42. The accident data recorder (ADR) has a continuous tape loop, contained in a crash-protected case, which records information from a data acquisition unit (DAU). The tape has a recording duration of 3 hrs 34 mins +/- 12 mins.



Prelims Fig 1 General Layout

LEADING PARTICULARS

Name: Hawk T Mk1/1A

Type: Single engine, tandem seat trainer

Crew: One or two

Duties: Flying training. Weapons training. Air Defence/Ground Attack - T Mk1A

Main Dimensions

Wing Span: 9·4 metres (30 feet 10 inches)

Overall Length: 11·9 meters (39 feet 3 inches)

Height: 4·0 metres (13 feet 2 inches)

Wing area: 16·7 square metres (179·6 square feet)

Aircraft Mass

Maximum for Take-Off: 5700kg

Maximum (Normal) for Landing: 5000kg

Maximum (Emergency) for Landing: 5700kg

Power Plant

Engine Change Unit (ECU)

RR/Tm Adour 15101

RR/Tm Adour 15102 Red Arrows a/c

RR/Tm Adour 15103 Post Mod 630 a/c

Engine Type: Twin shaft turbofan

Thrust Rating (ISA sea level): 23·1 kN (5200 lbs)

Starting Air Supply: Aircraft mounted GTS

Engine Oil

For approved engine oil refer to the Hawk TMk1 & TMk1A MOD AFD Release to Service.

Oil system capacity: 11·9 litres (21 pints)

Oil tank capacity: 7·4 litres (13 pints)

Usable oil: 4·5 litres (8 pints)

Oil consumption: 1 pint/hr

Fuel

For approved fuels refer to the Hawk TMk1 & TMk1A MOD AFD Release to Service.

Fuel System

Table 1 - Fuel Tank Capacities - Usable Fuel

Tank	*0·79 SG Kg*	*0·77 SG Kg*	*Litres*	*Imperial Gallons*
Fuselage	645	629	818	180
Wing	627	612	795	175
Total	1272	1241	1613	355

Electrical Systems

DC generation: One engine driven 9 kW generator

Supply: 28 Volts

Batteries: 2 x 24 Volts

AC Supply: 115 Volts 400 Hz single phase

Hydraulic Systems

Fluid: OM-15

Table 2 - Hydraulic power Sources

System	Power Source	Operating Pressure
No 1	EDP	207±10 Bars
No 2	EDP or RAT pump	207±10 Bars or 169±3·45 to 203±3·45 bars

Table 3 - Services Operated

System	Services Operated
No1	Aileron/Tailplane PFCUs, landing gear, wheelbrakes, flaps, airbrake.
No 2	Aileron/Tailplane PFCUs
RAT	Aileron/Tailplane PFCUs following failure of No 2 System.

Ejection Seat

Type: Martin-Baker 10B Mk 1, rocket-assisted

Front Cockpit: 10B1 Mk 1

Rear Cockpit: 10B2 Mk 1

Oxygen Systems

Regulator: Seat-Mounted Type 517

Table 4 - Oxygen Systems

	Main System	Emergency System
Type	Gaseous	Gaseous
Capacity	2 x 1400 litre cylinders	1 x 70 litre cylinder

Air Conditioning, Pressurization and Anti-G

Air Supply: 5th stage HP compressor air

Communications

CCS: ARI 23245/7

UHF (AN/ARC 164): ARI 23315/2

UHF (AN/ARC 164 - Havequick II): ARI 23315/10

Standby UHF (D403 MA): ARI 23159

VHF (AN/ARC 115): ARI 23259/1

Tacan (Cossor CAT 7000): ARI 23256/1

VOR (Cossor CNS 632): ARI 18227/4

IFF/SSR (Plessey PTR 446): ARI 5970/1

SIFF (Raytheon Mk XII)

ILS (Cossor CILS 75/76 with Raytheon Interference Resistant Mod RCL/C/136): ARI 18227/2

Sonar Locator Beacon Type 17638: ARI 23329/1

Underwater Acoustic Beacon DK120: ARI 23438/3

Miscellaneous

Weapon aiming: ISIS D-195R optical sighting system

Recorder camera: Vinten Gunsight Video Recording System (GVRS) - Post Mod 5141

Accident Data Recorder: Leigh ADR

ABBREVIATIONS USED IN TEXT

A/A	Air-to-Air
AC	Alternating Current
ACN	Aircraft Classification Number
ADR	Accident Data Recorder
ADU	Automatic Deployed Unit
AEA	Aircrew Equipment Assembly
AGL	Above Ground Level
AHRS	Attitude and Heading Reference System
AIM	Airborne Interception Missile
AIS	Airborne Instrumentation Sub-system
A/J	Anti-Jam
ALB	Acoustic Locator Beacon
AOA	Angle of Attack
AUM	All Up Mass
BCF	BromoChlorodiFluoromethane
BTRU	Barostatic Time Release Unit
CBLS	Carrier Bomb Light Stores
CCS	Communication Control System
CSI	Combined Airspeed Indicator/ Machmeter.
CWP	Central Warning Panel
CWS	Central Warning System
DAU	Data Acquisition Unit
DC	Direct Current
DGA	Displacement Gyroscopic Assembly
DGI	Directional Gyro Indicator
ECA	Engine Control Amplifier/Electronic Control Amplifier
ECCM	Electronic Counter-Counter-Measures
ECU	Engine Change Unit
EFATO	Engine Failure After Take Off
EHMS	Engine Health Monitoring System
EORU	Electrically Operated Release Unit
ERU	Ejector Release Unit
FCU	Fuel Control Unit
FRC	Flight Reference Card
GPS	Global Positioning System
GTS	Gas Turbine Starter
GVRS	Gunsight Video Recording System
HIRTA	High Intensity Radio Transmission Area
HP	High Pressure
HSI	Horizontal Situation Indicator
Hz	Hertz
IAS	Indicated Air Speed
IFF	Identification Friend or Foe
ILS	Instrument Landing System
ISA	International Standard Atmosphere
ISIS	Integrated Strike and Interception System
JB	Junction Box
kg	Kilograms
kHz	Kilohertz
kN	Kilonewtons
kW	Kilowatts
LFD	Longitudinal Fuselage Datum
LP	Low Pressure
LP	Long Play
MASS	Master Armament Safety Switch
Mb	Millibar
MCP	Missile Control Panel
MDC	Miniature Detonating Cord
MHz	Megahertz
MI	Magnetic Indicator
Mod	Modification
MWOD	Multiple Word of the Day
NET	Network
NL	LP Shaft Speed
NM	Nautical Miles
NRV	Non Return Valve
NWLO	Nose Wheel Lift Off
OAT	Outside Air Temperature
ODM	Operating Data Manual
PEC	Personal Equipment Connector
PFCU	Powered Flying Control Unit
PFL	Practice Forced Landing
PLB	Personal Locator Beacon
PRSO	Pressure Regulating and Shutoff
PRV	Pressure Reducing Valve
PSP	Personal Survival Pack
QRF	Quick Release Fitting
RAT	Ram Air Turbine
RPM	Revolutions Per Minute
SEAM	Sidewinder Expanded Acquisition Mode
SEM	Service Engineered Modification
SG	Specific Gravity
SIFCU	Sub-Idling Fuel Control Unit
SIFF	Successor Identification Friend or Foe
SLB	Sonar Locator Beacon
SP	Standard Play
SPI	Special Pulse Identification
SSR	Secondary Surveillance Radar
S-VHS	Superior Very High Standard
TGT	Turbine Gas Temperature
TOD	Time Of The Day
UHF	Ultra High Frequency
VCR	Video Cassette Recorder
VHF	Very High Frequency
VHS	Very High Standard
VISS	Video Index Search System
VOR	VHF Omni-Directional Radio Range
VSI	Vertical Speed Indicator
WCP	Weapon Control Panel
WMP	Weapon Monitor Panel
WOD	Word Of the Day

MODIFICATION NUMBERS REFERRED TO IN THE TEXT

Mod No.	*Effect of Embodiment*	*Location in the text*		
		Part	*Chap*	*Para*
630	EHMS introduced	1	4	54
646	Introduces Posinomic element to ECA	2	2	15
727	Post Mod 727 a provision of an extended rudder pedal assembly has been made.	1	6	19
745	Introduces missile telemetry switch	1	14	26
945	Fitment of telebrief	1	13	4
1015	Fitment of Havequick	1	13	20
1024	Fitment of underwater acoustic beacon	1	12	45
1029	Moves the Sonar Locator Beacon to the RAT bay		Prelims	
1029	Fitment of SLB into RAT Bay	1	13	70
1046	Front cockpit seat and MDC pin stowage placement	1	12	16b
1154	Airbrake auto retract on engine rundown	1	6	28
1195	Rear cockpit seat and MDC pin stowage placement	1	12	16b
1237	Anti-skid caption inhibited with landing gear selected UP	1	2	Table 2
1403	Modulates fuel booster pump output	1	3	15, Note
1863	Touchdown Protection	1	7	17
2010	Introduction of new centre and rear fuselage	1	3	26
2122	Introduction of Revue Thommen Mk 3A Altimeter	1	11	11
2154	Introduction of SIFF	1	12	50
2335	Introduction of SIFF to RAFAT	1	12	50
5141	Introduction of Gunsight Video Recording System		Prelims	
A0629	Introduces hydro-mechanical acceleration switch (Supplement 1)	Supplement 1		11
GEC 1403C	Fuel inverter - soft start	1	1	25, Note
SE141	ADU fitted to PSP	1	9	11
SEM 115	Introduction of Vinten Tape Recorder	1	13	
SEM 122	Carriage of sled	2	1	16
SEM 133	Introduction of additional stopwatch holder	1	13	10
SEM 155	Interference resistant ILS	1	13	43
SEM 157	Introduction of a waterproof avionics cover	1	12	48

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PART 1

DESCRIPTION AND MANAGEMENT

List of Chapters

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PART 1

CHAPTER 1 - ELECTRICAL SYSTEMS

Contents

DESCRIPTION

General

1. Primary DC is provided by an engine-driven 9 kW DC generator which supplies 28 volts to a Generator busbar. AC is provided by two static inverters which are connected in parallel to an AC busbar. The inverters are powered from the Generator busbar and each supplies 115 volts, 400 Hz to the AC busbar. On T Mk 1A aircraft a third 115-volt 400 Hz static inverter powered from the Generator busbar is connected to an Armament AC busbar. Warnings of generator and inverter failure are given on the Central Warning Panel (CWP).

2. Two 24-volt batteries provide power for an engine starting system and, following generator failure, for services which are essential for the normal operation of the aircraft. The batteries are connected to individual Battery busbars each of which is connected to the Essential Services Busbar by a contactor controlled from the battery master switches mounted in the front cockpit. A diode-protected supply from each Battery busbar supplies certain services (para 10 and para 11) from a common outlet.

3. An external DC supply can be connected and used for maintenance purposes. In the T Mk 1A, but not the T Mk 1, the external DC supply can also be used for charging the batteries.

4. A simplified diagram of the electrical system is at Fig 2, the system controls and indicators are listed in Table 1 and shown in Fig 1, Fig 4 and Fig 5 show the DC system and the AC system respectively; the weapon control supplies shown in Fig 5 are amplified in Chapter 14.

DC SYSTEM

DC Generator

5. The 9 kW 28-volt DC generator is below the forward end of the engine, and is driven by the engine external gearbox. Generator output is supplied to the Generator busbar which is connected, via diodes, to the Essential Services busbar.

Generator Failure Warning

6. Voltage Control and Protection. The output of the generator is controlled by a voltage regulator and an overvoltage unit. An output relay within the regulator operates in conjunction with protection circuits in the overvoltage unit, to take the generator off line if the voltage exceeds 30± 0·5 volts. When the Essential Services busbar voltage has decreased to 25 volts GEN is illuminated. Provided the overvoltage condition clears, the relay can be reset and the generator brought back on line by pressing the DC RESET button. During engine relighting the relay is energized when the engine start/relight button is pressed; the generator is taken off line. The generator is to be reset after a successful relight.

7. **Undervoltage and Time Delay Unit.** An undervoltage and time delay unit is connected, via a fuse, to the Essential Services busbar. When an undervoltage condition (25 volts or less) is sensed an integral failure relay is de-energized and GEN is illuminated. The relay is time-delayed (1·5 seconds) to prevent operation of the undervoltage unit by a transient undervoltage condition.

Note: Sealed lead-acid batteries maintain an output above 25 volts longer than earlier batteries. Hence, in flight, there is a delay between the illumination of AC 1, AC 2 and F.PR and the GEN. Also the GEN may not be illuminated between engine shutdown and selecting the battery switches off if this is less than about two minutes.

Battery Supplies

8. **General.** The two 24-volt 18 ampere-hour lead-acid batteries, No 1 and No 2, are in the main equipment bay. The batteries are controlled from the front cockpit by the 2-position switches, BATT 1 and BATT 2. Setting a battery switch on (forward) energizes an associated battery contactor to connect its Battery busbar to the Essential Services busbar. In this condition the battery is charged by the generator; if the generator is off line however, the battery provides a power supply to the Essential Services busbar. A commoned, diode protected, supply from the Battery busbars is provided direct to certain services (para 10). The commoned supply also provides, in conjunction with the STBY INST and UHF-NORMAL/BATT switches, an alternative supply to standby flight instruments, main UHF transceiver and the Communications Control System (CCS).

Table 1 - Electrical Systems Controls and Indicators

Item	*Marking*	*Location*	*Function*
Front Cockpit Only			
Battery switches (2) (on, forward)	BATT 1, BATT 2	Left Console	Connects associated battery to Essential Services busbar
DC Voltmeter	BATT VOLTS	Lower left panel	Indicates voltage at Essential services busbar
Inverter reset button (T Mk 1A)	AC 3 RESET	Left console	Brings No3 inverter on-line
UHF power supply switch	UHF - Normal, Batt	Centre panel	Selects UHF power from either the Essential services busbar (Normal) or the commoned battery supply (Batt).
Both Cockpits			
Generator reset button	DC RESET	Left panel	Brings generator on-line
Inverter reset buttons (2)	AC 1 RESET AC 2 RESET	Left panel	Brings associated inverter on-line
Generator warning caption	GEN	CWP	Indicates voltage at Essential Services busbar is 25 volts or less
Inverter off line captions (2 - TMk 1) (3 - T Mk 1A)	AC 1 AC 2 AC 3	CWP (T Mk 1A only)	Indicates associated inverter is disconnected from AC busbar. AC 3 indicates that No 3 inverter is disconnected from the armament busbar
Stby Inst power supply switch	Stby Inst - Normal, Batt	Centre panel	Selects Stby Inst power from either the Essential services busbar (Normal) or the commoned battery supply (Batt).

9. **Standby Function.** If the generator fails the services supplied by the Generator busbar are lost; however, those services connected to the Essential Services busbar continue to operate from the Battery busbars supply provided the battery switches are on. Fully charged batteries should support the Essential Services busbar for approximately 25 minutes; battery power may be conserved by selective load shedding.

10. **Emergency and Standby Services.** Irrespective of the setting of the battery switches the following emergency and standby services are powered from the commoned battery supply:

a. Landing gear standby lowering.

b. Flap standby lowering.

c. Cockpit emergency lighting.

d. Fire extinguisher.

e. Crash relay operation.

11. **Alternative Supplies.**

a. When the UHF - NORMAL/BATT switch is at NORMAL, the CCS, the main UHF transceiver and (post-Mod 945) the telebrief facility are powered from the Essential Services busbar; when the switch is at BATT they are powered from the commoned battery supply.

b. When the STBY INST - NORMAL/BATT switch is at NORMAL, the following instruments in the associated cockpit are powered from the Essential Services busbar; when the switch is at BATT they are powered from the commoned battery supply:

(1) Turn-and-slip indicator.

(2) Standby attitude indicator.

(3) Directional gyro indicator.

Voltmeter

12. The DC voltmeter is connected, via a fuse, to the Essential Services busbar. The scale of the voltmeter ranges from 21 to 29 volts and is graduated in 2-volt increments. Concentric with the graduated scale is a coloured scale which extends from 21 to 24 volts (orange) and from 24 to 29 volts (green). When the generator is off line (with the external DC supply switched off - T Mk 1A) and the battery switches are on, battery voltage is indicated; the voltage of each battery can be checked by selecting the switches off/on in turn. In the T Mk 1A with the generator off line, the external DC switched on and the battery switches on, the Essential Services busbar voltage is indicated; it is not possible to determine whether external DC supply voltage or battery voltage is indicated. In both marks of aircraft the voltmeter indicates generator voltage when the generator is on line.

Inertia Switches

13. Two inertia switches, one in each mainwheel bay, are connected in series. When a longitudinal deceleration of 3 g or more is experienced, both switches close automatically. Via the closed switches, a commoned battery supply energizes a crash relay. The relay de-energizes the No 1 and No 2 battery contactors, which open to disconnect the battery busbars from the Essential Services busbar. Simultaneously, the crash relay connects the commoned battery supply via the overvoltage unit to the voltage regulator output relay which takes the generator off line (Fig 3). The energized crash relay also connects the commoned battery supply to operate the engine bay fire extinguisher.

External Supply

14. An external 28-volt DC supply socket is under an access panel on the right side of the fuselage aft of the engine air intake. With the battery switches and both engine start master switches off switching on an external power supply energizes an external power supply contactor via the battery contactors and the undervoltage unit; 28 volts DC is then supplied, via the contactor and the Generator busbar, to the Essential Services busbar. When the external supply is connected and switched on the CWS is muted.

15. **T Mk 1.** If either of the battery switches or both of the engine start master switches are set on, the external supply contactor opens and cuts off the external power supply to the Generator and the Essential Services busbars; this prevents the external DC supply from charging the aircraft batteries, and prevents the engine starting system from being powered from the external supply.

16. **T Mk 1A.** If either of the battery switches or both of the engine start master switches are set on, the external power supply remains connected to the Generator and the Essential Services busbars. The batteries are charged from the external DC supply while the battery switches are on. In this configuration, care must be taken not to overcharge the batteries.

AC SYSTEM

AC Supplies

17. AC power is provided by two static inverters, No 1 and No 2, which are supplied with DC from the Generator busbar. The output of the inverters, 115 volts, 400 Hz, single-phase, is supplied to the AC busbar. Each inverter has voltage and frequency regulation and protection circuits. The inverters are interconnected for phase control and the first inverter to sense a satisfactory DC input assumes a master control function over both inverters. With a satisfactory DC input, and provided their output is within specified limits, the inverters are brought on line automatically. The DC input can be provided by the generator or from an external power source. Three step-down transformers are connected to the AC busbar; they provide 26-volt, 400 Hz, single-phase supplies to associated busbars. In the T Mk 1A a third 115-volt, 400 Hz, single-phase static inverter, No 3, is supplied with DC from the Generator busbar; its output is connected to an Armament AC busbar. No 3 inverter has voltage and frequency regulation and protection circuits which are similar to

those of No 1 and No 2 inverters; it is brought on line automatically provided its DC input is satisfactory and its output is within specified limits.

Inverter Control

18. The inverter protection circuits trip an inverter off line when certain fault conditions are detected. The fault conditions are grouped in two types, those associated with the input to an inverter and those associated with the output of an inverter. When an input fault condition has cleared the inverter is automatically reset but after an output fault has cleared the inverter is to be reset manually. Manual resetting of each inverter is controlled by the AC 1 RESET and AC 2 RESET (and AC 3 RESET - T Mk 1A) button respectively.

Inverter Failure Warning

19. Warning that an inverter has failed or is off line is indicated by an AC 1 , AC 2 or (T Mk 1A) AC 3 illuminated caption.

Note: The third inverter caption on the CWP is standard to both marks of aircraft but is not activated in the T Mk 1.

NORMAL USE

Before Flight

20. **Before Engine Starting.**

a. Check that the external DC power supply is disconnected.

b. Set both battery switches to on. Check that the GEN , AC 1 and AC 2 (and AC 3 - T Mk 1A) captions are illuminated and that the voltmeter reads a minimum of 23 volts. Check the voltage of the batteries by selecting the BATT 1 and BATT 2 switches off and on in turn; the voltmeter should read a minimum of 23 volts for each battery.

21. **After Engine Starting.**

a. Check that the GEN, AC 1 and AC 2 (and AC 3 - T Mk 1A) captions are out. If GEN remains illuminated, press the DC RESET button and check that the caption goes out. If an AC remains illuminated, press the appropriate AC RESET button and check that the caption goes out.

b. Check that the voltmeter indicates between 27 and 29 volts.

In Flight

22. In flight the GEN, AC 1 and AC 2 (and AC 3 - T Mk 1A) captions should remain out and the voltmeter should indicate between 27 and 29 volts.

23. In flight, if, with the throttle lever within 10mm of the Idle stop, either engine start/relight button is pressed the generator is automatically taken off line and the GEN , AC 1 and AC 2 (and AC 3 - T Mk 1A) captions are illuminated. Following engine relight, press the DC RESET button and check that the GEN caption goes out. When the generator output voltage is sufficient to sustain the inverters on line the AC captions should go out.

After Flight

24. During the **Shutdown Checks**, switch off all electrical services and then switch off the batteries.

MALFUNCTIONING

DC Generator Failure

25. As Generator busbar voltage falls due to generator failure the inverters are tripped off line and the AC 1 and AC 2 (and AC 3 - T Mk 1A) captions are illuminated. When the Essential Services busbar voltage has decreased to 25 volts a generator failure is then indicated by the GEN being illuminated and by the voltmeter indicating 25 volts or less. Press the DC RESET button to bring the generator back on line; if the fault was transient the GEN caption should go out. Automatic resetting of the inverters should extinguish the AC 1 and AC 2 (and AC 3 - T Mk 1A) captions but, if necessary, the inverters may be reset manually. If the generator cannot be reset, switch off all non-essential services and land as soon as possible.

Note: If F.PR remains illuminated (post-Mod GEC 1403C for longer than ten seconds) following the resetting of the DC generator, switch the FUEL PUMP off and then on to extinguish the caption.

26. If the generator cannot be reset:

a. The following services connected to the Generator busbar are lost:

(1)	AHRS
(2)	Fuel booster pump
(3)	Main altimeter
(4)	Main attitude indicator
(5)	Horizontal situation indicator
(6)	ILS localiser/glidepath receiver
(7)	ISIS control unit
(8)	Navigation mode selector

b. The services connected to the Essential Services busbar are supplied from the batteries provided the battery switches are on.

27. Following the loss of the generator voltage decreases immediately to that of the batteries, ie, approximately 24 volts. Set the STBY INST switch and the UHF switch to BATT. The voltage subsequently decreases to approximately 21 volts (the rate of decrease being dependent on the demand on the batteries) and then falls rapidly. When the battery voltage falls to 21 volts, switch on the cockpit emergency lighting if required. Then set the battery switches off; the voltmeter needle then deflects fully to the left. Subsequently make no attempt to determine battery voltage from the voltmeter.

28. After generator failure, the life of the batteries may be prolonged (beyond the nominal 25 minutes) by shedding selectable loads on the Essential Services busbar, as listed in Table 2. The loads listed below are given in amperes, based on a 24-volt supply; only loads of one ampere or above are given. If it should be necessary to isolate the Essential Services busbar, switch off both battery switches; all of the listed services are then lost.

Table 2 - Essential Services Busbar Loads

Standing Loads		*Selectable Loads*		*Short Duration Selectable Loads*	
Accident data recorder	1·0	Pitot tube heater	13·8	AC reset	
Airbrake indicator	-	Landing/taxy lamp	7·6	Airbrake Control - out	
Cabin pressurization - OFF, NORMAL, DEMIST or FLOOD selected (control valve solenoid energized)	1·0	Cabin pressurization - NORMAL, DEMIST or FLOOD selected	2·5	Trim control Aileron Rudder Tailplane (main or standby)	1·3
Central warning captions		Anti-collision lights	6·9	Flap control (normal)	1·3
Engine bleed valve control	1·0	Single anti-collision light	4·3	DC reset	
Engine control amplifier - T6/NL control	1·0	Cockpit lighting (normal)	2·7	Engine - start/relight button pressed	7·6
Aileron and rudder trim indicators		Navigation lights	2·1	Start master switch - START selected	13·8
Tailplane position indicator		Main UHF transmit	3·1	Ram air turbine (RAT) reset	
Fatigue meter		Standby UHF transmit	1·2	ILS marker light test	
Fire-wire control unit	1·0	VHF transmit	2·6	Weapon control	
Flap indicator		Tape recorder		Towed target release	
Fuel contents gauge		IFF	2·2	Seat pan height adjustment	12·8
Landing gear indication		Anti-skid control (gear down)	1·0	Flap control (normal)	
Landing gear external indicator light (gear locked down)		Landing gear control (normal)			
Cabin temperature control		Weapon control - MASS at UNLOCK LIVE (and No 1 battery busbar)			
Oxygen flow indicator		VOR receiver (Red Arrows aircraft)	1·0		
EHMS (post-Mod 630)	2·4				

29. After the UHF and the STBY INST switches have been set to BATT, the following loads are transferred to the No 1 and No 2 Battery commoned supply:

Standby attitude indicator	Start Run	4·1 1·7
UHF	Transmit Receive	3·1 0·9
Communications control system		0·3
Turn and slip indicator	Start Run	2·6 0·6
DGI	Start Run	0·8 0·6

Undervoltage and Time Delay Unit Failure

30. Failure of the fuse connecting the undervoltage and time delay unit to the Essential Services busbar causes the GEN to be illuminated. If the voltmeter indicates between 27 and 29 volts, failure of the fuse is confirmed and the warning is spurious; the voltmeter is to be monitored at frequent intervals. If the generator subsequently fails the AC 1 and AC 2 (and AC 3 - T Mk 1A) captions are illuminated and the voltmeter indicates battery voltage (approximately 24 volts).

Battery Failure

31. An unserviceable battery may cause the generator to trip off line and prevent it from being reset. If this occurs, the unserviceable battery is to be isolated. Set the battery switches off/on in turn; if the voltmeter registers an increase when either switch is at off, leave that switch off. A single fully-charged battery should supply the Essential Services busbar loads for approximately 12 minutes. If necessary, after an unserviceable battery has been isolated, press the DC RESET button to bring the generator on line.

AC Failure

32. Failure of No 1 or No 2 (or No 3 - T Mk 1A) static inverter is indicated by the AC 1 or the AC 2 (or the AC 3 - T Mk 1A) caption, respectively, being illuminated. Failure of both inverters (T Mk 1) or all three inverters (T Mk 1A) may be caused by failure of the DC generator; if, after resetting the generator, the inverters do not reset automatically, press the AC RESET buttons to bring them on line.

33. **Single Inverter Failure.** If a single inverter is tripped off line the associated AC 1 or AC 2 (or AC 3 - T Mk 1A) caption is illuminated. If the inverter fails to reset automatically, press the associated reset button. If the initial attempt to reset the inverter fails further attempts may be made during the remainder of the flight.

Note: The output of either No 1 or No 2 inverter is sufficient to power all the loads on the AC busbar.

34. **No 1 and No 2 Inverter Failure:**

a. If both No 1 and No 2 inverters trip off line, other than following a generator malfunction, attempt to reset one inverter only using the following procedure; if the attempt fails, the procedure should not be repeated immediately but may be repeated at intervals during the remainder of the flight:

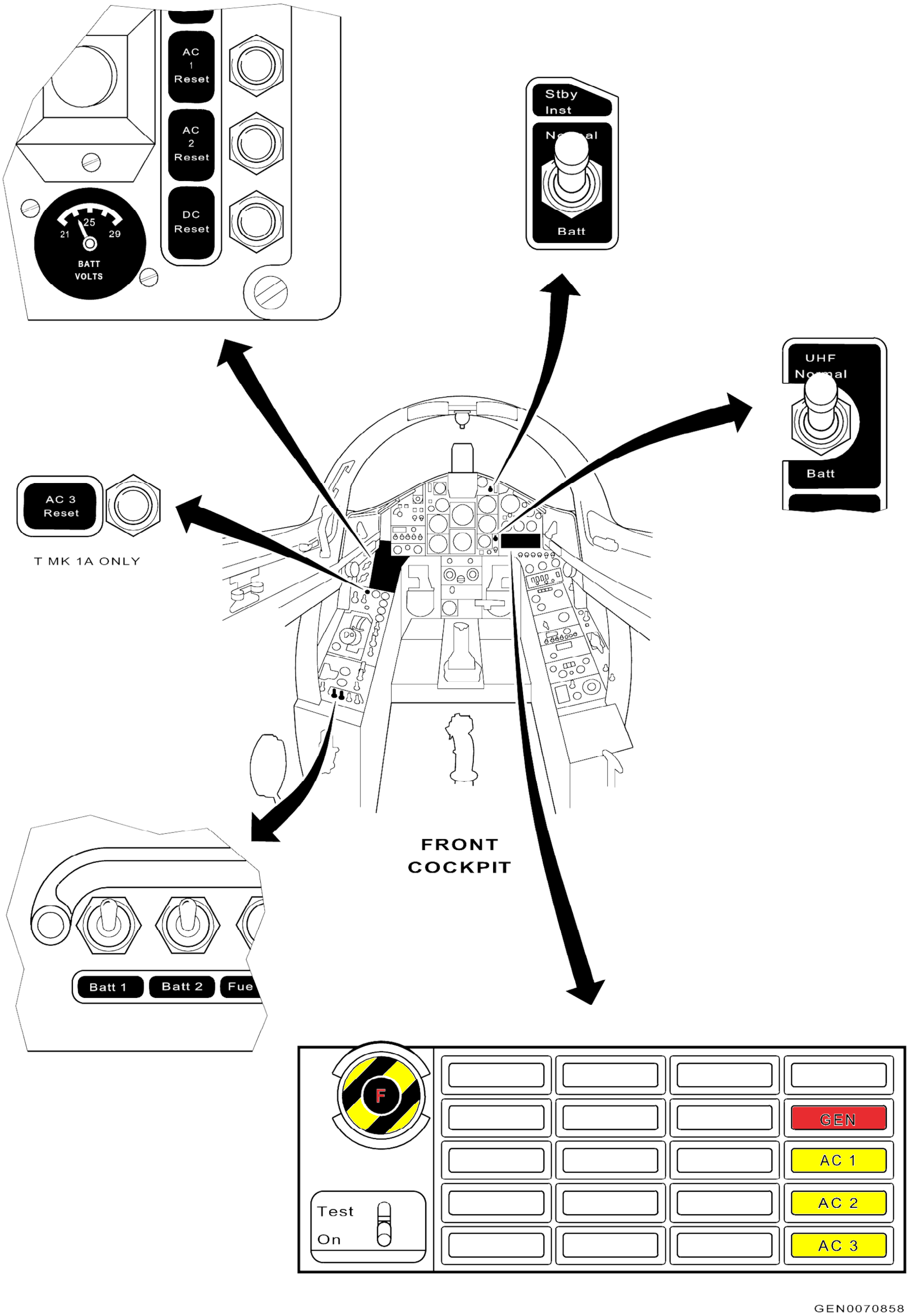
(1) Press the AC 1 RESET button.

(2) If No 1 inverter resets, do not attempt to reset No 2 inverter.

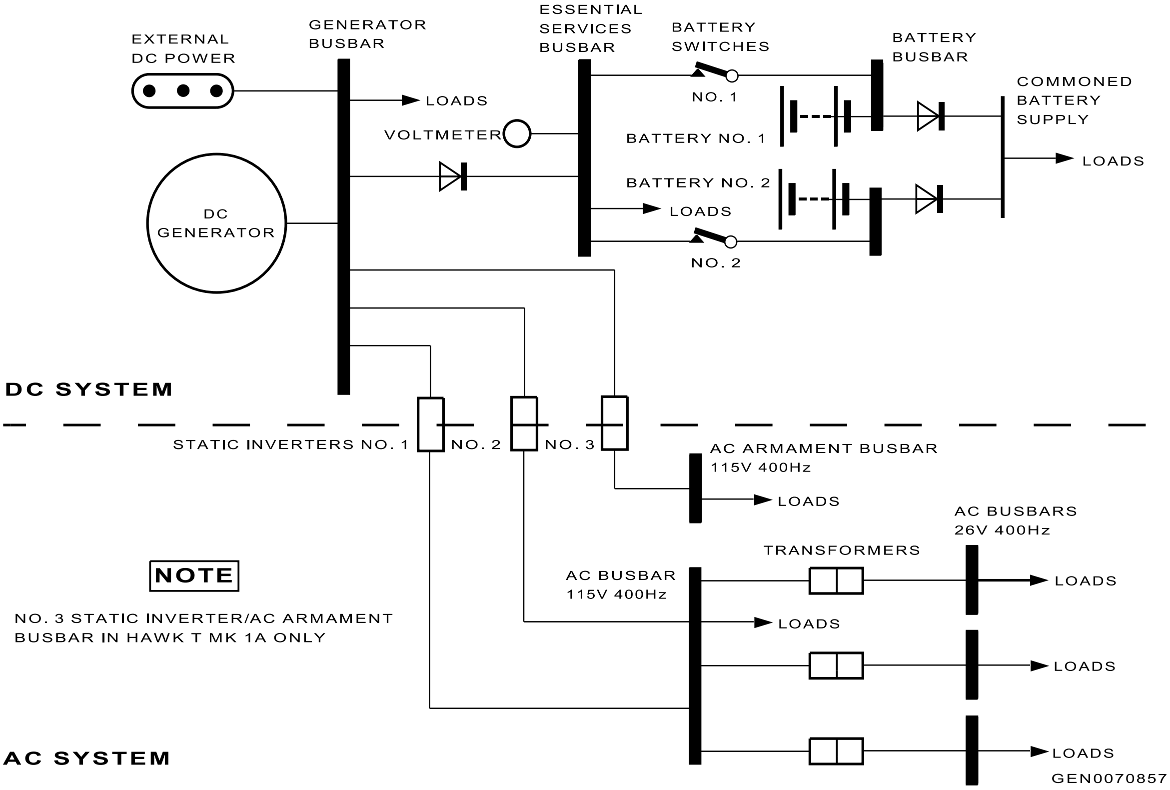
(3) If No 1 inverter fails to reset press the AC 2 RESET button.

(4) If No 2 inverter resets, do not make a further attempt to reset No 1 inverter.

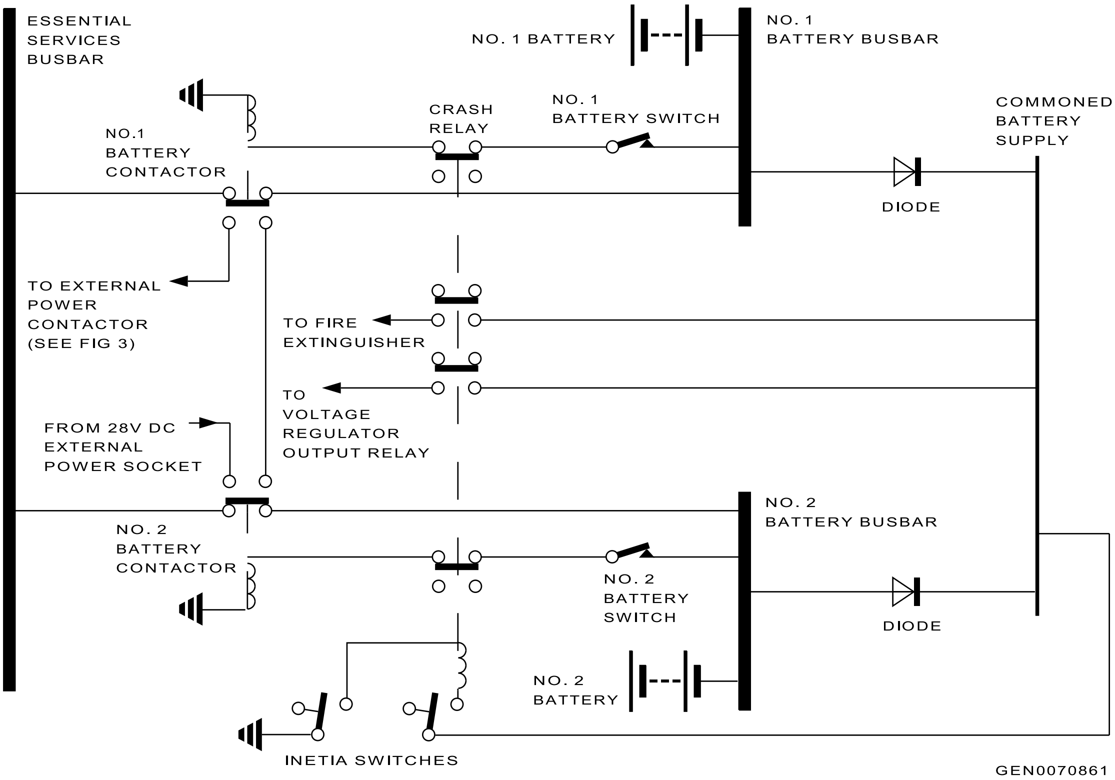
b. If both inverters remain off line, the main AI, the HSI, the AHRS and the main altimeters are unusable. The standby flight instruments, ie, standby attitude indicator, turn-and-slip indicator, standby altimeter and DGI continue to operate.



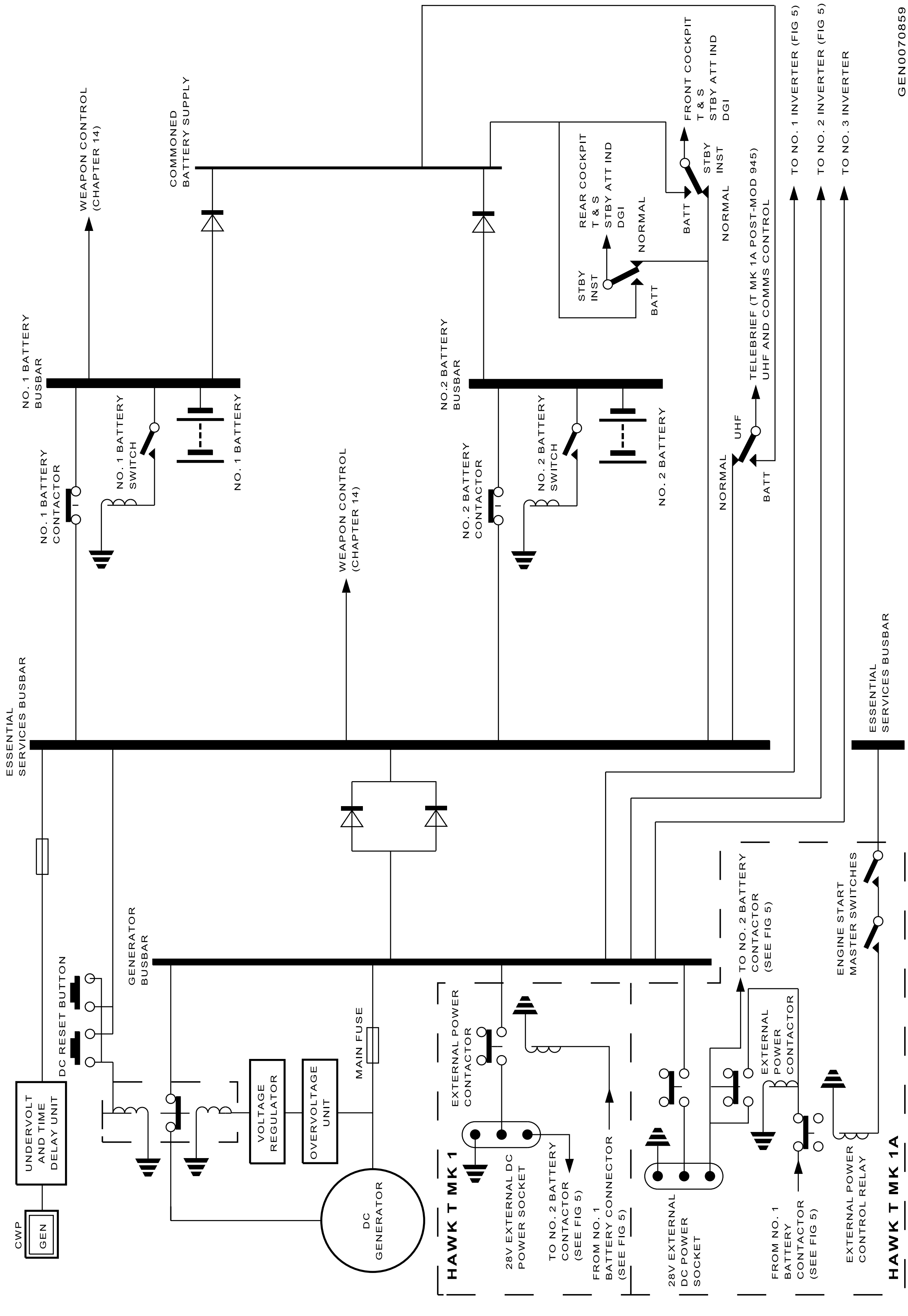
1 - 1 Fig 1 Cockpit Controls and Indicators



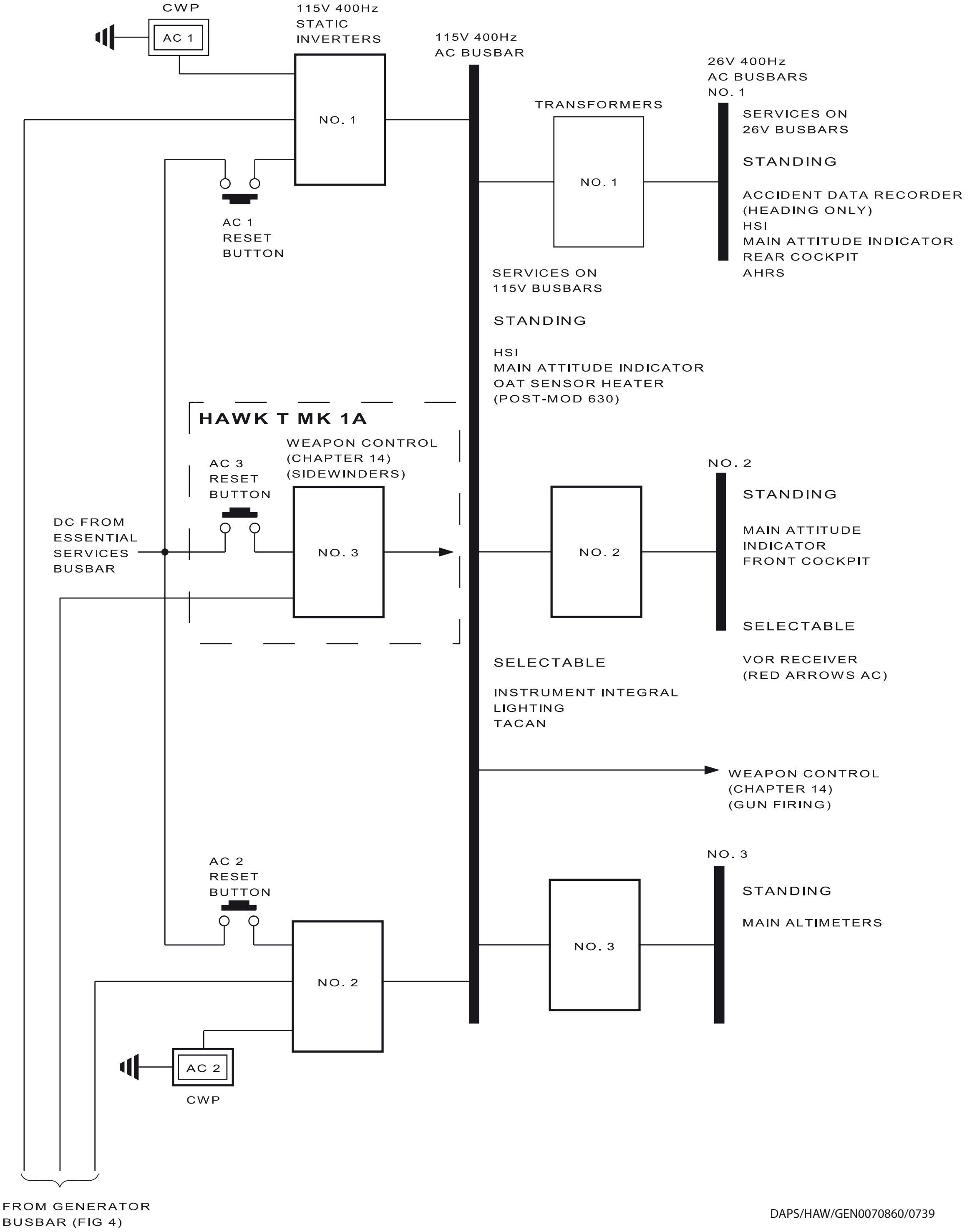
1 - 1 Fig 2 Electrical Systems - Simplified Schematic



1 - 1 Fig 3 Inertia Switches/Crash Relay System - Simplified Schematic



1 - 1 Fig 4 DC System - Simplified Schematic



1 - 1 Fig 5 AC System - Simplified Schematic
(Incorporation of Mod 2516 at AL3)

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PART 1

CHAPTER 2 - CENTRAL WARNING SYSTEM

Contents

DESCRIPTION

General

1. The Central Warning System (CWS) gives warnings of failures or events in the aircraft systems which require prompt action to ensure the safety of the aircraft. The CWS comprises a Central Warning Panel (CWP) and two attention lights in each cockpit, and an audio warning unit which operates through the headphones. Indication of engine bay or air producer bay fire is given on each CWP; indication of engine bay fire is also given by an integral light in a fire extinguisher button on each CWP. The failures and events are classified and appear as red or amber captions on the CWP; only the red captions are accompanied by the audio warning and they indicate more hazardous conditions than those signified by amber captions.

2. Each caption on the CWP is illuminated by a twin-filament lamp whenever the caption control circuit is activated by the associated aircraft system exceeding a limitation or deviating from normal operating parameters. When appropriate remedial action is taken, the CWS resets itself; it is self-cancelling if activated by transient failures or events. Power for the CWS is from the Essential Services busbar.

3. The CWS is automatically muted when an external DC power supply is connected and switched on. Muting is overridden when the LP fuel cock is ON.

Central Warning Panel

4. A CWP (Fig 1) is on the right panel in each cockpit; the captions and their meanings are listed in Table 1.

5. The layout of the captions on each CWP is similar and, with the exception of the OXY, identical captions are illuminated simultaneously on both panels. The OXY operate independently in association with the respective cockpit oxygen system.

6. **Fire Extinguisher Button.** A fire extinguisher button (spring-loaded) on each CWP is marked with black and yellow diagonal stripes. Each button has an integral lamp which illuminates a white F on a red background in the head of the button. Pressing a button activates the engine bay fire extinguisher which is energized by commoned supplies from No 1 and No 2 Battery busbars.

7. Test Switch. A guarded 2-position TEST/ON switch is on each CWP. The switch is spring-loaded from TEST to ON; at ON DC from the Essential Services busbar is supplied to the CWS.

Attention Lights

8. The two attention lights are integrally lit spring-loaded red panels, which incorporate a cancelling facility, at the top left and right corners of the centre instrument panel in each cockpit. When a CWS control circuit is activated, both attention lights in each cockpit flash; pressing any one of the attention light panels cancels the attention lights in both cockpits but the caption associated with the fault remains lit. If, after the attention lights have been manually cancelled the CWS control circuits are activated by another fault condition, the attention lights resume flashing. If the flashing circuit fails to operate when the CWS control circuits are activated, the attention lights show steady.

Table 1 - Central Warning Panel Red Captions

Caption	*Indicating*	*Caption*	*Indicating*
FIRE	Fire in the Engine Bay	T6NL	TGT or NL above approx. 685°C +5 ° minus 0° or 108% respectively
EOHT	Engine LP cooling air temp exceeds approx 400°C. See Note.	START	Fire in the air producer bay
HYD	Total hydraulic failure	CPR	Cabin alt exceeds 30,000ft
OXY	Low oxygen pressure in associated cockpit (Downstream of shut-off valve)	GEN	Essential Services busbar 25 volts or less

Note: For all post-MOD 2010 aircraft the wiring for the EOHT detection system has been removed leaving a false caption. If this caption were to illuminate it would be a spurious warning.

Table 2 - Central Warning Panel Amber Captions

Caption	*Indicating*	*Caption*	*Indicating*
HYD 1	No 1 hydraulic system pressure 41±4 bars or less	HYD 2	No 2 hydraulic system pressure 113·5 ±7·5 bars or less. (Remains on with RAT operating)
FUEL	160kg fuel remaining (approx). See Note.	F.PR	Low fuel pressure. Pressure rise across booster pump less than 0·27 bar or, pressure at engine filter outlet is less than 2·4 bars
AC 1	No 1 inverter off line	AC 2	No 2 inverter off line
AC 3	No 3 inverter off line - T Mk 1A only; caption is inoperative in T Mk 1 aircraft but is illuminated when the appropriate test switch is selected to ON	JP.OHT	Jet pipe bay temperature exceeds 150°C
TRANS	Low air pressure in fuel tanks; possible loss of fuel transfer	OIL	Engine oil differential pressure below 0·7 bar. See Note.
ECA	Failure of either or both amplifier lanes or a fault in amplifier controlling circuits or TGT is in excess of 780 °C (with T6NL caption)	SKID	ANTI SKID switch off, or Anti-skid control valve continuously engaged for more than 2 seconds, or Faulty anti-skid control valve solenoid, or Failure of power supply to anti-skid control unit. (Post-Mod 1237 the SKID caption is isolated when the landing gear is selected up).

Note: *Activation of these captions is delayed for approximately 10 seconds to prevent operation by short term symptoms caused by negative g.

Audio Warning

9. The audio warning is provided by a tone generator in the front cockpit, on the lower right side of the seat frame. When a failure or event associated with a red CWP caption activates the CWS control circuits the tone generator is energized and a continuous `whooping' audio warning sounds in the headphones in each cockpit. Pressing an attention light panel cancels the audio warning. If a fault condition associated with a red caption subsequently activates the CWS control circuits, the audio tone is regenerated.

Testing the CWS

10. The CWS is tested when a TEST/ON switch is held at TEST. With a switch at TEST the lights of all unlit captions on both CWP come on, the head of each fire extinguisher button is illuminated, the attention lights flash in both cockpits and the warning tone is generated. When the switch is released, all captions which were not lit before TEST was selected, and the fire extinguisher button lights, go out; the attention lights and the warning tone are cancelled. If, while a switch is held at TEST, an attention light panel is pressed, the attention lights and the audio warning are cancelled.

Muting the CWS

11. With the LP fuel cock set to OFF, connecting and switching on an external DC power supply causes all lit captions (except FIRE and START), the attention lights and the audio warning to be cancelled. Moving the LP fuel cock to ON closes a microswitch and causes the mute facility to be overridden.

NORMAL USE

Before Flight

12. Before starting the engine, when the batteries are switched on check that the CWP captions illuminate:

HYD			GEN
HYD 1		F.PR	AC 1
HYD 2	TRANS	SKID	AC 2
		OIL	AC 3

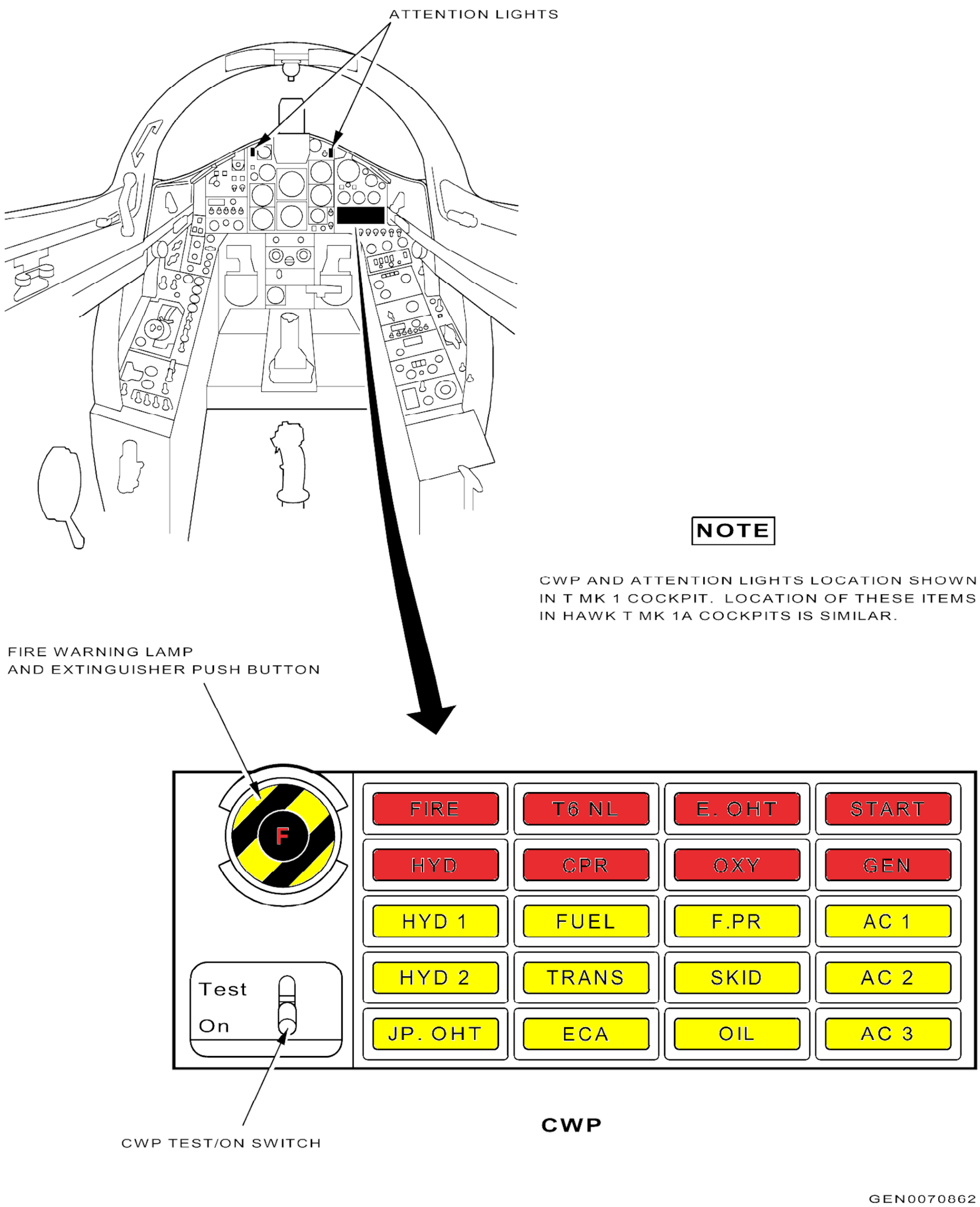
Note: Residual air pressure in the fuel system may prevent illumination of the TRANS caption if the engine has recently been run and not subsequently refuelled.

13. Check that when a test switch is held at TEST, all unlit captions on both CWP are illuminated, the attention lights and audio warning tones are activated, and the fire extinguisher button is illuminated. When the test is released, check that all indications revert to the pre-test state.

MALFUNCTIONING

Audio Warning

14. An electrical fault within the CWS can cause the audio warning to sound continuously and in isolation. In this condition the audio warning cannot be cancelled and radio communication is affected.



1 - 2 Fig 1 CWP and Attention Lights (Front and Rear Cockpit)

PART 1

CHAPTER 3 - FUEL SYSTEM

Contents

DESCRIPTION

General

1. Fuel is contained in a fuselage bag tank and an integral wing tank (Fig 1). The centre section of the wing tank forms a collector tank the forward part of which is a negative-g compartment containing a booster pump. The tanks are pressurized to assist the transfer of fuel to the collector tank, to prevent aeration of the fuel at high altitude and to prevent fuel at high temperature from boiling. Provision is made for pressure or gravity refuelling and for suction defuelling. During suction defuelling the tanks are pressurized via an external air pressure connection, so that the fuselage bag tank is held firmly in position. A simplified diagram of the fuel system is shown at Fig 3.

Table 1 - Fuel Tank Minimum Guaranteed Capacities - Usable Fuel

Tank	*kg (0·79 SG)*	*kg (0·77 SG)*	*Litres*	*Gallons*
Fuselage	645	629	818	180
Wing	627	612	795	175
Total	1272	1241	1613	355

Fuel Tanks

2. The fuselage tank is between and above the engine air intakes; the wing tank extends between the front and rear spar each side of the centreline. Table 1 shows the minimum guaranteed capacities of the tanks; normally a higher indicated content can be expected due to the tanks exceeding the guaranteed minimum.

3. **Residual Fuel.** The residual fuel, not included in Table 1, is approximately 29 kg in the wing tank.

Fuel Transfer

4. **Fuselage Tank to Wing Tank**. Fuel from the fuselage tank is transferred through separate lines to the outer sections of the wing tank. A flap-type Non-Return Valve (NRV) in each transfer line prevents a reverse fuel flow during aircraft manoeuvres.

5. **Wing Tank to Collector Tank**. Fuel transfers from the outer sections of the wing tank into the collector tank via a flap-type NRV on each side of the collector tank.

6. **Collector Tank to Negative-g Compartment**. Fuel from the collector tank transfers into the negative-g compartment via three flap-type valves, one in each bay of a diaphragm which forms the rear wall of the compartment. The valves prevent an excess of fuel flowing to the rear part of the collector tank when the aircraft attitude is nose high or during acceleration at low fuel states and thus ensures that fuel is available at the booster pump for delivery to the engine.

Tank Air Pressurization

7. The fuel tanks are pressurized by air from the engine HP compressor; the air enters the system via a filter and a pressure control valve. The pressure control valve incorporates an NRV, a reducing valve and a relief valve. The NRV prevents reverse air flow to the engine during refuelling and prevents fuel entering the air line; the reducing valve controls the air pressure to the fuselage tank; the relief valve prevents overpressure damage and allows the fuel system to function satisfactorily if the reducing valve fails fully open. A defuelling air pressure supply connection is on the filter. Datum pressure for the system is taken, at ambient pressure or slightly above, from an air inlet on the fuselage, and fed to the pressure control valve, a differential pressure switch and an NRV.

8. **Operation.** The reducing valve, within the pressure control valve, operates to ensure that compressor air pressure to the fuselage tank is slightly above the datum air pressure. The differential pressure switch senses datum pressure on one side and tank pressure on the other; if the tank pressure falls slightly below the datum pressure the TRANS illuminates. If fuel tank pressurization is lost, the NRV allows air to enter the tanks from the datum air source to offset the loss of pressure; the NRV also prevents air/vapour or fuel venting to atmosphere via the datum air source.

Tank Venting

9. **General.** The fuel tanks vent to atmosphere via two pipes, a main vent pipe which terminates at the end of the tail cone on the left side, and an excessive flow vent pipe which terminates at a vent hole in the left side of the fuselage above the rear of the wing root fairing. The main vent pipe is a branch of the excessive flow vent pipe. Venting normally takes place through the main vent pipe but if the venting flow exceeds the pipe capacity fuel is also discharged from the excessive flow vent pipe.

10. **Wing Tank.** Vapour from the collector tank is piped to a vent tank in the gas turbine air producer bay. A vapour release valve in the tank discharges the vapour via an NRV into the main vent pipe. The vapour release valve is float controlled, but under negative-g conditions it is held closed by a weighted arm to prevent fuel loss. Vapour from the outer sections of the wing tank is vented into the fuselage tank.

11. **Fuselage Tank.** Venting from the fuselage tank is via the relief valve in the pressure control valve. If the vapour pressure in the tank exceeds 0·55 bar the relief valve opens, the pressure reducing valve closes and the tank vents to atmosphere via the main vent pipe. If the reducing valve in the pressure control valve fails to control compressor air pressure entering the tank or, if the pressure refuelling system fails to shut off when both tanks are full, subsequent venting is in excess of the capacity of the main vent pipe; a relief valve

in the excessive flow vent pipe opens, downstream of the control valve, and the bulk of the venting flow discharges through the excessive flow vent pipe.

12. **Reservoirs** . During refuelling any fuel remaining in the outer wing tank vent pipes is pushed up into two reservoirs in the fuselage tank. Vapour from the outboard end of the wing tanks vents into the fuselage tank via the outer wing tank vent pipes and the reservoirs.

Fuel Feed

13. Fuel is supplied to the engine from the negative-g compartment via the booster pump, a bypass valve and a Low Pressure (LP) cock. A tapping downstream of the LP cock delivers fuel to the Gas Turbine Starter (GTS).

Booster Pump

14. The booster pump is an immersed, double-entry unit which ensures the engine fuel supply under negative-g conditions. A differential pressure switch, downstream of the bypass valve, senses the pressure rise across the pump; the switch is subjected to collector tank pressure on one side and to LP fuel line pressure on the other. If the pressure rise is less than 0·27 bar the switch closes and the FPR caption is illuminated.

15. **Power Supply.** The booster pump is driven by an integral AC motor which is powered by its own static inverter. Normally, the inverter power supply is from the Generator busbar and is controlled by a FUEL PUMP switch. Irrespective of the setting of the fuel pump switch, with the ignition switch to NORMAL, the inverter is supplied from the Essential Services busbar while either start/relight button is pressed; the pump continues running from this source until 30 seconds after subsequent GTS shutdown during engine starting or relighting. 30 seconds after GTS shutdown, with the fuel pump switch at on, the inverter supply reverts to the Generator busbar; with the fuel pump switch at off the inverter is then de-energized.

Note: GEC Mod 1403 delays the fuel booster pump maximum output for approximately 6 seconds after selecting engine start, relight or DC reset. There may be a corresponding delay in F.PR going out. Provided the FPR caption is out by the end of the start, relight or DC reset cycle, the system can be considered serviceable.

Booster Pump Bypass Valve

16. If the booster pump fails, the bypass valve, downstream of the pump, opens to allow an engine-driven LP pump (Chapter 4) to draw fuel directly from the bottom of the negative-g compartment. At the same time, the booster pump delivery line is closed to prevent air being drawn into the engine through either of the pump inlets, if they are uncovered.

Low Pressure Fuel Cock

17. The LP cock connects the aircraft fuel system to the engine fuel system and to the air producer gas turbine. The cock is controlled by a lever in the front cockpit; a white index read against ON and OFF markings adjacent to the lever indicates the settings at which the LP cock is open or closed respectively.

Fuel Low Level Warning

18. Warning of a low fuel state is indicated by the illumination of the FUEL caption and flashing of the attention lights. The warning is triggered by a float switch in the negative-g compartment; the switch closes when the usable volume of fuel falls to 205 litres (equivalent to approximately 160 kg). However, the mass of fuel indicated when the float switch closes depends on the type of fuel, the temperature and the aircraft attitude. In level flight the warning is given when the fuel tank contents indication is approximately 160 kg (but see para 30).

19. When the low level float switch closes activation of the CWS is delayed for 10 seconds by a time delay relay, thereby minimizing pilot distraction by intermittent warnings triggered during aerobatics. When the flaps and/or the landing gear are down a hold-on relay is energized and the FUEL caption, once triggered, remains on regardless of any subsequent position of the float switch. The action of the hold-on relay prevents

intermittent triggering of the fuel low level warning during an approach and landing, and thus prevents possible pilot distraction. The hold-on relay is de-energized when the flaps and landing gear are raised or when the batteries are switched off.

Controls and Indicators

20. The controls and indicators associated with the fuel system are listed in Table 2 and shown in Fig 2. For external controls see para 23, para 24 and para 25.

Table 2 - Fuel System Controls and Indicators

Control/Indicator	*Marking*	*Location*	*Function*
LP fuel cock lever	LP FUEL COCK CONTROL - OFF (up)/ ON (down)	Left wall, front cockpit	Controls LP fuel cock connecting aircraft fuel system to engine fuel system and to air producer gas turbine
Booster pump switch	FUEL PUMP	Left console, front cockpit	Controls power supply to booster pump
Contents gauge	FUEL kg X 100	Right panel, both cockpits	Indicates usable fuel contents
Fuel low level caption	FUEL	CWP, both cockpits	Indicates approximately 160 kg remaining in level flight
Fuel low pressure caption	F.PR	CWP, both cockpits	Indicates pressure rise across booster pump less than 0·27 bar or, pressure at engine LP filter outlet less than 2·4 bars
Tank air pressure failure caption	TRANS	CWP, both cockpits	Indicates low air pressure in tanks with possible loss of fuel transfer

Gas Turbine Air Producer Fuel Supply

21. Fuel for a gas turbine air producer, which is part of the GTS system, is tapped from downstream of the LP cock; it passes through a filter and an electrically-operated shut-off valve to a dual fuel/oil pump which delivers the fuel to the distribution block of the gas turbine air producer.

22. Excess fuel at the distribution block normally passes to the vent tank via a spill valve and an NRV, but during engine starting it spills, via a pneumatically-operated purge valve, into the main vent pipe for approximately eight seconds after the air producer has started. The purge valve is controlled by air pressure (P2) from the air producer and closes when a datum pressure has been reached. The short duration spill into the main vent pipe prevents vent tank back pressure from affecting the spill valve system.

Refuelling

23. A pressure refuelling coupling is on a control panel behind an access door in the engine left intake fairing. Refuelling is via a solenoid-operated refuelling valve, at the bottom of the fuselage tank, which is controlled by a REFUEL/FLIGHT switch on the control panel and by a high-level float switch in the fuselage tank. The DC power supply for the system is from No 2 Battery busbar. The refuelling rate is 680 litres/minute (150 gallons/minute).

24. When the control switch is set to REFUEL, DC is supplied to a switch in the refuelling coupling. When fuel is supplied to the coupling the switch is closed and DC, supplied via the closed contacts of the high-level float switch, energizes a solenoid which opens the refuelling valve. When the valve is open, a LIGHT OFF, TANK FULL indicator light on the control panel comes on. When the tanks are full the contacts of the float switch open; the refuelling valve closes and the indicator light goes out. If the refuelling valve fails to close when the fuselage tank is full, fuel is vented overboard via the pressure control valve (para 11). The REFUEL/FLIGHT switch is automatically set to FLIGHT when the control panel access door is closed.

25. The aircraft can be refuelled by gravity via a wire-locked filler cap under the UHF aerial panel on top of the fuselage.

Post-MOD 2010 Aircraft Refuelling

26. On post-MOD 2010 aircraft there is an additional indicator lamp on the control panel labelled DV OPEN. This lamp was intended to be connected to a fuel system modification as part of MOD 2010. Due to technical difficulties the fuel system modification was not embodied but the indicator lamp remains. The lamp is electrically isolated and is not connected to any aircraft system. Normal refuelling procedures as detailed at para 23 should be used.

Defuelling

27. The aircraft can be defuelled, using bowser suction, via the refuelling coupling and a manually operated defuelling cock in the left fuselage above the mid point of the wing root fairing. The defuelling cock is opened using a key stowed on the bowser; the key cannot be removed when the cock is in the open position.

28. During suction defuelling, fuel is withdrawn from the collector tank via the booster pump bypass valve, the defuelling cock and the refuelling coupling. As fuel is withdrawn from the system, suction relief is provided by inward venting of air through the NRV in the datum pressure air supply line.

Draining

29. The fuel system may be drained by gravity down to the residual fuel level (29 kg) by opening a wing tank drain valve in the left wheelbay. The residual fuel may be removed by opening the two water drain valves in the collector tank; the valve operating positions and the discharge points are in an underwing fairing on either side of the gun pod position. During draining, venting of the tanks may be improved by opening the gravity filler.

NORMAL USE

In Flight

30. The normal use is to check contents and monitor fuel use against anticipated fuel burn. If the indicated fuel contents is allowed to fall to approximately 160 kg, which is well below normal minimas FUEL is illuminated.

Note: At high IAS, low altitude and low fuel states (300 kg or below), the fuel low level warning light may come on, but go out on throttling back. This is due to the engine draining the collector tank at a faster rate than the fuel transfer system can replenish the collector tank. Provided that a reduced throttle setting (below 90% RPM) is maintained, all indicated fuel is available.

After Flight

31. To avoid fuel system damage, do not select the fuel booster pump off until immediately before selecting the throttle to HP Off for shutdown.

MALFUNCTIONING

Fuel Contents Low

32. If FUEL illuminates in flight, before reaching a planned contents of 160 kg, reducing power levels as per para 30 Note may extinguish caution and will also reduce consumption. If a cross check of the fuel gauge indicates more than 160 kg assume only 160 kg is usuable. If more than 160 kg is indicated and the **FPR** and **TRANS** captions are out, applying negative G then positive G may free the Vapour Release Valve, see para 38.

Tank Air Pressurization Failure

33. Failure of the tank air pressurization system is indicated by TRANS being illuminated. Fuel continues to flow to the collector tank by gravity. After the fuselage tank has emptied, the lack of pressurization allows the level of the fuel in the collector tank to fall with that in the outer sections of the wing tank. When the contents of the collector tank reduce to about 160 kg FUEL is illuminated but the total fuel remaining is more than 160 kg, ie, the fuel in the collector tank plus that in the outer sections of the wing tank. At altitude maximum thrust may be limited following the loss of tank pressurization.

34. Following the illumination of TRANS, reduce altitude to below 25,000 feet, avoid negative-g manoeuvres and land as soon as practicable. The FUEL, if illuminated following tank pressurization failure, may subsequently go out, indicating an improved fuel transfer rate.

Fuel Pressure Failure

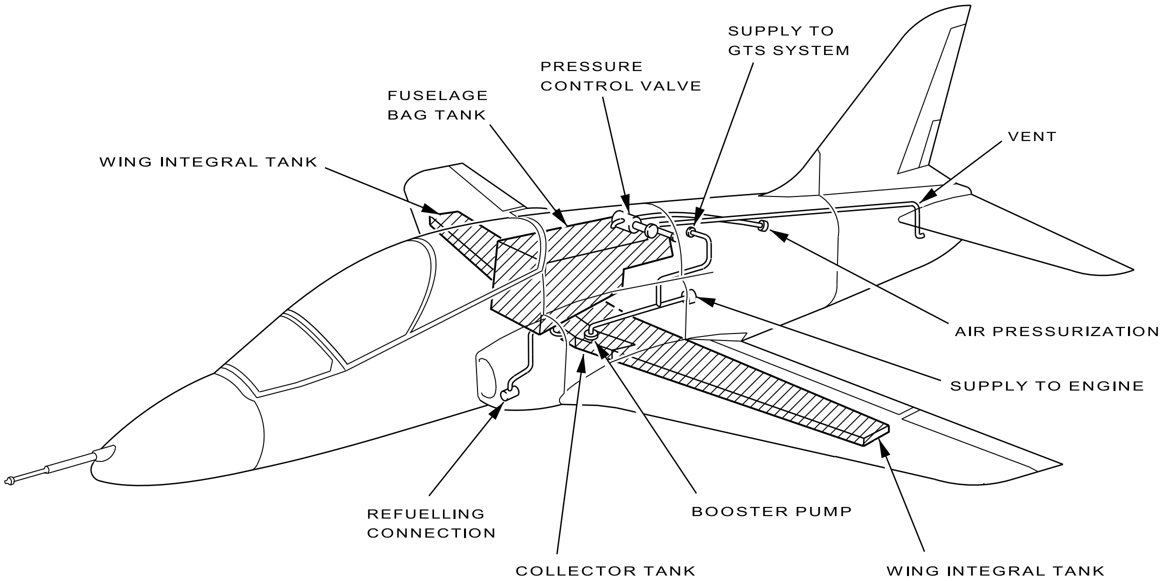
35. The F.PR comes on when the pressure rise across the booster pump or the fuel pressure at the LP filter outlet to the engine HP pump falls below datum (the booster pump also fails, and F.PR comes on, when the generator fails and deprives the pump of its power supply). The loss of pressure may be due to booster pump failure but other malfunctions can also activate the warning system, eg, fracture of the booster pump delivery line upstream of the bypass valve, partially closed LP cock, failure of LP fuel pump or blockage of the engine filter. The pilot cannot determine the cause of the warning. Failure of the booster pump does not seriously affect engine performance in normal flight.

36. Following the illumination of F.PR (by itself), reduce RPM to the minimum practicable and descend as low as practicable. Avoid negative-g manoeuvres and land as soon as possible. As soon as the first action has been initiated, check that the FUEL PUMP switch and the LP cock are on. Throughout the remainder of the flight, monitor the apparent rate of fuel consumption.

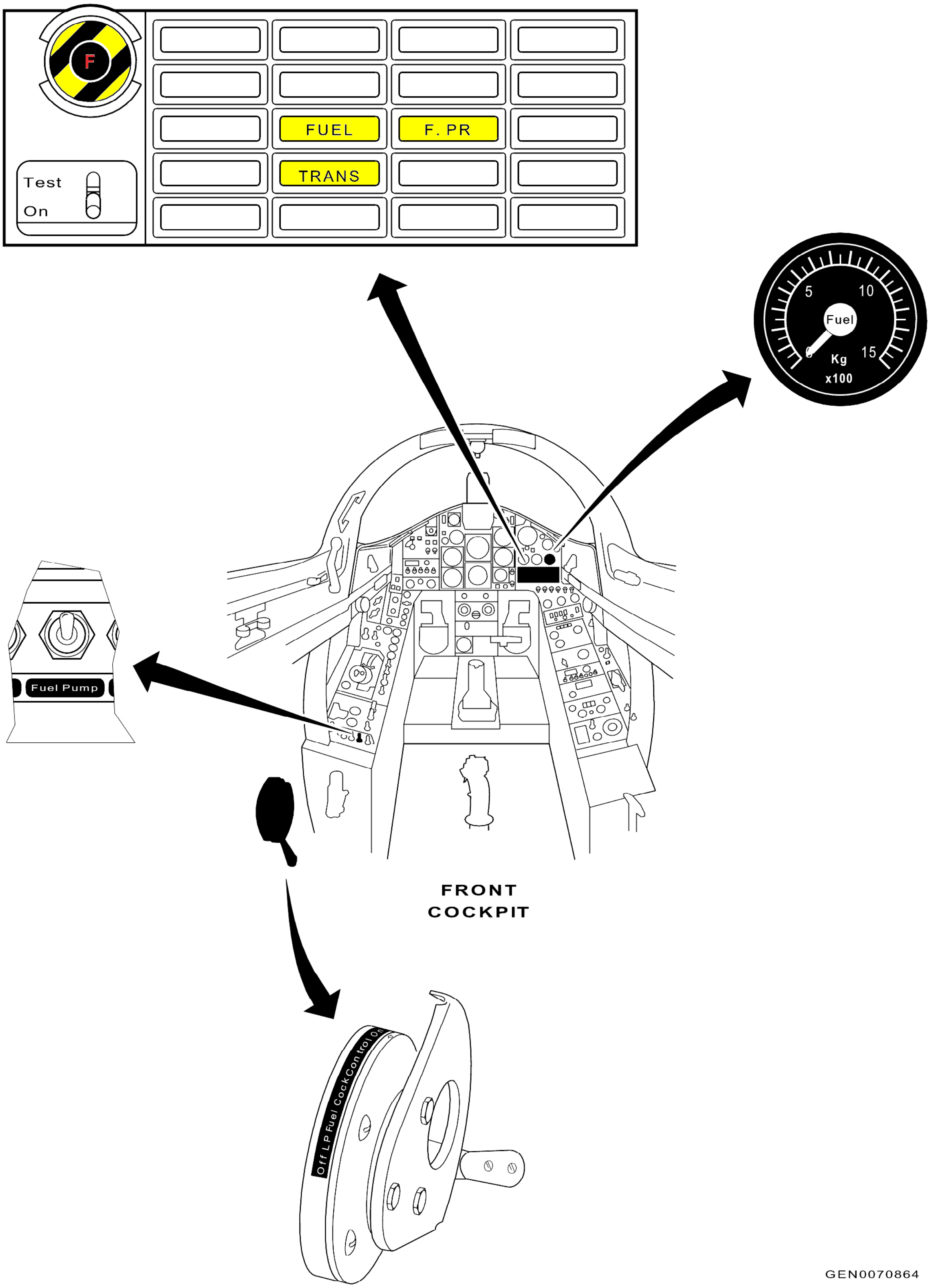
Vapour Release Valve Failure

37. **Valve Fails Open.** If the vent tank vapour release valve fails in the open position, fuel venting occurs causing the apparent fuel consumption to be higher than expected. Land as soon as practicable.

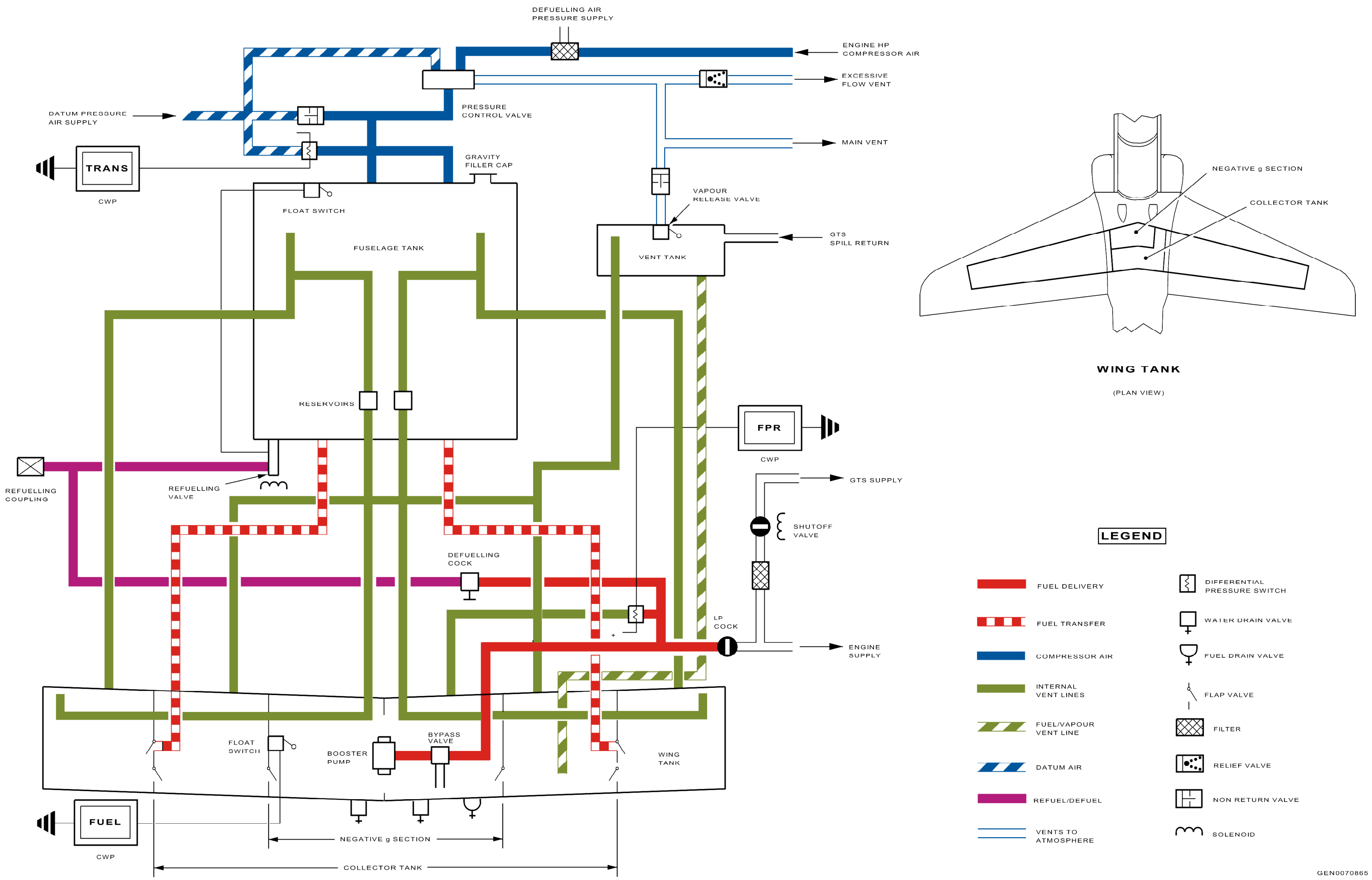
38. **Valve Fails Closed.** At altitude, if the vapour release valve does not open, the rate of fuel transfer into the collector tank is affected. The failure is indicated by FUEL being illuminated contrary to fuel gauge indications or, the warning persisting after inverted flight. Recover the aircraft to normal flight and attempt to free the valve by applying negative and then positive g. Carry out the Relighting drill if flame out has occurred. If FUEL continues, recover and land as soon as possible. If, after remedial action, the FUEL warning goes out, there is no immediate emergency but do not prolong flight unnecessarily.



1 - 3 Fig 1 Fuel System General Layout



1 - 3 Fig 2 Fuel System Controls and Indicators



1 - 3 Fig 3 Fuel System Simplified - Vertical Section

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PART 1

CHAPTER 4 - ENGINE SYSTEMS

Contents

Illustrations Fig

DESCRIPTION

General

1. The Adour Mk 151 is a turbofan engine (Fig 1) which has a 2-stage low pressure (LP) compressor driven by a single-stage LP turbine, and a 5-stage high pressure (HP) compressor driven by a single-stage HP turbine. The LP and HP shafts are concentric, but mechanically independent. In ISA sea-level conditions the engine develops 23·1 kN (5200 lb) static thrust. Post-Mod 630 an engine health monitoring system (EHMS) is introduced.

2. An external gearbox (driven from the HP shaft), at the front of the engine below the compressor, drives:

a. LP fuel pump.

b. HP fuel pump.

c. Engine oil pumps.

d. HP shaft tacho-generator.

e. DC generator.

f. Hydraulic pumps (two).

Table 1 - Engine Controls and Indicators

Control/Indicator	*Marking*	*Location*	*Function*
Front Cockpit Only			
Ignition switch	IGNITION - NORMAL/ISOLATE (Gated at NORMAL)	Left console	Controls power supply to the engine ignition units.
LP fuel-cock lever	LP FUEL COCK CONTROL -OFF/ON	Left wall	Controls LP fuel cock connecting a/c fuel system to engine fuel system and to air producer gas turbine.
Both Cockpits			
Start master switch (Gated from ON to OFF)	ENG START - OFF/ON/START (Spring loaded from START to ON)	Left console	Controls power supply to the GTS system and provides an emergency shutdown facility for the GTS system.

(Continued)

Table 1 - continued

Control/Indicator	*Marking*	*Location*	*Function*
HP cock/throttle lever	Idle position indicated by mark on throttle quadrant	Left console	Controls HP fuel shutoff valve and throttle valve/engine speed.
Idle stop lever	Unmarked	Throttle lever	Withdraws retractable idle stop to permit movement of HP cock from idle to HP OFF.
LP shaft rotation and igniter firing indicator	ROTATION (black/ green)	Right panel	Green indicates igniters are firing. Black: Indicates igniters are not firing. Igniters are inhibited if LP shaft speed below 100 RPM or rotating in wrong direction. Igniters are fired for the duration of the press of a relight button, for 45 seconds after selecting START during an assisted relight or engine starting or, when airborne, for 30 seconds after the button is released. In all cases, the igniters are only energized if the throttle is within 10mm of the idle stop.
Air producer start indicator	GTS (black/green)	Right panel	Black: indicates air producer shut down or speed below datum. Green: indicates air producer speed at or above datum.
Start/relight button	RELIGHT	Throttle lever	When pressed, with both start master switches ON, ignition switch at NORMAL and the throttle lever in the range HP OFF to idle: - Initiates start sequence - Energises igniter plugs for duration of press and when airborne, for 30 secs after button is released or until throttle is advanced beyond idle whichever occurs first. - Offloads DC generator in flight. - At any throttle position, transfers booster pump to Essential Services busbar for the duration of GTS system operation and for 30 secs after shutdown of GTS.
TGT indicator	°C x 100 TGT	Right panel	Indicates turbine exhaust gas temperature.
RPM indicator	% RPM	Right panel	Indicates HP shaft speed as a % (when shaft speed exceeds approx 11%).
TGT/NL over limit caption	T6NL	CWP	Indicates if TGT reaches 685+5 minus 0°C or LP shaft speed (NL) exceeds 108%.
LP cooling air overheat caption	EOHT	CWP	Indicates if LP cooling air temp exceeds approx 400°C.
Oil low pressure caption	OIL	CWP	Indicates if differential pressure is below 0·7 bar.
Fuel low pressure caption	F.PR	CWP	Indicates pressure rise across booster pump is less than 0·27 bar or pressure at engine filter outlet is less than 2·4 bars.
Engine control amplifier lane failure caption	ECA	CWP	Indicates failure of either or both amplifier lanes or a fault in amplifier controlling circuits or TGT is in excess of 780°C (with T6NL caption).
Jet pipe bay overheat caption	JP.OHT	CWP	Indicates if jet bay temperature exceeds 150°C.

Note: Post MOD 2010 the EOHT caption is inoperative.

3. The Adour engine is started by a Gas Turbine Starter (GTS) system; air from a gas turbine air producer powers a starter motor which drives the HP shaft through the engine external gearbox. Following flame out, the engine may be relit with or without the use of the GTS.

4. The engine bay and the air producer bay have fire detection and warning systems (see para 46); the jet pipe bay has an overheat detection and warning system. Only the engine bay has a fire extinguishing facility.

Controls and Indicators

5. The controls and indicators for the engine are listed in Table 1 and shown in Fig 2 and Fig 3.

Gasflow

6. Two intakes, one on each side of the fuselage, pass air directly to the LP compressor. Beyond the compressor the air divides into two approximately equal streams; one flows through an annular bypass duct, while the other passes through the HP compressor, an annular combustion chamber and the HP and LP turbines. The two streams meet in an exhaust mixer section and flow through a jet pipe to discharge through a fixed propelling nozzle (see Fig 4). Tappings at the HP compressor outlet supply air for engine and aircraft systems.

Bleed Valve

7. A bleed valve at the final stage of the HP compressor prevents compressor stall during engine starting, by bleeding off HP air into the bypass duct. The valve operates automatically in response to signals from a fuel differential pressure switch. Before the engine is started the bleed valve is open; it remains open during engine starting and closes when the HP shaft speed reaches 61 ±4%. Thereafter the valve normally remains closed under all conditions at or above idle, re-opening only when RPM fall to approximately 45%. However, it may reopen during the Shutdown Checks when the fuel pump switch is selected off before the throttle is selected to HP OFF. Bleed valve closure is indicated by an increase in idle RPM of about 3% and a decrease in TGT of about 50°C.

HP Compressor Bleeds

8. Air is tapped from the compressor section for cooling bearing housings and turbine discs, and for pressurizing oil and air seals. Some of the air enters the LP shaft and passes forward to provide continuous anti-icing of the LP compressor nose fairing. Surplus air from inside the shaft is dumped overboard through an outlet containing a temperature switch. If the air temperature reaches approximately 400°C, the switch closes and the EOHT comes on. Post MOD 2010 the EOHT caption is inoperative.

9. Two tappings at the final stage of the HP compressor bleed air for aircraft services. One tapping supplies the cabin air conditioning system, the anti-g system and the cockpit canopy seal; the other supplies air to pressurize the aircraft fuel system.

Turbine Gas Temperature Indicators

10. Thermocouples, downstream of the LP turbine, sense exhaust gas temperature and provide an input to the Turbine Gas Temperature (TGT) indicators and to an Engine Control Amplifier (ECA).

Throttle Levers

11. The throttle levers in the front and rear cockpits control an HP shut-off valve and a throttle valve; the levers are quadrant mounted and interconnected. A THROTTLE DAMPER friction control is at the rear of the front quadrant and the range of throttle movement is from HP OFF (fully aft) through an Idle position, which is indicated by a mark on each quadrant, to maximum (fully forward). A retractable idle stop in the front cockpit quadrant allows free forward movement of the throttle levers but prevents inadvertent rearward movement past Idle. The idle stop is withdrawn, to permit rearward movement of the throttle to HP OFF, by lifting a spring-loaded idle stop lever on either throttle; the rear cockpit idle stop lever operates by cable action to the stop on the front cockpit throttle quadrant. Maximum forward movement of the throttle levers is governed by a full throttle stop on the front quadrant. Forward of each throttle quadrant there is a RELIGHT-AUTO HOLD-IN label.

ENGINE FUEL SYSTEM

General

12. Fuel from the aircraft fuel system is supplied via an LP pump and filter to an HP pump; both pumps are engine driven. During normal running the HP pump supplies fuel to spray nozzles in the combustion chamber via a throttle valve and the HP shut-off valve in a Fuel Control Unit (FCU), and a fuel cooled oil cooler (heat exchanger)(see Fig 5). An additional flow from the HP pump bypasses the throttle valve; it passes to the spray nozzles via an idle bypass and a Sub-Idling Fuel Control Unit (SIFCU) which provide the control of fuel flow during engine starting and idling.

13. Fuel flow is automatically limited by an LP shaft speed (NL) limiter and a TGT limiter which operate through the ECA to regulate a fuel trim valve. RPM are limited by a hydro-mechanical governor integral with the HP fuel pump. At certain low altitude/high speed conditions, when air intake pressure exceeds a specific value, the fuel is limited by a flow control unit.

LP Fuel Supply

14. The LP pump maintains fuel pressure at the HP pump inlet to prevent cavitation within that pump. A pressure switch, downstream of the LP filter, closes to light the F.PR if pressure falls below 2·4 bars. The warning can result from booster pump failure, blockage of the fuel system, LP pump failure, LP filter blockage or a fuel leak .

HP Fuel Supply

15. **HP Pump** . The multi-plunger, variable stroke, HP pump supplies fuel at high pressure to the FCU and the SIFCU. Pump stroke is controlled by servo pressure derived from the pump itself. Servo pressure is modulated, to increase or decrease pump output, by changing the pump stroke in response to signals from the flow control unit and the hydro-mechanical governor. The hydro-mechanical governor reduces pump output if RPM rise to between 103% and 104%. Thus, for a particular throttle valve setting, the pump servo pressure modifies HP pump output to give a corresponding fuel flow (and hence RPM). Pump output is further modified to take account of changes in airspeed and altitude. Fuel flows which would induce engine overtemperaturing or overspeeding are automatically controlled.

Fuel Control Unit

16. **Throttle Valve.** The throttle valve consists of a sleeve which moves, to control a fuel flow orifice, in response to throttle lever movement. A dashpot assembly incorporated in the throttle acts as an acceleration control to prevent overfuelling as the throttle is opened; it has no effect on engine deceleration.

17. **Flow Control Unit** . The flow control unit modifies HP pump output in response to throttle valve position, fuel trim valve position, airspeed and altitude.

18. **Fuel Trim Valve.** The fuel trim valve keeps NL and TGT within limits by reacting to inputs from the ECA and, through the flow control unit, reducing pump output.

19. **HP Valve.** The HP valve is a shut-off valve controlling the fuel supply to the spray nozzles. The valve is interconnected with, and controlled by, the throttle lever. With the lever set to HP OFF, the valve is closed and fuel circulates to the LP side of the fuel system; fuel remaining in the spray nozzles then drains to atmosphere through an outlet beneath the fuselage, aft of the wing. When the lever is set to Idle the valve is fully open.

Sub-Idling Fuel Control Unit

20. The SIFCU automatically controls the fuel flow during engine starting and acceleration to idle. A diaphragm within the unit is subjected on one side to hydro-mechanical governor pressure and on the other side to LP fuel pressure; the difference between these pressures is proportional to RPM. Diaphragm movement, in response to pressure changes, actuates a fuel metering mechanism.

Engine Control Amplifier

21. **General.** The ECA receives signals of NL and TGT and provides:

a. Maximum TGT control.

b. Maximum NL control.

c. Excessive TGT or NL warning signal.

d. Warning of ECA failure.

e. Igniter Firing Signal for ROTATION MI.

22. TGT and NL Control. Reference values of TGT and NL are stored in the ECA. When either 665°C or 104% is approached, the ECA energizes the solenoid of the fuel trim valve. The amplifier then maintains the fuel trim valve in the position required to hold TGT or NL at the limiting value. Only one of the reference parameters can be in control at any one time.

Note: Minor disturbances to the ECA may occur when operating at full throttle near high intensity radio transmission area band C (32 to 790 MHz) transmitters within the HIRTA recommended limits.

23. **Excessive TGT or NL Warning.** If the ECA fails to control TGT or NL at the normal permitted reference values and they reach 685 +5 minus 0°C or 108% respectively, the T6NL is illuminated. If TGT then exceeds 780°C then the ECA will also illuminate.

24. **Amplifier Lane Failure Warning.** Control of TGT and NL is effected by lane 1 or lane 2 in the ECA. The lanes are similar but one is dominant and initially effects control. They are monitored within the amplifier and, if a malfunction occurs in the controlling lane, automatic changeover to the other takes place. Failure of either lane (whether controlling or not) or an amplifier malfunction, is indicated by the ECA coming on.

25. **Igniter Firing Signal.** LP shaft speed sensing probes supply signals to the ECA. When, during engine starting, the LP shaft reaches 100 RPM in the correct direction, a relay in the ECA closes to connect DC to the ignition units and to energize the ROTATION indicators which change from black to green. The indicators remain green providing the ignition units are receiving power until the starting cycle is completed or cancelled; they then revert to black. The igniters fire whenever a start/relight button is held in, for 45 seconds during a start or assisted relight, or, when airborne, for 30 seconds after the button is released. In all cases the igniters are only energized when the throttle is within 10mm of the idle stop.

ENGINE OIL SYSTEM

Oil Tank

26. An oil tank is beneath the aft end of the bypass duct. The tank has pressure and gravity replenishing points and a sight glass on the rear of the tank indicates contents.

Oil Circulation

27. A pressure pump draws oil from the tank and delivers it, through a fuel-cooled oil cooler and a filter, to the engine and the external gearbox (see Fig 6). A pressure relief valve protects the system, and a cooler bypass valve ensures the circulation of an adequate supply of oil at low temperatures or if the cooler is blocked. Three scavenge pumps return the oil through associated filters to the tank.

Oil Low Pressure Warning

28. A differential pressure switch monitors pressure difference between feed oil pressure and scavenge oil pressure at an internal gearbox. If the differential falls below 0·7 bar the switch closes to light the OIL. To eliminate transient low pressure warnings caused by negative g manoeuvres, caption activation is delayed for a nominal 10 seconds when the landing gear is up.

ENGINE IGNITION SYSTEM

Ignition Units and Igniter Plugs

29. The engine ignition system has two igniter plugs in the combustion chamber; each plug is energized by an associated ignition unit. The ignition units are supplied with DC during starting and relighting provided the ignition switch is at NORMAL. With the throttle lever at HP OFF the ISOLATE position of the switch allows the engine to be turned without the ignition units being energized. The ignition units are inhibited when the throttle is opened 10 mm beyond Idle; therefore, to achieve light up it is essential that, during starting and relighting, the throttle is held against the Idle stop.

ENGINE STARTING SYSTEM

General

30. The GTS system (Fig 7) is used for engine starting on the ground and can be used for relighting in flight. The system comprises a gas turbine air producer and a free turbine air starter. The air producer is at the top of the fuselage forward of the ram air turbine; it supplies air via a solenoid-operated start valve, when a dump valve is closed, to the air starter, which is fitted to the engine external gearbox, and drives the HP shaft through the gearbox. Until the dump valve is closed the air is exhausted overboard. To prevent shock loading the starter motor clutch, a speed switch inhibits operation of the start valve to prevent engagement of the air starter when engine RPM are above 20%. The air producer uses aircraft system fuel but has its own ignition, fuel pumping and control systems. The air producer and the air starter each have independent lubrication systems.

Air Producer

31. The air producer comprises a centrifugal compressor driven by a 2-stage turbine; it is rotated to self-sustaining speed by a DC motor. Air is drawn into the compressor through a grille on the top of the fuselage. A DC powered dual fuel/oil pump draws fuel from the aircraft tanks and supplies it to nozzles in a combustion chamber containing two igniter plugs. Power for the DC motor and the igniter plugs is from the aircraft batteries via the Essential Services busbar. When the air producer is at or above its underspeed datum the GTS indicators show green. The GTS system is automatically shut down when engine RPM reach 45% during starting or relighting; when this occurs the GTS indicators show black.

Note: During ground starting and flight test air starts allow intervals of three minutes between each air producer start and at least 20 minutes after three consecutive start cycles to prevent overheating of the GTS DC motor.

32. Protection circuits within the starting system automatically shut down the GTS system in the event of certain failures after a start/relight button has been pressed.

Note: Failure or reluctance of the GTS system to function satisfactorily is to be investigated. The aircraft is not to be flown if such a malfunction occurs during a ground start. If the GTS system fails or is reluctant to start during an air start, one of the start master switches is to be set to OFF for a minimum of five seconds and then reset to ON.

Air Starter

33. The air starter is a centripetal free turbine driven by air ducted from the air producer. The air starter drives the engine HP shaft via the external gearbox until at about 45% RPM the starting system is automatically shutdown.

Engine Starting Operation

34. With the battery switches on, the LP cock lever ON, the throttle lever at HP OFF, both start master switches ON and the ignition switch at NORMAL, the air producer is started by pressing momentarily a start/relight button. (On the ground the ROTATION indicators show green and the engine ignition units are energized for the duration of the press). The air producer accelerates to idle and, as the underspeed datum

is passed, the GTS indicator shows green; this should occur within 22 seconds of the start/relight button being pressed. When the GTS indicator shows green, momentarily setting a start master switch to START opens the start valve and air flows from the air producer to the air starter; the dump valve closes and the air producer accelerates to full power. The air starter rotates and drives the engine HP shaft which induces an airflow through the engine to rotate the LP shaft. When the LP shaft speed reaches 100 RPM in the correct direction of rotation, a relay in the ECA closes to energize the ROTATION indicators (which show green) and the engine ignition units.

35. When the ROTATION indicators show green and 15% to 20% RPM are indicated, setting the throttle lever to the Idle position fully opens the HP shut-off valve and fuel, scheduled by the SIFCU, is fed to the spray nozzles in the combustion chamber. Engine light up should normally occur within 10 seconds of Idle being selected. The engine should accelerate to reach starter cut-out speed, approximately 45% RPM, 22±3 seconds from selecting Idle. At starter cut-out speed the fuel to the air producer is cut off and it shuts down; simultaneously the GTS and ROTATION indicators change to black and the ignition units are de-energized. The engine continues to accelerate and should stabilize at approximately 52% RPM within approximately 30 seconds of selecting Idle.

36. After the RPM have stabilized open the throttle slowly to accelerate the engine through approximately 65% to close the bleed valve, after which return the throttle to Idle. With the bleed valve closed the engine idle RPM should be approximately 3% higher and the TGT approximately 50°C lower than when idling with the bleed valve open; however, the idle speed may vary depending on engine loading, air bleeds and ambient conditions. As the engine warms up the idle RPM increase and should be 55 ±1% before take-off. Any sudden change in the idling characteristics should be investigated.

37. The start cycle can be discontinued by setting the throttle lever to HP OFF; the GTS system continues running and, following a wet start, may be used to carry out a dry crank (see para 38). However, if it is intended to terminate the GTS system starting cycle, the start master switch is to be set OFF; subsequently observe the 3-minute interval before a further start is attempted.

Note: Any attempt to restart the GTS system in less than three minutes, besides overheating of the starter motor, may result in igniting any residual fuel in the engine since the igniters are activated when a start/relight button is pressed.

Dry Crank

38. The engine may be dry cranked by following a procedure similar to that for a normal start except that, when the GTS indicator shows green, the ignition switch is to be set to ISOLATE before the start master switch is set momentarily to START. Retain the throttle lever at HP Off throughout. The air producer automatically reverts to idle after 45 seconds. If a dry crank is initiated when the air producer is idling the start master switch is not to be selected to START until engine RPM are below 20%.

Relighting

WARNING: In all relight procedures, when the throttle is advanced to Idle it is essential that it is held against the idle stop to ensure that the igniters can be energized. If the throttle is against the idle stop and the ROTATION indicators do not show green, press and hold the relight button for a maximum of 30 seconds.

39. **General.** The engine relighting system allows a flamed out engine to be relit using an immediate relight, assisted or unassisted relight procedure. In the immediate relight and unassisted relight procedures the GTS system is activated and may run up to idle but is not used. In the assisted relight procedure the GTS system is activated and used when the aircraft is below FL 200; however the windmilling RPM is to be below 20% before making the relight because starter engagement is inhibited above that RPM. For all relight procedures the throttle is initially to be set to HP OFF. Except for an immediate relight, the bleed valve should be open (45% RPM or below) before relighting is initiated. As the engine runs down following flame out, No 2 hydraulic pump is automatically off-loaded as RPM fall through 42% provided that both start master switches are at ON. The RAT automatically extends and provides pressure to the No 2 hydraulic system when the HYD 2 system pressure drops below 103 bar. When a start/relight button is pressed and for 30 seconds after the button is released, the engine igniter plugs are energized (provided the throttle is within 10 mm of the idle stop), the DC generator is off-loaded and the booster pump is powered from the Essential Services busbar. The ROTATION indicators show green only if the 30-second hold-in facility is working. At stabilized idle RPM

following a successful relight, open the throttle slowly to maximum (see CAUTION below) and check that the bleed valve closes by 61±4% RPM; as the throttle is opened cross-check RPM and TGT for surge free engine operation. DC supplies are not to be manually reset until the bleed valve has closed otherwise transient pressure from the fuel booster pump may cause premature bleed valve closure resulting in engine stall. In all relight procedures the start/relight button is not to be pressed for longer than 30 seconds.

CAUTION: If, prior to relighting, the engine has been overtemped (exceeded 685°C) prove the engine to the minimum RPM required as detailed in the FRCs.

Note: If the GTS system has been activated it continues to run after a successful immediate or unassisted relight procedure. Whatever the GTS indication, following a successful relight, set one of the start master switches to OFF, to confirm GTS shutdown, for a minimum of five seconds and then reset it to ON.

40. **Immediate Relight.** An immediate relight may be attempted at any airspeed and altitude providing engine RPM is not too low (below 30% RPM an overtemperature condition may occur). Recover the aircraft to normal flight as quickly as possible during the relighting drill to ensure correct intake airflow. With the start master switch at ON, the ignition switch at NORMAL and the throttle at HP Off, an immediate relight is carried out by pressing a start/relight button and simultaneously advancing the throttle to Idle. Check the ROTATION indicators show green. At low IAS the TGT will probably increase close to the starting and relighting limit: the higher the speed the lower the peak temperature. If a relight is not obtained within 30 seconds of selecting Idle the throttle is to be returned to HP Off to prevent overfuelling. Allow a further 30 seconds to elapse, if practicable, to drain the engine and cool the GTS system starter motor before initiating an assisted relight. After a successful relight, shut down the GTS system.

41. **Assisted Relight.** The aircraft should be below FL 200 (unless the GTS is already running after previous relighting attempts above this level) between 165 and 250 knots with the throttle at HP Off, both start master switches ON and the ignition switch at NORMAL. Initiate the relight by pressing a start/relight button to start the air producer which runs up to idle: the ROTATION indicator shows green and the engine igniter plugs are energized while the button is pressed and for 30 seconds after the button is released or until the throttle is advanced beyond Idle. When the GTS indicator shows green (within 25 seconds of pressing the start/relight button above FL 150; within 22 seconds below FL 150) and with the RPM less than 20%, momentarily setting a start master switch to START causes the GTS to run up to full speed to accelerate the engine. Set the throttle to Idle. If due to a malfunction affecting the engine control amplifier (which may not cause the ECA caption to come on) the ROTATION indicator does not show green with other indications normal, press and hold the relight button for up to 30 seconds maximum and check the ROTATION indicators show green. When the engine has accelerated to 45% RPM the GTS system shuts down; the engine igniter plugs are de-energized and, after a 30-second delay, the booster pump is restored to the Generator busbar. If a relight is not achieved by the end of the start cycle, which lasts 45 seconds after selecting START, the throttle must be returned to HP Off to prevent over-fuelling.

Note: In an assisted relight the starting cycle is inhibited if the windmilling RPM is above 20% when the start master switch is set to START.

42. Unassisted Relight. An unassisted relight is to be carried out below FL 250 at a minimum of 250 knots. These limitations must be observed since above FL 250 light up is unlikely and below 250 knots a high TGT is probable and an over-temperature may occur. With both start master switches at ON and the throttle lever at HP Off, when the RPM fall below 45%, a start/relight button is pressed to energize the engine igniter plugs (the ROTATION indicators show green provided the 30-second hold-in facility is working) whilst simultaneously the throttle is advanced to the Idle position. At 270 knots at FL 250 engine light-up normally occurs in 5 to 10 seconds and flight idle is reached 15 -20 seconds later, the TGT peaking typically at 425°C. The effect of speed on TGT is very marked and non-linear, the peak temperature is close to 550°C at 250 knots, 475°C at 260 knots and 400°C at 280 knots. Approximately 30 seconds after 45% RPM has been exceeded, the booster pump is restored to the Generator busbar. After a successful relight, shut down the GTS system. Before attempting to relight the windmilling RPM should be above 15%. If the RPM is low and an assisted relight has been rejected as an option, accelerate the aircraft by diving to obtain the minimum 15%. This requires high indicated airspeed and therefore a steep dive which entails considerable height loss. This steep dive makes the unassisted relight less of a practical alternative at lower altitudes.

43. Post Relight. Following a successful relight complete the Post Relight Checks.

FIRE PROTECTION SYSTEMS

General

44. The fire protection systems (Fig 8) detect and give warning of fire, or overheating, in the engine bay and the air producer bay, and of overheating in the jet pipe bay; only the engine bay has an extinguishing facility. A fireproof bulkhead separates the engine bay from the jet pipe bay. Ventilation of the engine bay is by ram air through intakes on the underside of the fuselage at the forward end of the engine bay; the air exhausts through vents on the top of the fuselage at the rear of the engine bay. Ventilation of the jet pipe bay is by ram air through two intakes on the top of the fuselage forward of the bay; the air exhausts around the jet pipe nozzle.

Controls and Indicators

45. The controls and indicators associated with the fire protection systems are on the CWP and are listed in Table 2 and shown in Fig 8.

Table 2 - Fire Protection Systems Controls and Indicators

Controller/Indicator	*Marking*
Fire warning caption	FIRE
Fire extinguisher button and light	F
Air producer bay fire warning caption	START

Fire Detection and Warning

46. The fire detection system consists of two sets of fire-wire elements of the automatic resetting type. Each set of elements forms a continuous loop which is connected to a control unit; one set of fire-wire elements encircles the engine and the other encircles the air producer. The system is powered from the Essential Services busbar.

47. The fire-wire elements are temperature sensitive and the current flow in them increases as temperature rises. If the engine fire-wire reaches a critical temperature, current flow increases sufficiently to close a relay in the control unit which supplies DC to illuminate the head of the fire extinguisher buttons and the FIRE. If the air producer fire-wire is activated a relay in the control unit closes and DC is supplied to illuminate the START. If the temperature in the affected bay falls below the critical value the warning lights go out and the detection system is automatically reset; resetting may take up to 45 seconds.

48. The jet pipe bay has temperature sensors which activate the JPOHT caption when the bay temperature exceeds 150°C.

Fire Extinguishing

49. Methyl-bromide or BCF, from an extinguisher bottle in the fuselage, is discharged through a spray ring into the engine bay when an extinguisher button is pressed. A pin in the head of the extinguisher bottle protrudes and is visible when the bottle has been discharged. The system is supplied with DC from the No 1 and No 2 Battery busbars and is operable irrespective of the setting of the battery switches.

Inertia Switches

50. Inertia switches, one in each mainwheel bay, operate to energize a crash relay if a longitudinal deceleration of 3 g or more is experienced. When the relay is energized the fire extinguisher discharges automatically, the Battery busbars are disconnected from the Essential Services busbar and the generator is taken off line.

Test Facility

51. The fire detection and warning system is tested when a switch on the CWP is held at TEST. A serviceable system is indicated by the FIRE, START and JP.OHT together with all other unlit captions on the CWP in both cockpits, and the lamp in the fire extinguisher buttons, illuminating.

52. Do not test the fire detection and warning system in flight. Test the system before engine start up and again after flight (during **After Landing Checks**) and before heat from the cooling engine has had time to dry out the fire wire, ie, test the system when optimum conditions for moisture contamination have been experienced, when the aircraft has been parked in moist conditions or has encountered moisture in flight.

Ground Fire Appliance Access

53. A red, spring-loaded, FIRE ACCESS panel is on the left side of the fuselage above the rear of the wing root fairing. It gives access to the engine bay for the insertion of ground fire fighting equipment nozzles. Access to the air producer bay is through a frangible panel on the upper left side of the fuselage, forward of the Ram Air Turbine (RAT) bay.

ENGINE HEALTH MONITORING SYSTEM

General

54. Post-Mod 630, an Engine Health Monitoring System (EHMS) comprising a magnetic tape recorder, a Data Acquisition Unit (DAU) and 14 sensors is installed. The sensors monitor engine and aircraft performance and environmental parameters and provide signals representing these parameters to the DAU which is in the main equipment bay. The DAU processes the signals and transmits them to the recorder which is on the rear cockpit seat frame. A 2-position switch, OFF/ENGAGED, on the recorder is to be set to ENGAGED before flight. The sensors include an Outside Air Temperature (OAT) probe which is on the left side of the fuselage forward of the front windscreen arch. The OAT probe has an integral electric heater and is protected by a guard.

55. The system is powered from the Essential Services busbar and, providing the recorder switch has been set to ENGAGED, is automatically switched on during engine starting when the start master switch is set to START. When the system has been switched on it continues to operate until both battery switches are switched off. The recorder has a recording duration of at least two hours.

56. The OAT sensor is powered from the AC busbar when both landing gear weight-on-wheels microswitches operate after take-off.

57. The sensors monitor the following parameters:

1. HP shaft speed
2. HP compressor delivery pressure
3. HP compressor delivery temperature
4. LP cooling air temperature
5. LP shaft speed
6. Fuel flow mass rate
7. Fuel solenoid current
8. Throttle setting
9. Engine intermediate case vibration
10. Exhaust gas pressure
11. TGT
12. Altitude
13. IAS
14. OAT

NORMAL USE AND MANAGEMENT

Engine Starting and Handling

58. For engine starting and handling, refer to Part 2 and to the Flight Reference Cards. For engine limitations, refer to the Hawk TMk1 & TMk1A MOD AFD Release to Service.

MALFUNCTIONING AND ABNORMAL CONDITIONS

Air Producer Bay Fire (Unconfirmed)

59. If START comes on and there are no confirmatory signs of fire, fly above 5000 feet for a minimum of 10 minutes checking for signs of control system deterioration. If the warning goes out, and aircraft control remains satisfactory, make a precautionary landing after the 10-minute period.

60. If START remains on continue checking for a further 10 minutes. If, after the 20-minute period, control remains satisfactory, carry out a precautionary landing bearing in mind that ejection may be necessary at any stage. After clearing the runway, stop the aircraft and shut down the engine; if feasible, insert the ejection seat firing handle safety pin and then vacate the aircraft.

Engine Surge, Stall or Overtemperature

61. An engine surge, stall or overtemperature is indicated by an excessive TGT for the RPM setting; it may be accompanied by a banging sound from the engine and, if a TGT (T6) of 685°C has been exceeded, T6NL comes on. The temperature of 685°C is significant because, if it is exceeded, damage to the turbines may result; this possibility is reflected in the actions subsequent to engine surge or overtemperature. Essentially, all surges result from compressor stall; the principal causes are:

   a. Severe intake flow distortion.

   b. Hot gas ingestion.

   c. Compressor damage.

   d. Excessive combustion pressure.

   e. Excessive engine speed.

62. With the throttle at Idle in a manoeuvre which engenders intake flow distortion, eg, a spin, the engine can enter a state of surge which may not be apparent until the throttle is opened after recovery. Equally, a surge can be hidden at high forward speed with the engine at idle; again, the condition may not be appreciated until the throttle is advanced.

63. A surge can be either self-clearing, when simply throttling the engine to idle eliminates the condition or locked-in, when it is necessary to cut-off the fuel flow to the engine by closing the HP cock. In the latter case the stall clears as the fuel flow is stopped. If, after relighting, the engine again enters a stalled condition, consider whether the relighting parameters were within the limits or whether the engine has suffered damage.

64. As soon as a surge is identified, the throttle must be set to Idle and the TGT monitored.

WARNING: The throttle must remain at the idle stop while the TGT is monitored and the type of surge identified. In the case of a locked in surge, opening the throttle will result in a rapid increase in TGT, exacerbating the surge and causing further damage to the engine

65. If, in response to throttling back, the TGT falls below 450°C and a TGT of 685°C was not exceeded, prove the engine operation carefully over its whole range; if satisfactory, the engine may be used normally. If 685°C was exceeded, land as soon as practicable, proving the engine only up to the minimum RPM required for recovery.

66. If the TGT does not drop below 450°C after throttling back to Idle, a locked-in surge is indicated. Clear the surge by momentarily selecting the throttle to HP Off; then carry out an Immediate Relight.

67. If the immediate relight is unsuccessful or the engine enters a locked-in surge, close the HP cock and, without prejudice to a successful forced landing, allow the engine to cool and drain for a minimum of 30 seconds; then carry out an assisted or unassisted relight.

68. After a successful relight when a TGT of 685°C was not previously exceeded, prove the engine carefully through its whole range and, if satisfactory, land as soon as practicable. If 685°C was exceeded, prove the engine to the minimum RPM required for recovery and land as soon as practicable.

Note: All surges, whether self clearing or locked in, are to be reported.

Relighting Procedures

69. Do not attempt to relight an engine that has suffered a suspected mechanical failure. Without prejudicing a forced landing, carry out the following actions to obtain a relight:

a. Attempt an immediate relight.

b. Glide at 0·65M if above FL 200.

c. Below FL 250 attempt an unassisted relight (minimum speed 250 knots).

d. At FL 200 level out, check the GTS indicator colour and allow speed to decay to 180 knots.

e. Attempt an assisted relight.

f. Glide at 180 knots making repeated attempts at assisted relights providing the voltmeter is indicating 21 volts or more.

70. The relight drills are in the FRC. Following flame out at medium and low altitudes, ie, below FL 200, any one of the procedures may be adopted provided that the other relevant parameters are observed. Normally attempt an Immediate Relight first; if that fails attempt an assisted relight since it has the advantage of not demanding a departure from the best gliding speed (180 knots) at flight levels below 200; in addition the GTS should already be running as a result of the previously attempted immediate relight.

WARNING: In all relight procedures, when the throttle is advanced to Idle it is essential that it is held against the idle stop to ensure that the igniters can be energized. If the throttle is against the idle stop and the ROTATION indicators do not show green, press and hold the relight button for a maximum of 30 seconds.

TGT/NL Overlimit

WARNING: If the T6NL is illuminated during engine starting or at any other time on the ground, a take-off is not to be attempted, even if the warning has extinguished.

Note: If TGT exceeds 780°C then the ECA will illuminate.

71. If the T6NL is illuminated without signs of a surge, throttle back to 80% and check TGT. If the TGT is excessive, take action as for engine surge, stall or overtemperature. If, when the caption was illuminated, the TGT was not excessive the warning may be due to excessive NL. In all cases, avoid high RPM with maximum of 90% above FL200 and 95% below FL 200.

Engine Control Amplifier Failure

72. Failure of one lane of the ECA is indicated by a steady illumination of the ECA . If only one lane fails the other lane has full authority and the ECA functions normally. Total ECA failure, also indicated by a steady illumination of the ECA , usually results in a fuel no-trim condition causing TGT and RPM to increase. Engine limitations are easily exceeded and therefore are to be kept within limits by manual throttle control; above FL 200, 90% RPM is not to be exceeded, below FL 200, 95% RPM is not to be exceeded.

73. A failure resulting in a full-trim condition reduces fuel flow; TGT and RPM decrease. The available thrust may be reduced to as little as 71% of the normal full throttle value, which is equivalent to a loss of approximately 7% RPM. Since very low idling RPM may occur, the throttle is to be operated carefully to avoid surge. At medium altitude and low IAS, flame out may occur at the Idle stop; therefore, when decelerating, do not throttle back to less than 70% RPM. A failure of the ECA in one trim condition does not preclude a failure in the other trim condition. As this cannot be positively confirmed from the cockpit, observe the max and min RPM figures until touchdown. Land as soon as practicable with an ECA caption.

Note: Ignore momentary flashes of the ECA; a lane change due to a lane failure results in the ECA staying on and the attention lights operating.

Bleed Valve Failure

74. If the bleed valve opens in flight or fails to close, a loss of thrust of up to 25% may be experienced. The engine is to be handled with care and the throttle moved slowly to prevent engine surge; monitor the TGT. If the bleed valve fails to open during engine shutdown there is a risk of engine stall or overtemperature occurring during a relight.

Oil Pressure Failure

75. Loss of oil pressure is indicated by the illumination of OIL. If the caption is illuminated other than after 10 seconds of negative g, land as soon as possible and restrict RPM to the minimum practicable. Loss of oil pressure will result eventually in engine seizure. The optimum RPM rnge to prolong engine operation is 80-85% (based on Rolls-Royce analysis of actual loss of oil pressure incidents) although 78-87% RPM is acceptable. Engine seizure is delayed by the following:

- Minimising throttle movements.
- Maintaining 1g flight.

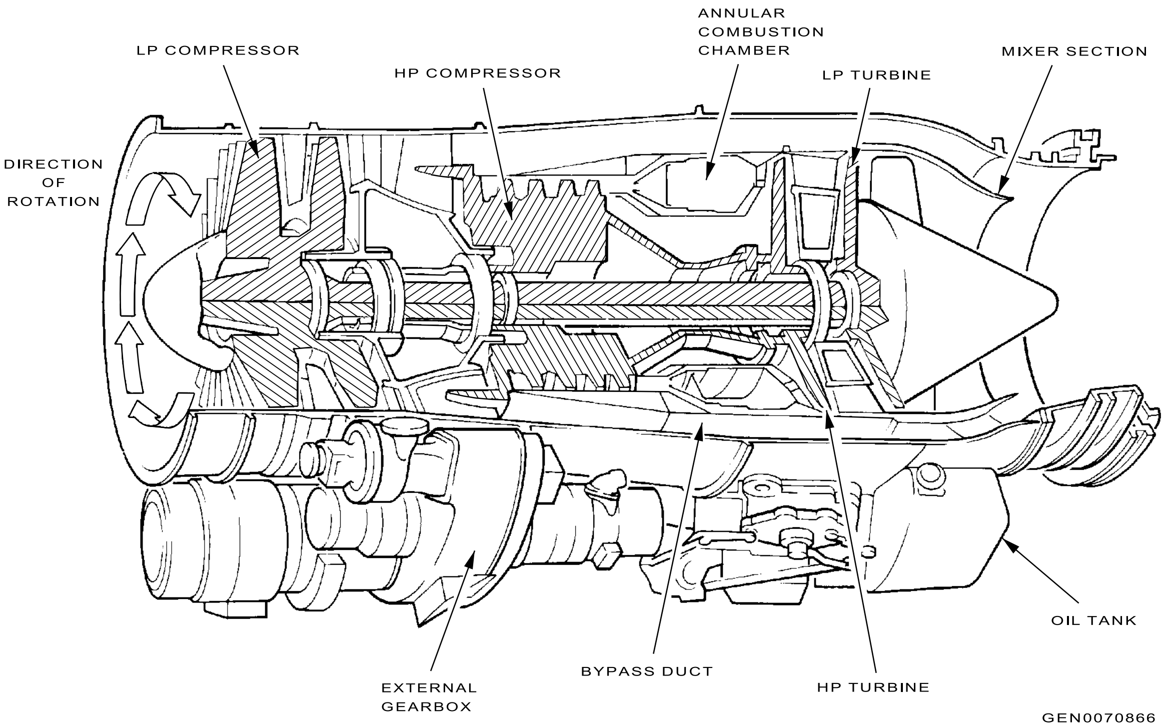
Loss of oil pressure may be accompanied by vibration associated with bearing failure which may lead to engine seizure. Engine seizure may be preceded by increasing vibration and a sudden drop in RPM. If necessary, throttle setting should be increased to recover lost power due to bearing failure. Engine bearing loads increase with reduced altitude. Handle the throttle smoothly and progressively to avoid high transient bearing loads and, where engine acceleration is unavoidable, limit the extent of the RPM increase and the duration at the higher RPM setting. On pre-MOD 2010 aircraft the EOHT caption may also be illuminated.

GTS Fuel Supply Failure

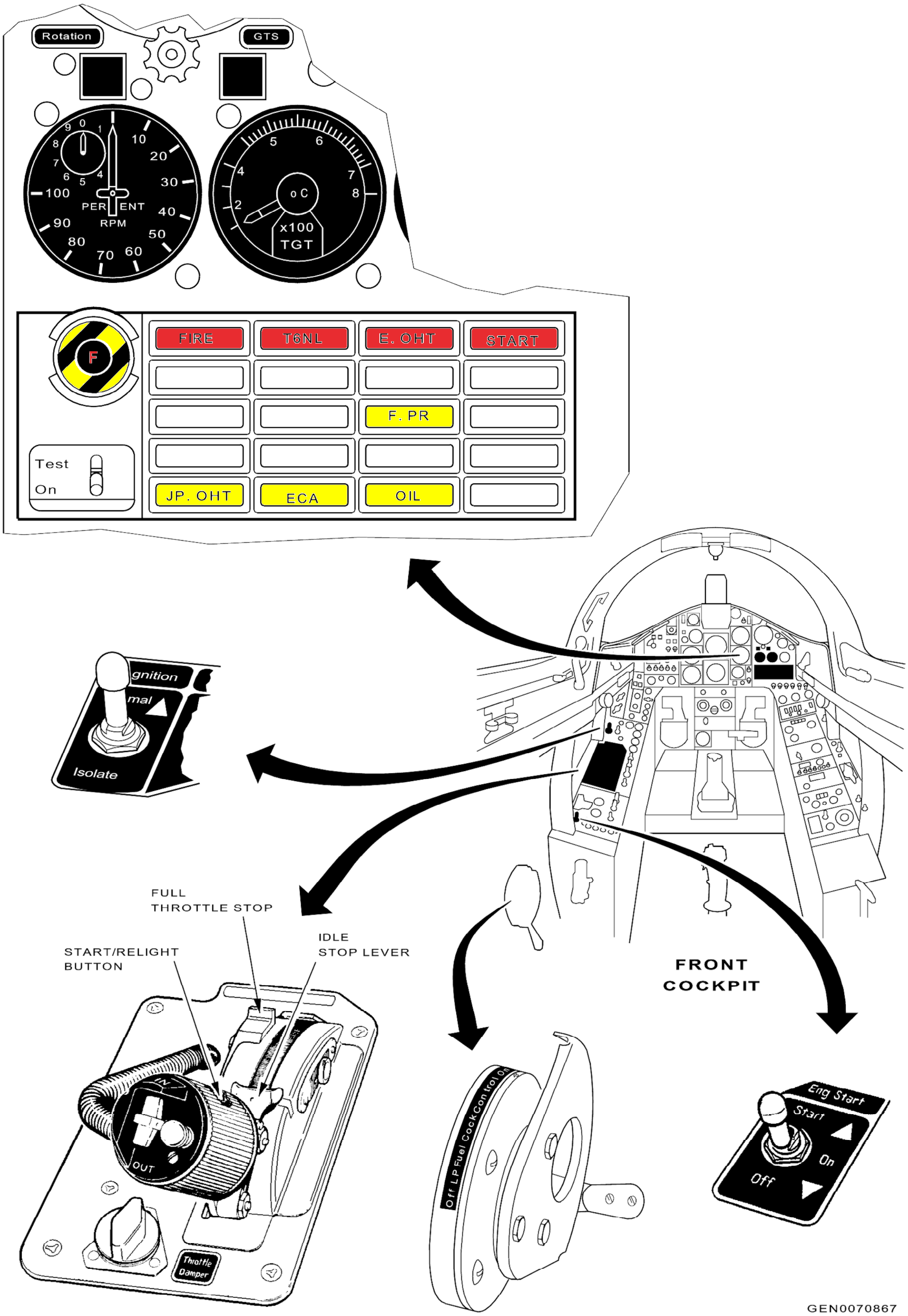
76. If the GTS fuel shut-off valve fails to open, only partially opens or a fuel leak occurs in the GTS fuel supply line, the GTS fails to run or runs up to idle only or, above idle RPM, runs erratically. Only the immediate and unassisted relights are available; following a relight, land as soon as possible. If the shut-off valve fails to close or only partially closes, the GTS is slow to run down or runs down erratically; terminate the sortie as soon as possible. If any of these symptoms are observed during starting on the ground, abandon the sortie.

Engine RPM Indication Failure

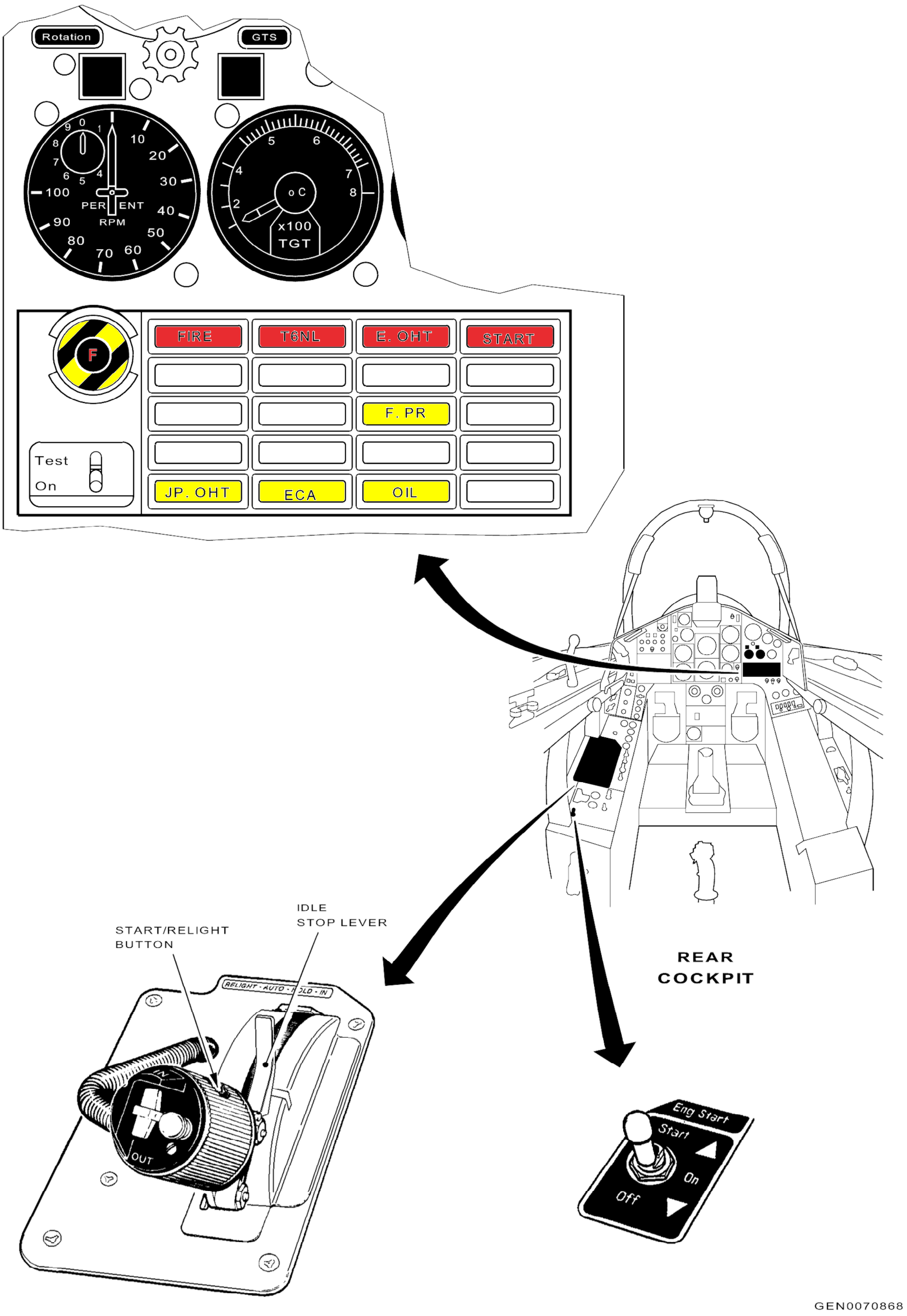
77. Mechanical failure of the RPM transmitter on the engine external gearbox may lead to failure of the gearbox with subsequent loss of auxiliary services. If engine RPM indication is lost when the aircraft is flown solo or, if both front and rear RPM indications are lost when the aircraft is flown with two crew, land as soon as practicable.



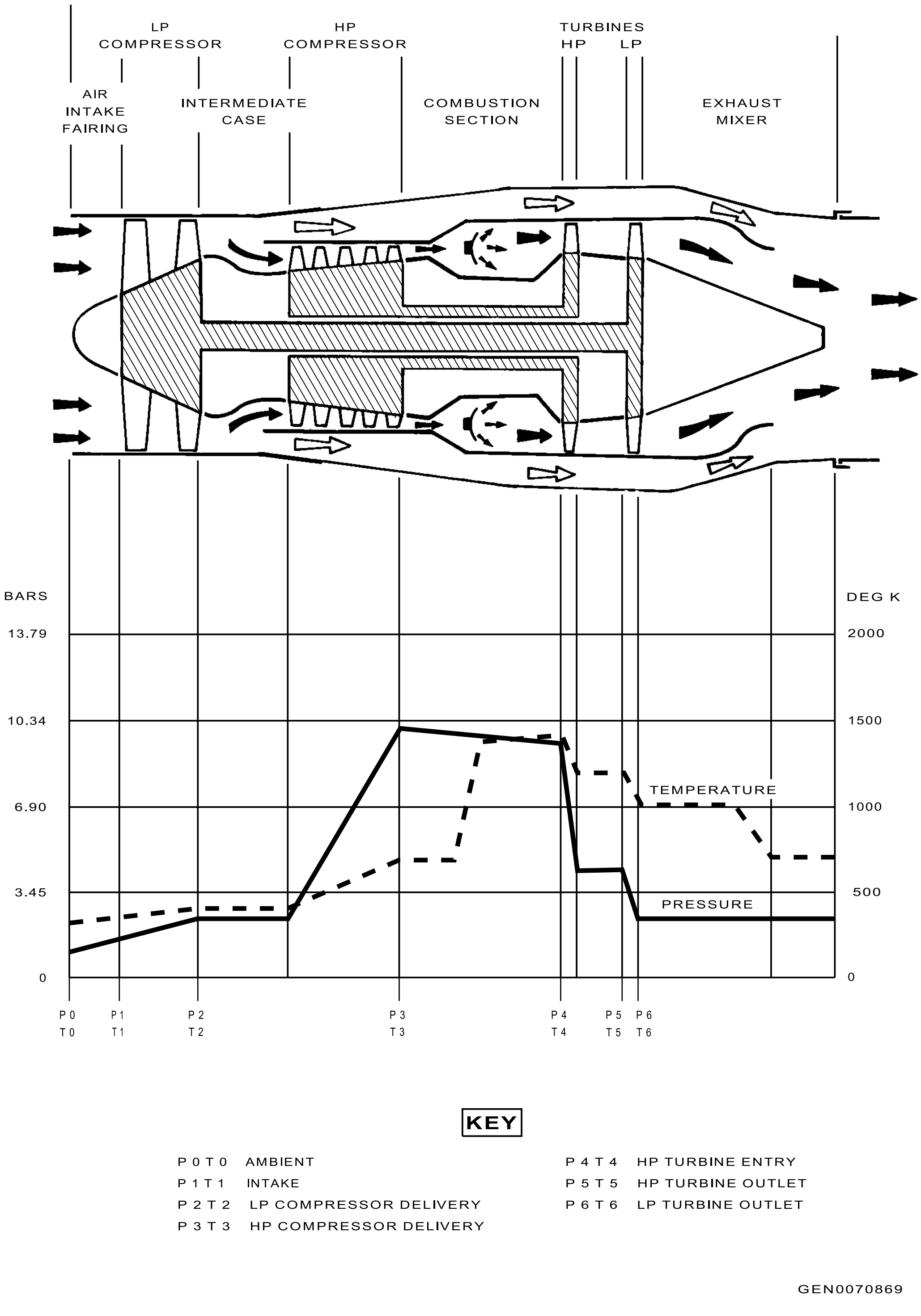
1 - 4 Fig 1 Principal Features of Adour Mk 151



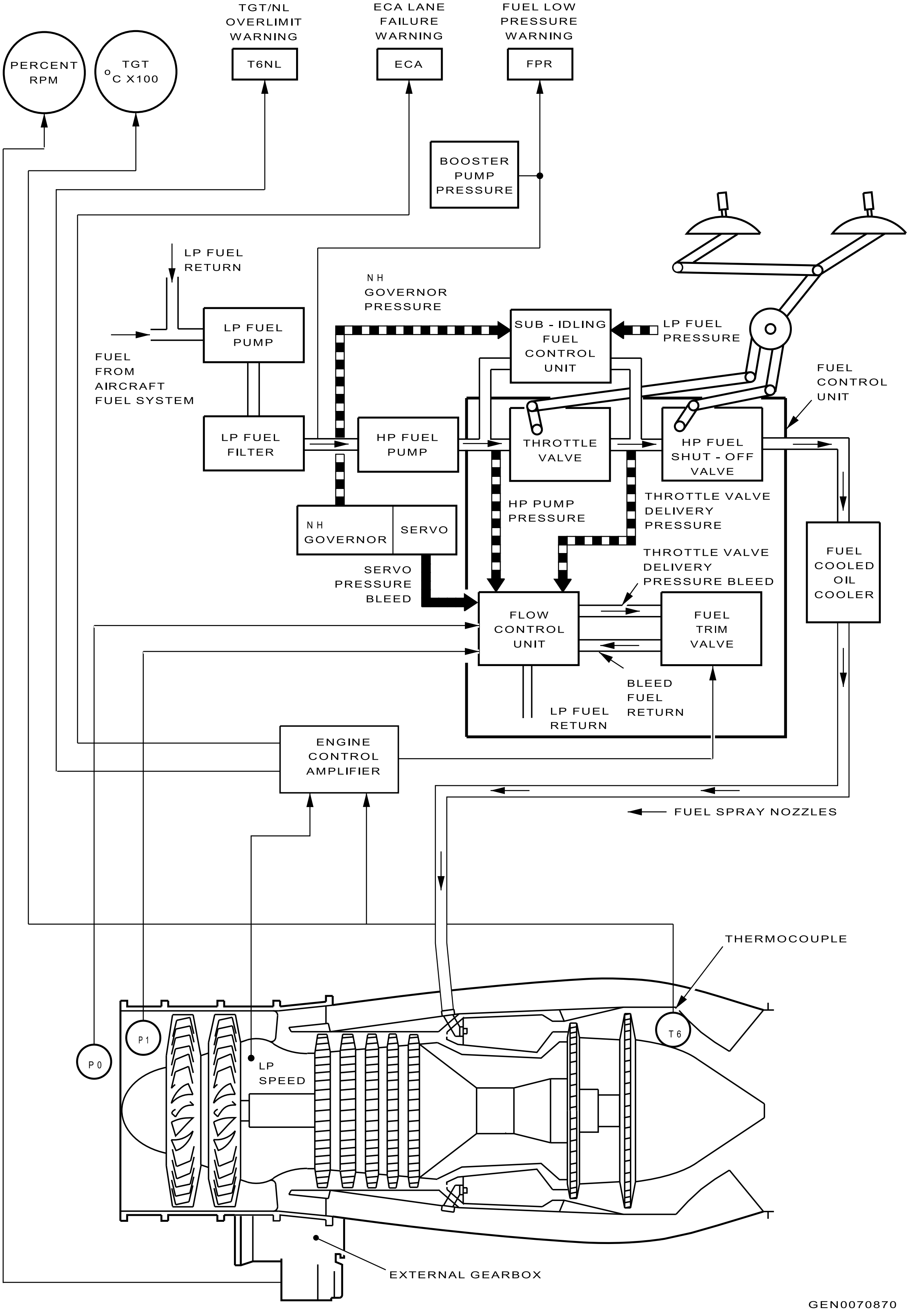
1 - 4 Fig 2 Controls and Indicators (Front Cockpit)



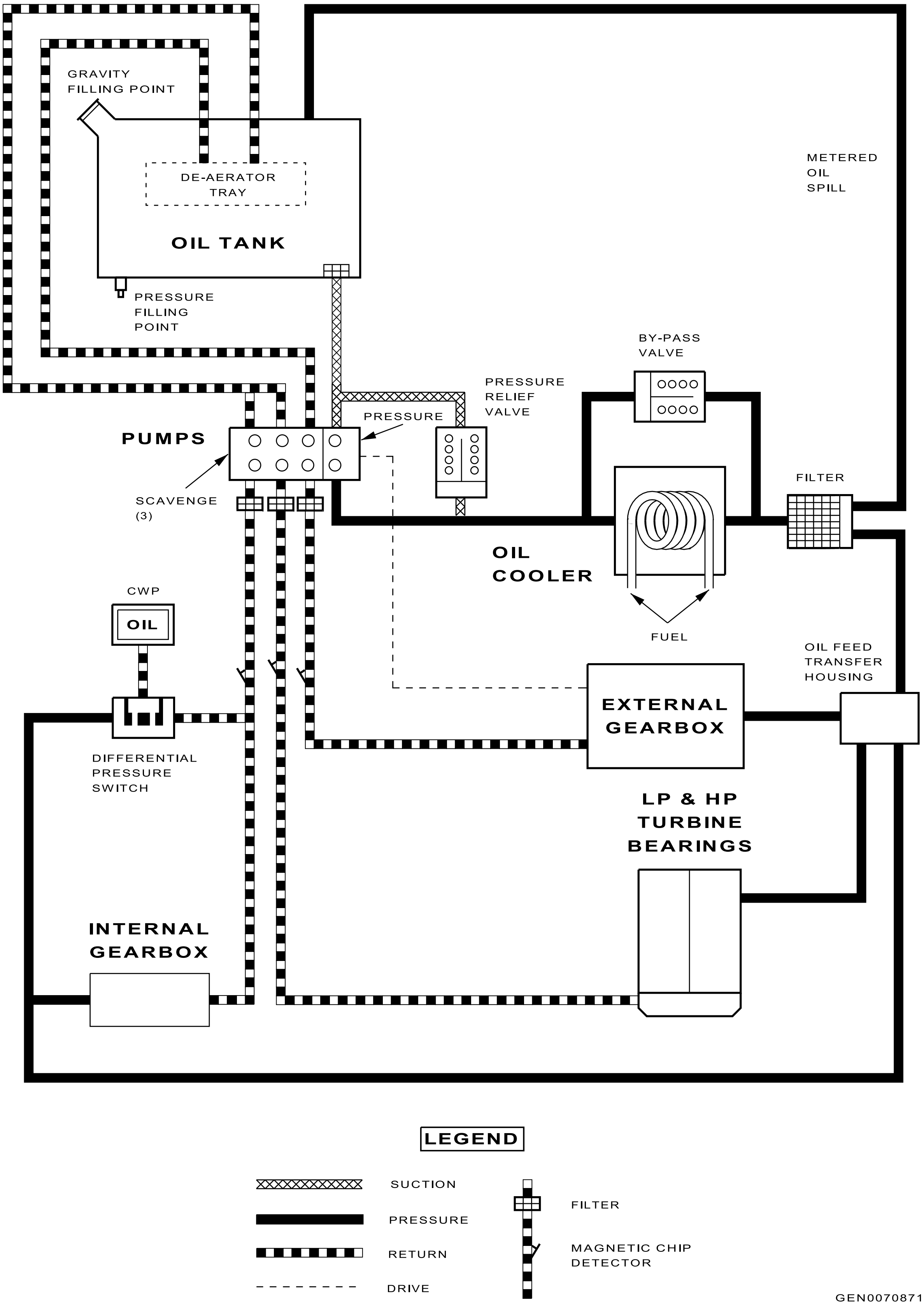
1 - 4 Fig 3 Controls and Indicators (Rear Cockpit)



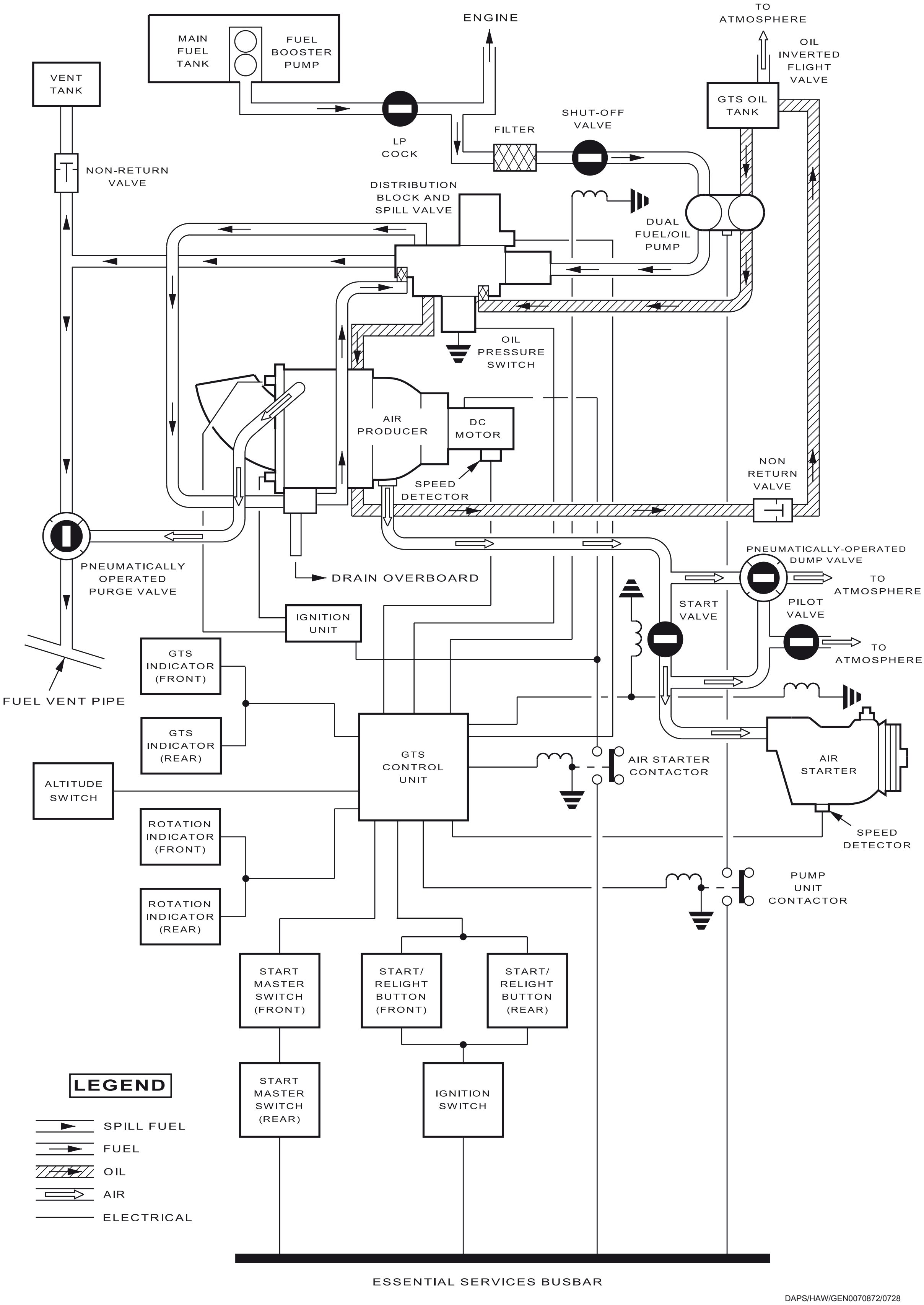
1 - 4 Fig 4 Gas Flow



1 - 4 Fig 5 Fuel and Control System Schematic

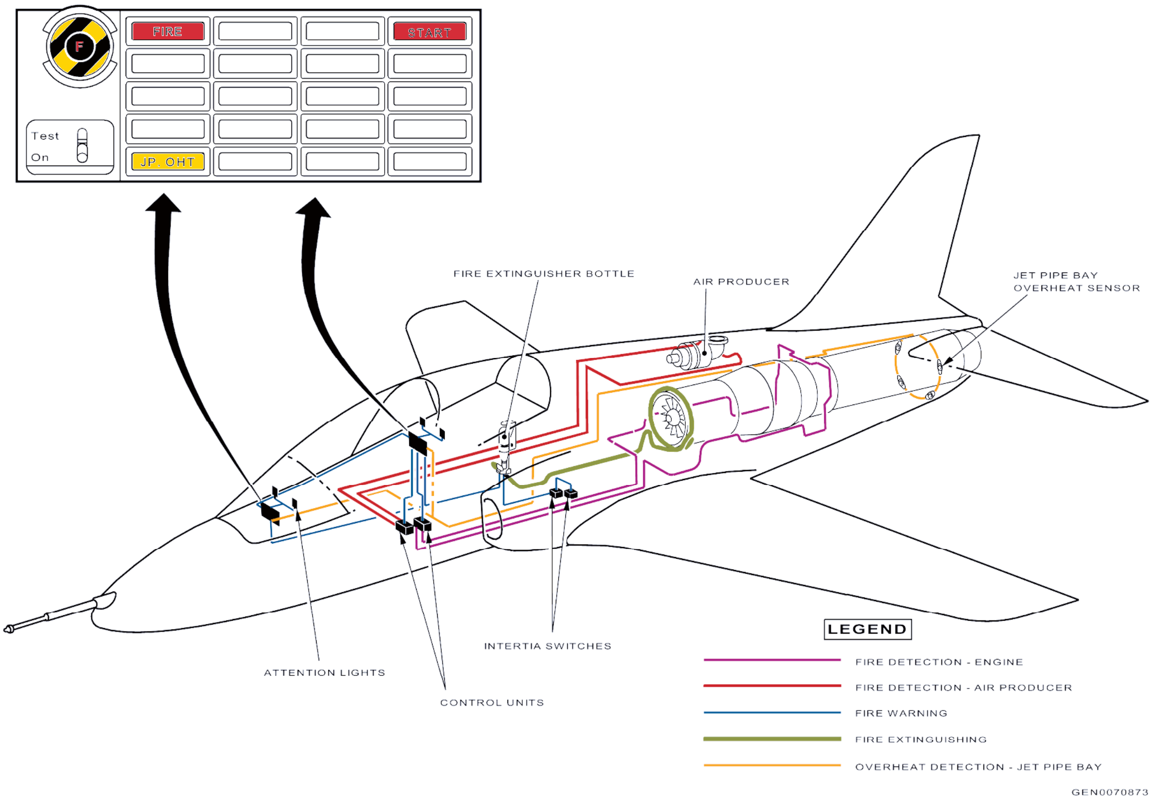


1 - 4 Fig 6 Oil System Schematic



1 - 4 Fig 7 Starting Systems

(Addition of Altitude Switch at AL3)



1 - 4 Fig 8 Fire Protection

PART 1

CHAPTER 5 - HYDRAULIC POWER SUPPLIES

Contents

DESCRIPTION

General

1. Two independent hydraulic systems, designated No 1 and No 2, supply hydraulic power for the operation of the powered flying controls. The No 1 system additionally supplies power for the normal operation of general services, ie, landing gear, wheelbrakes, flaps and airbrake. A Ram Air Turbine (RAT) extends into the airstream automatically to supply power to the aileron and tailplane Powered Flying Control Units (PFCU) in the event of engine failure or the failure of No 2 system pressure; the RAT can be restowed by use of a button in either cockpit. A hand pump in the No 1 system can be used on the ground for pressurizing the general services and a wheelbrakes accumulator when the engine is not running.

2. Each system contains a reservoir, an engine driven pump and a flying controls accumulator; a pressure gauge for each system is in both cockpits. The operating pressure of both systems is 207 ±10 bars. Pressure switches initiate warning of pressure failures, which are indicated by the illumination of captions on the CWP. Relief valves in the systems ensure that line pressures do not become excessive. The No 1 and No 2 system each have two filters, each with an integral red edged `tell-tale' indicator button which protrudes from its housing if the associated filter becomes blocked. The tell-tales are visible through inspection apertures on both sides of the fuselage.

3. The No 1 system powers one half of each PFCU and, when system pressure is 103 ±7 bars or more, provides power for the general services. The No 2 system powers the other half of each PFCU. This arrangement of the hydraulic power supplies ensures that the operation of the flying controls is not affected by the failure of either system. A solenoid operated bypass valve is associated with the No 2 system pump; the valve is automatically energized open to off load the pump during engine starting. The valve is also energized during relighting when the engine RPM fall to 42% or below provided that both engine start master switches are at ON. The pump can be manually reset from either cockpit when engine RPM are 45% or above.

Controls and Indicators

4. The controls and indicators for the hydraulic systems are similar in both cockpits; they are listed in Table 1 and their location in the cockpit is shown in Fig 2.

Reservoirs

5. The reservoir in each system is charged with nitrogen at 2·2 to 4 bars. The maximum fluid content of the No1 reservoir is 5·5 litres and of the No 2 reservoir 4·9 litres. Each reservoir has a fluid content gauge visible through a transparent panel forward of the fin, on the right (No 1 system) and left (No 2 system) side of the fuselage (Fig 3).

6. Each reservoir has a nitrogen charging/test point and an adjacent fluid filling point. The points are behind access panels aft of the wing, on the right (No 1 system) and left (No 2 system) side of the fuselage.

7. Hydraulic pressure in the systems dissipates slowly after engine shutdown; however, it can be dissipated more rapidly by movement of either control column.

Accumulators

8. The two flying controls accumulators, nitrogen charged to 76 ±3·45 bars, enable instantaneous demands from the flying controls to be met, and ensure a smooth delivery flow. An additional accumulator in the No 2 system, nitrogen charged to 66 ±3·45 bars, provides power to extend the RAT jack if the No 2 system pressure falls below 103 ±7 bars and maintains pressure to the flying controls whilst the RAT pump is running up. With the RAT extended, both accumulators in the No 2 system operate to smooth the delivery flow to the flying controls.

9. A wheelbrakes accumulator, nitrogen charged to 86 ±3·45 bars, is supplied by the No 1 hydraulic system pump.

10. Each accumulator has a nitrogen charging/test point and an adjacent pressure gauge. Those points for the No 1 system accumulator and the wheelbrakes accumulator are in the right wheelbay; those for the No 2 system accumulator are in the left wheelbay. Those for the RAT accumulator are behind an access panel on the left side of the fuselage, aft of the wing.

11. Before checking accumulator charge pressures, residual pressure in the flying control lines and the RAT system is to be exhausted and the wheelbrakes accumulator is to be depressurized. Flying control depressurization is effected by movement of either control column and, for the wheelbrakes accumulator by operating a brake pressure release valve in the right wheelbay.

Table 1 - Hydraulic Power supplies - Controls and Indicators

Control/Indicator	*Marking*	*Location*	*Function*
No 2 hydraulic pump/RAT reset button	HYD 2 RESET	Left Console	Resets No 2 system pump after engine start/ relight. Initiates RAT retraction, provided that No 2 pump pressure is above approx 130 bars
Pressure gauges (2)	HYD 1	Left Console	Indicates No 1 system pressure
	HYD 2	Left Console	Indicates No 2 system pressure or, RAT pump pressure

(Continued)

Table 1 - continued

Control/Indicator	Marking	Location	Function
System low pressure captions	HYD 1	CWP	Indicates No 1 system output pressure has fallen to 41±4 bars or below
	HYD 2	CWP	Indicates No 2 system pump output pressure has fallen to 113·5±7·5 bars or below (remains on with RAT operating)
	HYD	CWP	Indicates that both hydraulic systems output pressures have fallen to 41±4 bars or below

No 2 System Pump Bypass Valve

12. The No 2 system bypass valve solenoid is automatically energized to open the valve during engine starting. With the valve open the pump output is directed to its suction side and the pump is off loaded; the low output pressure causes the HYD 2 to be illuminated. When engine RPM rise through 45% the bypass valve solenoid can be de-energized and the valve closed by pressing the HYD 2 RESET button; subsequently, as No 2 system pump output pressure rises through approximately 137 bars, the HYD 2 caption extinguishes. Irrespective of the increased pump output pressure following the valve closure, the HYD 2 remains illuminated unless the HYD 2 RESET button is pressed. Whenever engine RPM fall through 42%, with both engine start master switches on, the bypass valve solenoid is automatically energized and the valve opened.

Ram Air Turbine

13. The RAT is an integral part of the No 2 system and supplies hydraulic power to the flying controls if engine failure occurs. The RAT and its jack are in a bay in the top of the fuselage, forward of the fin. The RAT is maintained in the retracted position by hydraulic pressure on one side of the jack piston and by spring loading within the jack.

14. The RAT is automatically extended whenever No 2 system pressure falls below 103 ±7 bars. At this pressure a shuttle valve operates to allow RAT accumulator pressure to the extension side of the RAT jack piston. Due to the difference in effective areas of the piston head, this pressure extends the jack and raises the RAT into the airstream. Simultaneously, the shuttle valve links the RAT accumulator and the RAT pump output to the No 2 system flying controls supply line.

15. A RAT cut-out valve regulates RAT pump output between 169 ±3·45 and 203 ±3·45 bars. Indication that the RAT is functioning is given by the HYD 2 pressure gauge cycling between 160 and 210 bars as control column demands are made. When operating, the RAT pump recharges both its own and the No 2 system flying controls accumulator.

16. If engine RPM fall to 42% during relighting, and both engine start master switches are on, No 2 system pump bypass valve solenoid is automatically energized and the pump output passes to the suction side of the pump; the reduction in system pressure allows the RAT to extend into the airstream. When RPM increase to 73% pressing the HYD 2 RESET button causes the solenoid of the bypass valve to be de-energized. At the same time the solenoid of the shuttle valve is energized so allowing No 2 system pump pressure to be supplied to the shuttle valve thus restoring normal operation of No 2 system; the HYD 2 caption is extinguished. With the shuttle reset, hydraulic pressure within the jack is directed to the retraction (spring) side of the piston head and the RAT retracts.

Note: The solenoid of the No 2 system pump bypass valve can be de-energized by pressing the HYD 2 RESET button when engine RPM have risen above 45%. However, the RAT shuttle valve cannot be reset at these RPM since the No 2 system pump output is insufficient to assist shuttle valve movement and the output passes to return via the shuttle valve. The RPM required to raise the pump output sufficiently to move the shuttle valve may be as high as 76%, depending on individual shuttle valve characteristics.

17. The output of the RAT pump is dependent on airspeed. At sea level, the pump develops maximum output at speeds in excess of 130 knots; at 105 knots the output is reduced to 75% of maximum.

18. Extension of the RAT can be tested on the ground with the engine running. On air test RAT functioning can be checked, if necessary, with the engine throttled back. For both tests the No 2 system hydraulic

pressure must be reduced by continuous movement of the control column until the HYD 2 .is illuminated and the RAT extends. On the ground, with the RAT extended, the HYD 2 pressure gauge shows RAT accumulator pressure; in flight the gauge reading cycles in response to RAT pump cut-out valve action between about 160 and 210 bars. In flight, depending on the engine RPM used during a test, the HYD 2 caption may extinguish after the RAT has extended and control column movement has ceased. To retract the RAT, increase to above 75% RPM and press the HYD 2 RESET button. Check that the HYD 2 pressure gauge indicates about 200 bars and does not cycle with mild demands from the flying controls.

Note: The extended RAT may cause slight airframe resonance. In order to conserve the tested safe fatigue life of the RAT system, only carry out in-flight checks during scheduled flight testing of the system. Every inflight RAT deployment must be reported.

19. During engine shutdown, the RAT extends when No 2 system pressure falls to 103 ±7 bars. When pressure has dissipated the RAT is retracted automatically by spring action and its bay doors close.

Hand Pump

20. The hand pump, with its operating handle clipped alongside, is behind an access panel on the engine right air intake fairing.

NORMAL USE

Before Flight

21. The pre-flight checks of the hydraulic systems are given in the **External** and **Internal Checks** in the Flight Reference Cards.

22. After engine start, check control response and feel normal on HYD 1 system and then press the HYD 2 RESET button. Check that the HYD, HYD 1 and HYD 2 captions are extinguished. Check that the HYD 1, HYD 2 and BRAKES SUPPLY pressure gauges indicate approximately 200 bars.

23. Before taxying, check the flying controls for full and free movement and that the HYD 1 and the HYD 2 pressures recover fully after control column movement ceases.

In Flight

24. During flight check that pressure in both systems remains at about 207 bars. A transient drop in HYD 1 pressure occurs during operation of the landing gear, flaps or airbrake, but pressure should restore when the operation is complete.

After Flight

25. During engine shutdown, the RAT extends when No 2 system pressure falls to about 103 bars; the RAT retracts when the system pressure has dissipated.

MALFUNCTIONING

General

26. In all cases of hydraulic system failure, except for Uncommanded RAT Extension, land as soon as possible.

27. A non-return valve is in each of the No 1 and the No 2 hydraulic system pressure lines to the tailplane PFCU (Fig 1). The valves cause a hydraulic lock and prevent a sudden nosedown tailplane runaway if hydraulic failure occurs in extreme conditions of high tailplane loading, ie, airbrake extended at high speeds. However, with a complete failure of one hydraulic system, high airspeeds and mach numbers should be avoided. In the event of a total hydraulic failure, the hydraulic lock will be insufficient to hold the tailplane position at speeds above 300 kts / 0.6 Mach.

No 1 System

28. If No 1 system pressure falls to about 103 bars, system pressure is confined to the operation of the PFCU only and:

a. Landing gear lowering is dependent on the standby system.

b. Flap lowering is dependent on the standby system.

c. The airbrake, if extended, remains so until blown in by airloads after being selected in.

d. Wheelbrakes operation is dependent on brake accumulator pressure.

29. If No 1 system pump output pressure falls below about 41 bars, HYD 1 is illuminated and the system fails.

30. The illumination of the HYD 1 when the landing gear is selected up may indicate a leak in the No 1 hydraulic system; selecting the landing gear down immediately may prevent the loss of fluid from the system. Do not attempt to reselect the landing gear up.

No 2 System

31. If No 2 system pump output pressure falls to about 113 bars, HYD 2 is illuminated. If pressure continues to fall to approximately 103 bars, the RAT extends; No 2 system pressure then increases and the pressure indication cycles between about 160 and 210 bars.

32. If the failure is transient, for example because of excessive control column movement at low engine RPM, the HYD 2 caption should extinguish when control movement ceases or when the engine RPM are increased.

33. If the failure is caused by loss of hydraulic fluid or reservoir nitrogen pressure, the RAT is inoperative and there is no cycling of the HYD 2 pressure indication. Any in-flight RAT extension must be reported on landing.

No 1 and No 2 Systems

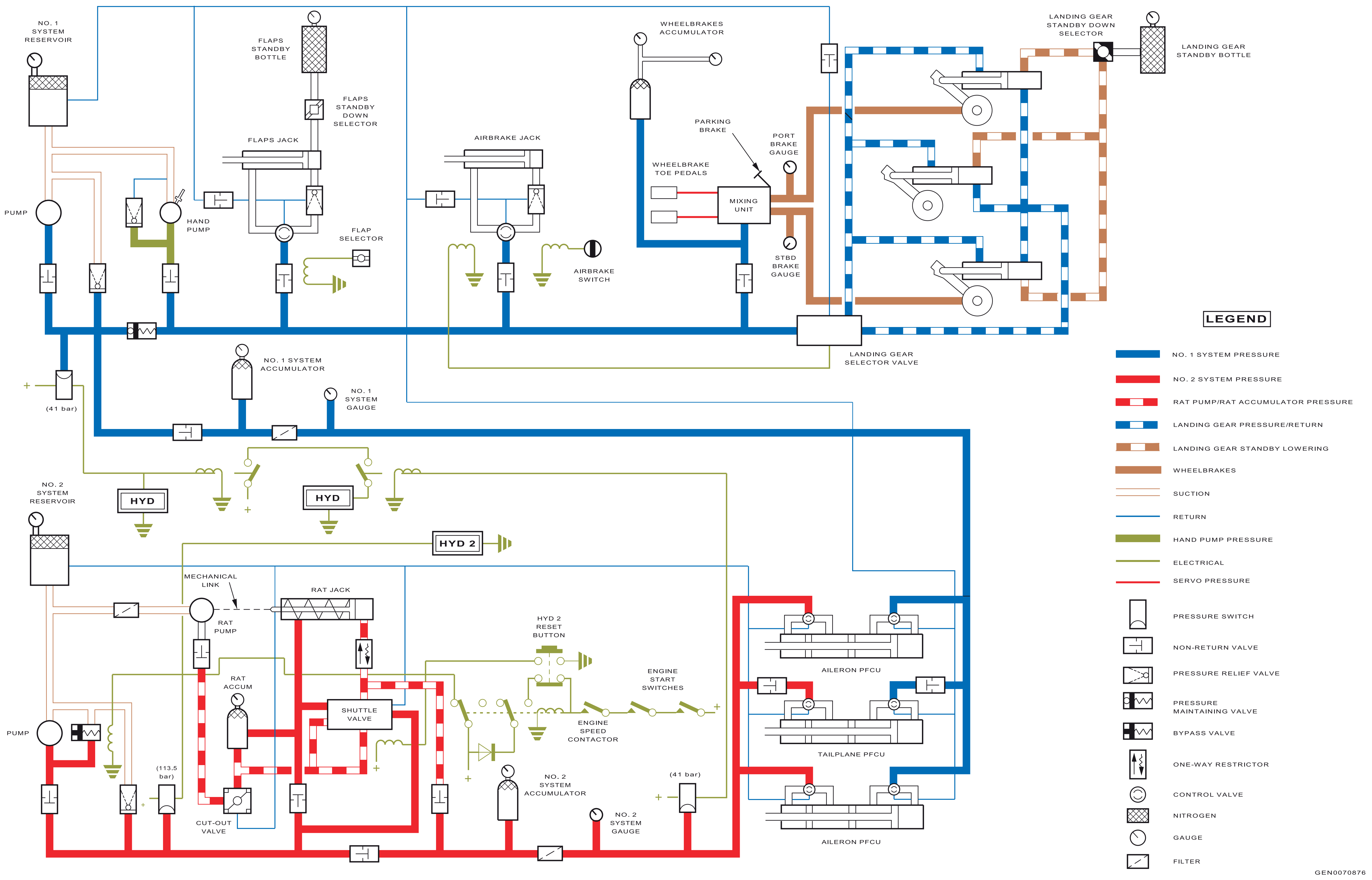
34. Failure of both engine-driven pumps is indicated by the illumination of the HYD 1 and HYD 2 captions and by pressure gauge readings. The RAT should extend when No 2 system pressure falls to about 103 bars; functioning of the RAT is indicated by the HYD 2 pressure indication cycling between about 160 and 210 bars as control column demands are made. Lowering of landing gear and flap is dependent on the standby lowering systems and wheelbrake operation is dependent on brake accumulator pressure.

Total Hydraulic Failure

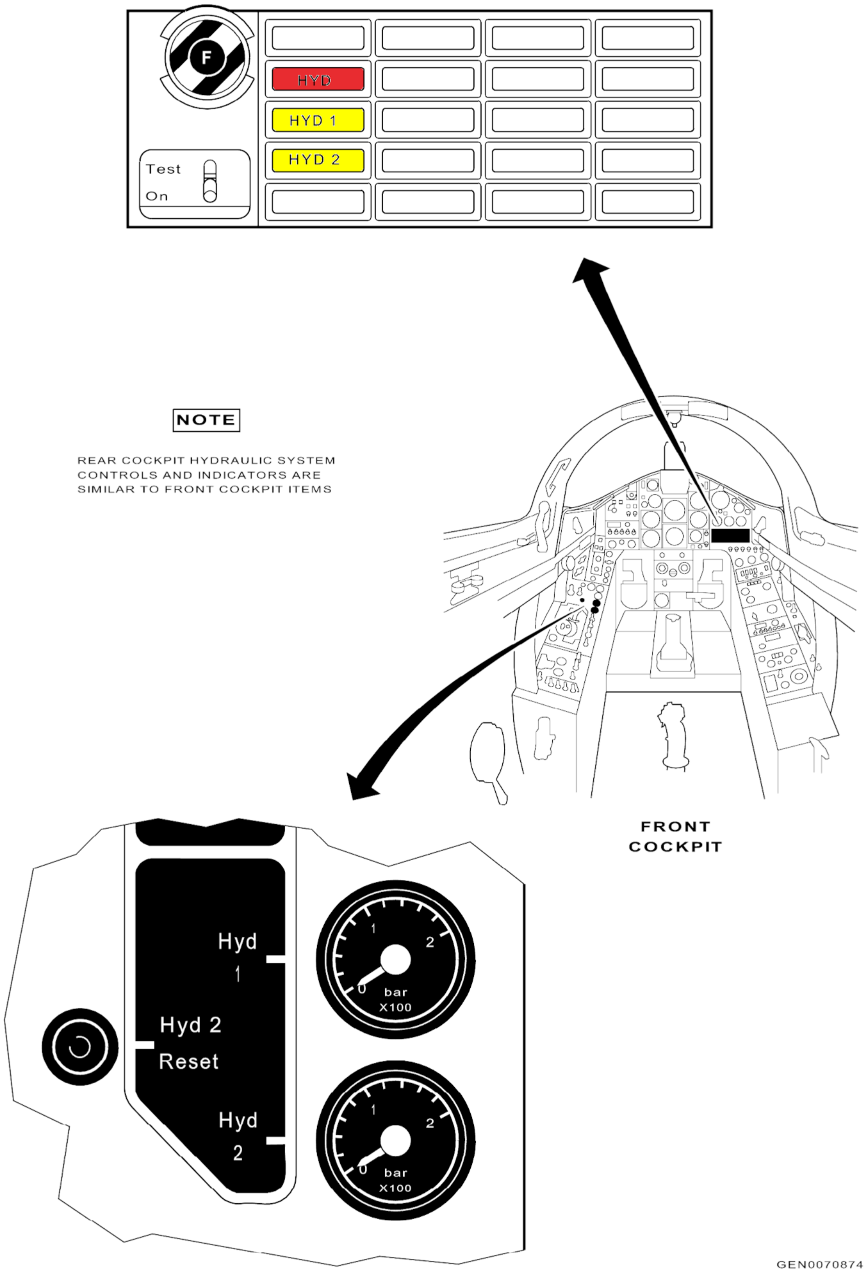
35. If failures of the hydraulic systems occur progressively the HYD caption (red) is illuminated, and is accompanied by audio warning when the third system failure occurs, ie, total hydraulic failure, irrespective of the sequence in which the systems fail. Following total hydraulic failure, abandon the aircraft before the flying controls accumulators are exhausted.

Accumulators

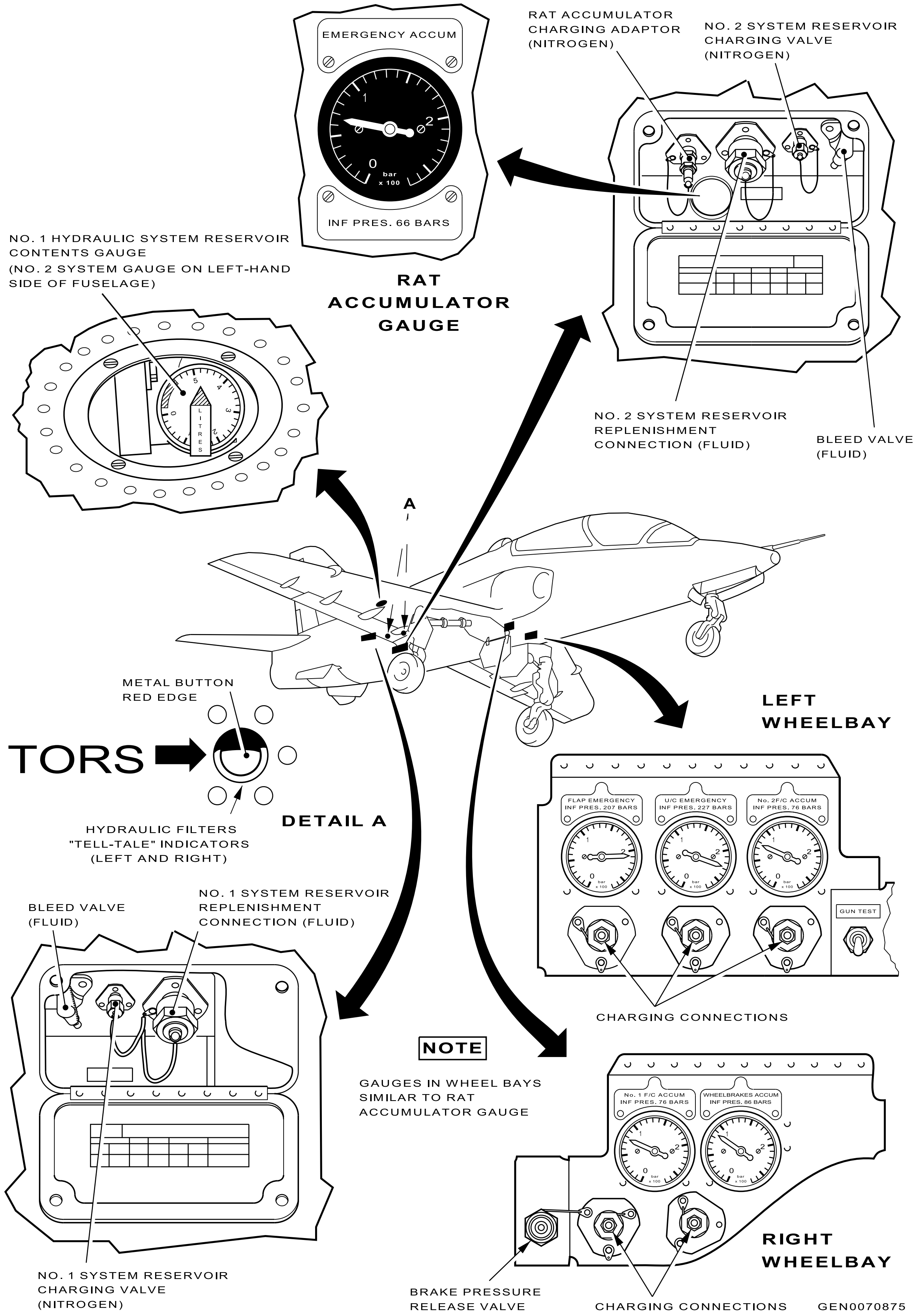
36. The complete loss of nitrogen from the No 1 or No 2 system accumulator results in the loss of damping of high pressure hydraulic pulses and is indicated by pressure fluctuations on the associated pressure gauge.



1 - 5 Fig 1 Hydraulic System - Schematic



1 - 5 Fig 2 Controls and Indicators



1 - 5 Fig 3 Hydraulic System - Equipment Location

PART 1

CHAPTER 6 - FLIGHT CONTROLS

Contents

DESCRIPTION

General

1. The flight controls comprise ailerons, an all-moving tailplane, a rudder, flaps and an airbrake.

2. The ailerons and tailplane are fully power-operated with no reversion to manual control; the rudder is manually operated. Artificial feel is provided at both control columns by spring feel units in the control run of the aileron and of the tailplane. Trimming facilities are provided for the ailerons, tailplane and rudder.

3. The flaps and airbrake are power-operated and a flaps standby lowering system is provided.

4. The dual control columns, which are interconnected, are linked by push-pull rods to hydraulically-operated PFCU, one at each aileron and one at the tailplane. In each cockpit a pair of rudder pedals is carried on a rudder bar; the rudder bars are interconnected and linked by push-pull rods to the rudder.

5. Hydraulic power for the operation of the aileron and tailplane PFCU is provided by the No 1 and the No 2 hydraulic systems. Hydraulic power for the flaps and the airbrake is from the No 1 hydraulic system.

Controls and Indicators

6. The controls and indicators for ailerons, tailplane and rudder are listed in Table 1.

Table 1 - Controls and Indicators - Ailerons, Tailplane and Rudder

Control/Indicator	*Marking*	*Location*	*Function*
Both Cockpits			
Aileron trim switches, spring loaded to centre off (front cockpit - two, rear cockpit - one)	AILERON TRIM	Left console	Control aileron trim actuator
Aileron trim indicator	AILERON	Left console	Indicates aileron trim setting
Tailplane main trim switches, spring loaded to centre off (two in each cockpit)	Unmarked	Top of control column	Control tailplane trim actuator main motor
Tailplane standby trim switch(es) cover	LIFT FOR STANDBY CLOSE FOR MAIN	Left console	Cover, when raised fully, operates integral switch to isolate trim actuator main motor, and exposes standby trim switch(es)
Tailplane standby trim switch(es) (front cockpit - 2, rear cockpit - 1)	Unmarked	Left console (under cover)	Controls tailplane trim actuator standby motor (front cockpit switches must be used together)
Tailplane position indicator	TAILPLANE	Centre panel	Indicates tailplane setting
Rudder trim switch (spring loaded to centre off)	RUDDER TRIM	Left console	Controls rudder trim tab setting
Rudder trim indicator	RUDDER	Left console	Indicates rudder trim tab setting
Rudder pedal adjustment control	RUDDER PEDAL ADJUST	Leg panel	Permits fore and aft adjustment of rudder pedals
Front Cockpit Only			
Rudder bar lock handle (red)	Unmarked	Right side of leg panel	Engages/disengages rudder system lock

Powered Flying Control Units

7. Each PFCU comprises an actuator, which has two cylinders and two pistons in tandem and which is anchored at one end to the aircraft structure. The pistons are connected to a ram which is linked to a control surface operating lever. Each half of the actuator has a control valve; the valves operate simultaneously, and in the same sense, to direct hydraulic fluid under pressure to one sideor the other of the associated piston depending on the direction of control column movement. One half of each actuator is supplied, via its control valve, from No 1 hydraulic system; the other half is similarly supplied from No 2 hydraulic system. If one hydraulic system fails, the control valve in the associated half of the PFCU operates to allow fluid to be displaced freely as the piston moves, thus preventing a hydraulic lock; the failure does not affect operation of the flying controls.

8. The pistons move relative to the actuator body and deflect the control surface via the ram and the operating lever. The ram has a mechanical feedback linkage which centralizes the control valve when the control surface reaches the demanded position. When control column movement ceases the control valves close to effect a hydraulic `lock' which prevents further movement of the pistons and, thus, of the control surface.

Control Surfaces - Range of Movement

9. **Aileron.** The range of aileron movement is approximately 12°.

10. **Tailplane.** The range of tailplane movement is +6·6° (aircraft nose down) to minus 15° (aircraft nose up) relative to the fuselage datum. Tailplane position is shown on the TAILPLANE position indicators by a pointer which moves against a scale graduated at 1° intervals from +7° to minus 17°; the scale has major graduations at 5° intervals.

11. **Rudder.** The range of movement of the rudder is 20±0·5° left and right, relative to the fore-and-aft axis of the aircraft. The rudder trim tab has a range of movement of 9° (minimum) left and right, relative to the rudder.

Artificial Feel

12. **General.** Air loads on the aileron and tailplane surfaces are resisted entirely by the PFCU and no loads are fed back to the control columns. Therefore, to provide feel at the control columns, both the aileron and the tailplane control runs incorporate a spring feel unit which gives artificial feel proportional to control column deflection but not to airspeed.

13. **Aileron Feel.** The aileron spring feel unit gives two linear ranges of feel force increment. In each range the feel force increases with applied aileron. The first range covers the first 29 mm of control column displacement from the neutral position and requires twice as much increment force for a given displacement of the control column as the second range.

14. **Tailplane Feel.** The tailplane spring feel unit provides two linear ranges of feel force increment in a similar manner to that of the aileron unit. The first range covers the first 76 mm of control column displacement from the neutral position and requires twice as much incremental force for a given displacement of the control column as the second range. An inertia weight, on an arm forward of and connected to the front cockpit control column, imposes an additional feel force proportional to g.

Trimming

15. **General** . Control column or rudder pedal forces are trimmed out using the aileron, tailplane or rudder trim switches which control a power supply to the motors of associated trim actuators. The tailplane can be trimmed using either the main or standby trim switches which control the main or the standby motor, respectively, of the tailplane trim actuator. The aileron and the rudder trim switches and the tailplane standby trim switches are electrically arranged so that the rear cockpit selections directly override front cockpit selections. Operation of the rear cockpit tailplane main trim switches overrides front cockpit selections indirectly by energizing either a tailplane nose down or a tailplane nose up override relay which disconnects the front cockpit power supply to the actuator main motor. The power supply for the trim actuator motor is from the Essential Services busbar, via the trim switches.

16. **Aileron Trim.** The aileron trim actuator operates to bias the aileron spring feel unit. Operation of the actuator is controlled by the AILERON TRIM switches; in the front cockpit the two co-located switches are to be operated together to operate the actuator. The amount of trim applied is shown on the AILERON trim indicator by a pointer which moves against an unnumbered arc from 270° through 0° to 90°. The range of trim afforded by the aileron trim actuator is governed by limit switches and by mechanical stops; the time required to trim from stop-to-stop is approximately seven seconds.

17. **Tailplane Trim.** The main motor of the tailplane trim actuator is controlled by two switches on the control column in each cockpit. Both switches are to be operated together to operate the motor. The standby motor of the actuator is controlled by two switches in the front cockpit and by a single switch in the rear cockpit. The standby trim control switches are under the LIFT FOR STANDBY CLOSE FOR MAIN cover. When either cover is fully raised the main motor is isolated and tailplane trimming, using the exposed switch(es), is then effected by the standby motor. In the front cockpit, the two standby control switches are to be operated together to operate the standby motor. The range of trim (+3° to minus 5° with respect to 0° tailplane position) afforded by the tailplane trim actuator is governed by limit switches and by mechanical stops; the time required to trim from stop-to-stop is approximately four seconds.

18. **Rudder Trim.** The rudder is trimmed by a rotary actuator which moves a trim tab on the rudder. The actuator is controlled by the RUDDER TRIM switch. The degree of trim is shown on the RUDDER trim indicator by a pointer which moves against an unnumbered arc from 315° through 0° to 45°. The range of trim afforded by the rudder trim tab is governed by limit switches only; the time required to trim over the full range is between 16 and 22 seconds.

Rudder Pedal Adjustment

19. The rudder pedals are spring-loaded aft and can be adjusted for reach when the RUDDER PEDAL ADJUST control is pulled and held. Pulling the control lifts a locking plunger to permit the pedals either to be pushed forward against spring pressure, or to move aft under spring pressure; release the control when the desired pedal position is reached. When pressure is released from the pedals, or gently applied, the locking plunger re-engages and the RUDDER PEDAL ADJUST control returns fully home. Positive locking of the pedals is checked by pressing firmly on both pedals. Post Mod 727 an extended rudder pedal assembly is introduced.

Rudder Bar Lock

20. The rudder bar lock handle, in the front cockpit only, enables the rudder pedals, the control linkage and the rudder to be locked in the central position. The handle is moved to the locked position by rotating it rearwards and upwards to the horizontal where it obstructs the right rudder pedal; the rudder pedals must then be moved gently to engage a latch which positively locks the mechanism. The lock is disengaged by rotating the handle downwards and forwards until the handle is in its unlocked position against the right side of the cockpit leg panel.

Flaps

21. **General.** A double-slotted trailing edge flap is on each side of the wing. Each flap is supported by hinges which are offset below the wing to give increased wing area when the flaps are lowered. The flaps are hydraulically operated by a single centrally mounted jack, powered by No 1 hydraulic system. A high pressure nitrogen standby system is provided for lowering the flaps if No 1 hydraulic system fails.

22. **Controls and Indicators.** The flaps are controlled by a 3-position UP/MID/DOWN selector on the left panel in the front cockpit and by a similar UP/PUPIL/DOWN selector on the left panel in the rear cockpit. The front cockpit selector has to be pulled out from the UP position before MID or DOWN can be selected; the rear cockpit selector has to be pulled out from the PUPIL position before UP or DOWN can be selected. Each cockpit has a FLAP x 10 (degrees) position indicator above the flaps selector. A T-handle marked F, on the left panel in each cockpit, operates the flap standby lowering system.

23. **Operation.** Operation of the flaps is via an electro-hydraulic selector valve which is electrically controlled by the cockpit selectors. With the rear cockpit flap selector at PUPIL, flap selection is controlled from the front cockpit. Irrespective of the front cockpit flap selector setting, selecting UP or DOWN in the rear cockpit isolates the front cockpit selector from its power supply and the flaps move to the position selected in the rear cockpit; the MID position cannot be selected from the rear cockpit. Control is returned to the front cockpit whenever the rear cockpit switch is set to PUPIL. Ideally, the front cockpit switch should be set to the same position as the actual flap position before control is returned to the front cockpit. With the flaps selected to MID or DOWN their nominal position is 25° or 50° respectively; however the actual position reached is governed by airloads. Any curtailment of flap extension at high speed due to airloads is progressively removed as speed is reduced. With MID selected and the flaps at 25° (nominal) the position indicator shows 22·5° (nominal). The flap position is correctly indicated with UP or DOWN selected. The rear cockpit selector must be set to PUPIL for solo flight.

24. **Standby Lowering System.** High pressure nitrogen, for lowering the flaps by the standby system, is stored in a bottle behind the rear cockpit bulkhead, on the left side. A charging/test point and a pressure gauge are in the left wheelbay. The bottle is charged to 207 ±3·45 bars. If the No 1 hydraulic system fails, the flaps can be lowered to fully down when the locking knob in the centre of the T-handle in either cockpit is pressed and the handle is pulled fully out (13 mm). When the handle is pulled, the flap selector valve is de-energized and a cartridge is electrically detonated to release the nitrogen which is directed via a shuttle valve, to the down side of the jack, causing the up-side fluid to be dumped overboard via a jettison valve. The flaps lower in approximately one second and cannot subsequently be raised. The standby lowering system operates irrespective of flap setting and of which cockpit has flap control.

Note: When the storage bottle is recharged by low pressure nitrogen bottles, operation of the standby lowering system will take longer.

25. **Power Supplies** . The power supply for normal flap operation is from the Essential Services busbar. The power supply for operation of the flaps using the standby system is from the commoned battery supply; normally a voltage of at least 14 volts is required to activate the system.

Airbrake

26. **General.** The airbrake, on the underside of the rear fuselage, is hydraulically operated by a jack powered by No 1 hydraulic system. The airbrake can be operated from either cockpit and is electrically controlled via an electro-hydraulic selector valve. Full extension of the airbrake is approximately 60°. There is sufficient ground clearance for full extension at the normal ground attitude of the aircraft. However, to ensure that an extended airbrake cannot strike the ground when the aircraft is in the landing/take-off attitude, an interconnect circuit automatically retracts the airbrake, and isolates the airbrake selection switch, when the landing gear is selected down by normal selection. The airbrake is also automatically retracted by operation of the rear cockpit landing gear selection control transfer button. The standby gear lowering system does not operate the airbrake automatic retraction facility.

27. **Controls and Indicators.** An AIR BRAKE - IN/off/OUT switch, spring-loaded to centre off, is on the top of each throttle lever handle. The rear cockpit switch overrides selections made on the front cockpit switch. An AIRBRAKE magnetic indicator (MI) is on the centre panel in both cockpits. The MI is de-energized to show black when the airbrake is fully retracted or when the electrical supply is not established. The MI is energized to show white when the airbrake is not fully retracted. A spring-loaded AIR BRAKE TEST switch, on the front cockpit right console, enables airbrake operation to be tested on the ground. The electrical supply for the airbrake system is from the Essential Services busbar.

28. **Operation.** In flight, operating an AIR BRAKE switch extends or retracts the airbrake provided that the landing gear is up. To prevent overstressing at high airspeeds, the angle of airbrake extension is adjusted by the airloads and by a pressure relief valve in the hydraulic down line. If the airbrake is in the extended position when the landing gear is lowered by a normal down selection, the airbrake is automatically retracted. If the No 1 hydraulic system fails, the airbrake is to be selected in and sufficiently high air loads are to be maintained to close the airbrake before the landing gear standby lowering system is used. Post Mod 1154 the airbrake is automatically retracted and reselection is inhibited when RPM fall below 42%.

29. **Testing.** On the ground, holding the AIR BRAKE TEST switch forward bypasses the landing gear interconnect circuit, allowing the airbrake to be operated using the AIR BRAKE - IN/OUT switch. When OUT is selected the airbrake moves to full extension; when IN is selected the airbrake retracts.

NORMAL USE

Before Flight

30. When the engine is not running and the PFCU hydraulic accumulators are exhausted, up to 62 mm of fore-and-aft control column movement is present and is normal.

31. Release the rudder lock. Adjust the rudder pedals ensuring that any gap between the back of the thighs and the front of the seat pan is minimized; check that the control knob returns fully but, to avoid overstressing the mechanism, do not press the knob home. Press firmly on both pedals to ensure that they are locked in position.

32. After starting the engine, check the flying controls for full, free and correct movement (obtain external assistance where necessary) and that the hydraulic pressures recover fully after control movement ceases. During the check of full and free tailplane movement (from the front cockpit), check that the full range of +6·6° to minus 15° is displayed on the tailplane position indicator in each cockpit.

33. Make the following checks, independently where appropriate, from both cockpits:

a. **Rudder Trim.** Check that the rudder trim functions over its full range and check the indicator. Set the trim to neutral.

b. **Aileron Trim.** Check that the aileron trim functions over its full range and check the indicator. Set the trim to neutral. In the front cockpit operate the switches individually; there should be no indication of trim change.

c. **Tailplane Trim - Main.** Check that the tailplane trim functions over its full range using the main trim switches and check the indicator. Operate the switches individually; there should be no indication of trim change.

d. **Tailplane Trim - Standby.** Lift the cover of the tailplane standby trim switch(es); check that the standby trim functions over its full range and check the indicator. In the front cockpit operate the switches individually; there should be no indication of trim change. Operate the tailplane main trim switches; there should be no indication of trim change. Lower the switch cover and check that main trim is again functioning. Return the trim to neutral.

34. **Flaps.** For solo flight the rear cockpit flaps selector is to be set to PUPIL. Check the operation of the flaps over the full range and check the indicator. If appropriate, return flap control to the front cockpit by setting the rear cockpit selector to PUPIL.

35. **Airbrake.** Confirm that personnel are clear of the airbrake. Hold the AIR BRAKE TEST switch forward and check the operation of the airbrake and the MI.

In Flight

36. Periodically check the hydraulic pressures. Although the airbrake is automatically retracted when the landing gear is selected down normally, the airbrake should be selected in before the landing gear is selected down.

MALFUNCTIONING

Tailplane Trim

37. If the main trim motor fails or runs away lift the cover of the standby trim switch(es) fully and use the standby trim control switch(es).

38. Each of the tailplane main trim switches has two sets of contacts. If either set of power supply side contacts of the rear cockpit switches weld together either the tailplane nose-down or the nose-up override relay is energized, rendering the front cockpit switches ineffective; in both cockpits the standby trim switch(es) are then to be used. If a similar failure occurs in the front cockpit the standby trim switches are to be used; the rear cockpit main trim switches are unaffected by the failure but are isolated if the front cockpit standby trim switch cover is raised.

39. A full tailplane trim actuator runaway results in an out-of-trim force which is easily held; no control authority is lost.

Aileron Trim

40. A full aileron trim actuator runaway results in an out-of-trim force which is easily held; no control authority is lost.

Rudder Trim

41. A full rudder trim actuator runaway results in an out-of-trim force proportional to IAS. The out-of-trim force is easily held at speeds below 200 knots with MID flap selected.

Flaps

42. If the flaps fail to lower using the normal system, select DOWN at the normal selector and then operate the T-handle of the flap standby lowering system. The standby lowering system gives full flap only; the flaps cannot be retracted subsequently.

43. **Undemanded Lowering.** Undemanded lowering of the flaps is indicated by a change in aircraft trim and the flap position indicator showing the flaps to be partially or fully lowered. Depending on the cause of the lowering, hydraulic fluid from No 1 system may be lost, causing the HYD 1 caption to be illuminated. If undemanded lowering occurs, immediately make a normal down selection; this reduces the possible loss of hydraulic fluid and may cause the HYD 1 caption to go out. Reduce speed to below 200 knots. Make no attempt to raise the flap.

44. **Undemanded Retraction.** Undemanded retraction of the flaps is indicated by possible sink, increase in buffet and a change in aircraft trim. The flap position indicator will accurately show the flaps to be partially or fully raised. If the flaps retract while on the runway if sufficient runway length remains abort the take-off (see Part 2, Chap 1, para 22) or carry out a flapless take-off (see Part 2, Chap 1, para 19). In flight, recover the aircraft to normal unaccelerated flight and confirm flap position. Match the flap selector to the actual flap position. When ready to land, lower the flaps using the Flaps Standby Operation Drill.

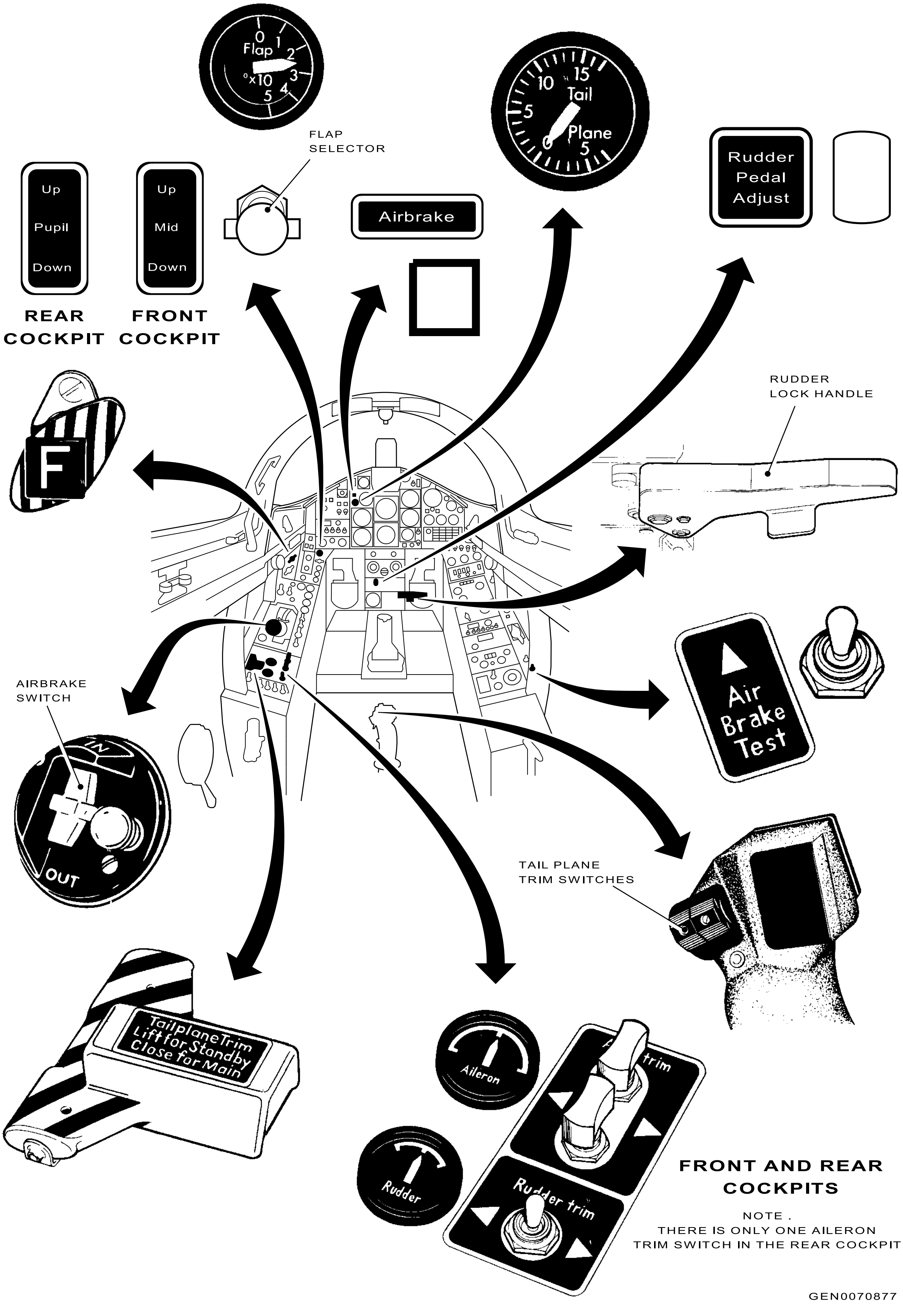
45. **Flap Selector Valve Malfunction.** An electrical or a mechanical malfunction could cause the flap selector valve to stick in the up position. In this condition the normal flap selector would not be effective. In the case of a mechanical malfunction the subsequent use of the appropriate standby lowering system would then cause the complete loss to atmosphere of No 1 hydraulic system fluid and a No 1 HYD failure. If a normal DOWN selection of the flaps fails the cause may be a transient fault, therefore make repeated normal selections before using the appropriate standby lowering system. If the affected service remains up make a normal DOWN selection before using the standby lowering system. Delay the standby lowering system selection until use of the flaps is essential, but be prepared for a subsequent HYD 1 failure.

Airbrake

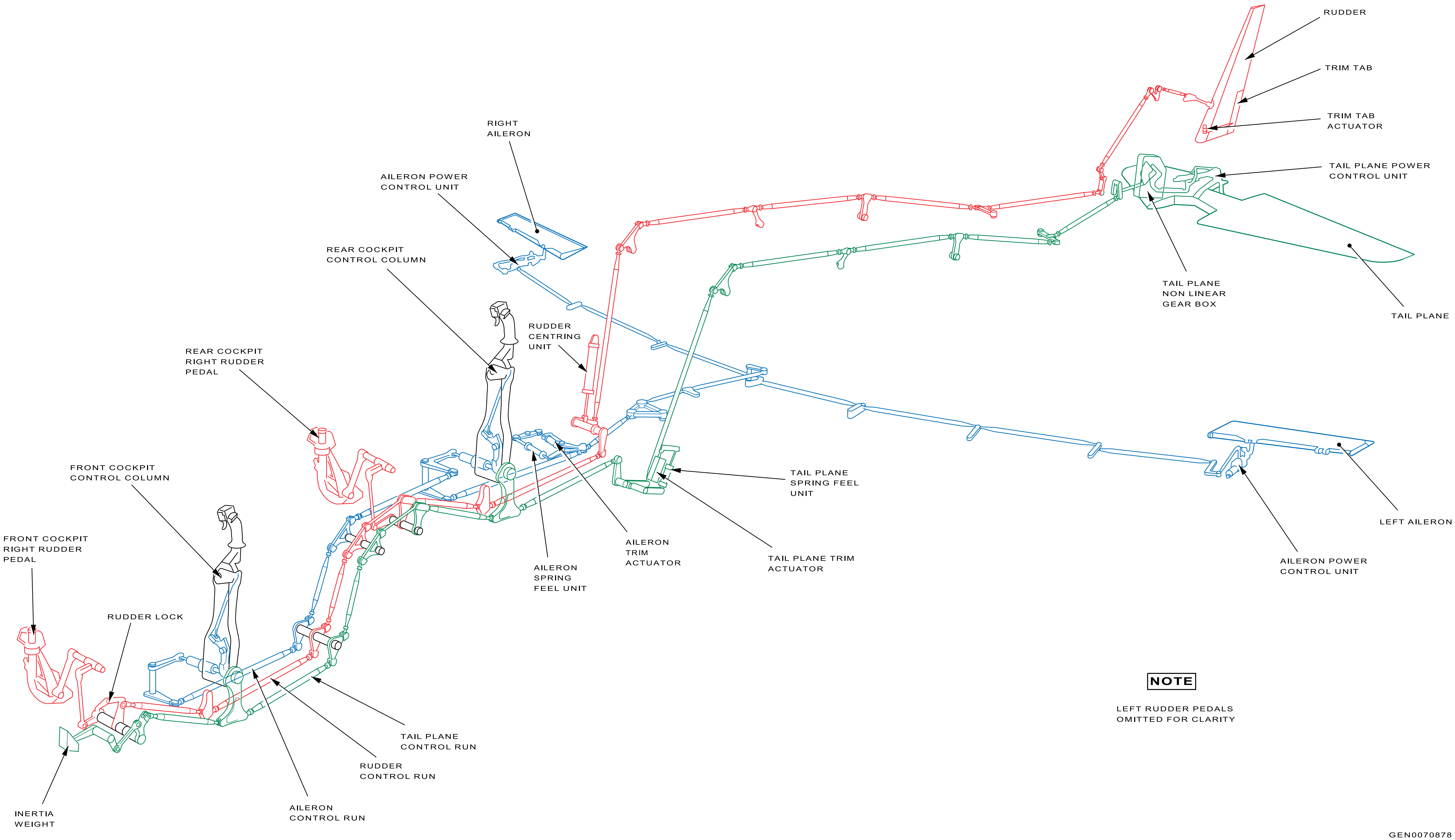
46. If the airbrake fails to operate, carry out the drill given in the Flight Reference Cards.

47. A failure of the electrical supply to the airbrake system causes the electro-hydraulic selector valve to return automatically to the airbrake `in' position; the airbrake retracts.

WARNING: If a HYD 1 and/or HYD 2 caption is illuminated the airbrake is not to be extended. In the event that the airbrake is out when the HYD 1 and/or HYD 2 system fails, it should be retracted immediately and the speed reduced to below 300 knots/0·6M without the assistance of the airbrake.



1 - 6 Fig 1 Controls and Indicators



1 - 6 Fig 2 Flight Control Runs

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PART 1

CHAPTER 7 - LANDING GEAR, WHEELBRAKES AND ANTI-SKID

Contents

GENERAL

Description

1. The landing gear consists of left and right main wheel units and a fully castoring nosewheel unit. Hydraulically operated wheelbrakes are fitted to the main wheels. The main wheels have fusible plugs designed to release tyre pressure when hub temperature exceeds 155°C.

2. The landing gear is normally operated by hydraulic power from the No 1 hydraulic system, but if this system fails the landing gear can be lowered using a high pressure nitrogen standby system.

3. The main wheel units retract inward into wheelbays in the wing, forward of the spar; fairing doors on each main unit leg retract with the unit. Separate inboard wheelbay doors are hydraulically operated and are electrically sequenced to retract after the main leg is retracted and to open before the main leg extends. The wheelbay doors remain open with the landing gear down.

4. The nosewheel unit retracts forward into a fuselage bay which is closed by three doors mechanically linked to the unit leg; the doors remain open with the nosewheel unit down. A cam, integral with the oleo leg of the nosewheel unit, self-centres the nosewheel, from 30° of centre, when the oleo extends during take-off. Two black horizontal datum lines on the wheel fork and two red horizontal datum sectors on the pivot bracket of the nosewheel unit enable a before flight check to be made that the nosewheel should castor when taxying is commenced. The wheel fork is marked TOWING & BEFORE FLIGHT ENSURE THAT THE BLACK LINE IS BELOW THE RED SECTOR; an arrow points to each of the black lines.

5. The main wheel and nosewheel units are secured up or down by mechanical locks. An amber external indicator light on the nosewheel leg illuminates when all landing gear legs are locked down.

6. Hydraulically-operated 3-plate wheelbrakes, incorporating a selectable electro-hydraulic cross-coupled anti-skid system, are fitted to the main wheels. The brakes are operated by independent toe pads on each of the rudder pedals thus permitting differential braking. A parking brake T-handle is in the front cockpit only.

LANDING GEAR

Controls and Indicators

7. The controls and indicators for the landing gear system are listed in Table 1 and shown at Fig 1.

Table 1 - Landing Gear Controls and Indicators

Control/Indicator	*Marking*	*Location*
Retraction selector button (with emergency retraction facility)	UP	Left panel, both cockpits
Lowering selector button	DOWN	Left panel, both cockpits
Selection control transfer button	Red	Left panel, rear cockpit
Unit position indicator	Unmarked	Left panel, both cockpits
Standby lowering selector T-handle	U/C	Left panel, both cockpits

Position Indicator

8. The electro-mechanical position indicator has three windows, one for each unit of the landing gear, through which the following indications are given:

Green Unit locked down

Red Unit unlocked or no electrical supply to the indicator

UP Unit locked up (in white on black background)

Operation

9. Operation of the landing gear is controlled via an electro-hydraulic selector valve by the UP and DOWN selector buttons. Each UP button has a solenoid-operated safety lock which prevents inadvertent up selection when the aircraft is on the ground. The solenoids are energized from the Essential Services busbar via the contacts of a `weight-on-wheels' microswitch on the oleo of each mainwheel leg. As the oleos extend after take-off, the microswitches close; the solenoids are then energized and withdraw the button safety lock to allow an up selection to be made.

Selection Control Transfer Button

10. The selection control transfer button is below the DOWN selector button in the rear cockpit. When the transfer button is depressed, landing gear selection is controlled from the front cockpit and the rear cockpit UP and DOWN buttons are automatically set to the out position. When an UP or a DOWN selection is made in the rear cockpit, the transfer button is released and full control of the landing gear, including the emergency retraction facility (para 14), is transferred to the rear cockpit; the front cockpit selector buttons are then electrically isolated and remain in the last selected position. Control of landing gear selection is returned to the front cockpit when the transfer button is again depressed. However, a solenoid-operated safety lock in

the transfer button ensures that this transfer can only be achieved when the setting of the front cockpit UP and DOWN selector buttons corresponds with the setting of the rear cockpit buttons. The transfer button is to be depressed for solo flight.

Standby Lowering System

11. High pressure nitrogen from a storage bottle is used to lower and lock the landing gear if No 1 hydraulic system fails. The bottle, which is behind the rear cockpit bulkhead, is charged to 227 ±3·45 bars. A charge/test point is in the left wheelbay.

12. The standby system is operated by pulling an U/C T-handle fully outwards (approximately 12 mm) after first depressing a locking button integral with the handle. The system operates irrespective of the setting of the landing gear selector buttons.

13. Pulling the U/C T-handle, in either cockpit, de-energizes the landing gear selector valve and electrically detonates a cartridge which operates a release valve to allow nitrogen from the storage bottle to be directed, via shuttle valves, to the down side of the landing gear jacks. Hydraulic fluid, displaced from the up side of the jacks is dumped overboard via a jettison valve. There is no sequencing. After the landing gear has been lowered using the standby system it cannot subsequently be retracted.

Note 1: A voltage of at least 14 volts is required to detonate the cartridge. This cannot be read on the voltmeter so, in the event of a Generator failure, a decision to lower the gear must be made by 21 volts.

Note 2: Hawk T Mk1/Mk1A aircraft on detachment may, in certain circumstances, be at airfields where the ground Nitrogen replenishment bottles do not have sufficient pressure to fully replenish the aircraft Flap and Undercarriage standby lowering cylinders. Dispensation has been granted to allow tradesmen to replenish these systems to a lower pressure. However, aircrew are to be aware that when a storage bottle is recharged by low pressure nitrogen bottles, operation of the standby lowering systems may be slightly slower.

Emergency Retraction

14. On the ground the button safety lock can be bypassed and the landing gear raised by rotating either landing gear selector UP button clockwise through 60° and then pressing the button. The facility is available from both cockpits when landing gear normal control is from the front cockpit (rear cockpit transfer button depressed) or from the rear cockpit alone when normal control is from that cockpit. The emergency retraction facility is inoperative if the landing gear has been lowered by the standby system or No 1 hydraulic system has failed.

15. In flight, if an UP button safety lock has failed to disengage, the emergency retraction facility can be used to raise the landing gear; it cannot be used if the landing gear has failed to retract following a normal up selection. When the facility is operated the solenoid-operated safety lock on the UP button is rendered inoperative and cannot be reset. When a landing is made subsequently, movement of the UP selection button is to be avoided since protection against an inadvertent up selection is lost.

Note: Use of the emergency retraction facility in flight is an abnormal operation and is only to be made in exceptional circumstances. It is not to be used if the aircraft has touched down, since a landing gear unit may remain compressed and foul its bay on retraction.

CAUTION: Use of the emergency retraction at high groundspeed will result in the loss of directional control and the aircraft will require a significant ground track to come to a halt.

Ground Locks

16. Ground locks (each with a warning flag) are provided for the nosewheel and main wheel units. They are fitted after flight and are to be removed before flight. A ground locks stowage is in the nose equipment bay.

WHEELBRAKES AND ANTI-SKID

Wheelbrakes

17. Hydraulically-operated wheelbrakes, incorporating a selectable electro-hydraulic cross-coupled anti-skid system, are fitted to the main wheels, see schematic at Fig 2. Mod 1863 introduces Touchdown Protection (TDP) to protect against landing with the brakes applied. The brakes are operated by toe pads on the rudder pedals and differential braking is provided. A parking brake is in the front cockpit only.

18. The rudder pedals consist of toe block, heel bar and cup. Pressure on the toe block rotates the whole pedal about the heel bar. This rotation generates hydraulic pressure in a brake master cylinder attached to the front of each pedal. This pressure is then transmitted via a hydraulic line to a twin brake control valve. The hydraulic lines from each master cylinder are independent of each other and of the No 1 and No 2 hydraulic systems. The brake control valve regulates pressure from No 1 hydraulic system (or the wheelbrake accumulator) to the brake unit. The toe blocks are operated independently for differential braking or together for uniform braking; the pressure at the brakes (with anti-skid selected off) is proportional to the amount of toe block depression. Adjusting the pedals away from the pilot or applying rudder rotates the pedal into a more vertical position. This brings the toe block closer to the toe of the boot when, with the boot heel in the cup, there is no contact between boot and heel bar. Pay particular attention to the position of the toes, to avoid inadvertently applying brake when kicking off drift, especially if the pedals are adjusted well away from the pilot.

19. A pressure-sensitive bypass valve and a restrictor in each brake pressure line minimize brake response time and improve the operation of the anti-skid system. When a pressure-sensitive valve is open pressure can be rapidly applied to the associated wheelbrake. When the applied pressure reaches a preset value the valve is automatically closed; pressure from the brake control valve can then only pass through the restrictor which allows a gradual rate of application of pressure at the brake and so provides for smooth operation of the anti-skid system by reducing the possibility of rapid wheel deceleration

20. The No 1 hydraulic system incorporates a wheelbrakes accumulator which provides brake function following a failure of the HYD 1 system. A brake supply gauge, on the left console in each cockpit, indicates the brake accumulator pressure. Prior to engine start, the gauge indicates the base pressure of the accumulator. Once the HYD 1 system is online it indicates system pressure. If the No 1 hydraulic pump fails, a fully charged accumulator provides a reserve of power sufficient to bring the aircraft to a braked stop, with anti-skid protection, after landing.

21. Two brake pressure gauges, PORT and STBD, adjacent to the SUPPLY pressure gauge, indicate the pressure applied at the respective brake. The gauges are graduated from 0 to 140 bars in increments of 10 bars; with the toe pads fully depressed the highest pressure indicated is between 85 and 100 bars. When the brakes are released a residual pressure of up to 10 bars may be indicated on the gauges and is acceptable.

Parking Brake

22. A PARKING BRAKE T-handle is aft of the right console in the front cockpit. The wheelbrakes can be applied by pulling up the T-handle; the brakes can then be locked on by turning the handle clockwise. Simultaneous full application of toe pad pressure and parking brake lever may cause damage to the brake control valve unit with subsequent malfunctioning of the braking system. When, with the wheelbrakes applied by toe pad foot pressure, it is required to apply the parking brake, eg, on a gradient, the foot pressure must be gradually released as the T-handle is pulled up. The parking brake is released when the T-handle is pulled up, turned counterclockwise and released; downward movement of the handle is assisted by spring tension.

23. When the parking brake is `on' an initial brake pressure of between 85 and 100 bars should be indicated for each main wheel provided the wheelbrake accumulator pressure is above this range. With the parking brake left on pressure may dissipate over a period of six hours but the accumulator can be recharged using the hand pump; during recharging the parking brake may be left on.

Anti-Skid

24. The anti-skid system provides automatic protection against main wheel skidding at the wheel speed equivalent of groundspeeds in excess of 10 to 13 knots and protection against landing with the wheel brakes applied. The main components of the anti-skid system are a control unit, two solenoid operated electro-hydraulic control valves and a speed sensor in each main wheel. The power supply for the system is from the Essential Services busbar, via a fuse, and is controlled by an ANTI SKID switch on the left console in each cockpit. The system operates automatically provided that the ANTI SKID switch in each cockpit is selected on. A SKID caption on the CWP is illuminated if either ANTI SKID switch is off or to indicate anti-skid system failure. Post Mod 1237 the caption is inhibited when the gear is selected UP.

25. **Anti-Skid Operation.** Each wheel-driven generator produces a voltage proportional to wheel rotation speed. The anti-skid control unit senses the rates at which the voltages decrease as the wheels decelerate and compares them with a preset datum rate. If the rate of change from either wheel exceeds the safe threshold (ie, the wheel is about to skid) the control unit energizes the anti-skid control valves which release all pressure at both brakes. The wheel speed now increases and the control unit, sensing when the wheels have spun up, de-energizes the anti-skid control valves and demanded brake pressure is restored to both wheels. The release of brake pressure at the wheels by the anti-skid control valves cannot be felt by the pilot through his toe pressure as the pressure in the master cylinders is unaffected.

Touchdown Protection

26. **Automatic Isolation.** A fail safe circuit in the control unit ensures that the anti-skid system is isolated if either control valve is continuously open for longer than two seconds on the ground, due to, for example, icy runway, slippery runway, aquaplaning or locked wheel. The anti-skid control valves close, restoring differential braking without anti-skid protection and the SKID caption comes on.

27. Mod 1863 introduces a modified anti-skid control valve with additional functionality to protect against landing with the wheel brakes applied. The modified control unit uses the anti-skid control valves to release brake pressure from the wheel brakes until after touchdown when either:

a. Both wheels have spun up above 20 knots ground speed.

b. A weight-on-wheels signal has been received from at least one mainwheel for at least 3 seconds.

28. Once either of the conditions are met, the anti-skid system functions as normal and brake pressure is available to the wheel brakes. The weight-on-wheels signal is provided as a back up to the possibility of loss of the wheel speed signal; the 3 second delay allows sufficient time for both wheels to touchdown and spin up. If the aircraft bounces and goes weight off both wheels, the timer is reset and TDP becomes active again until either condition is satisfied.

NORMAL USE

Before Flight

29. When carrying out the external inspection, check that the landing gear ground locks have been removed. Check that there are no fluid leaks from the landing gear or wheel brake units. Check the landing gear doors for condition and the door linkages for proper connection and security.

30. During the initial cockpit checks, in the front cockpit check that the landing gear selector DOWN button is in; in the rear cockpit, check that the control transfer button (red) is in and that the UP button and the DOWN button are both out. In both cockpits, check that the UP selector button has not been rotated to its emergency setting. For solo flight, check that the ANTI SKID switch in the rear cockpit is on and that the landing gear control transfer button is in.

31. During the internal checks, apply the parking brake and check that brake pressure at each main wheel is between 85 and 100 bars provided the wheelbrake accumulator pressure supply is above this figure.

32. When the chocks have been removed after engine starting, release the parking brake and allow the aircraft to roll forward gently. Check the action of the brakes. When the brakes are applied there is an initial break out force at the toe pads but no appreciable pad displacement. While taxying, check the differential action of the brakes. Before take-off select ANTI SKID on, check that the SKID caption is out and that braking is normal.

CAUTION: To avoid a possible loss of servo pressure and resulting loss of directional control do not `ride' the toe brakes. Continuous variation of applied pressure can lead to progressive loss of braking potential by reducing the available stroke of the foot motor servo piston. Regularly releasing the toe brakes completely will ensure full servo pressure is maintained.

In Flight

33. After take-off with the landing gear selected up, check that the unit position indicators show UP.

34. After lowering the landing gear, check that the unit indicators show green and that the DOWN selector is fully in. Check that the wheelbrake accumulator pressure gauge registers 195 to 210 bars and the residual pressure is below 10 bars. Before touchdown check that the feet are clear of the brake toe pads.

CAUTION: To ensure that the electrical contacts are made when the landing gear selector is operated, the UP or the DOWN button is to be pressed fully in.

Landing

35. Normal braking is unlikely to activate the anti-skid system. At high speed anti-skid operation can be felt as a fluctuating retardation rhythmically cycling typically two to three times per second. At low speed these fluctuations are more marked.

After Landing

36. After landing but before taxying select ANTI SKID off, check that the brakes accumulator pressure is approximately 200 bars and that braking is normal.

MALFUNCTIONING

Landing Gear

37. If the landing gear fails to begin to lower (even partially) when DOWN is selected, check that HYD 1 pressure is normal and check the selection in the rear cockpit, if occupied. Obtain a visual check. Below 200 knots with the flaps up make further landing gear selections, from both cockpits if possible. Allow 10 seconds between selections. If the landing gear still fails to lower, select DOWN and then operate the landing gear standby system by pressing the central knob and pulling the handle.

38. If the No 1 hydraulic system fails, the normal landing gear lowering system is inoperative; select DOWN and lower the landing gear using the standby system.

39. **Partial Extension.** If the landing gear only partially extends when DOWN is selected obtain a visual check, if possible. If HYD 1 pressure is normal and there are two green indications with a main wheel red select DOWN while applying prolonged negative g; after DOWN has been selected apply positive g. If this is unsuccessful make further selections allowing 10 seconds between each. If there is any other combination of gear indications make further selections while varying the g and the speed. If unsuccessful, consider the aircraft stores fit and decide on the best landing configuration.

40. **Undemanded Lowering.** Undemanded lowering of the landing gear is indicated by an audible rumble and the landing gear position indicator showing `down' or possibly three reds. Depending on the cause of the undemanded lowering, hydraulic fluid from No 1 system may be lost, causing the HYD 1 to be illuminated. If undemanded lowering occurs, immediately make a normal `down' selection; this reduces the possible loss of hydraulic fluid and may cause the HYD 1 caption to be extinguished. Reduce speed to 200 knots. Do not attempt to raise the landing gear.

41. **Landing Gear Doors** . Failure of a landing gear door to close completely after retraction is indicated by a red indicator and may be accompanied by an aerodynamic buzz. Keep airspeed below 200 knots and check that HYD 1 pressure is normal. Have a visual check made if possible. If the landing gear door appears to be up, reduce speed to a safe minimum (about 150 knots) select DOWN and obtain 3 greens then reselect UP maintaining straight and level flight during retraction. If a visual check is not possible or the landing gear door does not appear to be up, select DOWN and make no further attempt to raise the landing gear.

Landing Gear - Main Leg Asymmetric Lowering

42. Two identical up-lock units are fitted to the left and right landing gear assemblies; one locks the main landing gear up and the other locks the wheel door closed. Two situations could result from failure of a lock unit.

a. **Main Leg Up-lock Fails to Release.** If the main landing gear doors open but a main landing gear unit remains locked up, the landing gear position indicator shows red for the affected unit (no power supply due to open microswitch) and green for other units (one main, one nose).

b. **Wheel Door Up-lock Fails to Release.** If a wheel door up-lock fails to release, the landing gear position indicator shows UP for the affected unit and green for the other units (one main, one nose).

43. In either case, if possible, obtain a visual inspection to confirm the state of the undercarriage legs and doors and then carry out the actions detailed earlier for Partial Lowering (para 39).

CAUTION: It is unlikely that the landing gear standby lowering system would successfully unlock a jammed up-lock unit; additionally its use would result in the serviceable units being in an irretrievable down position. If an asymmetric landing gear situation occurs, consider whether the subsequent landing would be better attempted with all the landing gear units retracted rather than in an asmmetric configuration.

Landing Gear Selector Valve Malfunction

44. An electrical or a mechanical malfunction could cause the landing gear selector valve to stick in the up position. In this condition the gear normal selection would not be effective. In the case of a mechanical malfunction the subsequent use of the appropriate standby lowering system would then cause the complete loss to atmosphere of No 1 hydraulic system fluid and a No 1 HYD failure. If a normal DOWN selection of the landing gear fails the cause may be a transient fault, therefore make repeated normal selections before using the appropriate standby lowering system. If the gear remains up make a normal DOWN selection before using the standby lowering system. Delay the standby lowering system selection until use of the gear is essential, but be prepared for a subsequent HYD 1 failure.

Wheelbrakes

45. If the No 1 hydraulic system fails, the wheelbrakes are served by the brakes accumulator only. Do not test the brakes during the downwind checks. After touchdown, set the throttle lever to HP Off. When the main wheels and the nosewheel are firmly on the ground apply the brakes progressively, increasing the pressure as speed decreases. During the landing run pulling the control column fully aft (without lifting the nosewheel) increases the load on the main wheels and reduces anti-skid system activity thus minimizing the dissipation of the stored capacity of the accumulator. After the aircraft has been stopped, do not taxy.

46. When the brakes accumulator pressure drops below approximately 120 bars the brakes function with decreasing effectiveness. When the supply gauge indicates 100 bars it is unlikely that further braking will be possible.

47. **Brakes Accumulator Failure.** Loss of nitrogen pressure from the brakes accumulator results in a low or zero pressure indication on the brakes supply gauge. In this condition brake pressure is supplied by the No 1 hydraulic system only and pressure is indicated on the individual brake pressure gauges in the cockpit; this pressure is lost if the engine is shutdown. In these circumstances taxying should be limited to clearing the runway; subsequently the aircraft should be held with the brakes on and the engine running pending the arrival of assistance.

48. **Loss of Servo Pressure.** If the brake toe pad/control valve servo system fails, or the servo pressure is depleted by `riding' the brake, a fall in the resistance to foot pressure is experienced together with a loss of braking effectiveness. Release and re-apply the brake. If wheelbraking is not restored, uniform braking can be obtained by gradually applying the parking brake; no further attempt should be made to use the toe brakes, particularly if the servo failure affects one wheel only.

49. **Brake Servo Motor Failure.** If a brake servo motor piston jams in its cylinder toe brake pad movement is lost and no braking is available at the associated wheel. Differential braking is lost but uniform wheelbraking can be obtained by gradual application of the parking brake. During a landing directional control using the rudder is possible down to approximately 50 knots.

Note: A servo motor jamming in one cockpit does not affect the serviceability of the brake system in the other cockpit.

50. **Landing with Residual Brake Pressure.** If, during the **Before Landing Checks**, a residual brake pressure in excess of 10 bars is indicated in a pre-MOD 1863 (Touch Down Protection) aircraft, turn off the anti-skid and use the brakes without anti-skid protection. If residual brake pressure actually exists, ie, not a gauge error, and a tyre burst occurs on touchdown, any resulting directional change can be controlled with the brakes. A landing with residual brake pressure in excess of 10 bars and anti-skid on could cause a rapid and uncontrollable directional change at touchdown and possible departure from the runway (see Part 2, Chapter 3). If the aircraft is post-MOD 1863, land with the anti-skid system on. Whilst Touch Down Protection (TDP) was originally intended to prevent tyre burst on landing with the brakes inadvertently applied, typically whilst correcting cross-wind drift, Mod 1863 will also protect the aircraft during landings where residual brake pressure above 10 bar is evident on cockpit gauges. Therefore, the anti-skid system should be switched ON for landing where excessive residual brake pressure is indicated. If subsequent brake problems are encountered after landing the anti-skid system should be switched off.

Anti-Skid

51. Malfunctioning of the anti-skid system, including failure of the fuse in the control unit DC supply line, is normally indicated by the SKID illuminating; select the anti-skid system off, the caption remains illuminated and braking without anti-skid protection is then available.

52. With either one or both anti-skid control switches off, wheelbrake pressure is controlled directly by depression of the brake toe pads. The pressure at the brakes is proportional to the amount of toe pad depression and is maintained for as long as the toe pads are held depressed.

53. If a loss of braking, without warning indication, is experienced whilst taxying or during the landing run, select anti-skid off.

Note: Before selecting the anti-skid system off during a landing run, brake pressure must be released to avoid a tyre burst.

54. **Anti-Skid Control Valve Failure.** A mechanical failure of an anti-skid control valve can cause complete loss of braking to the appropriate main wheel irrespective of the setting of the anti-skid switch. If a single brake failure is suspected during a landing run but the gauge indications appear normal, assume anti-skid control valve failure. Toe brake pad movement appears normal and the failure is unlikely to be indicated on the corresponding brake pressure gauge. Application of the parking brake does not achieve pressure at the wheel with the faulty valve. Once rudder effectiveness is lost, loss of directional control is likely. The decision whether or not to continue with the landing run depends on how early the failure has been detected and the anticipation of a successful roll out run or barrier engagement.

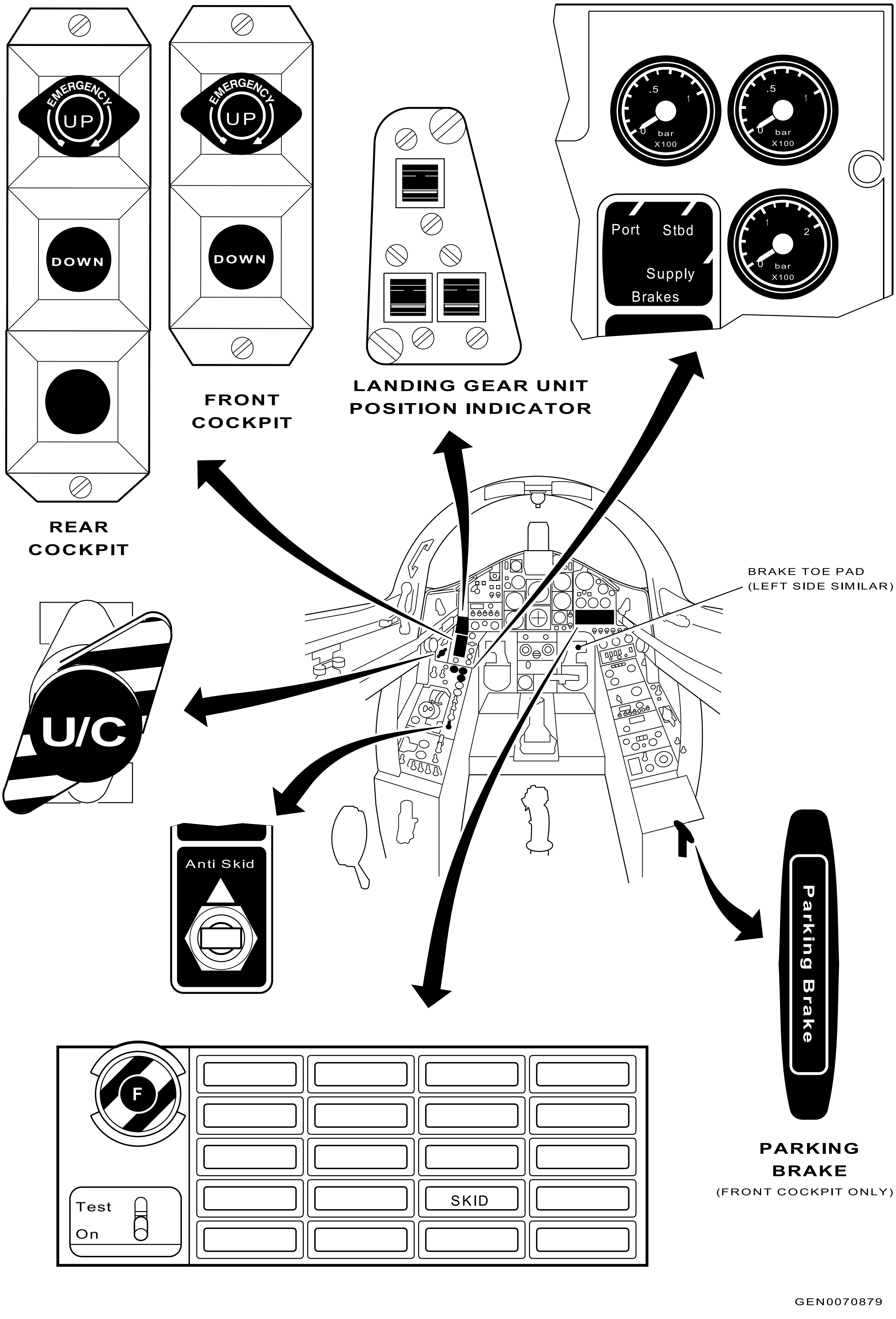
Tyre Overheat

55. It is possible for tyre temperature to exceed 155°C (when fusible plug deflation occurs) if brake cooling limitations (refer to the Hawk TMk1 & TMk1A MOD AFD Release to Service) are not observed or taxying is prolonged. Experience shows that, in summer temperatures, even a normal landing on a long runway followed by taxying can blow the fusible plugs once the parking brake has been applied. More seriously, excessive taxy distances coupled with too much braking and a high outside air temperature may result in a

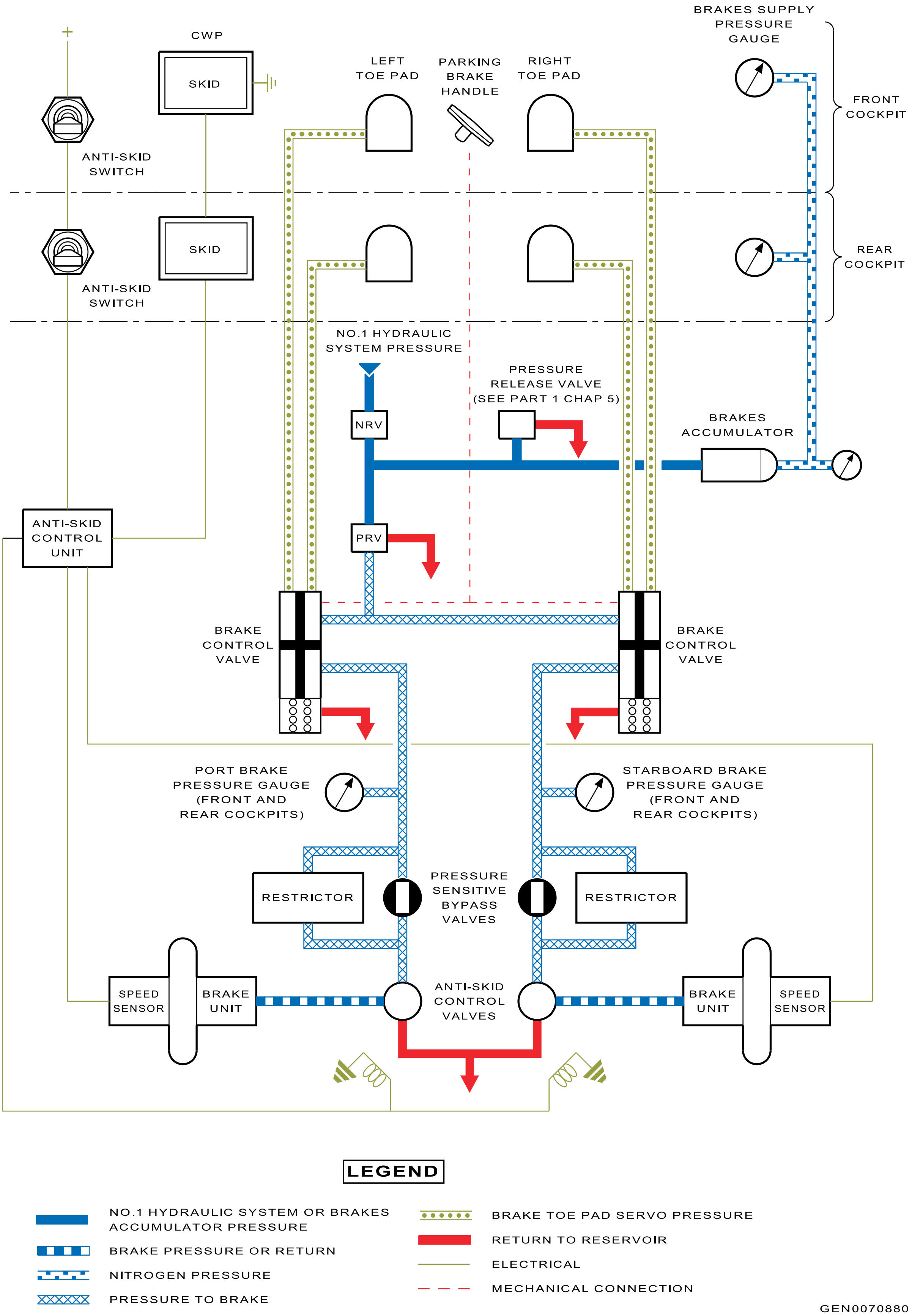
fusible plug deflating the tyre whilst airborne. If, at take-off, there is a possibility that tyres may be overheating, consider a delay in landing gear retraction after take-off in order to cool brakes and tyres.

Tyre Burst

56. If a tyre bursts on landing or during the landing roll, or has deflated due to the action of the fusible plugs, the erratic rotation of the affected wheel may activate the anti-skid system and may cause brake pressure to be applied or removed from both wheels unpredictably. Loss of directional control is likely. Cease braking immediately and select anti-skid off. Directional control may then be retained or regained using rudder and differential braking but may subsequently be lost when the rudder becomes ineffective below 50 knots. Bear this in mind if contemplating a barrier engagement. Take care to avoid bursting the other tyre during subsequent braking without anti-skid protection.



1 - 7 Fig 1 Controls and Indicators



1 - 7 Fig 2 Wheelbrakes and Anti-Skid Schematic

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PART 1

CHAPTER 8 - AIR CONDITIONING, PRESSURIZATION AND ANTI-G

Contents

AIR CONDITIONING AND PRESSURIZATION

General

1. The front and rear cockpits are contained in an air conditioned pressure cabin. Air, tapped from the final stage of the engine HP compressor, is ducted to a cabin pressurization and air conditioning (ventilation and temperature) system. Compressor air flows through the duct to the cabin via a Pressure Regulating and Shut-Off (PRSO) valve and a cold air unit/heat exchanger unit. Tappings from the duct supply air for inflation of a cabin canopy seal and for anti-g suits. When air conditioning is switched off in flight, the cabin is ventilated by ram air.

Controls and Indicators

2. The controls and indicators associated with air conditioning and pressurization are listed in Table 1 and shown in Fig 1.

Pressure Regulating and Shut-Off Valve

3. The PRSO valve combines the functions of a pressure regulator and an on/off valve. A valve operating solenoid is energized to close the valve when the cabin conditioning control switch is at OFF. At all other settings of the switch the solenoid is de-energized and the valve is open and operates to keep the pressure of the ducted engine HP compressor air within a set range.

Table 1 - Air Conditioning and Pressurization Controls and Indicators

Control/Indicator	*Marking*	*Location*	*Function*
Cabin conditioning control switch	OFF/NORMAL/ DEMIST/FLOOD (Guarded at ON) A catch to the right of the switch must be pushed outboard before the switch can be set to OFF from NORMAL	Right console, front cockpit	- OFF - closes PRSO valve; ram air valve open - NORMAL - selects air conditioning on. Ram air valve and an inducer valve controlled automatically via landing gear microswitches - DEMIST - increases flow of conditioned air to canopy sprays; decreases flow to ventilation sprays - FLOOD - boosts conditioned air mass flow and increases its temperature
Rotary temperature control switch	CABIN AIR TEMP - MANUAL FIXED/AUTO sectors - AUTO sector extremities WARM/COOL	Right console, front cockpit	- MANUAL FIXED - for setting temperature control valve manually - AUTO - permits automatic operation of temperature control valve
Cabin altimeter	ALT	Right panel, both cockpits	Indicates cabin pressure in terms of altitude
Cabin altitude caption	CPR	CWP, both cockpits	Indicates cabin altitude exceeds 30,000ft

Air Conditioning System

4. The air conditioning system receives and cools a proportion of the air tapped from the engine HP compressor; the remainder bypasses the system. The air flowing to the air conditioning system is directed into a primary heat exchanger where it is cooled; it then passes through the compressor of a cold air unit which delivers it to a secondary heat exchanger. The cooled air then flows to drive the turbine of the cold air unit and in the process its temperature is further lowered. The temperature of the air is then modified by the addition of engine HP compressor air which has bypassed the cold air unit and heat exchangers. The conditioned air finally passes via a water extractor, to the cabin.

5. An aspirator draws water from the water extractor drain pipe and injects it into the air inlet of the secondary heat exchanger so increasing the efficiency of that unit. The aspirator consists of a venturi blown by air tapped from the charge air inlet of the cold air unit; a drilling close to the venturi throat is connected to the water extractor drain pipe.

6. In flight, ram air is used in the heat exchangers to cool the air from the engine HP compressor. When the volume of ram air passing through the intakes is low, ie, during ground running or in flight at low speeds with the landing gear down, air is drawn into the ram air intakes and through the heat exchangers under the influence of cooling air inducers in the exhaust duct of each heat exchanger. Engine HP compressor air is injected into the exhaust duct where the inducer creates a venturi effect which causes a greater volume of cooling air to be drawn through the heat exchanger. A solenoid-operated shut-off valve controls the injection of air into the inducers. The valve is energized closed when the cabin conditioning control switch is at OFF; at other settings of the switch the valve is automatically controlled through the operation of the uplock microswitch on the right mainwheel leg. When the landing gear is lowered the microswitch opens, the shut-off valve solenoid is de-energized and the valve opens. The solenoid is energized and closes the valve when the landing gear is locked up.

Water Extractor

7. The unit extracts free water from the conditioned air and injects it into the ram air intake of the secondary heat exchanger.

Cabin Ventilation

8. **Conditioned Air.** Conditioned air passes into the cabin and is distributed by ventilation sprays and canopy sprays. Ventilation pipes on each side of both cockpits distribute the air through fixed foot and head spray grilles and rotatable body spray louvres. A vent/demist changeover valve, controlled by the cabin conditioning control switch, regulates the proportion of conditioned air supplied to the ventilation and the canopy sprays. When the switch is at NORMAL, about 60% of the conditioned air is directed to the ventilation sprays and the remainder goes to the canopy sprays; when DEMIST or FLOOD is selected the proportions are reversed. Selection of FLOOD also increases the mass flow by about 50%, and raises its temperature by adding HP compressor air to the conditioned air supply.

9. **Ram Air.** If the cabin conditioning system is switched off in flight, cabin ventilation is by ram air from a duct in the nose of the aircraft. An inlet and an outlet valve are controlled by a solenoid-operated ram air control valve which is in series with compression microswitches on the main landing gear oleos. On the ground the solenoid is energized and closes the control valve; the inlet and outlet valves then open to ventilate the cabin. In flight, when the compression switches open, the control valve opens and engine HP compressor air closes the inlet and outlet valves; pressurization of the cabin then takes place.

Temperature Control

10. **General.** A temperature control valve regulates cabin temperature by scheduling the mixing of compressor air which has bypassed the air conditioning unit with the cold air delivered from the air conditioning unit. The control valve is operated either automatically or manually according to the setting of the temperature control switch. In the automatic mode, the switch setting together with inputs from sensors measuring fuselage skin temperature, cabin temperature and conditioned air delivery temperature, are fed into a control circuit to operate either a cool demand relay or a warm demand relay. The contacts of the operated relay close and the valve is motored in the appropriate direction.

11. **Temperature Control Switch.** The temperature control switch can be set to any position within the AUTO sector, the extremities of which are marked COOL and WARM, to set a variable resistor. The temperature control valve is then adjusted automatically to maintain the selected cabin temperature. Click-stops at the COOL and WARM positions offer slight resistance to rotation of the switch into the MANUAL FIXED sector where the switch is spring-loaded to the 12 o'clock position. In the MANUAL FIXED sector, rotating the switch against its spring-loading towards either COOL or WARM progressively closes or opens the valve. When the switch is released it returns to the 12 o'clock position under the influence of its spring; the valve remains in its new position. Under manual operation, the valve takes between seven and 15 seconds to motor from fully closed to fully open.

Canopy Seal

12. The internal and external controls of the canopy (Chapter 12) are mechanically connected to a canopy seal control valve. With the canopy closed and locked the control valve is open and, with the engine running, HP compressor air flows to inflate a canopy seal via a pressure reducing valve. The canopy seal ensures that conditioned air which is used to pressurize the cabin does not leak to atmosphere. When the canopy is unlocked, the control valve closes and the canopy seal deflates to atmosphere. A canopy seal ground test connection is behind an access door on the underside of the fuselage between the engine air intakes.

Pressurization

13. **General.** With the cabin sealed, the cabin is pressurized by controlling the rate of discharge of conditioned air. A pressure controller receives inputs of cabin pressure and ambient pressure (from the pitot-static system) and controls the discharge of conditioned air to maintain a cabin differential pressure at a value which is related to aircraft altitude. A warning of excessive cabin altitude is given by CPR on the CWP.

14. **Pressure Control.** The pressure controller, on the front pressure bulkhead, automatically regulates cabin pressure by opening and closing two discharge valves, one integral with the controller and one on the rear seat frame. The forward valve discharges conditioned air into the forward equipment bay; the aft valve discharges air into the fuselage aft of the cabin. Pressurization commences at about 5000 feet. As altitude is increased the controller regulates the discharge of air until a differential pressure of 0·276 bar is reached at about 40,000 feet, above which the differential pressure is maintained constant.

Cabin Pressure Altimeter

15. The cabin pressure altimeter indicates cabin pressure in terms of altitude. Corresponding normal values of aircraft and cabin altitude (when pressurized) are shown in Table 2.

Table 2 - Altimeter Readings - Aircraft and Cabin Altitudes

Aircraft Altitude (Ft)	*Cabin Altitude (Ft)*
10,000	7800
20,000	12,700
30,000	16,800
40,000	20.100

Cabin Altitude Warning

16. A pressure switch is in the rear cockpit, aft of the right console. If cabin altitude reaches 30,000 feet, the switch closes; the CPR on the CWP and the attention lights come on and the audio warning is activated.

Pressurization Safety Valve

17. A safety valve, on the cabin centre bulkhead, protects the pressure cabin against overpressurization. The valve also operates to admit ambient air to the cabin to relieve negative differential pressure during a rapid descent.

Forward Equipment Bay Cooling

18. The conditioned air discharged into the forward equipment bay (para 14) provides the cooling required for the satisfactory operation of the avionic equipment.

ANTI-G SYSTEM

General

19. The anti-g system provides a controlled supply of air to the inflatable anti-g suit of each occupant. Air, tapped from the cabin conditioning HP supply, is delivered to the associated suit via an anti-g valve unit in each cockpit and the PEC on the appropriate ejection seat.

20. The anti-g valve unit, on the lower left side of the cockpit aft of the console, comprises a shut-off valve and control lever, a g-sensitive control valve and a relief valve, all integral in the unit. A test button is on top of the unit.

a. The shut-off valve controls the air from the cabin conditioning system and is operated by the 2-position control lever on the unit. When the lever is forward the valve is open. When the lever is set aft, the system is `off' and, in the case of failure of the g-sensitive valve, the anti-g suit deflates.

b. The g-sensitive control valve responds to the application of positive g. When g in excess of approximately 2 g is applied, the valve allows air to flow into the anti-g suit; when applied g is reduced, air from the suit is progressively vented through the valve and into the cockpit. The valve also regulates the air pressure in the suit to a value proportional to the applied g.

c. The relief valve limits the maximum pressure in the suit to avoid over-inflation.

21. **Test Button.** The test button is a rubber diaphragm on top of the anti-g valve unit. Pressing the button operates the g-sensitive valve against spring pressure (simulating the application of g) and, with the engine running and the system selected on, allows air to inflate the anti-g suit; the amount of suit inflation depends on the amount of movement of the button. When the button is released the suit deflates.

NORMAL USE

Before Flight

22. Before starting the engine check that the canopy is locked and that the cabin conditioning control switch is at NORMAL. To minimize the possibility of ice forming in the cabin conditioning system as engine RPM are increased for take-off, set the CABIN AIR TEMP switch to not colder than approximately the 6 o'clock position in the AUTO sector. Turn on the anti-g system (lever forward). After starting the engine, gently press the anti-g test button and check that the suit inflates; check that the suit deflates when the button is released. The checks of the anti-g system are to be made independently in each cockpit. On the ground at idle RPM the cabin conditioning system is not very effective; when stationary, increasing to between 60 and 70% RPM provides effective cabin conditioning.

Note: Press the anti-g test button a small amount gently, otherwise overinflation of the suit occurs with severe discomfort to the wearer.

In Flight

23. After take-off adjust the CABIN AIR TEMP switch as required for comfort. Especially in hot and humid conditions, too low a temperature selection can cause ice to form in the spray pipes and discharge into the cabin; at the same time cabin conditioning efficiency is reduced. If ice is seen to form, it is easily removed by increasing the temperature slightly. Before descending from medium and high altitudes, set the cabin conditioning control switch to DEMIST. If severe misting of the transparencies occurs in flight set the switch to FLOOD until the transparencies have cleared. Setting the cabin conditioning control switch to FLOOD, when the temperature control is set to fully WARM in the MANUAL FIXED sector, can result in damage to the water extractor and also to the canopy sprays and the ventilation sprays.

Note: The use of FLOOD at high engine RPM may produce high cabin temperatures which are tolerable for only a short period.

24. At low altitude, and depending on ambient atmospheric conditions and engine RPM, the selection of low temperature can cause ice to form downstream of the cold air unit, particularly in the water extractor. The onset of this condition in flight is difficult to predict and leads to very sudden fogging in the cabin and/or the discharge of ice crystals and water over the pilots, instruments and equipment in the cabin. This condition is unlikely to occur, in any combination of atmospheric conditions and engine RPM, if the cabin temperature selector is set to no cooler than the six o'clock position in automatic mode. Note that the cabin inlet temperature is very sensitive to cabin temperature selector positions between six o'clock and five o'clock. Hence, even small deflections cooler than the six o'clock position can lead to sudden fogging during a descent and/or when engine RPM are reduced.

25. The anti-g system should remain selected on throughout flight and be selected off after landing.

WARNING: Reduced performance of the anti-g system is to be expected under flight idle conditions; slower inflation of anti-g trousers at idle power settings (eg - VRIAB) may initially reduce the g-protection to each occupant. Proactive anti-g strain is necessary under these conditions to minimise G-LOC.

MALFUNCTIONING

Pressurization Failure

26. If the cabin is under-pressurized above an aircraft altitude of 8000 feet the failure can only be detected by comparing aircraft and cabin altimeter readings (see para 15 and Table 2). If a discrepancy is observed, check the setting of the cabin conditioning switch.

27. If the cabin altitude exceeds 30,000 feet the CPR comes on, and the attention lights and audio warning are activated; check the validity of the warnings against the cabin altimeter. Set the mask toggle down and descend below 25,000 feet cabin altitude. During the descent set the cabin conditioning switch to FLOOD.

28. In all cases of cabin pressurization failure, return to base at the lowest altitude that the fuel state permits.

Canopy Seal Failure

29. A failure of the canopy seal control valve or a punctured seal, may be indicated by an abnormally high in-flight noise level. Full pressurization may not be possible.

Toxic Fumes

30. If fumes contaminate the cabin select 100% oxygen, set the mask toggle down, turn off the defective equipment and make a rapid descent to below 25,000 feet cabin altitude. During the descent set the cabin conditioning control switch to OFF when below FL 350; the cabin is then ventilated by ram air. As a last resort, if the above drill fails to clear the cabin of fumes or smoke, reduce speed to a minimum, lower visors and operate the MDC facility with eyes tightly closed. Land as soon as possible. Do not engage the barrier if the MDC has been operated.

Temperature Control Failure

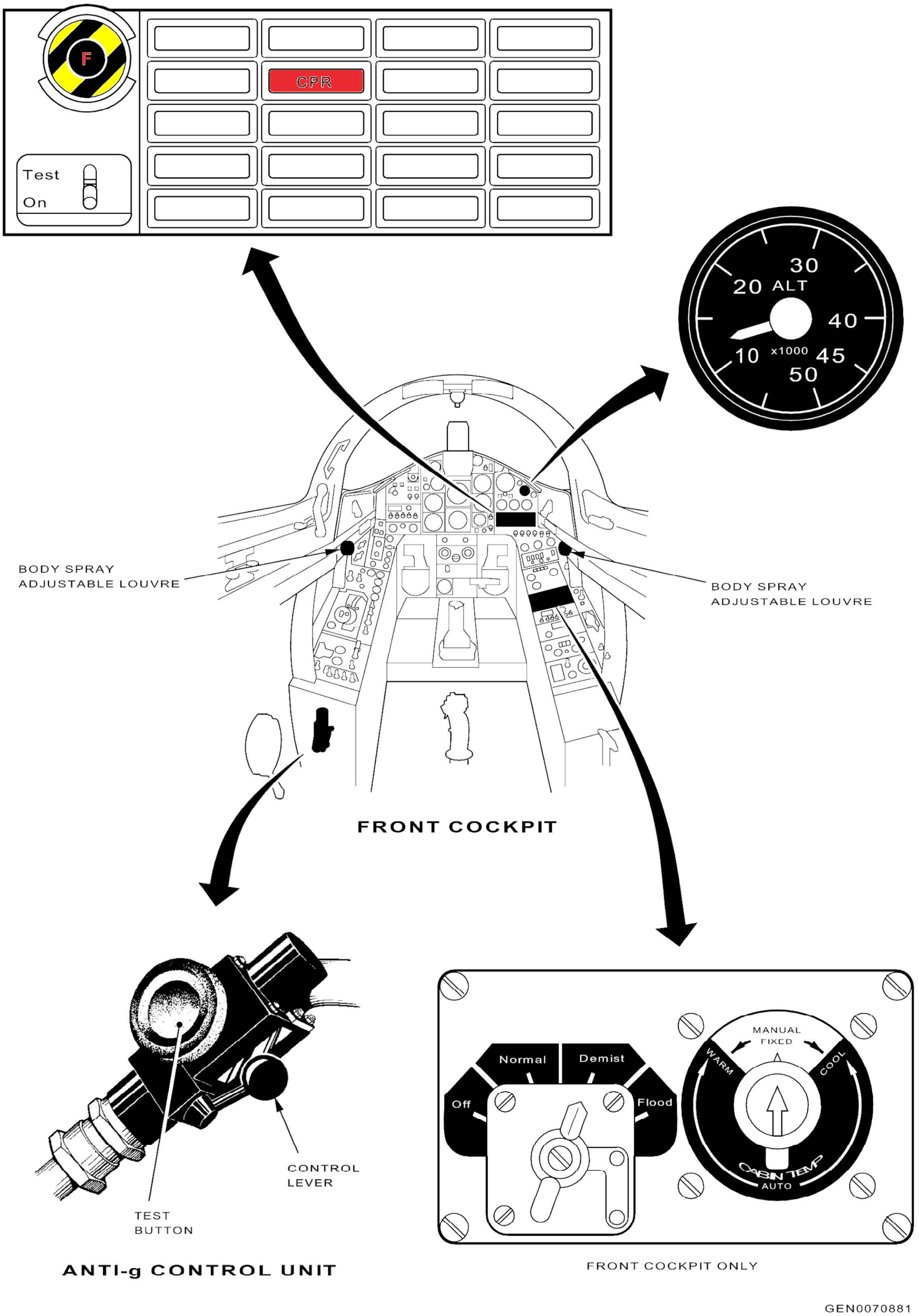
31. **Automatic Control Failure.** If overheating or overcooling occurs, set the CABIN AIR TEMP switch to MANUAL FIXED and make COOL or WARM selections. If the temperature responds, leave the switch in the MANUAL FIXED sector, making manual adjustments as required.

WARNING: Manual full hot temperature selections at above approximately 80% RPM can cause fumes in the cabin and damage the system. To reduce this risk, inch the temperature control valve open by making short (one second) selections, allowing for the delay which occurs between a selection and a temperature change in the cabin.

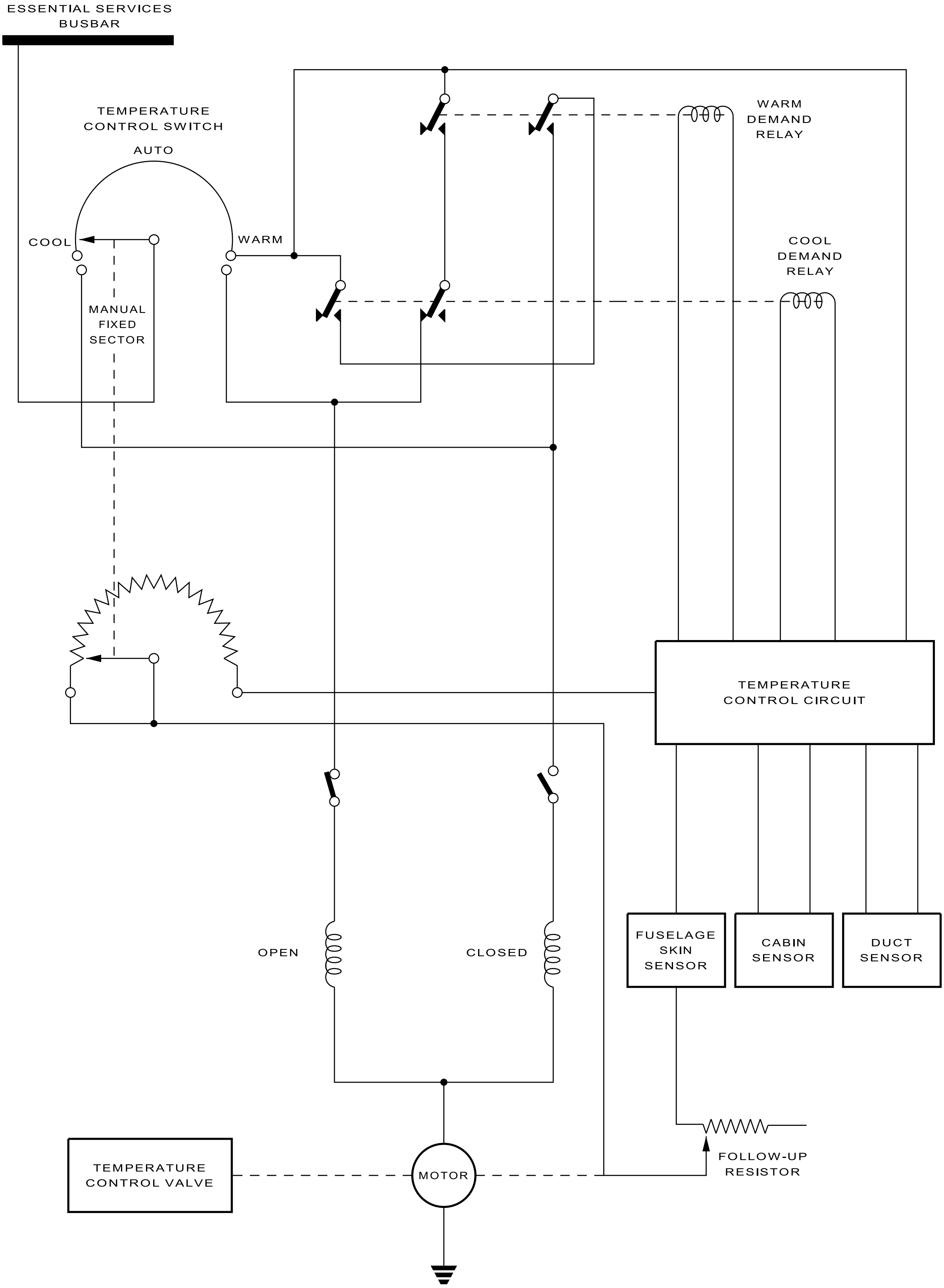
32. **Manual Control Failure.** If, with MANUAL FIXED selected, overheating or overcooling persists, descend below FL 250 and set the cabin conditioning switch to OFF. Subsequently the canopy can be demisted by setting the cabin conditioning switch to NORMAL as required. Return to base at the lowest altitude that the fuel state permits. An overcooling failure condition can be relieved by setting the cabin conditioning switch to FLOOD.

Anti-g System Failure

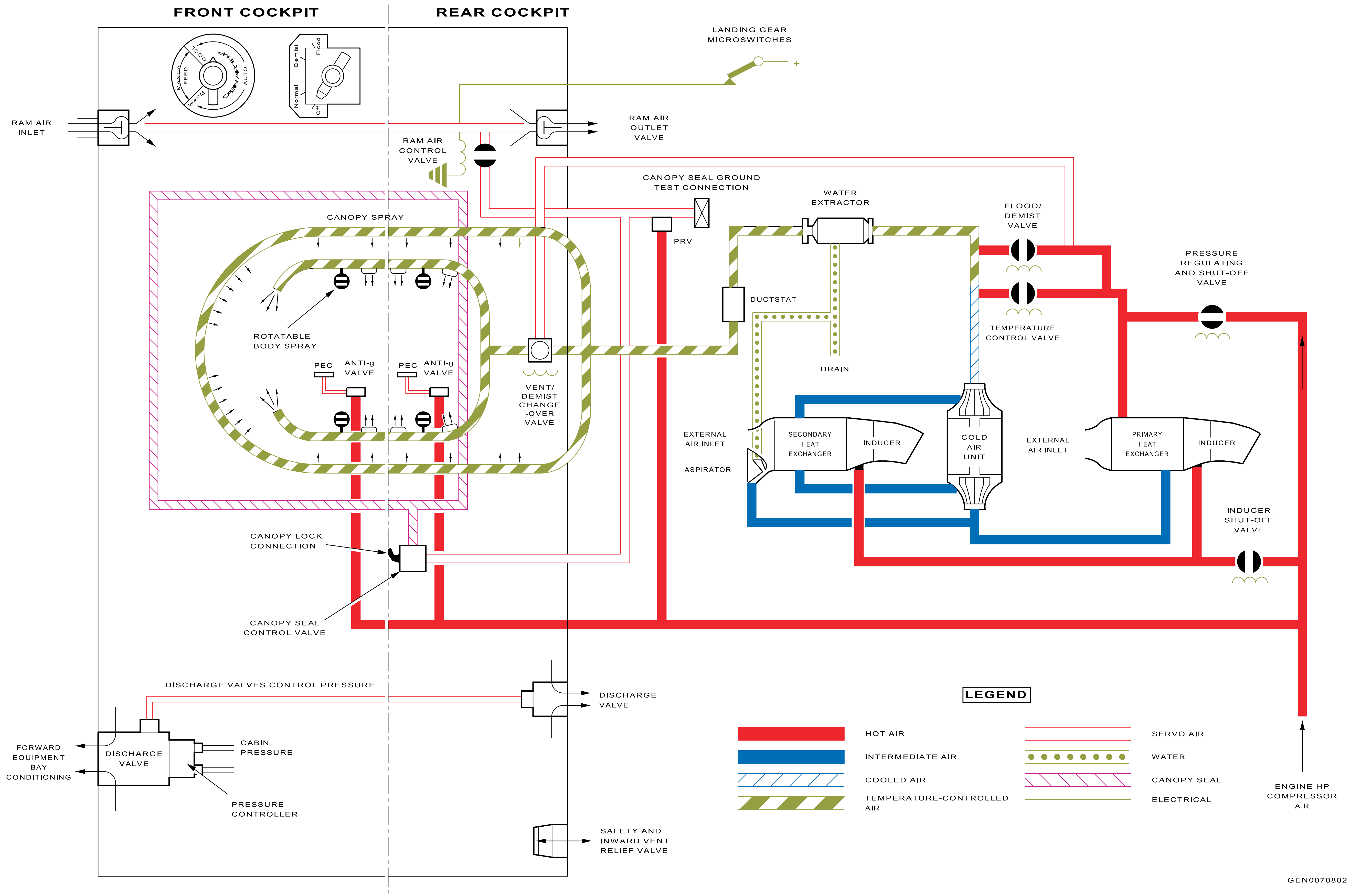
33. If the anti-g suit overinflates, or fails to deflate, set the anti-g control lever off.



1 - 8 Fig 1 Controls and Indicators



1 - 8 Fig 2 Temperature Control - Simplified Schematic



1 - 8 Fig 3 Pressurization and Air Conditioning Systems

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PART 1

CHAPTER 9 - EJECTION SEATS

Contents

DESCRIPTION

General

1. Each cockpit has a fully-automatic rocket-assisted Type 10B ejection seat which provides escape facilities at all altitudes and speeds within the flight envelope of the aircraft, and down to zero height/zero speed in level attitude conditions for aircrew boarding weights up to 120.0kg.

2. The front seat is a Type 10B1 Mk 1 and the rear seat is a Type 10B2 Mk 1. The seats are similar in operation but have individual features which cater for a command ejection system. In this chapter, reference to one seat applies to both unless otherwise stated.

3. Both front and rear canopies are fitted with a miniature detonating cord (MDC). Each seat has a striker which, as the seat starts to rise at the beginning of the ejection sequence, fires twin detonators to activate the MDC above the associated cockpit. The MDC in both cockpits can also be fired manually by a handle on the inside of the canopy rail in each cockpit or by external MDC handles. Tests show that if the MDC fails, the seat penetrates the canopy without detriment to seat performance.

4. A combined seat harness and parachute harness is fitted; the parachute and drogues are packed in a container at the top of the seat. After ejection, separation of the harness (and occupant) from the seat, and deployment of the parachute, and personal survival pack (PSP), occur automatically. A manual separation facility is provided for use if any of the automatic functions fail to operate, or if it is decided to achieve man/seat separation prematurely.

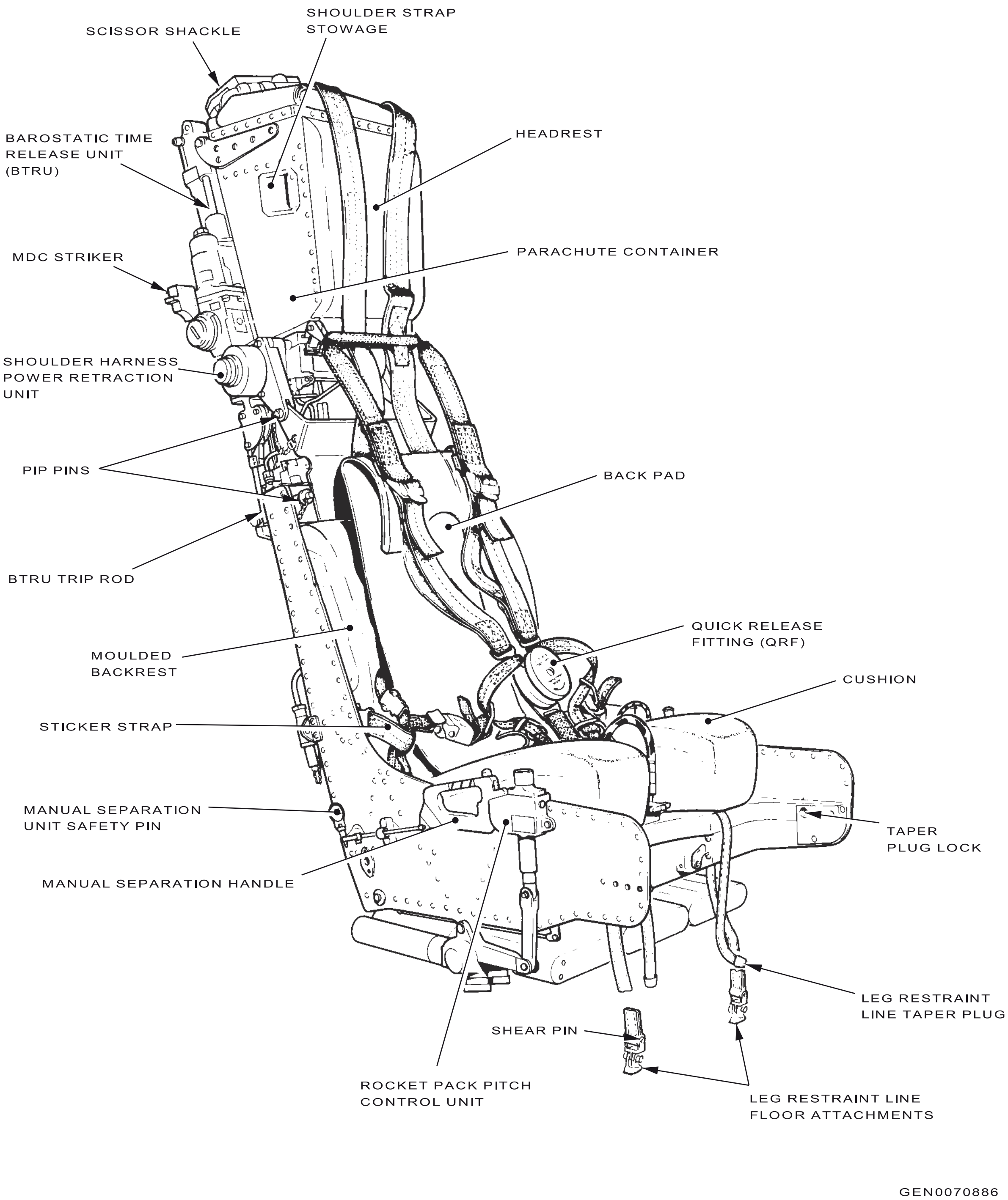
5. The seats can be fired individually or can be fired in an automatic sequence, the rear seat followed by the front seat, initiated by the firing of the rear seat (command ejection).

6. Each seat has three main parts:

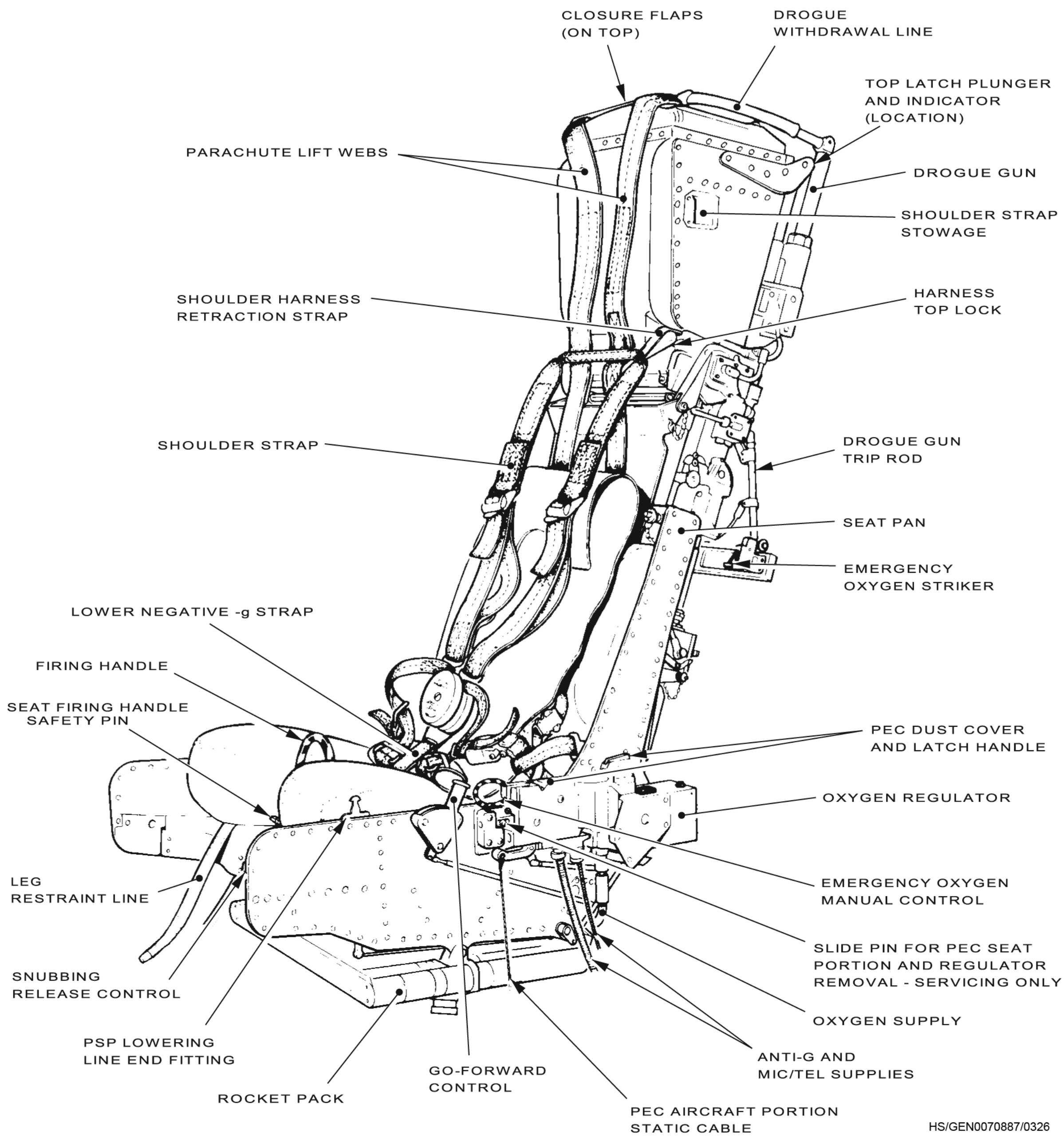
a. **Ejection Gun.** The ejection gun initiates ejection of the seat and is fixed to the aircraft structure so that it remains in the cockpit after ejection of the seat.

b. **Main Beams.** Two upright main beams ride on guide rails attached to the ejection gun. The beams carry the parachute container and the majority of the seat operating devices.

c. **Seat Pan.** The adjustable one-piece seat pan rides on tubes on the main beams and comprises an upright backrest and a `well' containing the PSP. A rocket pack is on the underside of the seat pan.



1 - 9 Fig 1 Ejection Seat - Right Side

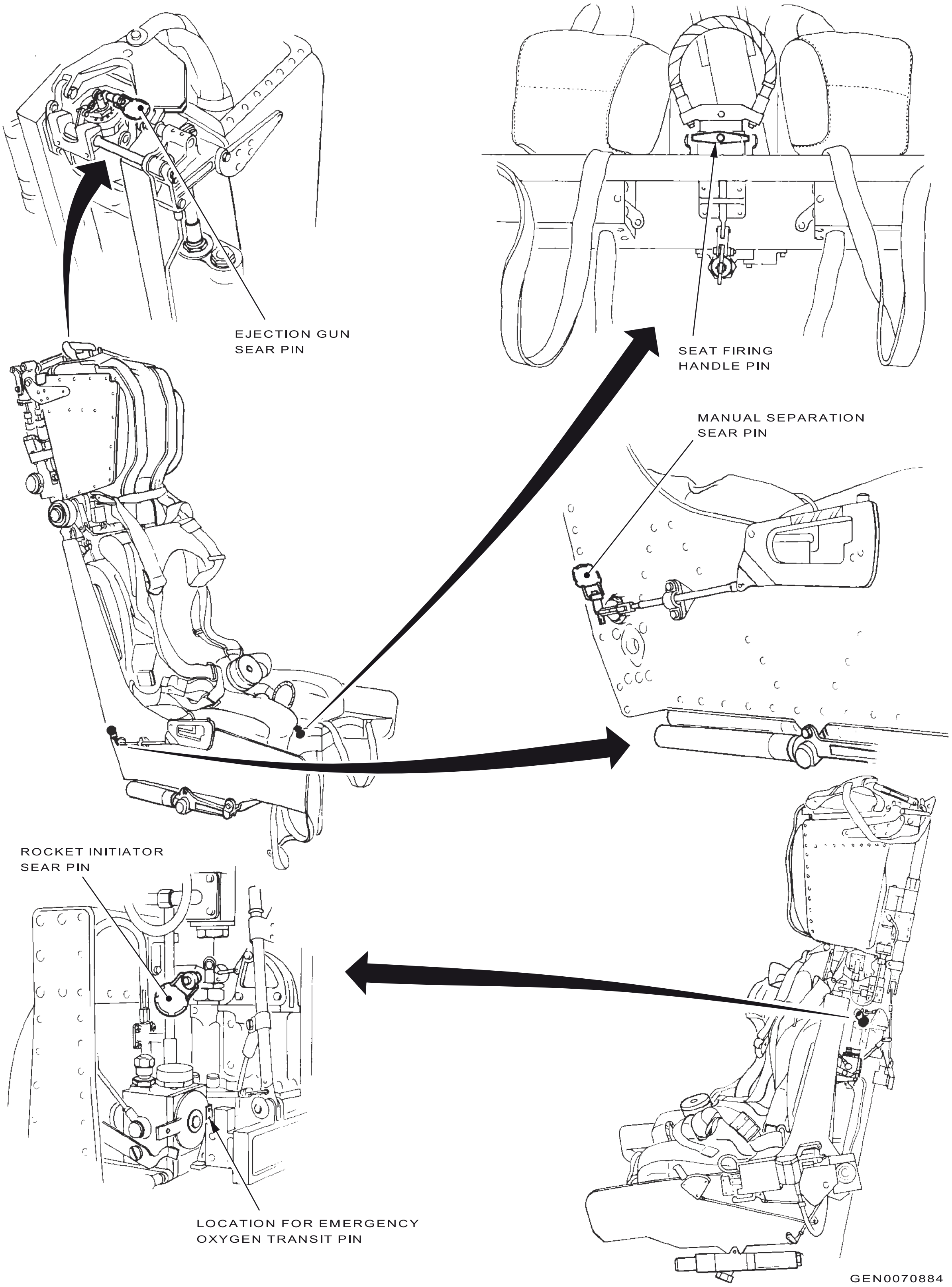


1 - 9 Fig 2 Ejection Seat - Left Side

Safety Pins

7. Each seat has four safety pins, and the MDC has two safety pins in each cockpit. Table 1 lists the safety pins and their markings; the location of the seat pins is shown at Fig 3.

8. A 2-place stowage for the seat firing handle safety pin and the MDC firing handle safety pin is fitted on the left glareshield in each cockpit. An 8-place central stowage for the other pins from each cockpit is at the rear of the front cockpit on the upper left side. Stowages for the safety pins are shown at Fig 32.



1 - 9 Fig 3 Ejection Seat Safety Pins

WARNING 1: When the seat firing handle safety pins, the MDC firing handle safety pins and the MDC firing unit safety pins are correctly fitted to their respective units in each cockpit the aircraft is Safe for Parking.

WARNING 2: When all the pins listed in Table 1 are fitted to their respective units in each cockpit the aircraft is Safe for Maintenance.

Table 1 - Ejection Seat and Safety Pins

Unit	*Pin Marking*
Ejection gun sear	MAIN GUN SEAR
Seat firing handle	SEAT FIRING
Rocket pack initiator sear	ROCKET INITIATOR SEAR
Manual separation firing unit sear	MANUAL SEPARATION SEAR
MDC firing handle	CANOPY MDC
MDC firing unit	MDC

Safety Apron

9. A safety apron is provided to secure the PSP, the harness and the appendages of the rear seat when the aircraft is flown solo. A stowage for the apron is in the rear cockpit, on the left side of the aft bulkhead.

Seat Pan Height Adjustment

10. The height of the seat pan is adjusted by an electric actuator controlled by a SEAT - LOWER/RAISE (forward to lower, aft to raise) switch on the right console. Limit switches cut off the electrical supply (Essential Services busbar) when the seat pan reaches the end of its 15 cm (6 inch) travel. To avoid overheating the actuator, the facility should not be used continuously for more than 1 minute in any 8 minute period.

Personal Survival Pack

11. The PSP is a fibreglass case topped by a cushion which together serve the dual purpose of seat cushion and container for a liferaft and survival equipment. The pack extends forward in the shape of two horns which give rigid support to the thighs on ejection. The pack is attached to the combined harness by a retaining strap which passes over the PSP and the seat cushion. The outer end of the strap terminates in arrowhead connectors which locate in quick-release connectors on the parachute harness. Manual operation of either connector releases the pack. Post-Mod SE141, an Automatic Deployment Unit (ADU) is fitted to the inner right side of the PSP shell and a warning label, ADU FITTED, is on the front of the shell. The ADU has MANUAL or AUTO settings which can be viewed through a slot under the seat cushion. With AUTO selected, man/seat separation initiates the ADU firing unit and, after a 4-second delay, the PSP is automatically released. With MANUAL selected, either quick-release must be operated to lower the PSP.

12. The 4·4 m (14·5 feet) lowering line connects the PSP to the occupant. The line emerges from the front left side of the pack and terminates at an end fitting retained by a sticker clip on the left inner side of the seat pan. During strapping-in, a quick-release connector on an attachment strap at the left side of the LSJ is secured to the end fitting. On man/seat separation after ejection, the force required to separate the PSP connector from the sticker clip pulls the PSP lanyard taught and activates the PLB in the LSJ.

Note: The lowering line is not to be disconnected unless the PSP is to be jettisoned.

Combined Harness

13. The combined harness secures the occupant to the parachute (by lift webs which are integral with the harness) and to the seat (by harness locks on the seat). Two sticker straps (stickers) from the rear of the harness are retained by spring clips on the seat pan. The combined harness is secured on the occupant by a Quick-Release Fitting (QRF) mounted on a negative-g strap which in turn is locked to the seat pan.

14. **Harness Quick-Release Fitting.** The QRF has a rotatable face marked TURN TO UNLOCK and PRESS TO RELEASE, and has two upper slots which accept and lock the shoulder strap lugs during strapping-in. The locks are secure when a yellow notch on the edge of the face is uppermost. When the face of the QRF is rotated clockwise through 90°, the locks are prepared for release and a red line, on the edge of the face, is uppermost. When firm pressure is then applied to the face of the fitting the QRF is unlocked, allowing the shoulder straps to pull free.

15. **Harness Fastening.** Two yellow lines, one broken and one solid, on the edge of the QRF are used during strapping-in. To engage the shoulder strap lugs, the QRF should be checked at the 'locked' setting and the face then rotated and held a few degrees anti-clockwise until the yellow notch on the edge of the face passes the broken line; the first shoulder strap lug can then be inserted and locked into place. The face of the QRF returns to its central spring-biased locked position when released, and the yellow notch should be aligned with the solid line. The process should be repeated for the second shoulder strap lug.

WARNING: Since the QRF secures the occupant to the seat and to the parachute, it is only to be pressed when separation from the parachute is intended.

Negative-g Restraint

16. Negative-g restraint is provided by a lower negative-g strap secured to the front of the seat pan at a harness lock; the upper end of the strap is permanently attached to the QRF. Restraint is enhanced by a `V' strap arrangement connected between the negative-g lug at the bottom and the harness leg loops at the top.

WARNING: It is possible, when strapping in, to route the negative-g restraint to the side and in front of the seat firing handle. If this occurs, the restraint can dislodge the seat firing handle from its housing when the seat firing pin is removed or the seat occupant moves. Occupants should make a positive check of the negative-g restraint routing before removal of the seat firing pin.

Leg Restraints

17. An automatic leg-restraint system operates to ensure that the occupant's legs are held against the seat pan during ejection. Two leg-restraint lines are attached to the cockpit floor by pip pins which are in turn attached to shear pins. From its shear pin each line is routed up through a one-way snubbing unit at the front of the seat pan, then through two rings on an associated leg garter worn by the occupant before being secured by a taper plug in a lock on the side of the pan.

18. The snubbing units allow the lines to be pulled downwards as the seat rises during ejection, until the legs are tightly restrained and the shear pins break; the snubbers then maintain their grip on the lines (which thus maintain restraint of the legs) until man/seat separation occurs. Two snubber release controls in the frontal recess of the seat allow the lines to be lengthened (ie, pulled upwards through the snubbers) during strapping-in; pressing backwards on a control frees the associated line.

19. The taper plug locks are released and the legs are freed from restraint when the man portion of the Personal Equipment Connector (PEC, para 48) is released either manually (after flight) or automatically (after ejection).

Shoulder Harness Power Retraction Unit

20. The seat shoulder harness is connected by roller fittings to two looped retraction straps above the seat pan. The retraction straps are attached at one end to individual harness locks and at the other to a cartridge-operated power retraction unit. The retraction unit has two spring-loaded spools around which the straps are wound, and a ratchet mechanism which can lock the spools to prevent extension of the straps.

21. The ratchet is normally controlled by a 2-position go-forward control lever on the left side of the seat pan; the lever has to be lifted before its position can be changed. When the lever is forward (unlocked), the occupant can lean forward against spring pressure to a maximum of 30 cm (12 inches). When the lever is aft (locked) the spools take up slack in the retraction straps and prevent forward movement.

22. If, with the lever forward, the retraction straps are extended at an excessive rate (eg, during a rapid deceleration of the aircraft), the ratchet automatically engages to prevent any further forward movement of the occupant; when the load on the straps falls below a critical value forward movement is again possible.

WARNING: If there is insufficient deceleration to engage the ratchet and the go-forward lever is forward, the seat occupant may be thrown forward and/or downward resulting in his head striking the coaming, the ISIS sight head or the top of the control column. This situation may be met during a heavy landing, turbulence at low level or a barrier engagement. Therefore, the go-forward lever is always to be selected aft (locked) for take-off, flight in severe turbulence and landing.

23. When ejection is initiated a retraction unit cartridge fires; the resultant gas pressure powers the retraction unit which winds in the retraction straps, pulling the occupant's shoulders back into the seat.

Harness Lock Release

24. The lock release system frees all of the man/seat connections automatically after ejection or when the manual separation handle (para 43) is pulled. The locks are in two groups:

a. **Top Locks.** The two top locks secure the retraction straps and thus the shoulder harness.

b. **Bottom Locks.** The bottom locks secure the harness lap straps (two), the negative-g strap (one), and the man portion of the PEC (one) which is interconnected with the leg-restraint taper plugs (two).

Seat Firing Handle

25. The seat firing handle is a black and yellow flexible loop at the front of the seat pan; the firing handle has a seat firing handle safety pin which is to be removed after strapping-in and closing the canopy fully. When the handle is pulled sharply upwards (20 to 70 lb pull force) it moves approximately 4 cm (1·5 inches) to fire a cartridge before being restrained. Gases from the cartridge operate the harness power retraction unit and fire the seat ejection gun. On the rear seat the gases also fire a command ejection cartridge.

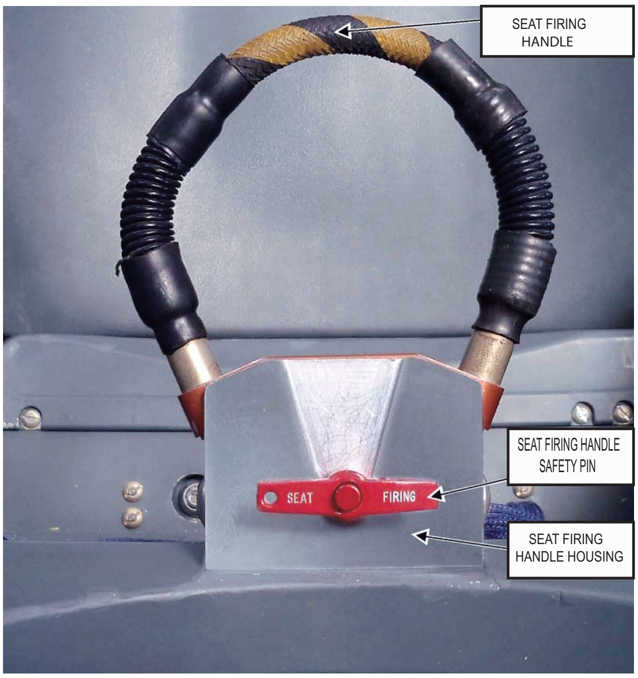
26. The seat firing handle also controls a mechanical safety lock which prevents operation of the manual separation handle (para 43) until the seat firing handle has been pulled fully upwards.

Ejection Seat Firing Handle Housing

27. The ejection seat firing handle is situated within a housing. The housing has a plate that covers the exposed front face of the firing handle. This is designed to enhance safety, eliminating the possibility of incorrectly inserting the seat firing handle safety pin through a dislodged handle. The housing also provides two additional benefits:

a. The alignment of the top surface of the housing and the top surface of the handle provides a visual and tactile means of verifying that handle is correctly stowed.

b. The housing profile guards the lower extremities of the handle attachment which decreases the probability of harness webbing, leg lines, safety pins or other equipment becoming snagged on or inserted beneath the handle itself.



1 - 9 Fig 4 Ejection Seat Firing Handle Housing

WARNING: All seat occupants are to confirm the seat firing handle is fully engaged into the seat firing handle housing prior to cockpit entry, and also before leaving the cockpit post flight. The seat firing handle safety pin is to be inserted through both the seat firing handle and the seat firing handle housing to avoid inadvertent ejection of the seat.

Command Ejection System

28. The command ejection system interconnects the firing systems of the seats and allows the sequenced ejection of both seats to be initiated from the rear cockpit. A COMMAND EJECTION SELECT VALVE - ON/OFF lever is in the rear cockpit at the lower right side. When the lever is set to ON (up) the command system is operative; at OFF (down) the command system is inoperative.

29. A cartridge at the selector lever fires when the rear seat firing handle is pulled; the sequence then depends on the setting of the selector lever:

a. With the selector lever at ON, the cartridge gases are passed to the front seat and immediately operate the front seat power retraction unit; after a delay of 0·35 seconds the gases fire a breech unit cartridge in the front cockpit to initiate the firing of the front seat ejection gun.

b. With the selector lever at OFF, the cartridge gases exhaust into the rear cockpit with no effect.

30. The command ejection selector lever is lift-guarded at both settings and has a rotatable knurled knob, used to lock the lever at the selected setting. The lever setting is altered by rotating the knob anti-clockwise, lifting the lever against spring pressure and moving it to the new setting (up for ON, down for OFF) where it can be correctly located when released. The lever is then to be locked at the new setting by rotating the knob fully clockwise.

Note: The front seat firing handle remains effective (for front seat independent ejection) irrespective of the setting of the command ejection selector lever.

Ejection Gun

31. Ejection of the seat is initiated by the telescopic ejection gun, power being provided by a primary and two secondary cartridges which fire in sequence. The gun barrel is fixed to the aircraft and the seat is attached to the inner of two sliding tubes which are locked within the barrel by a top latch mechanism. During ejection the sliding tubes extend. The outer tube forms an extension of the gun barrel and remains with the aircraft; the inner tube is ejected with the seat.

32. The gun is fired when the seat firing handle is pulled (or, on the front seat only, when the command ejection system operates). Gas pressure from the firing unit cartridge (or the command breech unit cartridge) causes rotation of a cross shaft which withdraws the sear from the ejection gun and fires the primary cartridge. Gas from the primary cartridge initiates upward movement of the tubes. As the tubes rise ports are opened which allow the primary cartridge gas to ignite the secondary cartridges in turn. When the tubes are fully extended, separation of the inner and outer tubes occurs; the seat is then free of the aircraft.

Rocket Pack, Initiator and Pitch Control Unit

33. **General.** The rocket pack, on the underside of the seat pan, is ignited automatically (as the ejection gun tubes separate) and sustains the acceleration of the seat. To ensure that the ejected seat follows a controlled optimum trajectory despite weight variations (seat CG variations) between occupants, the pitch angle (thrust vector) of the pack can be preset by the occupant to match their own ‘boarding’ weight.

34. **Rocket Pack.** The pack has a firing unit and tubes of solid fuel connected to a chamber having two pairs of downward-facing exhaust nozzles, one pair at each side of the pack. The pairs of nozzles are of different sizes and produce a slightly asymmetric thrust (the asymmetry being opposite on each seat) to ensure that the seats diverge after ejection. The rocket pack is ignited by an initiator system and burns for 0·25 second.

35. **Initiator.** A remote initiator on the rear left side of the seat is fired by a static cable stowed in a dispenser and attached to a drogue gun trip rod (para 40). During ejection, as the seat reaches the point of ejection gun tube separation, the static cable becomes taut and withdraws a sear from the initiator unit, firing its

cartridge. The resultant gases are piped to the firing unit in the rocket pack to fire a cartridge and ignite the rocket fuel. The ROCKET INITIATOR SEAR safety pin is to be checked as having been removed from the sear before strapping-in.

36. **Pitch Control Unit.** A rocket pack pitch control unit is on the right side of the seat pan; it has a setting knob and a weight scale which is visible in an adjacent window. The scale is graduated from 65 to 110 kg (140 to 240 lb) in increments of 5 kg. The `boarding' weight of the occupant, which includes full flying kit, is set on the weight scale by rotating the setting knob. Rotation of the knob simultaneously adjusts the angle of the rocket pack in relation to the seat pan according to the weight set. To ensure optimum performance in marginal conditions it is essential that the 'boarding' weight is set accurately.

Drogues and Parachute

37. A duplex drogue assembly comprising a 56 cm (22 inch) controller drogue and a 1·5 m (5 feet) main drogue are packed with a 5·2 m (17 feet) Aeroconical personal parachute in the container at the top of the seat. Both drogues are deployed automatically in turn to stabilize and retard the seat before deployment of the parachute, to which they are attached. The top of the parachute container is covered by fabric closure flaps secured by a closure pin which is withdrawn automatically during the ejection sequence.

38. The controller drogue is deployed by a withdrawal line attached to a drogue gun piston, and in turn deploys the main drogue which is attached to the parachute by a parachute withdrawal line. This withdrawal line is secured by a scissor shackle at the top of the seat beams and is further restrained within the parachute container. Operation of a barostatic time release unit releases both the container restraint and the scissor shackle, allowing the main drogue to deploy the parachute.

39. The Aeroconical parachute is designed to travel horizontally (as well as vertically) after deployment with the occupant facing the direction of horizontal movement. The horizontal component, although small, results in improved stability and a relatively low rate of descent. The parachute is steerable via two lines routed down the front lift webs, one line on each web. With the parachute canopy inflated, pulling down a hand-loop at the end of the appropriate line turns the parachute in that direction (ie, pull the left line to turn left, and vice versa); pull the loop down to shoulder level for maximum steering response. To stop the turn, gradually relax the pull on the line and allow the line to rise to its original position.

Drogue Gun

40. The drogue gun, on the top left side of the seat, is fired automatically by a trip rod. The drogue gun ejects a piston which (via an attached line) removes a pin securing closure flaps on top of the parachute container and then deploys the drogues. The gun has two separate cartridges, one mechanically fired by the trip rod 0·5 second after the trip operates during ejection, the other gas fired by the action of the barostatic time release unit or by the operation of the manual separation handle. A shear pin is fitted through the top of the drogue gun barrel, to retain the piston until the gun fires.

Barostatic Time Release Unit

41. The barostatic time release unit (BTRU) on the top right side of the seat, provides for the automatic release of the drogue scissor shackle, deployment of the personal parachute and separation of the occupant from the seat after ejection. The deployment/separation sequence occurs when a cartridge in the BTRU is detonated. Three devices in the BTRU (a time delay mechanism, a main barostat and a g-stop) delay the firing of the cartridge, depending on the ejection conditions:

a. **Time Delay.** The mechanical time delay is triggered by a static trip rod when the ejection seat starts to rise during the ejection sequence. If the delay mechanism is unobstructed (see b and c below), it allows the BTRU cartridge to fire 1·5 seconds after seat ejection.

b. **Main Barostat.** After ejection at altitude, the main barostat prevents operation of the time delay until the man/seat have descended to an altitude where tolerable oxygen/temperature conditions exist. The barostat has a normal setting of 10,000 +3000 minus zero feet (pressure altitude). After ejection, the drogue-stabilized seat descends rapidly with the occupant still strapped in; at 10,000 +3000 minus zero feet the barostat removes its restraint on the time delay, which is then free to operate.

c. **G-Stop.** After an ejection at high airspeed, below the altitude setting of the main barostat, the time delay would normally allow the parachute to deploy 1·5 seconds after seat ejection, with resultant overloading of the parachute and occupant during development of the parachute canopy. To prevent this, an automatic switch called a `g-stop' interrupts the operation of the time delay until deceleration forces on the man/seat have fallen to an acceptable value. Since the danger of overloading decreases with reduction in altitude, and since rapid parachute deployment is essential for successful escape at low altitude, the g-stop has its own barostat, set to inhibit the g-stop below 7500±500 feet. Thus the g stop extends the normal 1·5 seconds time delay (by up to 1·5 seconds depending on IAS at ejection), after high airspeed ejection above approximately 7500 feet.

d. **Deployment/Separation Sequence Delays.** A summary of the deployment/separation sequence delays is given in Table 2.

Note 1: The main barostat and g-stop barostat are set for ICAO standard atmospheric conditions.

Note 2: The setting of the main barostat can be changed to 5000 metres to suit the height of the terrain over which the aircraft is to operate; the setting cannot be changed by the occupant but is marked on the unit.

42. When the BTRU cartridge fires, the resultant gas simultaneously:

a. Operates a release mechanism to free the restraint on the parachute withdrawal line within the parachute container.

b. Operates a BTRU piston which opens the drogue scissor shackle and releases the top locks of the combined harness. The opening of the scissor shackle frees the drogue from the seat, thereby initiating deployment of the personal parachute.

c. Releases the harness bottom locks, allowing the occupant to be pulled from the seat as the parachute develops.

d. Fires the second cartridge of the drogue gun. This overcomes any failure of the mechanical firing of the gun and is normally a redundant action.

Manual Separation

43. The manual separation facility provides an alternative method for firing the drogue gun and BTRU, thus catering for the failure of either or both, allowing the occupant to deploy the parachute and separate from the seat if the automatic sequence of actions fails or if it is desired to achieve separation prematurely.

44. The facility is operated by a black and yellow striped MANUAL SEPARATION HANDLE on the right side of the seat pan (Fig 1); a thumb button on top of the handle has to be held pressed to release a mechanical lock before the handle can be pulled. When the handle is pulled a cartridge in a firing unit aft of the handle is detonated and produces gases which operate the mechanisms normally operated by the BTRU. A safety interlock prevents operation of the manual separation handle until the seat firing handle has been pulled fully upwards.

WARNING: If the front seat is ejected via the command ejection system and the occupant subsequently has cause to use the manual separation facility, they are first to pull the seat firing handle.

45. The manual separation firing unit sear, on the right side of the seat, has a safety pin marked MANUAL SEPARATION SEAR which is to be checked as having been removed from the sear and stowed before strapping-in.

Seat/MDC Interconnection

46. When the seat starts to rise during the ejection sequence a striker on the right side of the seat engages a lever on the MDC firing unit on the canopy frame, detonating the MDC which shatters the associated section of canopy before contact with the seat. If the MDC fails the seat ejects through the canopy.

Note: The seat/MDC interconnection operates to shatter only that section of the canopy covering the cockpit from which the ejection is made, whereas operation of the MDC firing handles (internal or external) causes shattering of the entire canopy (ie, front and rear sections). Refer to Chapter 12.

47. The interconnection operates so long as the safety pin of the associated MDC firing unit is removed; operation is not prevented if the safety pin of the MDC firing handle on the associated canopy is still fitted.

WARNING: In each cockpit, take care to avoid inadvertent operation of the MDC firing unit, either by hand or by unauthorized stowed articles, when strapping-in or when closing the canopy.

Table 2 - Summary of Deployment/Separation Delays

Ejection Altitude (Nominal)	*Sequence Delayed by*	*Total Delay Before Sequence Commences*
Above 10,000/13,000ft	Main barostat plus time delay	No deployment/separation until 10,000/13,000 ft, plus 1·5 seconds
7500 - 10,000 ft	g-stop plus time delay	Up to 1·5 seconds (at high IAS), plus 1·5 seconds
Below 7500 ft	Time delay only	1·5 seconds in all cases

Personal Equipment Connector

48. A PEC, on the left side of the seat pan (Fig 2), provides single action connection/disconnection of the occupant's mic/tel and personal supplies before and after flight respectively; it also provides automatic disconnection during the ejection sequence. The PEC comprises seat, aircraft and man portions.

a. **Seat Portion.** The seat portion provides for connection of the man portion on its top face and the aircraft portion on its lower face. It is locked to the seat pan and is coupled to the oxygen regulator. A catch at the front end of the seat portion enables the whole unit to be removed for maintenance. A metal dust cover, provided to protect the seat portion when the seat is not occupied, is stowed on the cockpit left wall. The dust cover is marked SELECT OXYGEN ON BEFORE CONNECTING PILOTS SERVICES. The time when the seat portion is not covered by either the dust cover or the PEC man portion (sub-para 48c) is to be kept to a minimum.

b. **Aircraft Portion.** The aircraft portion connects the communications system and anti-g supplies from the aircraft to the seat. It is held on the lower face of the seat portion by a lever-operated latch which is linked by static cable to the cockpit floor, so that these portions disconnect automatically during the ejection sequence.

c. **Man Portion.** The man portion is part of the flying clothing and has an oxygen tube, anti-g tube and mic/tel lead which is to be connected to the occupant's oxygen mask hose, anti-g suit and helmet mic/tel lead respectively. The man portion is connected by aligning it over the seat portion, locating its front end, and pressing down firmly on its aft end until it locks into place. It is released manually by pulling up its latch handle after pressing a thumb catch on the handle; it is released automatically after ejection by a linkage from the harness lock release mechanism. Both release methods also disconnect the leg-restraint lines.

Note 1: During the strapping-in procedure, to prevent the possibility of surplus oxygen tube and mic/tel lead fouling the pilot's elbow they should be pulled forward through the restraint flap on the life preserver to reduce to a minimum the length between the flap and the PEC.

Note 2: The man portion is not to be connected to the seat portion until after the main oxygen supply has been selected ON; it is to be disconnected and the dust cover fitted before the oxygen supply is selected OFF after flight.

Oxygen System on the Seat

49. The main oxygen system is connected to the seat at an automatic pull-off bayonet connector behind the right side of the seat pan, and thence by pipe and flexible tube to the regulator/PEC.

50. An emergency oxygen cylinder on the rear left of the seat feeds into the main supply line and has a supply release mechanism which is tripped automatically by a striker during ejection, or can be operated

manually at any time by pulling sharply upwards and backwards on a control ring on the left side of the seat pan. When the control ring has been pulled a red band on its mounting is visible.

51. The oxygen systems are fully described in Chapter 10.

Independent Ejection Sequence

52. The following sequence occurs when independent ejection is initiated, ie, the command ejection selector is at OFF or, with the selector at ON, the front seat firing handle is pulled before the rear seat handle is pulled.

53. When the seat firing handle is pulled sharply the firing unit cartridge detonates immediately and the movement of the handle releases the lock of the manual separation handle, readying that control.

54. Gases from the firing unit are distributed to the following:

a. The harness power retraction unit, firing its cartridge to pull the occupant's shoulders back into the seat and lock the retraction straps.

b. The ejection gun sear withdrawal unit, rotating the cross shaft to fire the primary cartridge of the ejection gun.

c. The command ejection selector valve (rear seat only), firing the command ejection cartridge. If the command system is selected OFF, the gases are vented into the rear cockpit. If the command system is selected ON but the front seat handle is pulled first, the gases pass to the front cockpit but have no effect since the front seat has already been ejected.

55. Gases from the ejection gun primary cartridge initiate upward movement of the seat, releasing the locking plunger from the top latch and thus unlocking the seat from the gun barrel.

56. As the seat accelerates up the guide rails, the following events occur automatically:

a. The ejection gun secondary cartridges fire in turn.

b. The MDC firing unit is engaged by the striker, detonating the MDC which shatters the associated section of the canopy.

c. The static trip rods withdraw the sears from the drogue gun and the BTRU, and static cables disconnect the command ejection system, the aircraft portion of the PEC, and the main oxygen supply.

d. The emergency oxygen supply is selected on and the regulator set to 100%.

e. The leg-restraint lines are pulled downwards through the snubbing units and restrain the occupant's legs. The units maintain the restraint after the shear pins break to free the lines from the floor.

57. As the telescopic tubes of the ejection gun separate (about 0·25 second after initiation of ejection) the rocket initiator cartridge is fired by the pull of the dispensed static cable and the gases fire the rocket pack cartridge to ignite the rocket fuel.

58. As the rocket pack completes its burn the drogue gun fires, ejecting its piston which withdraws the pin from the closure flaps on the parachute container and deploys the controller drogue. The controller drogue pulls out the main drogue which is fully developed approximately one second after initiation of ejection.

59. The remainder of the sequence is controlled by the BTRU.

a. **Above Main Barostat Altitude.** If the ejection is made above main barostat altitude, the seat descends to that altitude band and the main barostat then allows the 1·5-second time delay mechanism to operate and fire the BTRU cartridge.

b. **Below Main Barostat Altitude.** If the ejection is made below the main barostat altitude, but above the g-stop barostat altitude, the g-stop interrupts the time delay until the deceleration on the seat is below the g-stop value. The time delay is then free to operate and fire the BTRU cartridge.

c. **Below g-Stop Barostat Altitude.** If the ejection is made below the g-stop barostat altitude, the main barostat has already removed its restraint on the time delay, and the g-stop is inhibited. The 1·5-second time delay therefore operates immediately and fires the BTRU cartridge.

60. When the BTRU cartridge fires, its gases cause the drogue scissor shackle and the harness top locks to be released; the gases also release the harness bottom locks and pass to the drogue gun to fire its second cartridge (normally a redundant action).

61. The release of the harness locks frees, but does not separate, the occupant from the seat. The release of the scissor shackle transfers the drag of the main drogue to the personal parachute which is then pulled from its container.

62. The occupant is then held in the seat only by the restraint of the seat pan stickers. As the parachute develops it lifts the occupant and the PSP from the seat, pulling the seat pan stickers and PSP lowering line connector from their clips (the latter initiating PLB operation). The occupant has to release his grip on the seat firing handle at or before this stage. The seat then falls away cleanly and the leg-restraint lines run out freely through the rings on the leg garters. A normal parachute descent should then follow.

Command Ejection Sequence

WARNING: If the command ejection system is operative (ie, selected ON), removal of the rear seat firing handle safety pin renders the front seat 'live', whether or not the front seat firing handle safety pin is fitted. Therefore, the front seat occupant should always be properly strapped in whenever the rear seat firing handle safety pin is not fitted.

63. The following ejection sequence occurs when the command ejection system selector lever is at ON and the ejection of both seats is initiated by pulling the rear seat firing handle.

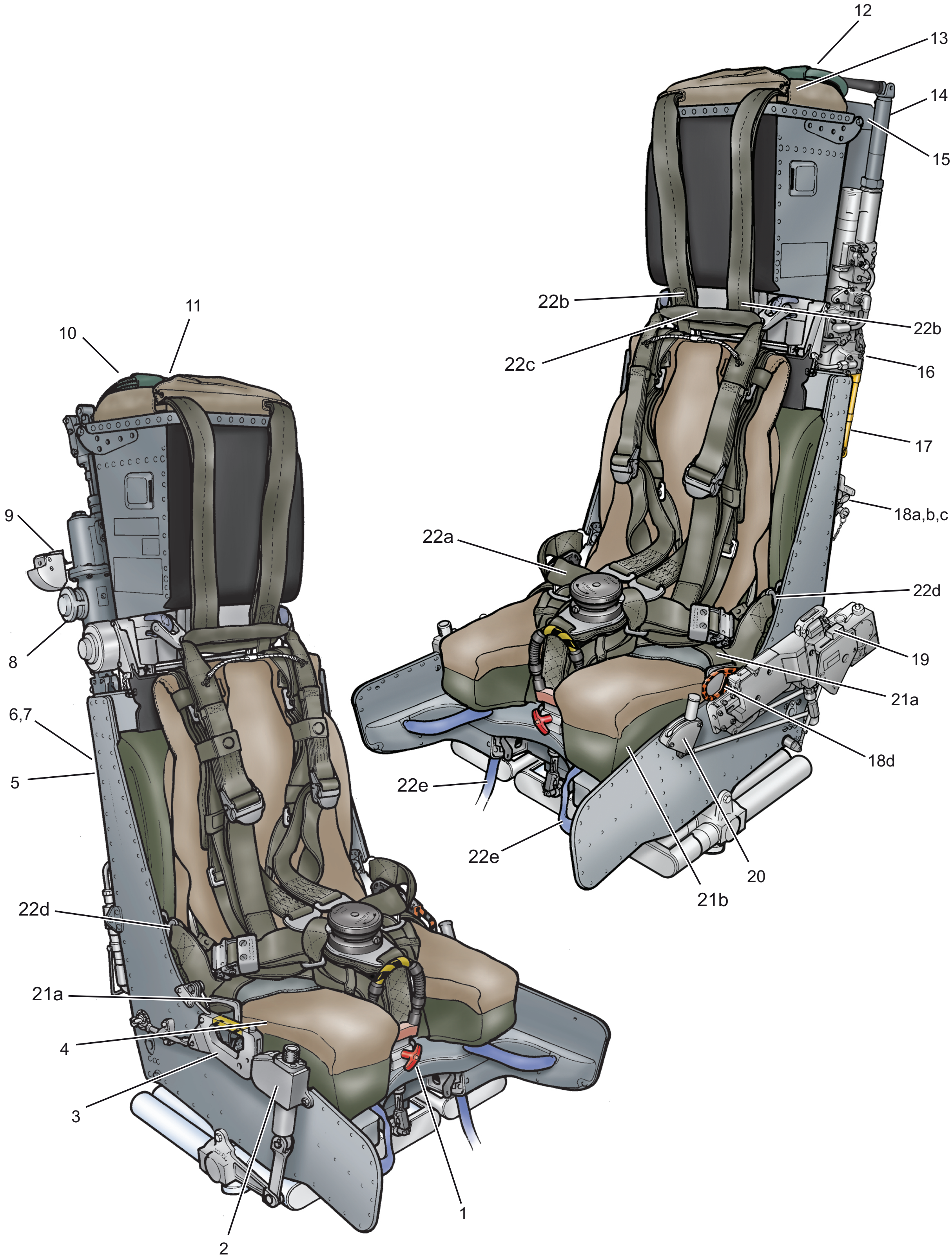
64. When the rear seat firing unit cartridge fires, gases are fed to the command selector valve firing its cartridge. The ejection of the rear seat continues as in the independent sequence.

65. From the selector valve cartridge gases are passed to the command breech unit in the front cockpit, and also (via a bypass) to the front harness power retraction unit which immediately pulls the occupant's shoulders back into the seat. After a 0·35 second delay the command breech cartridge fires to operate the front sear withdrawal unit which detonates the ejection gun, thus initiating seat ejection; the sequence then continues as in the independent ejection sequence.

SEAT NORMAL PROCEDURES

Checks Before Flight

66. Before dual or solo flight check that the aircraft is Safe for Parking and then carry out the Ejection Seat Checks given in the Flight Reference Cards and amplified below.



1 - 9 Fig 5 Ejection Seat

Rear, Ejec Seat

EJECTION SEAT CHECKS

1.	Seat firing handle safety pin	Fitted through housing & firing handle
2.	Pitch control unit	Set boarding weight
3.	Manual separation handle . .	Locked down, safety pin removed
4.	Automatic Deployment Unit:	
	a. Static line	Connected to seat
	b. Mode	AUTO/MANUAL as required
5.	BTRU static trip rod	Secured to cross beam
6.	Command ejection pipe(s). . . .	Visually confirmed not disconnected
7.	Command/BTRU telescopic tubes.	Visually confirmed not disconnected, pip pin fitted
8.	BTRU capsule.	Check operating altitude
9.	MDC trip arm	Clear of obstructions
10.	Ejection gun sear	Linkage connected, safety pin removed
11.	Scissor shackle.	Closed and flat
12.	Drogue shackle.	Connected to scissor shackle, minimum 1.5 threads visible, tie intact
13.	Parachute container	Closed, 2 ties intact
14.	Drogue gun piston	Attached to drogue withdrawal line; shear pin fitted
15.	Top latch:	
	a. Indicator spigot	Flush with, or slightly protruding from, plunger
	b. Plunger	Flush with, or slightly recessed into, housing face
16.	Rocket initiator	
	a. Cable.	Connected to drogue trip rod
	b. Firing link.	Connected to firing unit sear
	c. Telescopic tube	Connected
	d. Safety pin	Removed
17.	Drogue gun static trip rod . .	Secured to cross beam
18.	Emergency oxygen	
	a. Contents	Full
	b. Pip pin	Fitted
	c. Trip lever	Horizontal
	d. Operating handle	Fully down
19.	Oxygen regulator	Selector to 100% (forward)
20.	Go forward mechanism . . .	Check HPRU operates & locks
21.	PSP:	
	a. Suspension strap	Routeing correct
	b. Lowering line	Connector in spring clip
22.	Combined Harness:	
	a. Straps.	Secure in locks
	b. Parachute lift webs	Inboard of retraction straps
	c. Retention strap.	In front of lift webs, in top locks
	d. Sticker straps	Outside lap straps, in spring clips
	e. Leg restraints	Attached to floor, routeing correct

1 - 9 Fig 6 Ejection Seat Checks

(Fleet embodiment of Mod PA820 AL3)

67. When checking the rear seat before solo flight a check is to be made that the seat safety apron is securely fitted and tightened over the locked and tightened harness, with the top of the apron secured by the two pip-pins on the apron, the leg-restraint lines and PSP lowering line secure and the skirt of the apron tucked round the seat cushion and survival pack. Leave the PEC dust cover attached.

68. In the rear cockpit, set the command ejection selector lever as required (up for ON, down for OFF). Check that the knurled knob on the lever is rotated fully clockwise and the lever is locked at its selected setting.

69. Check that the main oxygen supply is selected ON in both cockpits. Remove and stow the PEC dust cover as required.

Before Strapping-In (Both Cockpits)

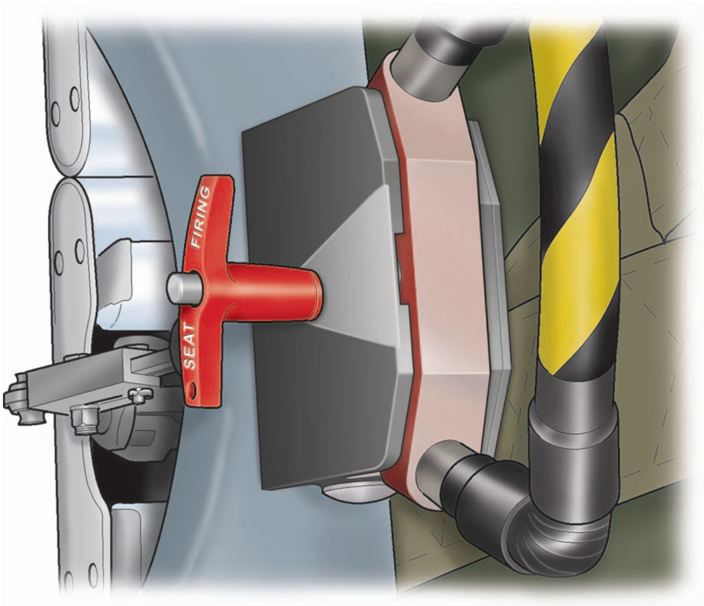
70. Before strapping-in check that the PEC oxygen tube and mic/tel lead are routed through the flap on the life preserver. Check that the oxygen, anti-g and mic/tel connections are properly made at the PEC man portion and that the PEC oxygen tube is secured to the front of the LSJ by the dog-lead clip.

71. In the cockpit check that the safety pins are fitted to the seat firing handle, the MDC firing handle and the MDC firing unit. Check that the other three pins from the associated cockpit are in the central stowage. In both cockpits, remove and stow the MDC firing unit pin.

72. Check that the face of the QRF is at the locked setting.

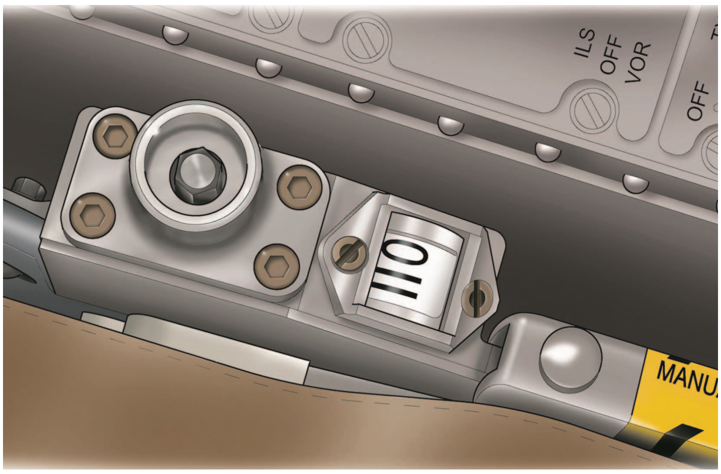
73. Check the following on the seat and equipment:

(1) The seat firing handle safety pin is fitted through the housing and firing handle.



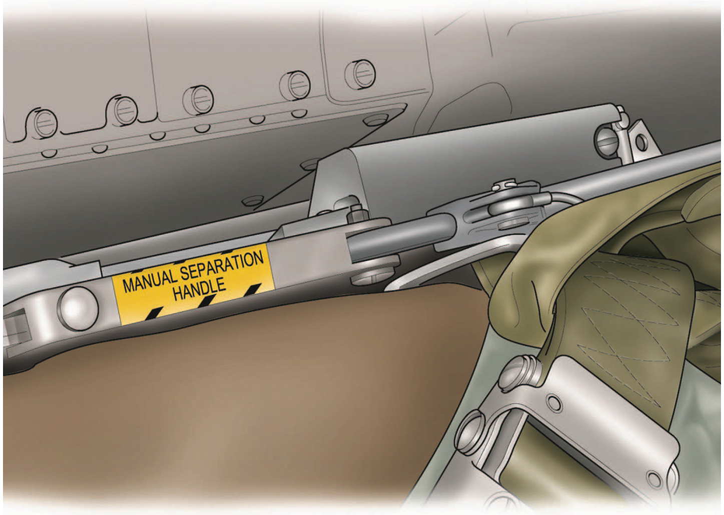
1 - 9 Fig 7 Seat Firing Handle Safety Pin

(2) The correct boarding weight is set on the pitch control unit.



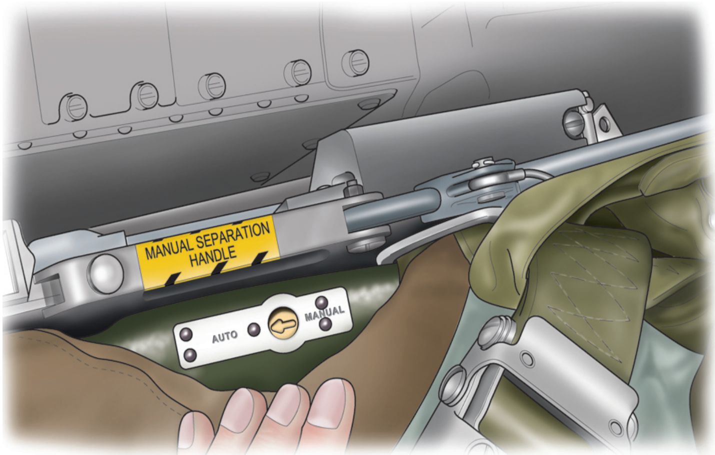
1 - 9 Fig 8 Pitch Control Unit

(3) The manual separation handle is locked down and the firing unit safety pin has been removed.



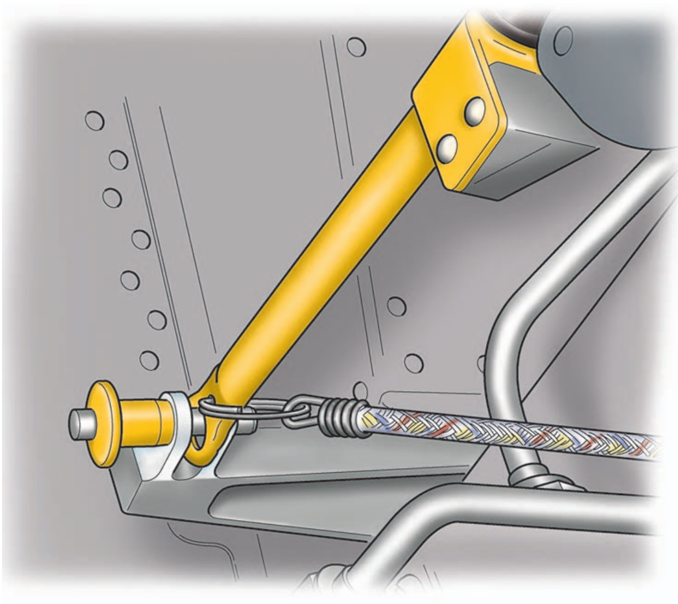
1 - 9 Fig 9 Manual Separation Handle

(4) The ADU static line is connected to the seat and AUTO/MANUAL is set as required.



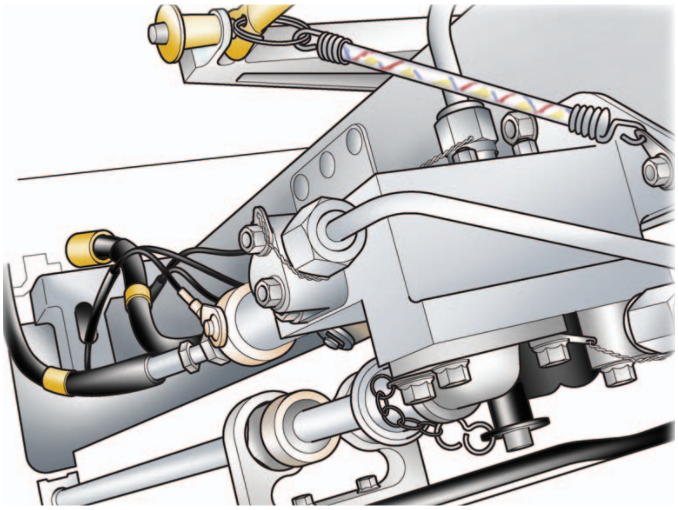
1 - 9 Fig 10 Automatic Deployment Unit

(5) The BTRU static trip rod is secured to the cross beam.



1 - 9 Fig 11 BTRU static trip rod

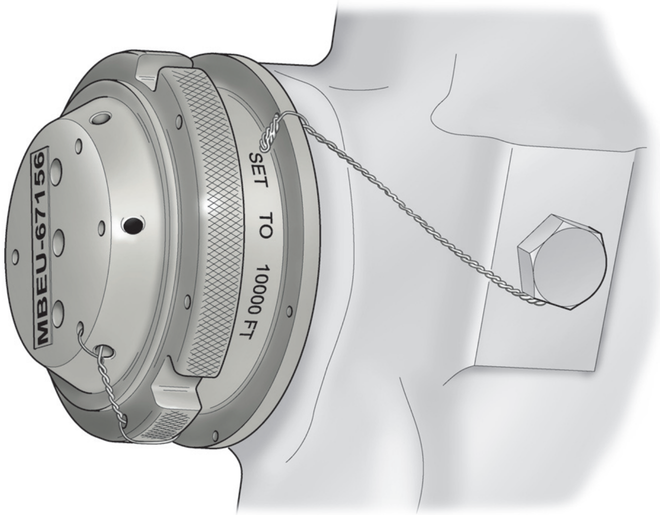
(6) The command ejection pipe(s) is (are) visually confirmed to be not disconnected.



1 - 9 Fig 12 Command Ejection Pipes and BTRU Telescopic Tubes

(7) The command/BTRU telescopic tubes are visually confirmed to be not disconnected and the pip pin is fitted (above).

(8) The BTRU capsule displays the correct operating altitude.

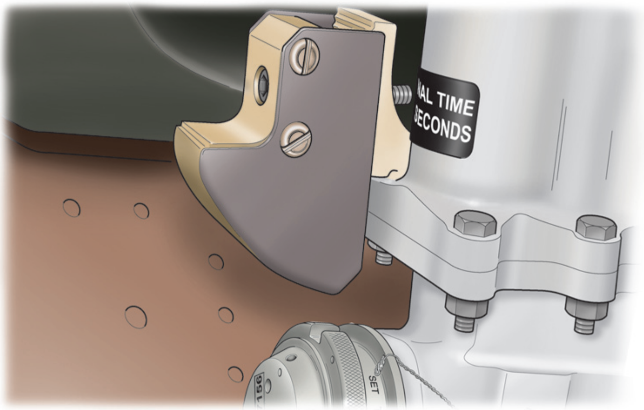


1 - 9 Fig 13 BTRU capsule

Note 1: The position of the wire locking may differ on the BTRU from the graphic shown.

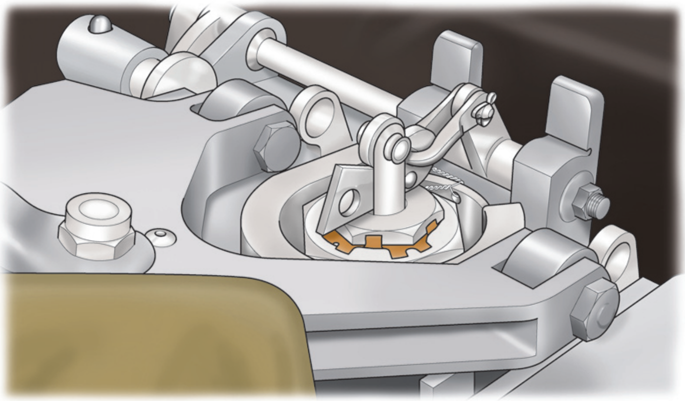
Note 2: Flights that require the BTRU to operate at an altitude higher than 10,000 ft have an additional spacer fitted, marked SET TO 5000M.

(9) The MDC trip arm is clear of obstructions.



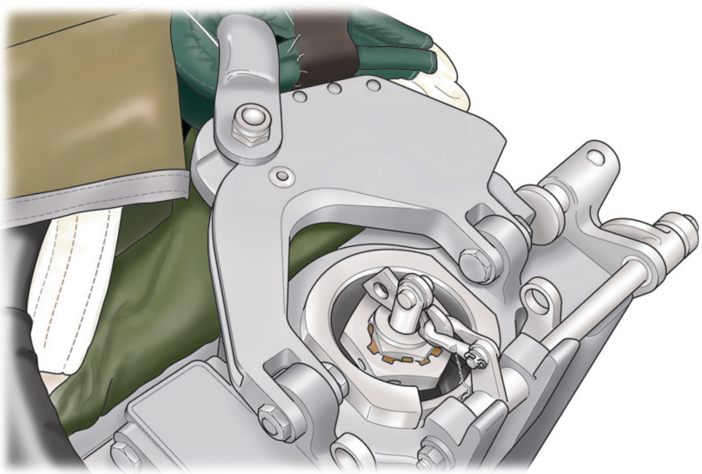
1 - 9 Fig 14 MDC Trip Arm

(10) The ejection gun sear linkage is connected to the gun sear and the safety pin has been removed.



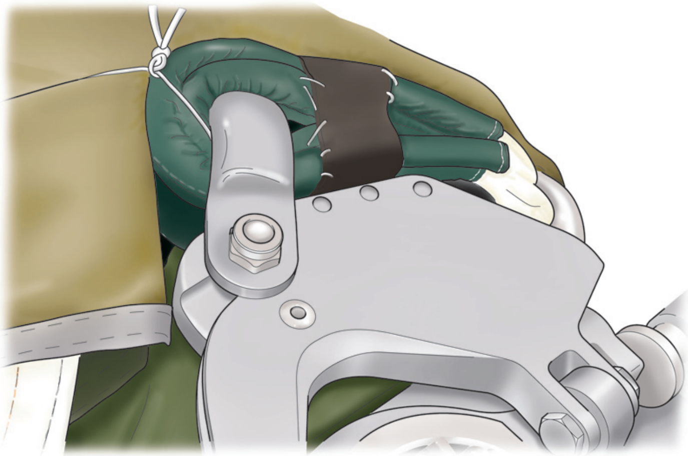
1 - 9 Fig 15 Ejection gun sear

(11) The scissor shackle is closed and flat.



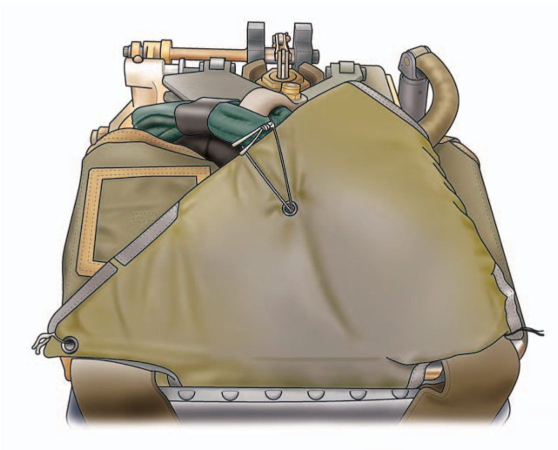
1 - 9 Fig 16 Scissor shackle

(12) The drogue shackle is connected to the scissor shackle with a minimum of 1.5 threads of the drogue shackle bolt visible, and the tie is intact.



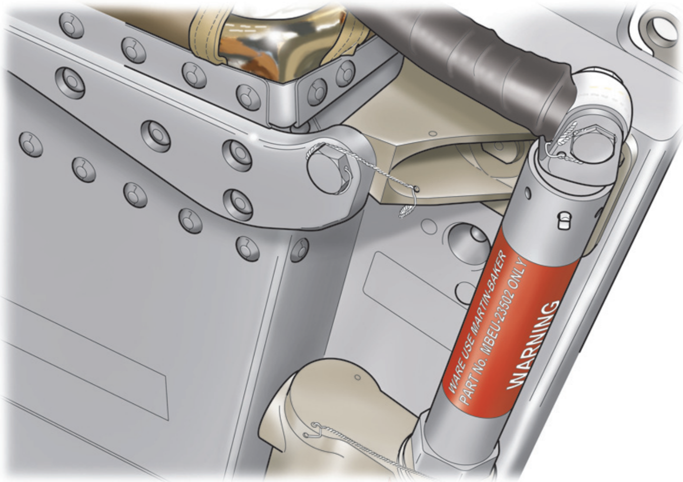
1 - 9 Fig 17 Drogue shackle

(13) The parachute container is closed with 2 ties intact.



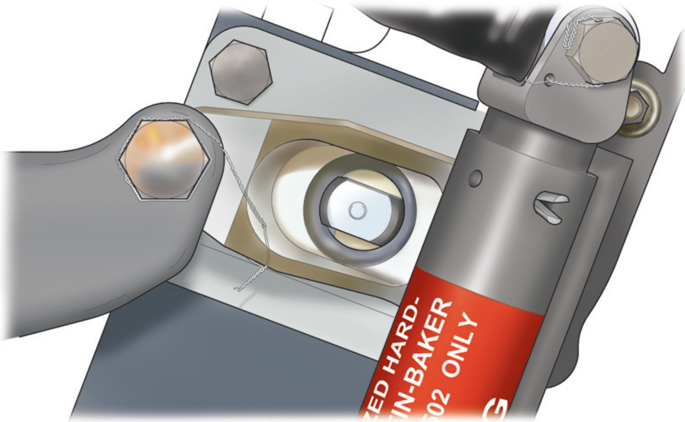
1 - 9 Fig 18 Parachute container

(14) The drogue gun piston is attached to the drogue withdrawal line, the shear pin is fitted through the gun barrel.



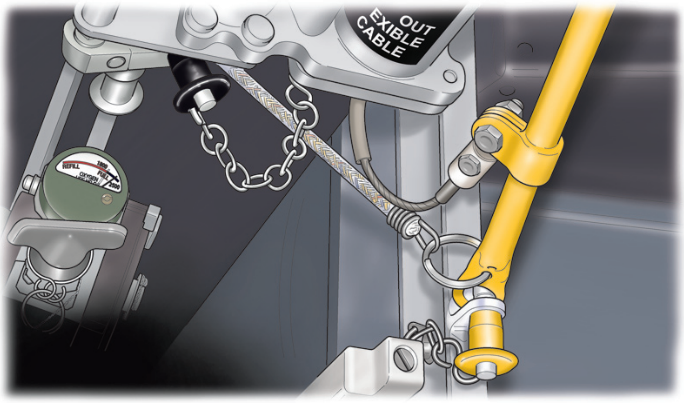
1 - 9 Fig 19 Drogue gun piston

(15) The top latch indicator spigot is flush with or slightly protruding from the plunger and the plunger is flush with or slightly recessed into the housing face.

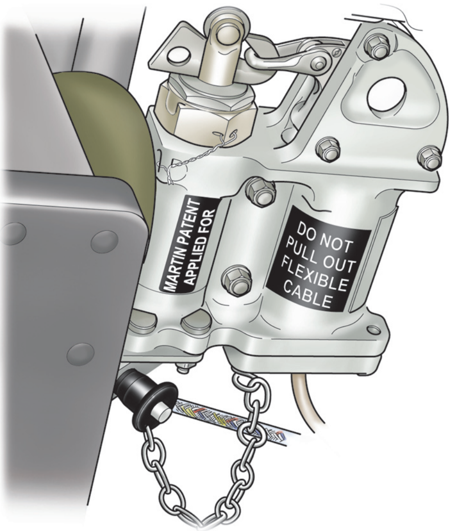


1 - 9 Fig 20 Top latch

(16) The rocket initiator static cable is connected to the drogue gun static trip rod and the firing link is connected to the firing unit sear. The telescopic tube is connected with the pip pin fitted, and the initiator safety pin has been removed.

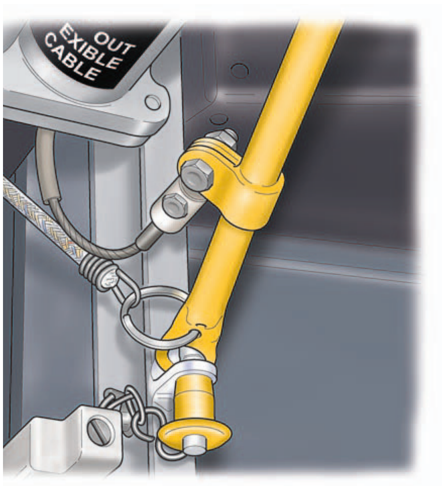


1 - 9 Fig 21 Rocket initiator and drogue gun static trip rod



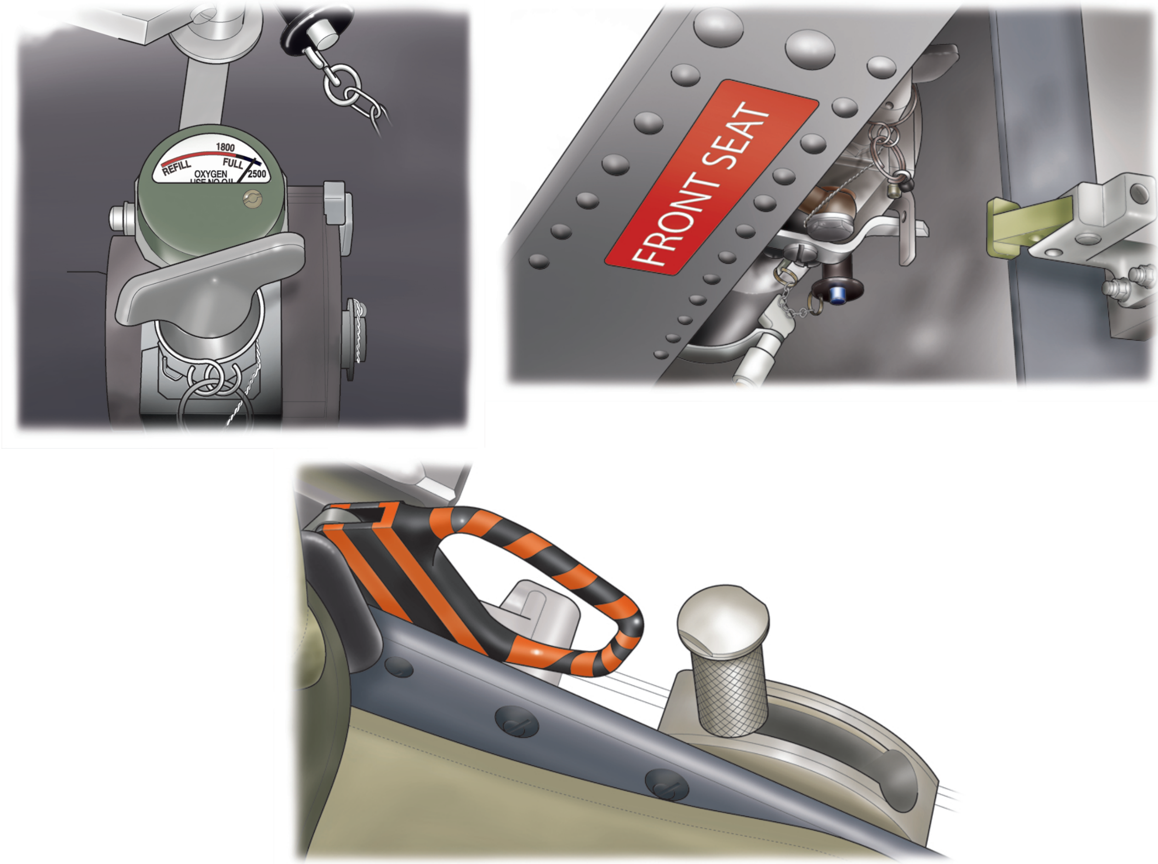
1 - 9 Fig 22 Rocket initiator

(17) The drogue gun static trip rod is secured to the cross beam.



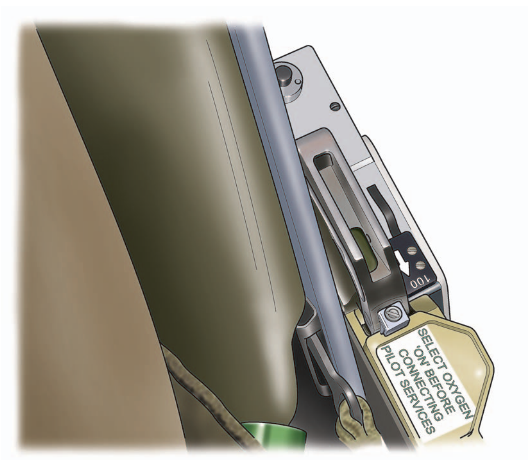
1 - 9 Fig 23 Drogue gun static trip rod

(18) The emergency oxygen contents gauge indicates full (green mark) and the pip pin is fitted. The trip lever is horizontal and the operating handle is fully down/has not been pulled (red band not visible).



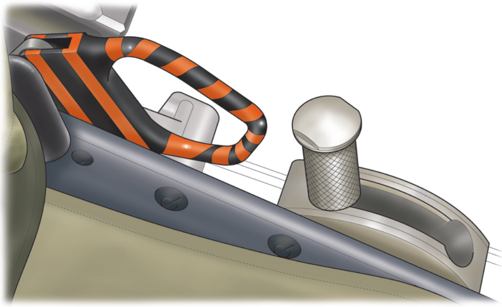
1 - 9 Fig 24 Emergency oxygen

(19) The oxygen regulator changeover selector is set to its forward (100%) setting (Chapter 10).



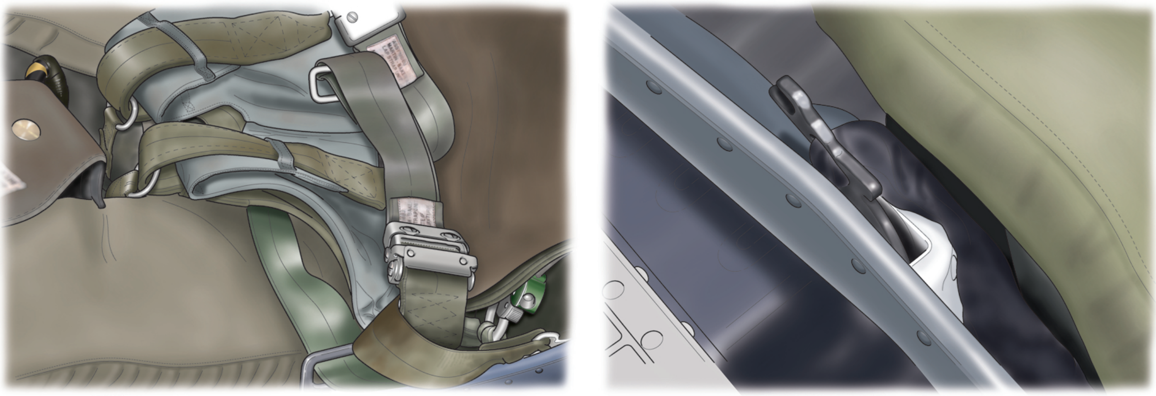
1 - 9 Fig 25 Oxygen regulator

(20) The go-forward mechanism/HPRU operates correctly and locks.



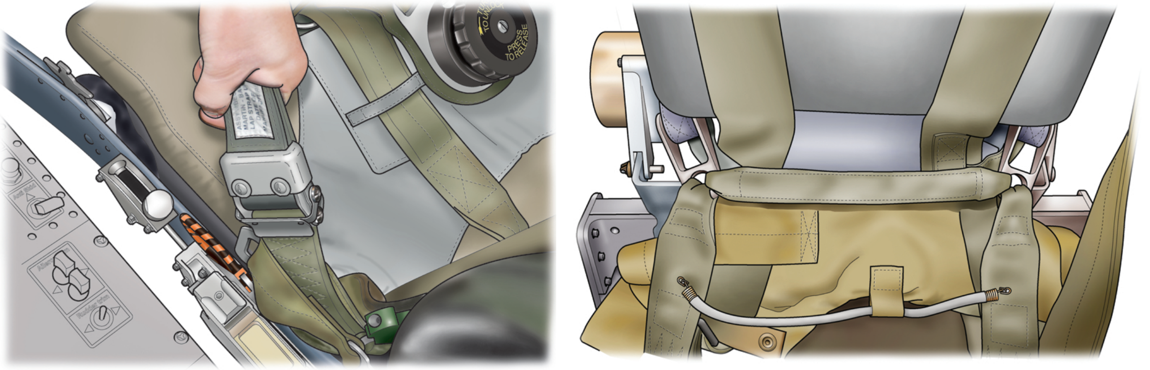
1 - 9 Fig 26 Go-forward mechanism

(21) The PSP suspension strap is underneath the parachute harness seat-pad and is routed through both rings on the PSP; check that each end of the strap is routed inside the sticker strap and is secured at the associated side connector on the parachute harness. Check that the PSP lowering line connector is secure in the seat pan spring clip.

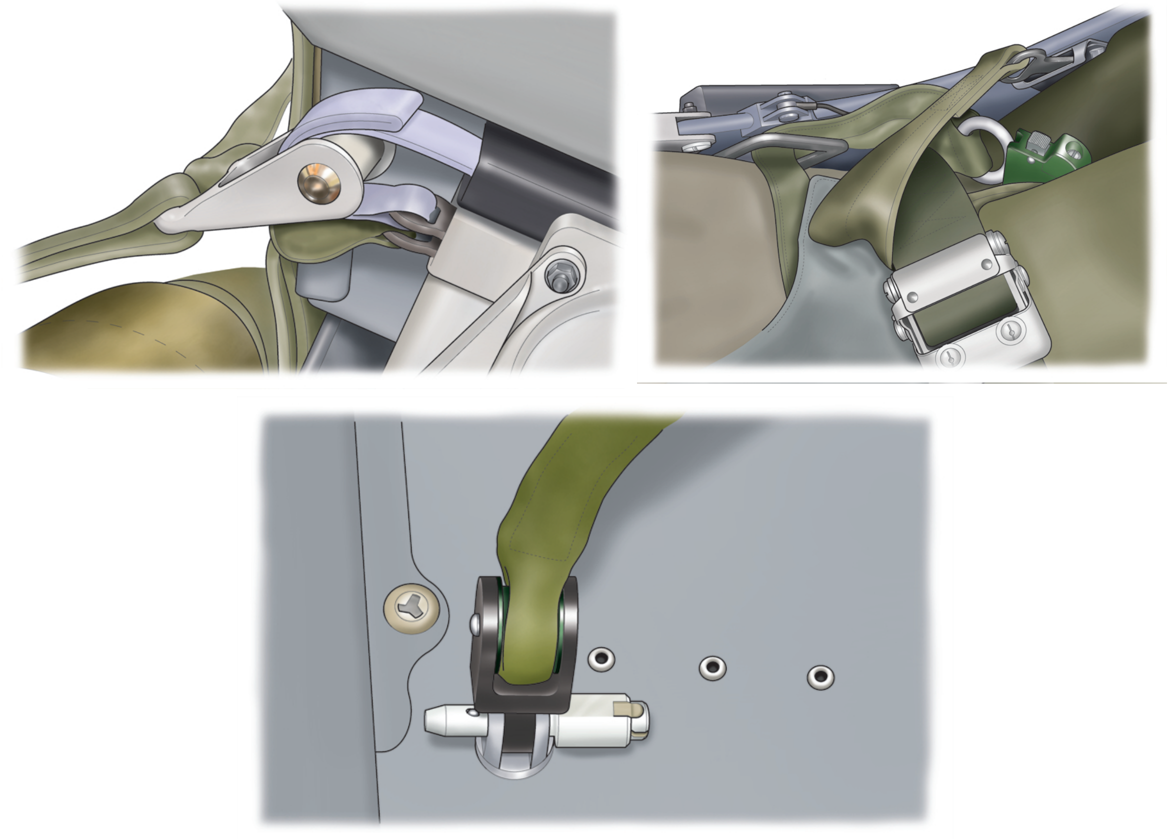


1 - 9 Fig 27 PSP

(22) On the combined harness, check that the shoulder straps, lap straps and lower negative-g strap are secured in the harness locks, by pulling on each in turn. Check that the parachute lift webs are routed inboard of the retraction straps and that the retention straps are in front of the lift webs and secure in the harness top locks. Lift the shoulder harness clear and stow it on the clips on the parachute container. The sticker straps are routed outside the lap straps and connected to the spring clips on the seat pan. The leg-restraint lines are connected to their floor attachment points and are correctly routed through the snubbing units.



1 - 9 Fig 28 Combined harness



1 - 9 Fig 29 Combined harness

> **Note:** If the harness shoulder straps are incorrectly stowed, they may cause the seat to jam when its height is adjusted and lead to the release of the harness top locks. It is essential, therefore, to ensure that the shoulder harness straps are correctly stowed.

74. Ensure that the harness is prepared for strapping-in: crotch loops forward over the cushion and through the loops on the underside of the lower apron, lap straps laid clear of the cushion, shoulder straps in the stowed position and the negative-g strap not through the seat firing handle.

Strapping In

WARNING 1: To prevent the leg restraint line taper plugs snagging during pull through on an emergency ground egress, it is important that the leg garters are worn with their quick-release connectors on the inside of the leg. The free end of the garter adjustment strap should be at least 25 mm away from the outer D-ring. The garters are fitted below the knee, slightly above the mid-calf position and around all items of aircrew equipment assembly ie coveralls and anti-g trousers (Fig 30).

WARNING 2: Ensure that all loose objects are safely stowed before operating the SEAT RAISE/LOWER switch. Ejection seat components may be damaged, and ejection sequences inadvertently initiated, if the seat is raised or lowered with objects under the seat or between the seat and side consoles.

WARNING 3: When strapping in ensure that there is no possibility of the AEA fouling seat mechanisms during subsequent ground operations and flight. A particular hazard has been identified with AEA snagging the manual separation handle causing initiation of the system.

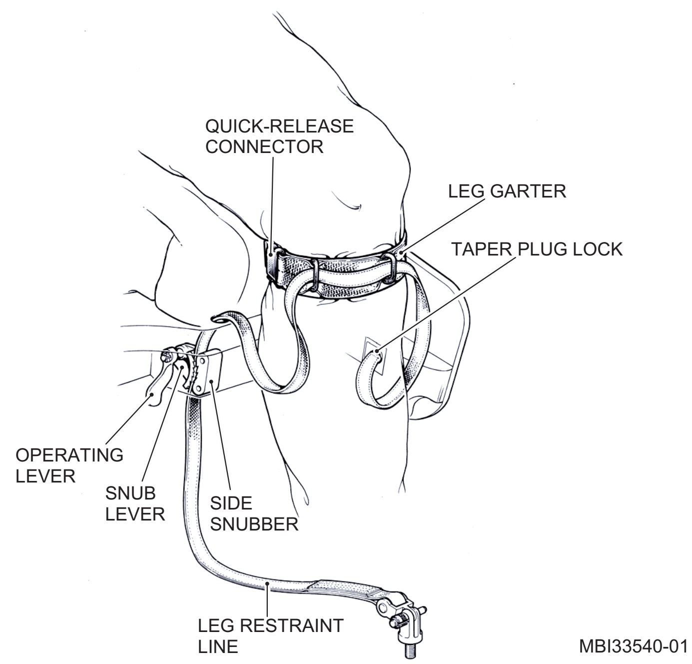
WARNING 4: Because a command ejection system is fitted, when dual, do not move any safety pins until both occupants are correctly strapped in, the canopy is closed and the command ejection selector is confirmed OFF.

75. Lay the lap straps clear and occupy the seat, taking care not to stand on the seat firing handle. Adjust the rudder pedals and set the go-forward lever to its locked (aft) position. Move the back pad fully up before leaning back into the seat.

76. Connect the quick release connector on the left side of the life preserver to the PSP lowering line, routeing the strap outside the left thigh. Re-check that the lowering line end fitting is secure in the seat pan sticker clip and that the line is below all hoses and the lap strap.

77. Lay the left lap strap on the left thigh. Connect the PEC by offering the man portion to the seat portion at an angle in excess of 45° and pushing the man portion forward into the guide slot as far as possible before pressing down into position, ensuring its security.

78. Pass the left leg-restraint line from the snubbing unit through the garter rings on the front of the left leg, passing the line from inboard to outboard, and insert the taper plug in the lock on the left side of the seat pan. Similarly pass the right leg-restraint line through the rings on the right garter and secure its taper plug on the right of the seat pan. Ensure that the lines are not crossed and are not snagging the lower negative-g strap.



1 - 9 Fig 30 Leg Restraint Routing

Note: If necessary the taper plug locks can be checked for release at this stage by pulling up the PEC latch handle to release the man portion. The taper plugs should eject from their locks. The PEC is to be reconnected and the taper plugs again inserted in their locks, care being taken to ensure that the connections are secure.

79. Adjust the leg-restraint lines so that there is just sufficient line above the snubbing units to allow enough leg movement for the application of full rudder in both directions. Pull any excess leg-restraint line down through the snubbing units. If the lines prevent the application of full rudder in both directions, operate the snubbing release controls in turn and pull up the required amount of line.

80. Bring the negative-g strap and attached QRF up between the legs, ensuring it is aft of, and not through or caught on, the seat firing handle. Check that the QRF is locked, ie, yellow notch on the face uppermost.

81. Bring the left leg loop up inside the left thigh, ensuring it is aft of, and not through, the seat firing handle and pass it through the left lap strap D-ring from below. Fold the leg loop through 90° using a forward twist, bring down the left shoulder strap and pass its lug through the left leg loop. Rotate the face of the QRF slightly and push the lug down into the QRF left slot until the lug is securely locked. Repeat the process for the right side of the harness.

WARNING: Positively check that the shoulder strap lugs are locked in the QRF before tightening the lap straps. Tightening the lap straps causes the lugs to geometrically lock in the QRF slots; this may disguise an insecure lug.

82. Check that the PEC supplies are outside of the left lap strap, and the life preserver attachment strap is under the left lap strap; check that the oxygen tube is under the left shoulder strap. Pull the oxygen tube and the mic/tel lead forward through the restraint flap on the life preserver to reduce to a minimum the surplus between the flap and the PEC.

83. Fully tighten the lap straps, positioning the QRF centrally.

84. Fully tighten the shoulder straps ensuring that the QRF remains in a central position. Have any slack pulled rearwards through the shoulder D-rings and tucked away behind the shoulders. At this stage the tension in the shoulder straps should be slightly overtight. It is this degree of overtension which extracts the correct amount of harness power retraction unit blue strap when the go-forward lever is unlocked.

85. Check that the shoulder straps are clear of the lobes and inflation handle of the life preserver.

86. With power applied, adjust seat pan height so that the head is approximately centred on the headrest of the seat.

WARNING: Adjusting the seat too high can result in backache, head and spinal injuries during ejection and fouling of the control column by the knee or thigh. Once strapped in the occupant may adjust the seat height to improve visibility for taxying and manoeuvring but the seat should be returned to the normal in-flight position before take-off.

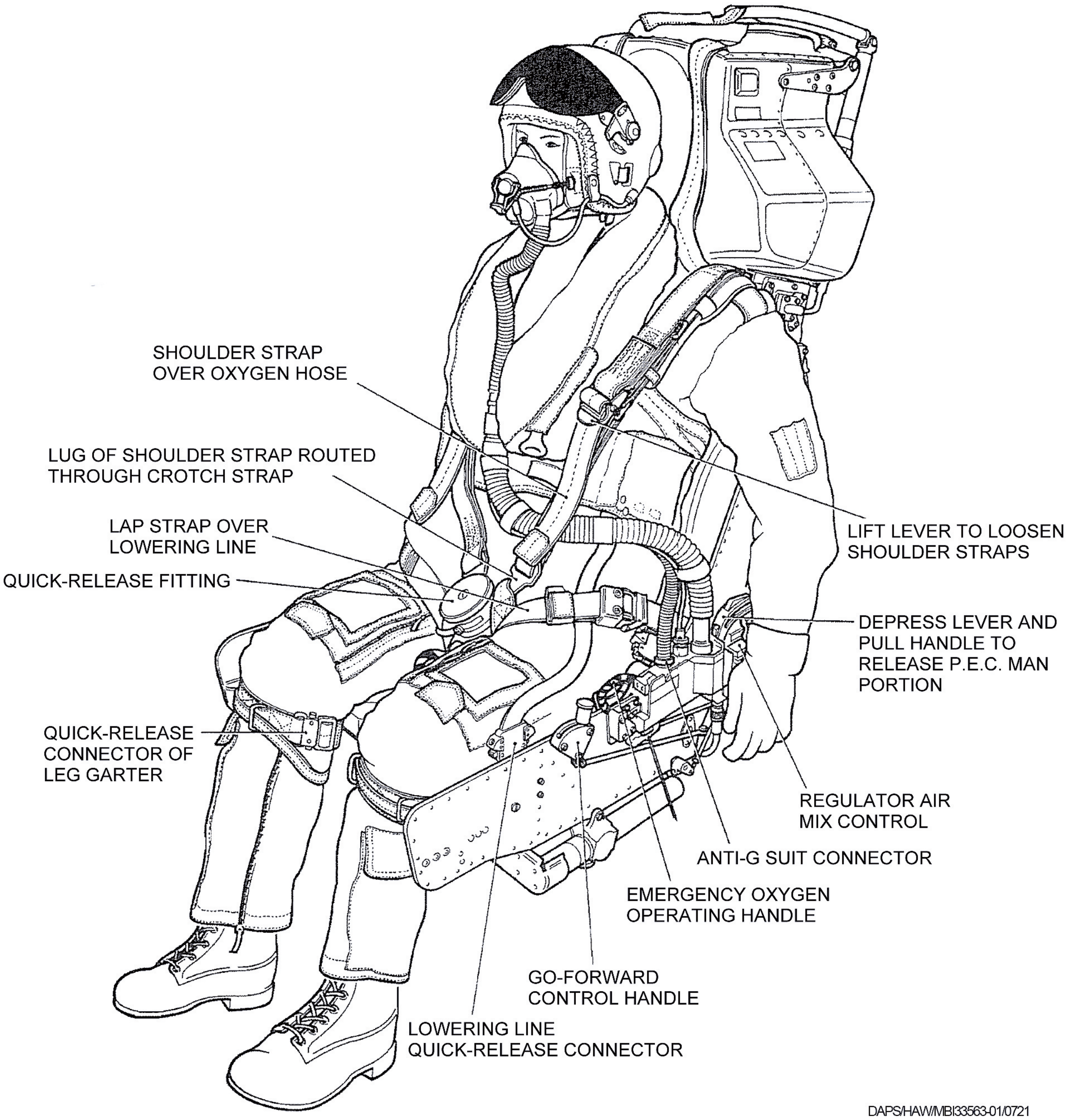
87. Set the go-forward lever to its forward (unlocked) setting and lean forward to extend the shoulder straps. Set the go-forward lever aft (locked) and slowly sit hard back into the seat while checking for correct locking of the power retraction unit. Re-tighten the shoulder straps firmly. At this stage ensure that approximately 2 to 3 inches of the inertia reel blue webbing strap is horizontal and clear of the inertia reel fairing blocks (groundcrew assistance is an advantage) and that the shoulder strap adjustment buckles lie comfortably forward on the shoulder (below the collar bone).

Note 1: If the go-forward lever is inoperative, the aircraft is not to be flown.

Note 2: If a shoulder strap becomes twisted when leaning forward, the strap may jam during retraction. To untwist, pull the strap directly forward manually and allow it to retract slowly into its housing.

88. Ensure that there is no obstruction between the seat MDC striker and the MDC firing unit lever, ensure that at least one visor is lowered and that the eyes are closed and then close the canopy. If any subsequent adjustment of the seat pan height is made ensure that the helmet does not strike the MDC pattern above the head. In the front cockpit there is normally adequate clearance between the helmet and the canopy but in the rear cockpit a check is to be made to ensure that this clearance is not less than that which allows the flat of the hand to pass between helmet and canopy.

89. Finally, check that there are no straps or lines routed through the ejection seat firing handle.



1 - 9 Fig 31 Ejection Seat - Occupied

Normal Exit Procedure

WARNING 1: To mitigate the chance of the command ejection sequence being initiated during safety pin insertion, when dual, do not move any safety pins until the command ejection selector is confirmed OFF.

WARNING 2: The occupant/occupants should always remain properly strapped in until it is confirmed that the seat firing handle safety pin/pins is/are correctly inserted and the aircraft is shutdown.

90. With eyes shut and visor down open the canopy.

91. Release the oxygen mask. Check the PSP lowering line is disconnected. Release the harness by rotating and then pressing the face of the QRF; free the shoulder straps from the QRF and insert them in the headrest housing. Return the face of the QRF to the locked setting. Slip the leg loops from the lap strap D-rings and lay the straps clear.

92. Stow the PSP lowering line. Disconnect the PEC man portion. Pull the leg-restraint lines free of the leg garter rings.

93. Stand up and insert the MDC firing unit pins in the forward to aft direction in the short sear (see Fig 32). Vacate the cockpit. Confirm the aircraft is **Safe for Parking**. Replace the dust cover on the PEC seat portion, select the regulator to 100% and the main oxygen selector to OFF. Disconnect the mask hose and mic/tel leads and remove the helmet.

USE OF THE SEATS

General

94. The ejection facility is available from ground level at zero speed for aircrew boarding weights below 120.0kg and throughout the flight envelope as defined in the Hawk T Mk 1 and 1A MOD AFD Release to Service. The minimum ejection terrain clearance required in various flight conditions is shown in Fig 33 and Fig 34. From a ditched aircraft it is recommended that ejection should be attempted whether the aircraft is floating or submerged; only limited trials data exist to show that an ejection from a submerged aircraft will succeed.

95. In flight the optimum speed for ejection is in the range 200 to 250 knots. To avoid excessive loading on the parachute and the seat occupant, reduce the aircraft speed, whenever possible, to within the optimum range before ejecting. This is particularly important when flying at high speed below the g-stop barostat altitude where the parachute is deployed without the delaying action of the BTRU barostat or the g-stop; in these circumstances convert excess speed to height by carrying out a zoom manoeuvre. However, ejection is not to be delayed if the aircraft is in a descent from which it cannot be recovered.

96. If recovery from a spin has not been achieved by 5000 feet AGL, eject. If the aircraft is out of control at high IAS, eject above barostat/g-stop altitude if possible.

97. In all ejection or emergency egress procedures, before pulling either the ejection seat firing handle or the MDC firing handle, warn the other occupant (if appropriate), check that the visor is lowered, ensuring that the legs are not relaxed outwards, sit erect and close the eyes tightly.

WARNING 1: If ejection is initiated when the roll-rate of the aircraft is greater than that equivalent to half-stick deflection at 550kts there is an increased risk of injury.

WARNING 2: Detonation of the MDC, whether during emergency egress or during ejection, causes the implosion of fine metal debris which can cause injury to exposed facial skin and to the eyes. It is therefore essential that the visor is in the lowered position when the MDC fires (with minimum/zero gap between the visor and the top of the oxygen mask - ascertain the absence of this gap when the helmet and mask are initially selected and fitted) and that, if possible, the eyes are tightly closed. For the above reasons, and also to protect against the effects of bird strike, the visor should be lowered at all times; this is particularly vital for the front seat occupant when the command ejection system is selected ON.

Note 1: If the command ejection sequence is operative (ie, command ejection selector lever at ON) both occupants should complete each of the personal checks referred to at para 98; the occupant of the front seat should then grasp the seat firing handle and close his eyes tightly before ejection is initiated by the rear seat occupant.

Note 2: If the independent ejection sequence is operative (ie, command ejection selector lever at OFF) the rear seat occupant should eject first.

Note 3: If required, and if time permits, the rear seat occupant can alter the setting of the command ejection lever to suit the prevailing circumstances.

Note 4: The seat firing handle is to be grasped as tightly as possible with both hands (or with one hand and the other hand grasping the wrist) to avoid the arms flailing during ejection. However since the firing handle remains attached to the seat at all times, and to avoid the handle being snatched from their hand(s), the occupant should release their grip on the handle at or just before man/seat separation.

Note 5: When the control column is fully aft some difficulty in grasping and pulling the firing handle may be experienced; try to pull centrally upward with both hands to avoid the possibility of unintentionally rotating the QRF.

Premeditated Ejection

98. To carry out a normal ejection complete as much of the Premeditated Ejection drill as time and conditions permit.

99. At low altitude the aircraft should be in substantially level flight to provide the optimum ejection conditions. If the aircraft is descending, has an excessive bank angle, has an excessive pitch attitude or an excessive rate of descent, additional terrain clearance is to be allowed. Where circumstances permit, escape is facilitated by initiating a zoom manoeuvre.

100. At high altitude aircraft attitude is not critical, however, in controlled ejection conditions, adjust speed and height before ejection. Ideally, position the aircraft over an unpopulated area or over the sea. If possible, set aileron trim at one-half in either direction and set the throttle lever to Idle before ejection; consequently the aircraft should impact within a short radius of the ejection point.

WARNING: If a parachute descent is being made into water it is important that the PSP is lowered before splashdown, since the side connectors may be difficult to operate if `parachute dragging' conditions develop once in the water. This dragging can have disastrous results. In the event of a failure of the ADU, the occupant must be ready to manually deploy the PSP by releasing one of the PSP retaining strap quick-release connectors.

Ejection on the Ground

101. On the ground the ejection option exists providing the individual aircrew boarding weights are less than 120.0kg, the occupant is properly strapped-in, the seat safety pins are removed, the canopy is closed and locked and the aircraft is substantially level; ejection is not normally to be attempted unless each of these conditions is satisfied.

WARNING: If the command ejection system is operative the rear seat occupant is not to initiate ejection unless the front seat occupant is also strapped-in; however, the pilot occupying the rear seat can deselect the operative command ejection system (by setting the selector lever to OFF) and eject independently.

MALFUNCTIONING

Ejection at Low Level

102. Successful ejection at low level requires observance of the limitations on dive angle, bank angle, airspeed and terrain clearance given in Fig 33 and Fig 34. The minimum ejection terrain clearances stated are the minimum heights required above ground level, presuming the surface to be level and unobstructed.

103. The aircrew must make the final decision as to the minimum safe height from which an ejection can be made in the prevailing conditions, but every effort must be made to initiate ejection well above the minimum height.

104. Fig 33 and Fig 34 show the ejection seat performance capability (either when fired individually or when fired by the command ejection system) from the instant of the first pull of a seat firing handle, ie no allowance for pilot reaction time has been made. The data is presented in terms of IAS and actual (not barometric) height and are applicable to steady-state unaccelerated flight conditions. Altitude effects on seat performance require that the given terrain clearance must be increased by 2% for every 1000 feet above sea level.

105. The ejection seats follow slightly divergent paths after ejection, the front seat diverging to the left and the rear seat to the right. This has the effect on the maximum bank angle which can be tolerated for a given minimum safe terrain clearance. The top graph of Fig 34 shows the bank angle correction, for divergence, which must be applied to the value used in the main figure. For example, from the main graph, an aircraft at

200 knots IAS with 90L bank requires a minimum terrain clearance of approx 75 feet; however, since the front seat diverges to the left, a correction of about 5L (see top graph) must be applied, giving a maximum tolerable bank angle of 85L in these flight conditions. Similarly, since the rear seat diverges to the right, a bank angle of about 95L can be tolerated.

Failure of Seat to Eject

106. If the seat fails to eject, immediately check that the seat firing handle safety pin is removed and pull the handle sharply again. If, with the command ejection system operative, the front seat fails to eject in sequence, the front occupant is immediately to pull his own seat firing handle. If a seat fails to eject, abandon the aircraft using the following procedure:

a. Disconnect PSP lowering line and side connectors (both if possible).

b. Disconnect PEC.

c. Pull through the leg-restraint lines from garter rings or release the garters.

d. Operate the MDC firing handle. Lower visor and sit erect, grasp the MDC firing handle, close eyes tightly and pull MDC firing handle.

e. Trim fully forward and invert aircraft.

f. Release control column.

g. Operate manual separation handle (with seat firing handle pulled fully upwards).

WARNING: When carrying out this procedure do not operate the QRF.

107. In the above procedure emergency oxygen is not available for the descent, therefore the aircraft should, if possible, be abandoned below 10,000 feet. The developing parachute imposes high loads on the occupant and it is possible that collision with the tail fin may occur. The PSP does not accompany the occupant; if possible, therefore, do not attempt the escape over water.

Manual Separation

WARNING: If automatic separation of the front seat occupant fails following command ejection, he must first pull the seat firing handle, to release the interlock, before pulling the manual separation handle.

108. If automatic separation from the seat fails to occur below main barostat altitude, look for and grasp the MANUAL SEPARATION HANDLE, press the thumb button on top of the handle and then pull the handle upwards.

Failure of Automatic Sequence After Ejection

109. **Drogue Gun Failure.**

a. **Failure Above Main Barostat Altitude.** If the drogue gun fails to fire during an ejection sequence initiated above main barostat altitude, the seat is unstabilized and descends in this condition until the BTRU operates at main barostat altitude. Without the drogues, the seat may descend in a stable condition, in which case the occupant can wait for BTRU operation. If, however, the seat gyrates in a manner which causes severe discomfort or which may result in the occupant losing consciousness, pull the manual separation handle. This action deploys the drogues and parachute and releases the harness; man/seat separation is almost instantaneous. Operation of the manual separation handle, if possible, is to be delayed until the seat has descended to an altitude where tolerable oxygen and temperature conditions exist.

b. **Failure Below Main Barostat Altitude.** If the drogue gun fails to fire during an ejection sequence initiated below main barostat altitude, the occupant is to assume that the BTRU has failed and is to pull the manual separation handle immediately to initiate parachute deployment and man/seat separation.

110. **BTRU Failure.** If the BTRU fails to operate at or below barostat altitude, the drogue-stabilized seat continues its descent without automatic man/seat separation. The manual separation handle is to be pulled to fire the BTRU cartridge and thus initiate separation.

Emergency Ground Egress

WARNING: The manual separation handle must not be used for ground egressing.

111. In certain emergency ground escape situations, consider ejecting if necessary (occupant must be fully strapped in).

WARNING: If the decision to eject is made, the canopy must be closed and locked.

112. Where the use of the ejection seat has been rejected, use the following manual escape procedure:

a. Select the throttle to HP OFF.

b. Correctly fit the seat firing handle safety pin.

c. Open the canopy or operate the MDC.

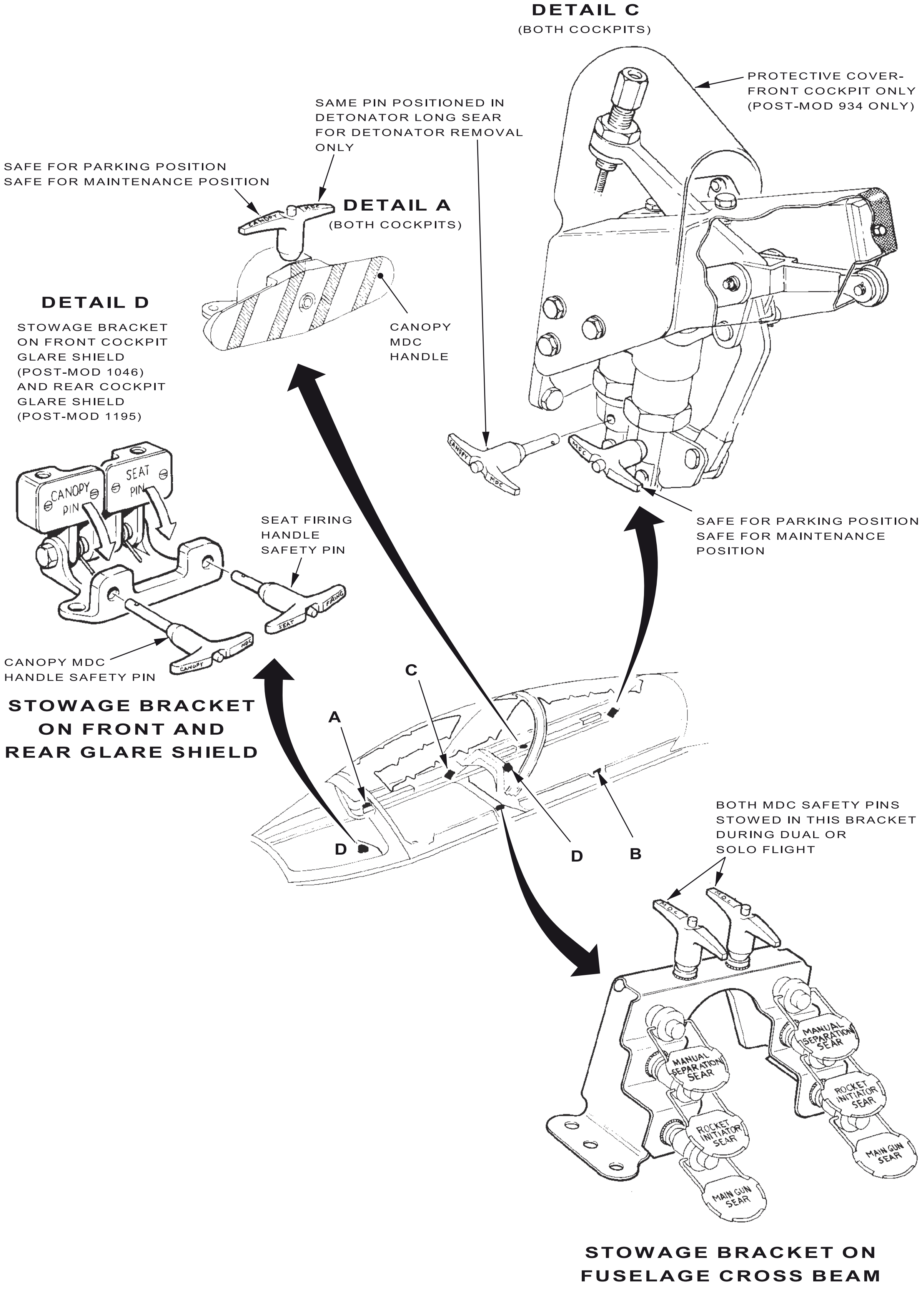
d. Unstrap completely. Release the QRF, disconnect the PEC and PSP lowering line and pull through or release the leg restraint lines/garters.

e. Vacate the aircraft and if appropriate move away upwind.

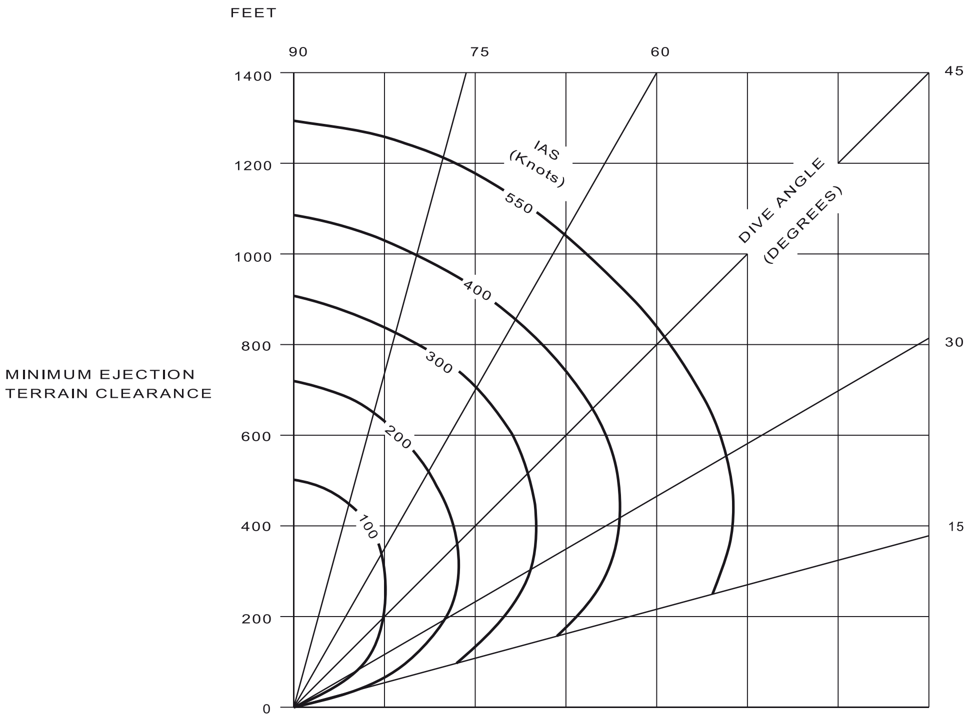
113. If a single ejection takes place and the aircraft is subsequently landed by the remaining pilot, operation of the MDC may provide the only means of egress if rapid evacuation of the aircraft is necessary. After operation of either ejection seat the outer tube of the ejection gun barrel is extended and prevents normal opening of the canopy. If time and circumstances permit, appropriate engineering assistance may be requested to allow the pilot to get out of the cockpit. However, the pilot should not hesitate to operate the MDC if circumstances warrant.

Escape on/in Water

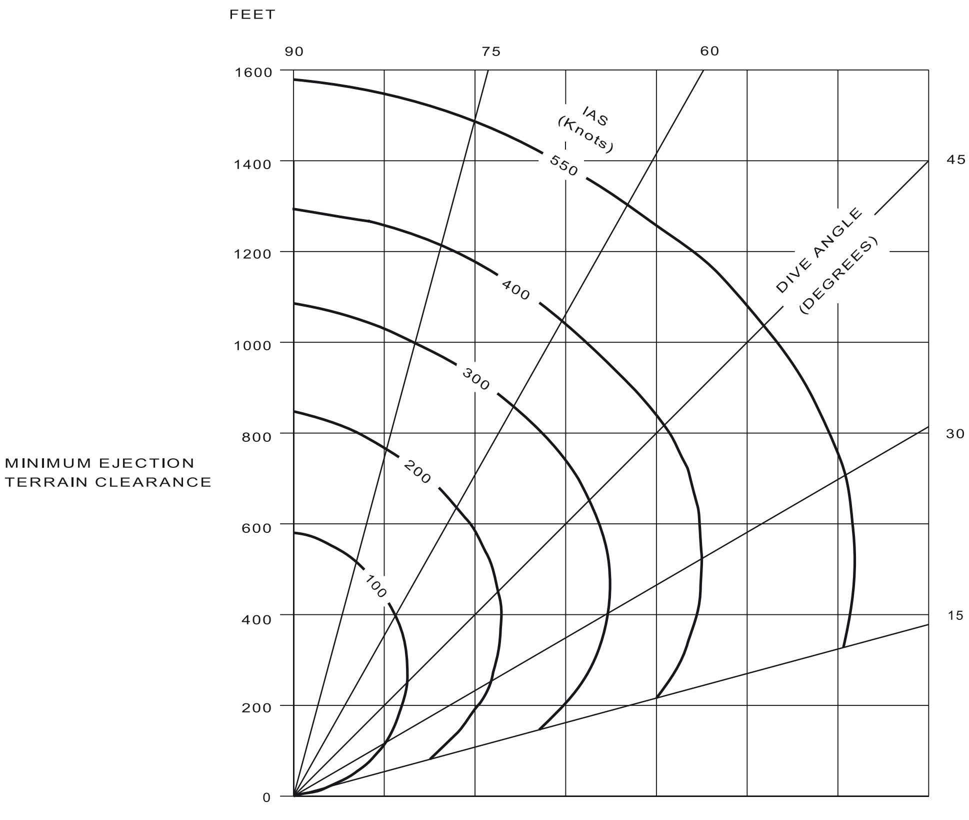
114. If ejection from a ditched aircraft is impossible carry out the Emergency Ground Egress procedure (para 112) but do not operate the MDC until after all other unstrapping/disconnection actions are completed. If feasible, disconnect the nearer of the two PSP side connectors and lift out the PSP. When clear of the aircraft inflate and board the liferaft.



1 - 9 Fig 32 Ejection Seat and MDC Safety Pin Stowages



EITHER SEAT INDEPENDENT EJECTION

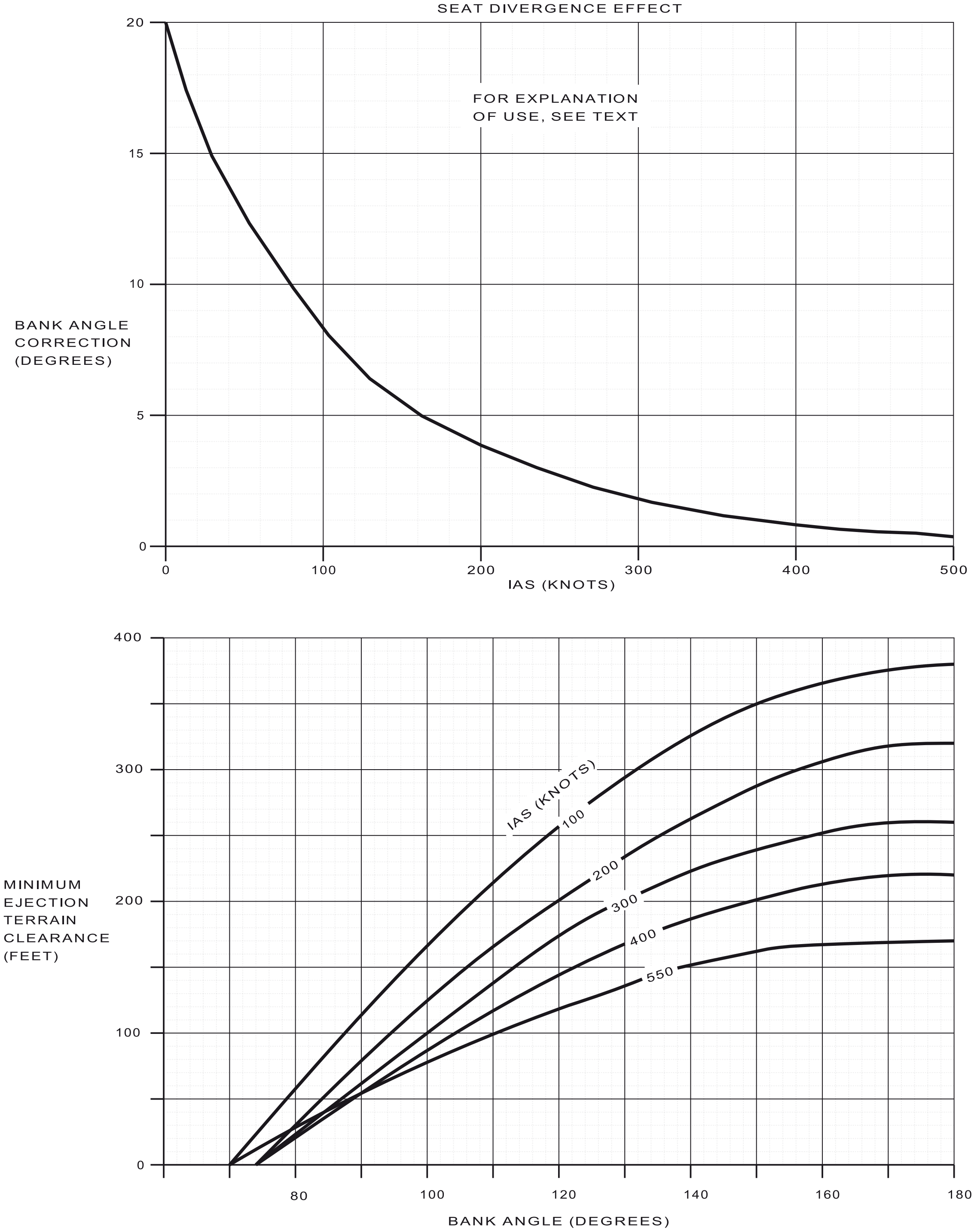


FRONT SEAT COMMAND EJECTION (0.35 SEC DELAY)

ROLL ATTITUDE LEVEL
IAS SEA LEVEL (SEE TEXT)
DATA: TEST AND CALCULATED

HS/HAW/GEN0070929/0317

1 - 9 Fig 33 Minimum Ejection Terrain Clearance vs IAS and Dive Angle



NOTE PITCH ATTITUDE LEVEL
IAS SEA LEVEL (SEE TEXT)
DATA: TEST AND CALCULATED

DAPS/HAW/GEN0070930/0730

1 - 9 Fig 34 Minimum Ejection Terrain Clearance vs IAS and Bank Angle

PART 1

CHAPTER 10 - OXYGEN SYSTEMS

Contents

DESCRIPTION

General

1. A gaseous main oxygen system provides both occupants with a common supply from two 1400-litre cylinders behind the rear cockpit bulkhead. A 70-litre cylinder on each seat provides a gaseous emergency supply for each occupant; it is selected on automatically during ejection or can be selected manually at any time.

2. A charging point for the main cylinders, on the left side of the nosewheel bay, has a shut-off control and a captive cover. The emergency cylinders have individual charging points. A main system contents gauge is in each cockpit and a contents gauge is on each emergency cylinder.

3. An outlet from the main cylinders is routed through a combined pressure reducing valve (outlet pressure 4·8 to 5·8 bars) and relief valve before dividing to provide a separate supply line to each cockpit. In each cockpit the main oxygen flow reaches the seat via a shut-off valve, a flow indicator transmitter and a low pressure switch. At the seat the supply is connected at a pull-off bayonet connector and then flows via a coupled pressure demand regulator/PEC and the PEC tube to the face mask.

4. From each emergency cylinder the supply flows through a pressure reducing valve (outlet pressure 3·45 bars) to the pressure demand regulator via the main system supply line which it joins upstream of the regulator. A non-return valve at the pull-off connector (para 3) prevents feedback of the emergency supply into the main system.

5. The endurance of the main supply, when the regulator is set for oxygen economy (air mixture) is approximately 4·5 hours when the aircraft is flown dual and approximately 7 hours when the aircraft is flown solo.

6. The emergency supply is designed primarily to provide the seat occupant with a supply of 100% oxygen during the descent of the drogue-stabilized seat after ejection at high altitude. If the system is selected manually without ejection it has an endurance of approximately 3·5 minutes at low cabin altitudes and approximately 11·5 minutes at high cabin altitudes.

Note: An oxygen cylinder contains a fixed mass of oxygen, and a constant volume is used for each breathing cycle. The pressure of the inspired oxygen (and thus the mass flow) reduces with increasing cabin altitude. Hence, the endurance of the system is greater at altitude than at low level.

Controls and Indicators

7. The oxygen system controls and indicators, which are similar in each cockpit, are listed in Table 1and shown at Fig 2.

Table 1 - Oxygen System Controls and Indicators

Control/Indicator	*Marking*	*Location*
Main supply selector (2-position rotary control)	OXYGEN-ON/OFF	Right Console
Main supply contents gauge	OXY	Right Panel
Flow magnetic indicator (Main system only)	OXY	Right panel
Regulator change-over selector (2 position slide control)	100← (arrow points forward)	On regulator (rear left of seat)
Test button	-	On regulator
Emergency supply control	Black and yellow ring	Left side of seat pan
Emergency supply contents gauge	Two coloured segments -Green (full); orange marked REFILL	On top of emergency supply cylinder
Oxygen supply low pressure caption (Main system only)	OXY	CWP

Main Supply Selector

8. The main supply selector operates the shut-off valve which controls the oxygen supply to the associated seat. The valve is open when the selector is pointing forward and closed when the selector is athwartships.

Main Supply Contents Gauge

9. The main supply contents gauge is a direct reading gauge showing cylinder pressure in terms of contents. The gauge scale is graduated in eighths from full (F) and has major markings at quarter intervals; below 1/8 the scale is coloured red. When the needle registers in the red sector the system is to be considered empty.

Main Supply Flow Indicator

10. The oxygen flow magnetic indicator in each cockpit functions in respect of the main oxygen supply only. The indicator in each cockpit is electrically operated by a flow transmitter in the supply line to the appropriate seat. An indicator is de-energised and shows black when no oxygen is flowing or there is no electrical supply: it is energised to show a white vertical bar when oxygen flows. When the main oxygen system is in operation the indicator should give alternating black and white bar indicators in time with the user's breathing. At high altitude, when breathing may be shallow, the flow of oxygen may not be sufficient to operate the transmitter and the indicator remains black; the user is to immediately check the integrity of the indicator by breathing more deeply.

Main Supply Low Pressure Warning

11. The main supply low pressure warning is controlled by the low pressure switch which closes to illuminate the OXY when the main system pressure to the associated seat is below 3·10 to 3·45 bars. The caption illuminates only in the cockpit of the affected seat but the attention lights and the audio warning are activated in both cockpits. If the main oxygen supply pressure to the seat rises to 4·15 bars or above, the warning is cancelled.

Pressure Demand Regulator

12. The pressure demand regulator is a two-in-one unit which is coupled to the seat portion of the PEC. The regulator provides a controlled air/oxygen mixture or a 100% oxygen breathing supply to the mask at all cabin altitudes up to 50,000 feet and has the following main components:

a. Air/oxygen mixture regulator.

b. 100% oxygen regulator.

c. Regulator changeover selector.

d. Dump valve.

e. Test button.

13. **Air/Oxygen Mixture Regulator.** When the air mixture regulator is in use an air/oxygen mixture is supplied to the mask. The proportions of the mixture are progressively adjusted by an aneroid up to a cabin altitude of approximately 30,000 feet; above this altitude no air is admitted and the regulator delivers 100% oxygen. The mask hose delivery pressure is adjusted by the regulator according to the cabin altitude as follows:

a. Below approximately 15,000 feet cabin altitude, the regulator delivers a supply to the mask, at ambient pressure, only when the user inhales.

b. Above approximately 15,000 feet cabin altitude, the mask hose delivery pressure is in excess of cabin pressure, providing a safety pressure.

c. Above approximately 38,000 feet cabin altitude, the mask hose delivery pressure increases as altitude increases, providing pressure breathing up to a maximum cabin altitude of 50,000 feet.

14. **100% Regulator.** When the 100% regulator is in use, undiluted oxygen is supplied to the mask irrespective of cabin altitude and safety pressure is provided from sea level. Above approximately 38,000 feet cabin altitude, pressure breathing is in operation as with the air mixture regulator.

15. **Regulator Changeover Selector.** The sliding changeover selector is used to select the required regulator. The air mixture regulator is in operation at the aft setting and the 100% regulator at the forward setting. The selector is to be set positively to the full extent of its travel in the required direction; since the selector is not visible to the seated occupant it has to be located and moved by feel. Whenever the emergency oxygen system is selected on, the changeover selector is automatically set to 100% and brings the 100% regulator into operation.

16. **Dump Valve.** The dump valve is a pressure-compensated relief valve which is sensitive to mask hose delivery pressure and to cabin pressure; it ensures that no rapid increase in delivery pressure takes place if cabin decompression occurs or if the regulator fails.

17. **Test Button .** The test button allows the occupant to check his face mask for correct fit and to test the system and connections for leaks. Pressing the button increases the flow and pressure at the mask to confirm that there are no significant leaks; any escape of oxygen from around the mask indicates that the mask is not properly fitted. The test is effective only with the air mixture regulator selected.

Mask and Mask Hose

18. The oxygen mask is connected to the helmet by cables. A bayonet connector joins the mask hose to the PEC oxygen tube which is secured to the front of the life preserver by a dog-lead clip. The PEC tube is restrained at the left side of the life preserver by a flap which allows the occupant to position the tube to prevent elbow obstruction and which prevents flailing of the tube and PEC man portion after man/seat separation following ejection.

Emergency System

19. The emergency oxygen cylinder, on the rear left side of each seat pan, has a charging point (via which the cylinder can be charged in situ), a contents (pressure) gauge, and an operating lever which is connected to manual and automatic release mechanisms on the seat. A transit safety pin can be fitted to the emergency cylinder operating mechanism to prevent inadvertent operation during maintenance. The pin is fitted near the head of the cylinder on the aft side and its removal must be checked before strapping-in.

20. An emergency cylinder is selected on manually by pulling its seat-mounted control ring sharply upwards and backwards to actuate the cylinder operating lever. The control ring requires a pull force of between 20 and 30 lb; when the ring is pulled, a red band is exposed on the ring mounting. Once an emergency supply has been selected on it cannot be turned off. The emergency system is automatically selected on during the seat ejection sequence when an aircraft-mounted striker engages the cylinder operating lever. There is no flow indication when emergency oxygen is being used.

Note: It may be necessary for some seat occupants to ease their left thigh away from the control ring, to prevent obstruction of the ring when it is being pulled.

21. Since the outlet pressure at the reducing valve in the emergency system is lower than the outlet pressure at the reducing valve in the main system, emergency oxygen cannot flow if the emergency system is selected on when the main system pressure is dominant. If the emergency supply is required in these conditions, eg, contaminated main supply, the main supply selector is to be set to OFF.

22. Since the emergency system is seat mounted, the supply is lost when man/seat separation occurs.

NORMAL USE

Before Flight

23. Check the system in accordance with the drills in the Flight Reference Cards. Since the emergency system contents gauge cannot be viewed when the occupant is seated, it is to be checked during the before strapping-in checks of the ejection seat. The main oxygen system is not to be less than half full.

Note: Back pressures, created at the regulator by flexing of the oxygen tube or by breathing into the face mask before the oxygen supply has been selected ON, can damage valves within the regulator. To prevent damage, the PEC man portion is only to be connected to the PEC seat portion (seeChapter 9) after the oxygen supply has been selected ON. Similarly, after flight, the man portion is to be disconnected and the PEC seat portion dust cover fitted before the oxygen supply is selected OFF.

24. **Testing the System.** After strapping-in, make the following system checks:

a. **With Air Mixture Selected.** Check that the OXY flow indicator shows a white bar during inhalation and black both when exhaling and when holding the breath. Press the test button; check that pressure is felt at the mask and that the flow indicator gives black/white bar indications during three consecutive breathing cycles. Release the test button. Select 100% regulator (forward setting).

b. **With 100% Selected.** Check that the flow indicator gives the correct response in time with breathing (sub-para 24a.). Lift the edge of the mask from the face and check that the flow indicator shows a steady white bar. After the test, select air mixture (aft setting).

Note: The above tests are to be made independently in each cockpit.

In Flight

25. The system is selected on before strapping-in and should remain on throughout the flight. The regulator selector should normally remain at air mixture; it should only be changed to 100% if it is suspected that the air mixture regulator has failed or if another emergency calls for selection of 100% oxygen (see Flight Reference Cards). Periodic checks should be made of the oxygen contents and of the operation of the flow indicator.

26. The emergency oxygen supply is of limited duration and once selected it cannot be turned off; therefore its use is to be restricted to emergency situations only.

After Flight

27. After disconnecting the PEC and fitting the PEC dust covers, turn the oxygen supply OFF and set the regulators to 100% in both cockpits.

MALFUNCTIONING

General

28. Indication of main oxygen system malfunction can be given by illumination of the OXY caption, by the flow indicator, by signs of abnormal consumption, by physical sensation or by a combination of these indications. The flow indicator may continue to indicate normal flow when the system pressure is below the minimum required by the user; therefore, the illumination of the OXY caption is always to be regarded as genuine unless by a process of cross-checking it is proved to be spurious. Indications of a system malfunction may not appear simultaneously in both cockpits; therefore, any indication of failure given in one cockpit should, where possible, be cross-checked with the other. Note that a failure downstream of the main supply selector affects the associated cockpit only.

29. Malfunction of a demand regulator in either cockpit could occur in the air mixture or the 100% regulator but is unlikely to occur in both regulators at the same time. Therefore, if a regulator failure is suspected, set the changeover selector to the alternative setting and check that the failure symptoms have disappeared.

30. If a system malfunction is indicated, by either illumination of the OXY caption, a steady indication of the flow indicators or by difficulty in breathing investigate the situation as follows:

a. Check all connections and the mask seal.

b. Check that the system is selected ON.

c. Check that the contents are sufficient.

31. If the contents are above zero select 100% to try the other regulator. If this alleviates the problem, continue the sortie but monitor the oxygen contents and the flow indicator. If the contents are zero, breathing is restricted or supply is not restored immediately, pull the emergency oxygen ring.

32. If the emergency system is selected manually, make an immediate descent to below 10,000 feet cabin altitude, since the duration of the emergency supply is limited and there are no means of monitoring the system contents or operation. If the main system pressure has failed or the system has been turned off, the OXY caption remains illuminated and the flow indicator shows black. Once the emergency supply is exhausted disconnect the main oxygen hose.

33. If a flow indicator remains white when safety pressure is being delivered (cabin altitude above approximately 15,000 feet) check to ensure that oxygen is not leaking from the mask. Although this situation should not cause breathing difficulties it may result in rapid oxygen depletion. The usual cause is a stuck expiratory valve in the mask which can often be re-seated by a sharp exhalation.

34. If there is resistance to breathing, not associated with pressure breathing, confirm that the air mixture regulator is selected and then, while lifting the mask off the face, press the test button. Replace the mask on

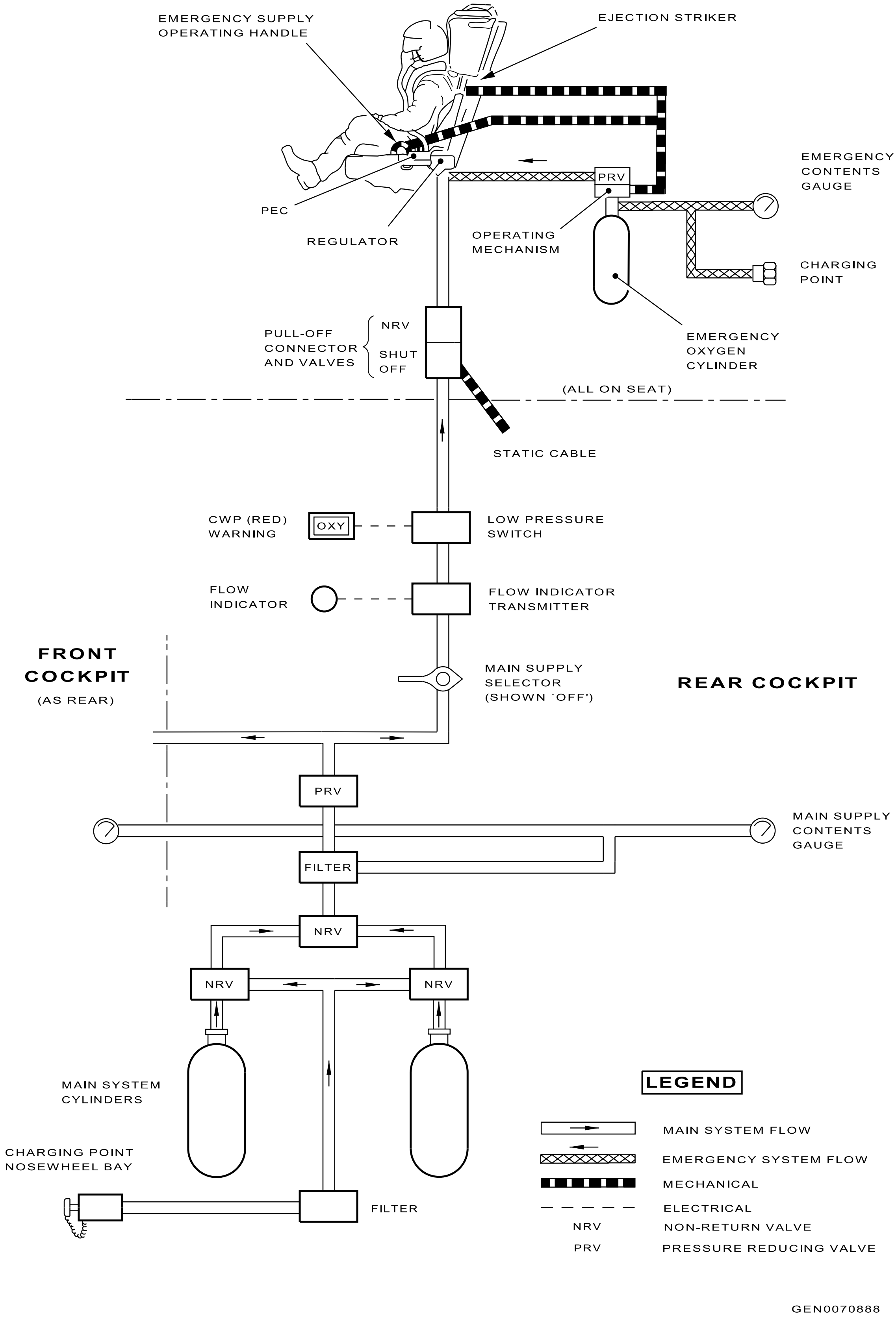
the face. If the fault persists, lift the edge of the mask from the face to breathe out and descend below 10,000 feet cabin altitude.

High Consumption

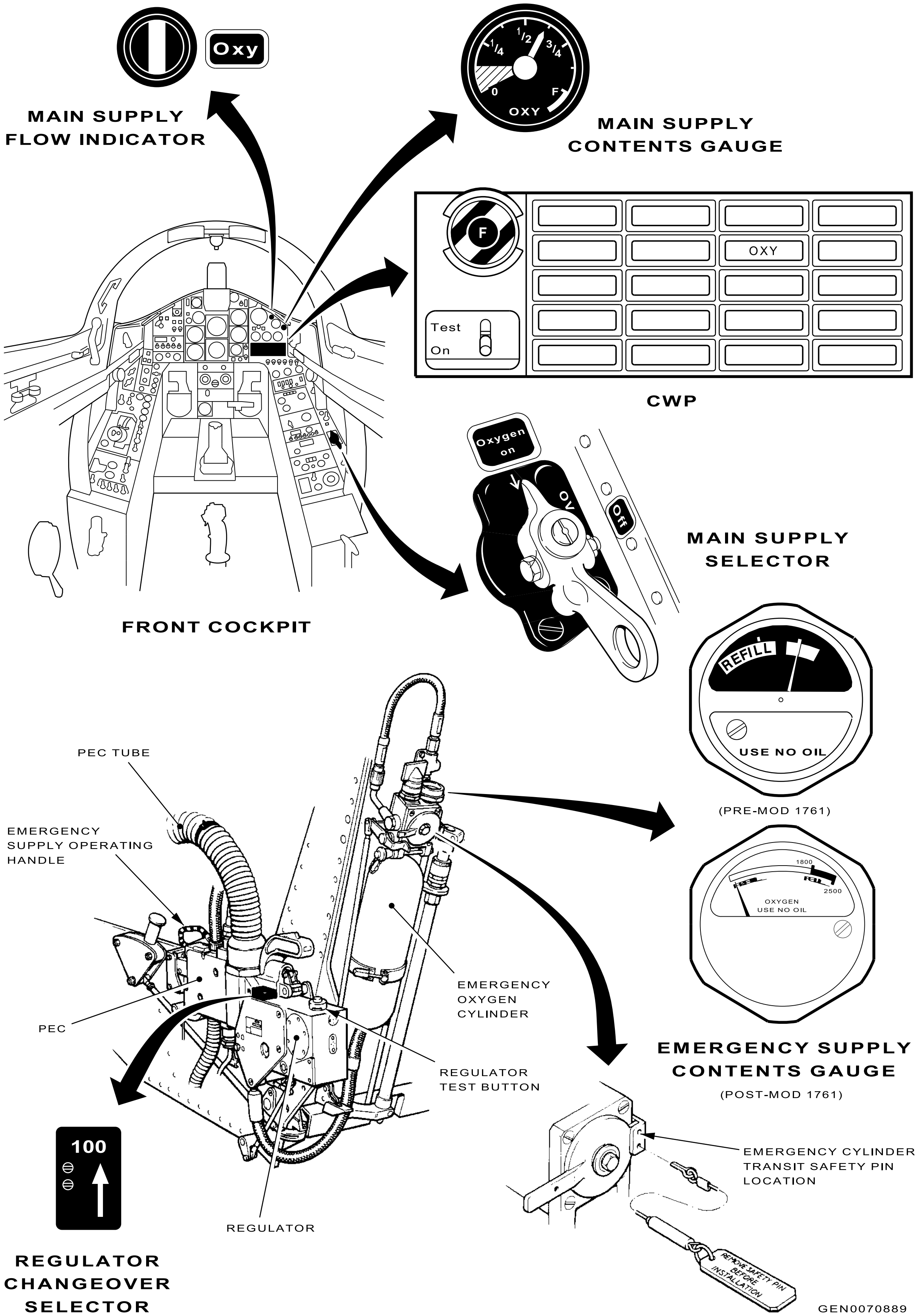
35. If the contents gauge indicates that oxygen consumption is higher than expected, check the mask and system connections for leaks and descend below 10,000 feet cabin altitude while oxygen endurance remains. Selecting 100% may isolate a leak in the air mixture regulator. Other leaks downstream of the main supply selector may be isolated by setting the selector to OFF after first selecting emergency oxygen in the associated cockpit; this action may preserve the main supply for use in the other cockpit (when appropriate). However, remember that the location of the leak may permit the escape of emergency oxygen after it has been selected on.

Suspected Hypoxia

36. If symptoms of hypoxia are experienced check PEC and mask hose connections are made and that the mask is making a correct seal on the face. If the oxygen flow is not restored select emergency oxygen and descend rapidly below 10,000 feet cabin altitude. If one occupant observes symptoms of hypoxia in the other occupant he is to initiate the descent while encouraging the other occupant to check his oxygen system and/ or to select emergency oxygen.



1 - 10 Fig 1 Oxygen System - Schematic



1 - 10 Fig 2 Controls and Indicators

PART 1

CHAPTER 11 - FLIGHT INFORMATION DISPLAYS AND INSTRUMENTS

Contents

DESCRIPTION

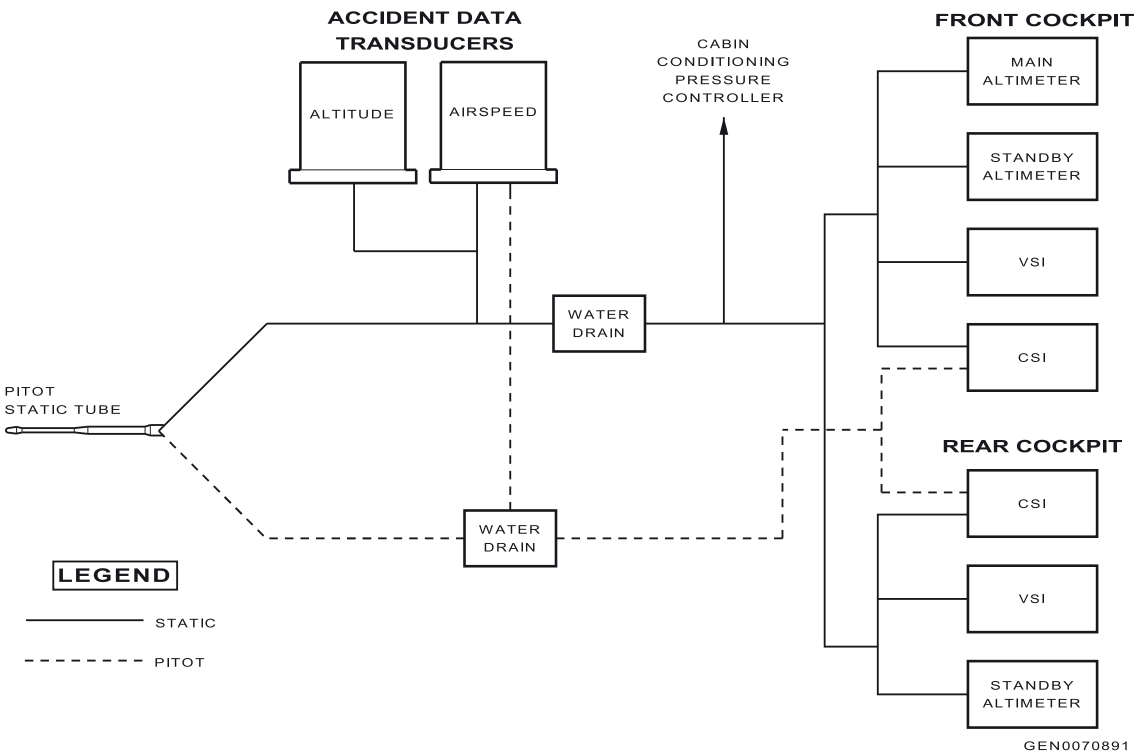
General

1. A primary flight instrument display, on the centre panel in each cockpit, comprises a Combined Speed Indicator/machmeter (CSI), a main altimeter, a main attitude indicator, a turn-and-slip indicator, a Vertical Speed Indicator (VSI) and a Horizontal Situation Indicator (HSI). Each cockpit also has a standby attitude indicator and a Directional Gyro Indicator (DGI) on the centre panel, a standby altimeter on the right panel and a standby magnetic compass on the canopy centre line.

2. An Attitude and Heading Reference System (AHRS) provides pitch and roll information to the main attitude indicators and gyromagnetic compass heading or Directional Gyro (DG) heading to the HSI in each cockpit. ILS glidepath and localiser information and Tacan range and bearing information or Tacan range, bearing and steering information are presented on each HSI by selection at a navigation mode selector (Chapter 13) in the front cockpit. Power for either system is from the AC busbar; if this supply fails, a display of attitude and of direction is provided by the standby attitude indicator and the DGI respectively. The CSI, HSI, main altimeter, main attitude indicator, VSI and the DGI have integral lighting (Chapter 12).

Pitot-Static System

3. An aerodynamically-compensated pitot-static tube is on the nose of the aircraft. The tube is shaped in the vicinity of the static holes so as to induce, locally, a static pressure equal and opposite to that caused by the aircraft's presence. The pitot entry is shaped to minimize errors in total pressure up to high incidence. An outer sheath on the tube has a heater element which is supplied with 28 volts DC from the Essential Services busbar. The power supply is controlled by a 2-position PITOT HT switch at the aft end of the left console in the front cockpit.



1 - 11 Fig 1 Pitot - Static System

4. The pitot-static system (Fig 1) supplies the following cockpit instruments:

a. Main altimeter (repeater in rear cockpit).

b. Standby altimeters.

c. VSI.

d. CSI.

5. Tappings from the pitot and static lines provide inputs to altitude and airspeed transducers in an accident data recorder. An additional tapping from the static line gives a datum for the cabin pressurization system controller.

PRESSURE OPERATED INSTRUMENTS

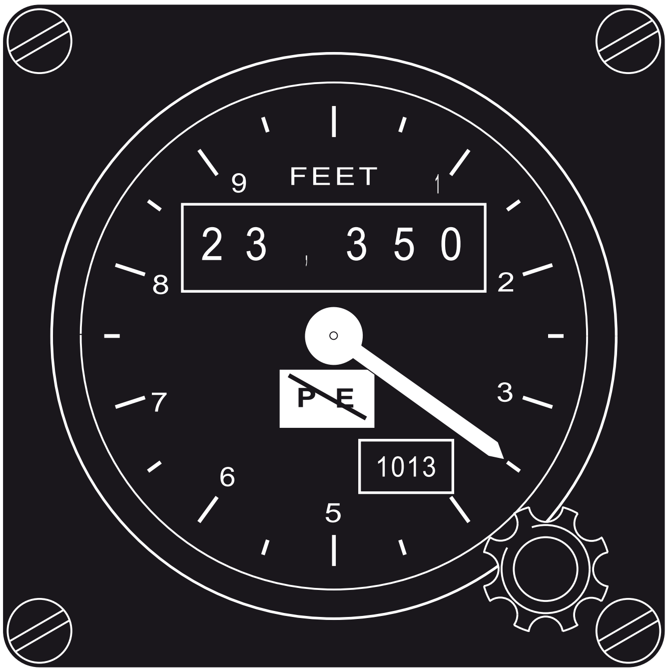
Main Altimeter

6. A Mk 3B servo-type altimeter (Fig 2) in the front cockpit gives indications of altitude on a counter and by a single pointer. The altimeter, which uses inputs of static pressure, has a range of operation from minus 2265 to 50,000 feet. The instrument is electrically driven and provides electrical outputs to a Mk 3C repeater-type altimeter in the rear cockpit. On both altimeters the pointer makes one full rotation for each thousand feet of altitude. Each altimeter has a 4-drum, 5-digit counter which indicates altitude in increments of 50 feet. Between zero and 9950 feet, the tens of thousands of feet digit is obscured by a black and white striped flag; below zero feet, however, the digit is obscured by a red and white flag. Altitude below zero feet is calculated by adding the indicated height to minus 10,000 feet, eg, a true pressure altitude of minus 150 feet is indicated by the red and white flag obscuring the tens of thousands of feet digit with the altimeter display reading 9850 feet (minus 10,000 feet +9850 feet).

7. **Altimeter Pressure Datum.** Both the Mk 3B and the Mk 3C altimeters have a pressure datum setting control, at the lower right-hand corner, for adjusting the millibar scale of a 4-digit pressure setting indicator in the face of the instrument. The controls of the front and rear cockpit altimeters are not interconnected.

8. **Altimeter Coded Output.** A digitizer in the front cockpit altimeter gives a continuous coded output of altitude to the IFF/SSR equipment. The coded output is related to 1013·25 mb and is not affected by changing the setting of the millibar scale.

9. **Altimeter Ground Test.** A 2-position switch, spring-loaded to off, marked ALTIMETER TEST, is at the forward end of the left console in the front cockpit; a similar switch on the centre panel in the rear cockpit is similarly marked. The front cockpit switch, collectively marked GROUND USE ONLY with the ignition switch (Chapter 4), enables the electrical operation of both altimeters to be tested. The rear cockpit switch enables the Mk 3C altimeter servo to be tested in isolation from the Mk 3B servo. When the front cockpit switch is held on, with power applied to the altimeters, the altitude indication on both altimeters should progressively increase by a fixed value irrespective of the setting of the millibar scale. The value increases with increasing instrument altitude above sea level; at sea level the value is 5000 ±300 feet and at 5000 feet AMSL it is 5415 ±325 feet. When the switch is released the altimeters should progressively return to their previous indication. When the rear cockpit switch is held on, the rear cockpit altimeter indication should progressively increase until a value of 11,100 ±200 feet is indicated; the front cockpit altimeter indication remains unaltered. While the altimeters are running up to, or down from, the test values, the altitude counter is obscured by a red and black striped bar. If the rear cockpit switch is held on while the front cockpit switch is at on, the rear cockpit indication should then increase to 11,100 ±200 feet. The altimeter test switches are not to be operated in flight.



1 - 11 Fig 2 Altimeter Mk 3B

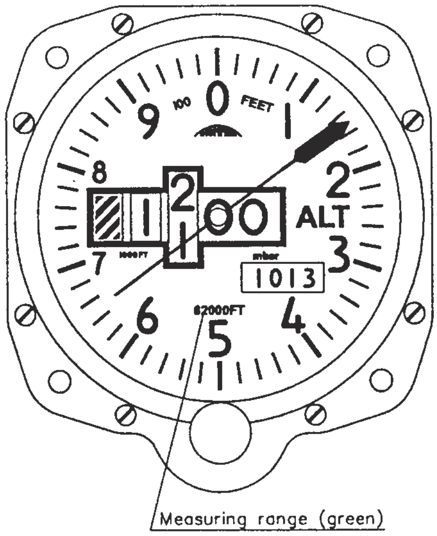
10. **Altimeter Power Supplies.** Both altimeters are supplied with AC from the No 3, 26 volt, AC busbar; if the power supply fails or if the servo mechanism runs away, the altitude counter is obscured by the red and black striped bar. The front cockpit altimeter has, at the centre of its face, a window in which a black flag is displayed when a 28-volt fuse-protected supply from the Generator busbar is present at the instrument. If the DC supply fails the black flag is replaced by a white flag with black letters PE. This does not affect the servicability of the front cockpit instrument because it is a pressure error signal and not a DC voltage direct from the Generator busbar, but causes the red and black striped bar to obscure the altitude counter of the rear cockpit altimeter, rendering it unusable.

Standby Altimeter

11. **Description.** Post Mod 2122, a Revue Thommen (RT) Mk 3A Altimeter (Fig 3) is fitted on the right panel in each cockpit. The altimeter gives indications of altitude on a counter and by a single pointer. The single pointer makes one full rotation for each thousand feet of altitude. Each altimeter has a 3-drum, 5-digit counter which indicates altitude in increments of 100 feet. Between zero and 9900 feet, the tens of thousands of feet digit is obscured by a black and white striped flag; below zero feet, however, the digit is obscured by a red and white flag. The altimeter, which uses inputs of static pressure, has a range of operation from -1500 to +62,000 feet and a operating temperature range of -40 °C to +75 °C.

12. **Altimeter Setting .** The altimeter barometric setting is indicated on a 4-digit pressure setting indicator in the face of the instrument which is adjusted by a barometric setting knob in the 6 o'clock position. The barometric range is 900 to 1050 mb.

13. **Limitations.** Although the altimeter incorporates a vibrator it is not electrically connected. As a result of lag in the altimeter a standby pressure instrument allowance of 100 feet must be added to procedure minima.



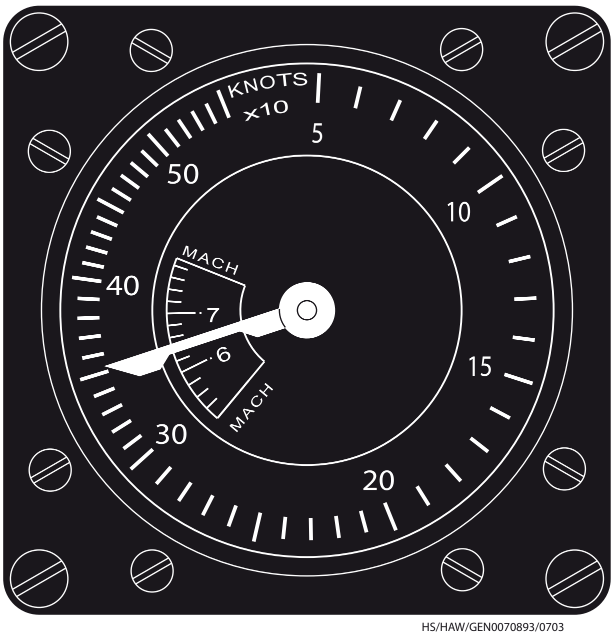
1 - 11 Fig 3 Post Mod 2122 Revue Thommen Mk 3A Standby Altimeter

Vertical Speed Indicator

14. The VSI is calibrated in thousands of feet per minute and registers positive and negative vertical speed to a maximum of 6000 feet per minute.

Combined Speed Indicator

15. The CSI (Fig 4) gives indication of airspeed and mach number derived from pitot and static pressure. Airspeed is indicated by a pointer which moves against a scale graduated from 50 to 550 knots (VNE) in 10 knot increments. Mach number is shown on a scale which is displayed in a window and read against the airspeed pointer; the scale is calibrated from 0·3 to 1·2 in increments of 0·02M. The mach number scale moves independently of the airspeed pointer and the scale window to maintain the correct relationship between airspeed and mach number.



1 - 11 Fig 4 Combined Speed Indicator

ELECTRICALLY OPERATED INSTRUMENTS

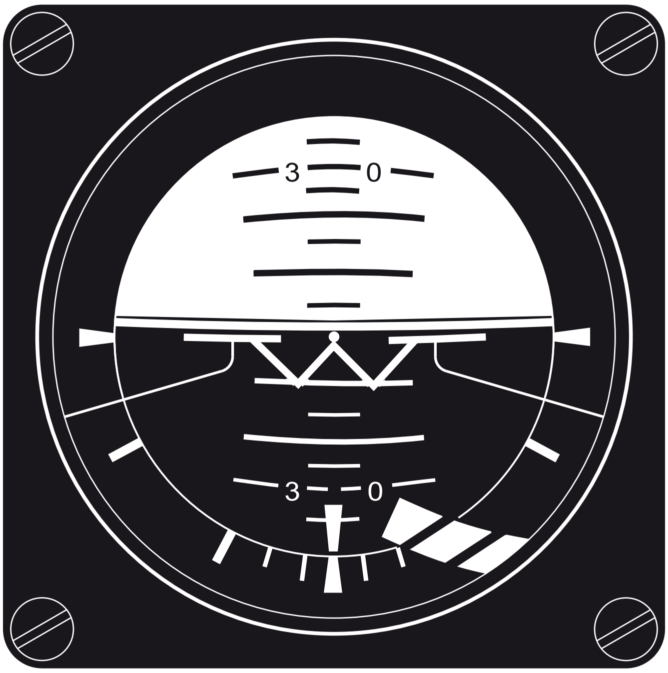
Standby Flight Instruments Power Switch

16. A 2-position switch, STBY INST-NORMAL/BATT, is on the centre panel in each cockpit. When the switch is set to NORMAL, a 28-volt DC supply from the Essential Services busbar provides power for the turn-and-slip indicator, the standby attitude indicator and the DGI. When the switch is set to BATT, these instruments are powered by commoned supplies from No 1 and No 2 Battery busbars.

Main Attitude Indicator

17. The main attitude indicator (Fig 5) in each cockpit is of the moving ball type; it receives pitch and roll attitude signals from AHRS Navigation Sensing Unit. The moving ball has a grey top half with black pitch attitude markings, representing the area above the horizon, and a black bottom half, with white pitch attitude markings, representing the area below the horizon; a white line between the two halves represents the horizon. Pitch attitude is indicated by division lines, marked on both halves of the ball parallel to the horizon line at 5° intervals, read against a fixed yellow aircraft symbol. The division lines are numbered at 30° intervals from the horizon line to show 30°, 60° and 90° of climb or dive. The words CLIMB and DIVE are marked at the 45° division lines on the grey and black halves respectively. Roll attitude in each direction is measured by movement of an index against a fixed semi-circular scale which has 30° divisions up to 90° and 10° subdivisions to show bank angles up to 30°.

18. **Power Supplies.** The main attitude indicators are powered by a 115 volts 400 Hz supply from the AC supplies Junction Box and a 28 volts DC supply from the Generator busbar. Failure of either supply to a main attitude indicator or failure of a valid signal from the AHRS is indicated by the appearance of a red and black striped warning flag across the bank scale on the lower right of the indicator.



1 - 11 Fig 5 Main Attitude Indicator

Turn-and-Slip Indicator

19. Each turn-and-slip indicator has a pointer which indicates direction (left or right) and rate of turn and a ball which indicates slip or skid. The rate scale is graduated, left and right of a centre mark, with marks to indicate rate 1 and rate 2 turns. A warning flag appears in the presentation when the DC supply is interrupted or when the rotational speed of the gyro drops to a level whereby accuracy is impaired.

20. **Power Supplies.** A static inverter within each turn-and-slip indicator is powered from either the Essential Services busbar or from commoned supplies from No 1 and No 2 Battery busbars depending on

the setting of the STBY INST switch. After the application of power, the gyro requires three minutes to spin up to its operating speed; do not use the instrument within this period.

Standby Attitude Indicator

21. **Description:**

a. **General.** The standby attitude indicator (a FH32A artificial horizon) is smaller than the main attitude indicator but is similar in appearance (except that it has a white aircraft symbol) and presents similar information.

b. **Erection System.** The erection system is pneumatic, the air pressure being generated by a radial compressor machined into the gyro wheel itself. Control is by a gravity sensitive pendulum mechanism with roll and pitch acceleration cut out at 0·25g (14·5° bank). The normal erection rate is nominally 3° per minute.

c. **Errors.** The instrument panel is inclined 12° to the vertical and the instrument indication is therefore corrected to show straight and level flight when the instrument is tilted 12° nose down; this causes geometric pitch errors whenever bank is present. The maximum geometric pitch error is in inverted flight (ie, 180° bank) such that when the instrument indicates level inverted flight the aircraft nose is 24° below the horizon. Smaller pitch errors are present at all intermediate angles of bank eg, 6° nose up error at 60° bank, 12° nose up error at 90° bank. The instrument has full freedom in roll but reaches gimbal stops in pitch at 97° climb and 73° dive when it undergoes a controlled toppling so that, having passed through the zenith or nadir, it again indicates approximately correctly. However, if small amounts of left bank are present while pitching through the vertical this controlled toppling feature can produce gross errors. Even without pitching through the vertical significant errors can build up during combat manoeuvres or repeated range patterns. The indicator should therefore be checked for errors after any series of manoeuvres, particularly if 60° pitch has been exceeded.

d. **Caging.** To cage the instrument a caging knob at the lower right corner of the instrument face should be pressed fully in, using a constant pressure, until all oscillatory motion has ceased and the instrument has settled in the caged position (within 2° of datum). This may take up to 60 seconds. The knob is not to be jabbed repeatedly nor pressed with undue force. The knob should then only be released in straight and level flight. A red flag is displayed on the left side of the bank scale, between the 30° and 60° divisions, while the caging knob is pressed in. The caging knob is not to be used until at least 30 seconds after power has been applied to the instrument.

22. **Power Supplies.** The standby attitude indicator has an integral static inverter which provides AC to drive the gyro. The inverter is powered from either the Essential Services busbar or from commoned supplies from No 1 and No 2 Battery busbars, depending on the setting of the STBY INST switch. If the power supply to the indicator fails a red and black striped flag is displayed at the top of the instrument face. After the application of power, the gyro requires three minutes to spin up to its operating speed; do not use the instrument within this period.

Directional Gyro Indicator

23. The DGI has a rotating compass card graduated at 5° intervals and with alpha-numeric markings at 30° intervals. DG heading is indicated by a fixed white index above the top of the compass card. Pushing in and rotating a control knob, marked PUSH ALIGN and PULL V, on the lower right-hand corner of the indicator face, aligns the compass card to a desired heading. When the knob is pulled out and rotated, a yellow set heading index is moved round the edge of the compass card which remains in a fixed position. When the knob is released, the set heading index is locked to and rotates with the card as the aircraft changes heading. If 85° of pitch or roll is exceeded the gyro may topple. The DGI is provided as a standby instrument, for use if the compass function of the HSI fails.

24. **DGI Power Supplies.** The DGI contains a static inverter which is powered from either the Essential Services busbar or from commoned supplies from No 1 and No 2 Battery busbars, depending on the setting of the STBY INST switch; it can be used within three minutes of power being applied. If the static inverter fails, a red and black striped warning flag is displayed on the lower left-hand part of the compass card.

Attitude and Heading Reference System

25. **General.** The Attitude and Heading Reference System (AHRS) supplies signals which are representative of flight attitude and heading to indicating instruments and other user equipment within the aircraft. Aircraft pitch and roll attitude signals are displayed via the main Attitude Indicators (AI) situated one in each cockpit. Aircraft heading, Magnetic (SLV) or Grid (DG) depending upon the heading mode selected, are displayed via a Horizontal Situation Indicator (HSI) also situated one in each cockpit. The AHRS comprises the following units:

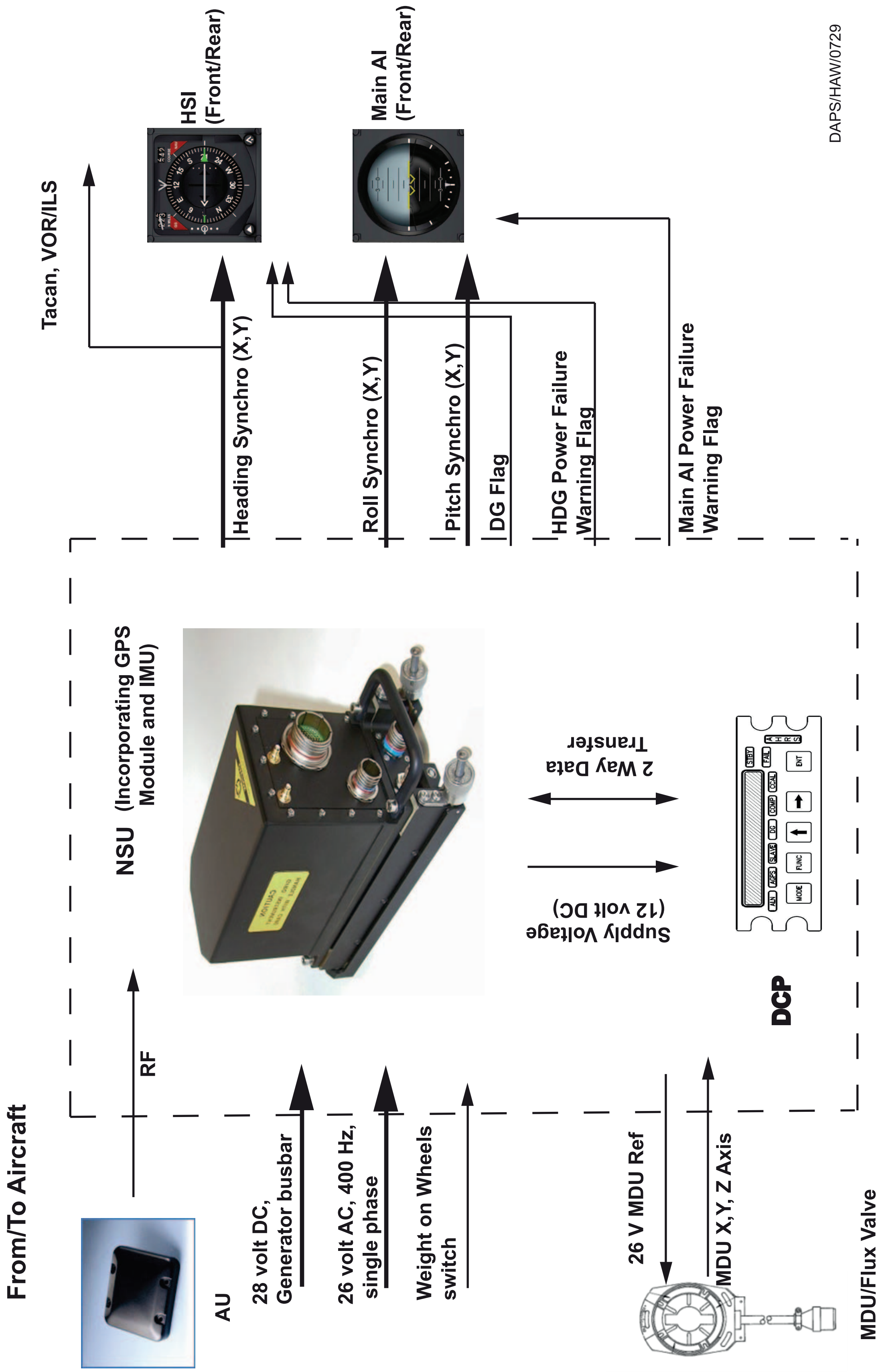
a. Navigation Sensor Unit (NSU), comprising an Inertial Measuring Unit (IMU) and GPS.

b. Digital Control Panel (DCP) Fig 7.

c. Magnetic Detector Unit (MDU).

d. Antenna Unit (AU).

26. **Navigation Sensing Unit (NSU).** The Navigation Sensor Unit is a strapdown attitude and heading reference system incorporating an embedded GPS receiver connected to the GPS Antenna Unit. The NSU also incorporates an Inertial Measuring Unit (IMU) to provide X, Y and Z axis angular rates and acceleration values. The modes/functions of the NSU can be selected by the Digital Control Panel installed in the front cockpit of the aircraft. The NSU uses the MDU to give a heading reference.



1 - 11 Fig 6 AHRS

a. **NSU Function.** As soon as electrical power is applied to the NSU, it performs a power-on sequence. Simultaneously, the DCP performs a power-up sequence and at the end of the power-up Built-In-Test (BIT) the message ‘AHRS START UP’ is momentarily displayed and communication with the NSU is established.

b. When the power-on sequence is completed and all conditions are valid, the NSU is ready to operate in the following modes:

(1) Standby (STBY).

(2) Alignment (ALN). Static, In-Flight or Suspended.

(3) AHRS/GPS (AGPS).

(4) SLAVE. Back-up mode (in case GPS is not available or failed) using MDU and IMU inputs.

(5) Directional Gyro (DG). Back-up mode in case GPS and MDU are not available or failed, using only IMU input.

(6) Compass (COMP). Back-up mode in case of IMU failure.

(7) FAIL state.

c. **Power Supplies.** The NSU operates using 28-volt DC from the Generator busbar. It also uses 26-volt AC, 400Hz, single phase as reference for analogue outputs and for MDU. The NSU will only power up once the aircraft generator comes online; the DCP will also not receive power until this point.

d. **NSU Startup.** The NSU enters STBY when the power-up sequence is completed or when standby mode is commanded by the DCP (on ground only). When this mode is active, the ‘STBY’ indicator is illuminated on the DCP. After the power-up sequence, if the initialization data is available and all conditions are valid, the NSU enters the alignment phase.

e. In alignment mode the ‘ALN’ indicator is illuminated on the DCP. There are three possible Alignment modes: Static, In-Flight or Suspended.

f. If GPS data is available and valid, after alignment is completed, the equipment automatically enters AGPS Mode (unless another mode is selected on the DCP).

27. **Digital Control Panel (DCP).** The DCP (Fig 7) is the pilot interface with the NSU. The DCP shows the NSU current mode and FAIL indication. In addition, it can also provide information about Present Position (Heading, Latitude/Longitude, Altitude and NSU/GPS qualifier data). The DCP is fitted to the front cockpit only.

a. The DCP allows the pilot to perform the following operations:

(1) NSU operational mode selection.

(2) NSU initialisation data entry (Latitude, True/Magnetic Heading, Magnetic Variation).

(3) NSU maintenance functions selection (including BIT code request).

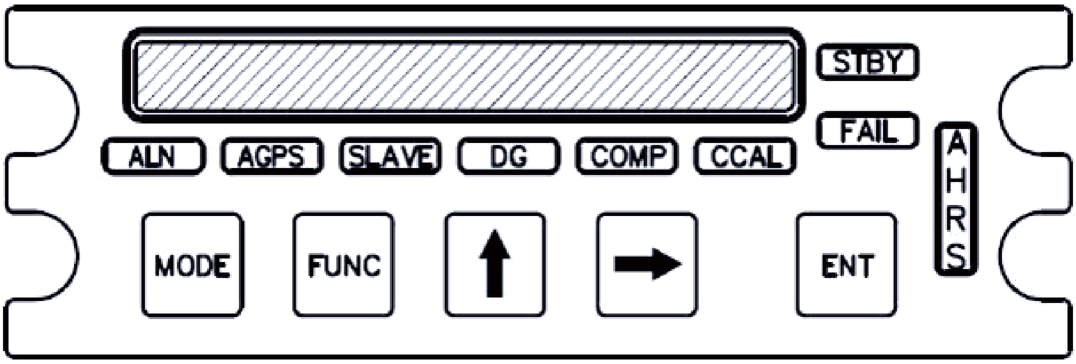
(4) Dimming of the display.

b. **Front Panel Decription.** The DCP incorporates a Front Panel which includes:

(1) Five push-button keys with back-lighted legends (MODE, FUNC, ⇑, ⇒, ENT).

(2) Eight indicators (STBY, FAIL, ALN, AGPS, SLAVE, DG, COMP, CCAL).

(3) 2 x 8-characters displays.



1 - 11 Fig 7 Digital Control Panel (DCP)

c. **MODE Key.** The MODE key cycles through the available modes and the mode selection can be entered from any other menu. When the required mode is displayed, the ENT key must be pressed and held for at least 2 seconds to select the mode, the relevant indicator will then be illuminated on the DCP. If no key is activated within 30 seconds, a time-out will occur, causing the present menu to be terminated and the DCP reverts to the default menu. STBY and COMP modes are only selectable when the weight-on-wheels switch is activated, ie the aircraft is on the ground. The following modes are available:

(1) **AGPS.** The AGPS mode is the default operational mode. It is automatically entered when the alignment is completed, GPS data is available and the IMU is serviceable. When this mode is active, the ‘AGPS’ indicator is illuminated on the DCP. In AGPS mode a filtered (digitally signal-processed and averaged) GPS position fix is available with IMU dead reckoning. The minimum requirements for AGPS mode are correct functioning of the GPS and IMU.

(2) **SLAVE.** In SLAVE mode a filtered input is received from the MDU and IMU. When this mode is active, the ‘SLAVE’ indicator is illuminated on the DCP. The NSU automatically enters this mode when GPS data is not available for 30 seconds (or when SLAVE mode is selected). In such a condition, when GPS becomes available again for at least 10 seconds, the AGPS mode is automatically entered again (unless SLAVE mode has been selected on the DCP). This mode can also be entered when SLAVE mode is commanded from the DCP, even if GPS is available. The minimum requirements for SLAVE mode are correct functioning of the MDU and IMU.

(3) **Directional Gyro (DG).** In DG mode a filtered input is received from the IMU. The DG mode is a reversionary mode to provide continued functionality, with reduced performance, when both GPS and MDU are not valid/usable. When this mode is active, the ‘DG’ indicator is illuminated on the DCP. In addition the DG flag will be displayed on the HSIs. The heading output is a pure gyro heading and is not slaved to the MDU or GPS, as such it will wander over time. It is not possible to update the heading in order to align it with the E2C in the air. The minimum requirement for DG mode is correct functioning of the IMU. If DG mode is automatically selected due to GPS and MDU failure then:

(a) If the GPS and MDU become available again for at least 10 seconds, AGPS mode is automatically re-entered.

(b) If the MDU (but not the GPS) becomes available again for at least 10 seconds, SLAVE mode is automatically re-entered.

d. **Compass (COMP).** In Compass mode a filtered input is received from the MDU. The Compass mode is a reversionary mode to provide heading with reduced performance when the IMU has failed. When this mode is active the ‘COMP’ indicator is illuminated on the DCP. Compass mode can be entered automatically (in case of IMU failure) or selected by the MODE switch on the DCP (on ground only). The minimum requirement for COMP mode is correct functioning of the MDU. In COMP mode the main attitude indicators will be unavailable and warning flags will be present.

e. **Standby (STBY).** STBY mode is only user selectable when the aircraft is on the ground and the weight-on-wheels switch is activated. STBY mode allows access to maintenance functions such as access to BIT codes and to manually set the aircraft heading.

DCP INDICATION	NSU INPUTS			NOTES
AGPS	GPS	√	√	Default mode, entered automatically. AGPS mode is still possible with a MDU failure
	IMU	√	√	
	MDU	√	x	
SLAVE	GPS	x		Automatically entered if GPS unavailable
	IMU	√		
	MDU	√		
DG	GPS	x		It is not possible to manually enter the heading from the E2C when airborne, the DG heading will therefore slowly drift
	IMU	√		
	MDU	x		
COMPASS	GPS	x	√	In Compass mode the Main Attitude Indicators will be unavailable and warning flags present. The GPS will be unavailable if the IMU has failed, the system fails to Compass mode
	IMU	x	x	
	MDU	√	√	

1 - 11 Fig 8 DCP Modes

f. **Function (FUNC) Key.** The FUNC key is used to access Data Display, Data Entry and Maintenance functions. The function selection can be entered from any other menu when the FUNC key is activated. When the required function is displayed, pressing and holding the ENT key for 2 seconds will select the function and the related menu or data display will be shown. If no key is activated within 30 seconds, a time-out will occur, causing the present menu to be terminated and the DCP reverts to the default menu. The following functions are available:

(1) **Present Position.** This function is used to display navigation data. It is the only menu option that does not have a 30 second time-out. Pressing MODE or FUNC will exit this function. Once the Present Position display is selected, pressing and releasing the ⇑ or ⇒ key will display the following circular list of options:

(a) Magnetic heading in degrees.

(b) Latitude/longitude in degrees, minutes and decimals of minutes.

(c) Altitude in feet, indicating the height above the GPS WGS84 reference ellipsoid (a mathematical representation of the Earth's shape). It should be noted that it does not indicate the altitude above ground level or sea level. Refer to the Hawk T1 RTS for limitations on the use of this function in flight.

(d) NSU and GPS Figures of Merit (FOM) in numerals 1-9.

(2) **Magnetic Variation Set.** Magnetic Variation Set allows the operator to manually enter the magnetic variation (E/W, degrees.decimals), in the range E180.0 to W180.0 to override the current stored value. The magnetic variation setting is only user selectable when the aircraft is on the ground and the weight-on-wheels switch is activated.

(3) **Latitude Set.** Latitude Set allows the operator to manually enter the Latitude (N/S, degrees.decimals), in the range S90.0 to N90 to override the current stored value. The Latitude setting is only user selectable when the aircraft is on the ground and the weight-on-wheels switch is activated.

(4) **Heading Set.** Heading Set allows the operator to manually enter Heading (true or magnetic) in the range 000.0 to 359.9 degrees, to initialize the NSU for DG Mode operation or for the execution of the compass calibration. Heading Set is only user selectable when the aircraft is on the ground and the weight-on-wheels switch is activated.

(5) **Maintenance.** The Maintenance menu allows the operator to select various maintenance functions. The only function relevant to aircrew is the BIT CODE function which allows the operator to identify a fault in the system. The remaining maintenance functions are not listed. When the BIT CODE function is entered, each time the ⇑key is pressed and released the next item (in descending order) of the list will be displayed and each time the ⇒ key is pressed and released the previous item (in ascending order) of the list will be displayed. On shut-down the system will only retain the last BIT CODE failure recorded in the non-volatile memory, and it can be viewed on the DCP after powering down and back up. As only the last code is retained post shut-down it is advisable for aircrew to record any failure BIT codes experienced during flight prior to shut down, in case of multiple failures.

(6) **Dimming.** Dimming is used to adjust brightness of the DCP display, indicators and backlight in 32 steps. The default setting is max brightness. Once the dimming function has been selected the ⇑ key increases the brighness and the ⇒ key reduces it. The last brightness level entered by the operator is stored in the non-volatile memory of the DCP and for short power interrupts (<75ms) this brightness setting will be recovered.

g. **Up Arrow Key⇑.** Depending on the active function and on the status of the function, different actions are associated with the ⇑ key:

(1) **Menu Items or Options Display.** By activation of the ⇑ key (press and release) the next item available or the next available option of the Menu will be displayed in a circular list.

(2) **Data Field Editing.** When editing a numerical or an alpha-numerical field, the activation of the ⇑key (press and release) replaces the character (blinking on the display) with the next available value. Holding the ⇑ key pressed for more than 2 seconds (press and hold ⇑) cycles through the next available characters. When the key is released, the last displayed value is shown. When the last editable character of a field is selected, a further ⇑ key press will select the first character again (ie the system operates in a circular manner).

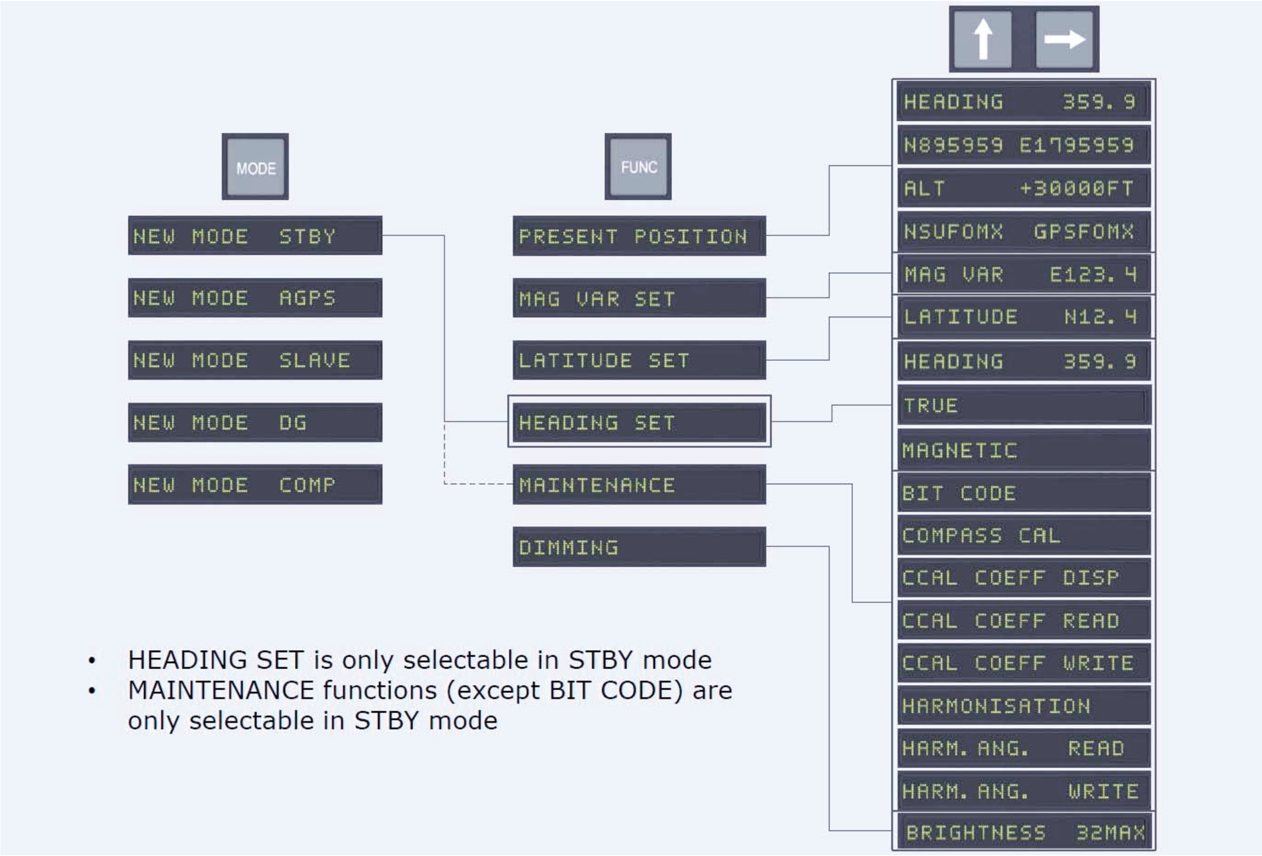
(3) **Dimming.** When no function is active (or when ‘Dimming’ is selected from Function menu) the activation of the ⇑ key increases the brightness of the display.

h. **Right Arrow Key⇒.** Depending on the active function and on the status of the function, different actions are associated to the ⇒ key:

(1) **Menu Items or Options Display.** By activation of the ⇒ key (press and release) the next item available or the next available option of the Menu will be displayed in a circular list.

(2) **Data Field Editing.** When editing a numerical or an alpha-numerical field, the activation of the ⇒key (press and release) will indicate the next editable character of the field, to the right of the present character. The editable character will start blinking. When the last editable character of a field is selected, a further ⇒ key press will select the first character again (ie the system operates in a circular manner).

(3) **Dimming.** When no function is active (or when ‘Dimming’ is selected from Function menu) the activation of the ⇒ key decreases the brightness of the display.



1 - 11 Fig 9 AHRS MENU - GROUND

i. **Indicators.** The following indicators are illuminated on the DCP according to current status of the NSU:

(1) STBY (amber), when illuminated the NSU is in standby mode.

(2) ALN (green), when illuminated the NSU has been initialised and it is performing the alignment (Static/In-Flight), but it is not at full performance. When the alignment is completed, this indicator extinguishes.

(3) AGPS (green), when illuminated the NSU is operating in AHRS/GPS mode.

(4) SLAVE (green), when illuminated the NSU is operating in SLAVE mode.

(5) DG (green), when illuminated the NSU is operating in DG mode.

(6) COMP (green), when illuminated the NSU is operating in COMPASS mode.

(7) CCAL (green), when illuminated the NSU is operating in Compass Calibration mode for MDU Calibration.

(8) FAIL (red), when illuminated the NSU has a malfunction such that no GPS, no AHRS/IMU and MDU functionality (or other) is available.

j. **Fail Messages.** The following failure messages will be displayed, accompanied with a DCP ‘FAIL’ indication, according to the NSU or DCP indication:

(1) AHRS FAIL - The NSU has detected a failure in the AHRS/SEU section.

(2) GPS FAIL - The NSU has detected a failure in the GPS module.

(3) IMU FAIL - The NSU has detected a failure in the IMU sensor.

(4) MDU FAIL - The NSU has detected a failure of the MDU. The MDU FAIL message may be cleared by pressing ENT on the DCP. Subsequently one of the following states will be displayed:

(a) The MDU FAIL message is extinguished. The AHRS continues to function with valid MDU inputs.

(b) The MDU FAIL message does not extinguish, or re-appears. Heading will be computed using inertial management and GPS data.

(c) The red FAIL indication is illuminated, with or without the MDU FAIL message. AHRS information should be considered suspect, the HSI and main attitude indicator should not be used.

(5) DCP FAIL - The DCP has detected an internal failure.

(6) ANTENNA FAIL - The NSU has detected a failure in the antenna link.

(7) 26V REF FAIL - The NSU has detected the absence of the 26 volt AC, 400Hz reference signal.

(8) NO DATA RECEIVED - There is a communication failure with the NSU.

k. The following failure message will be displayed, without an accompanying DCP ‘FAIL’ indication, according to the NSU or DCP indication:

(1) GPS BATTERY LOW - NSU has detected a low voltage in the GPS module battery.

l. If the DCP recognises a NSU permanent failure the ‘FAIL’ indicator will be illuminated permanently.

28. **NSU Alignment.** Upon completion of STBY mode the NSU automatically enters ALN mode. When this mode is active, the ‘ALN’ indicator is illuminated on the DCP. There are three possible alignment modes; Static, In-Flight or Suspended:

a. **Static Alignment.** Under normal conditions (weight-on-wheels switch activated, no motion detected and heading known) the NSU performs 10 seconds of Static Alignment. If valid GPS data is available, after alignment completion the equipment automatically enters AGPS mode (unless another mode is selected from the DCP). If GPS data is not available or not valid after alignment completion, the equipment automatically enters SLAVE mode, it transfers automatically into AGPS mode when GPS data becomes usable. If motion is detected before completion of the Static Alignment, the equipment enters Suspended Alignment.

b. **In-Flight Alignment (IFA).** If the transition from STBY to ALN mode occurs when the aircraft is in motion with valid GPS data and a ground velocity greater than 12 kts, and these conditions are maintained for at least 10 seconds, the NSU enters In-Flight Alignment. During In-Flight Alignment, the aircraft should be maintained in straight, level and unaccelerating flight. The In-Flight Alignment should be complete if the MDU signal is valid for 2 seconds, or if airborne, when the weight-on-wheels switch is indicating ‘OFF’, and within 2 minutes of continuous GPS availability. After alignment is complete the AHRS should automatically enter AGPS mode (or SLAVE mode if GPS is not available and MDU signal is valid). If the velocity becomes lower than 12 kts, or the GPS becomes unavailable before completion of the In-Flight Alignment, the equipment enters into Suspended Alignment.

WARNING: After an interruption of AC power, and when within the parameters in sub-para b., the NSU will enter an IFA. If the aircraft is not maintained in straight, level and unaccelerating flight when power is reapplied to the NSU it will not align correctly, making cockpit attitude and heading indications incorrect with no fail flags displayed.

Note: It is not possible to force a manual In-Flight Alignment of the AHRS via the DCP.

c. **Suspended Alignment.** Suspended Alignment is entered when the Static Alignment or the In-Flight Alignment cannot be completed because some of the required conditions are not met. This mode is maintained until the conditions to perform the alignment are again valid. If no motion is detected and accurate heading is known (from the DCP or MDU) the equipment automatically enters Static Alignment. If GPS is usable and ground velocity is greater than 12 kts, and these conditions are maintained for at least 10 seconds or MDU data is valid for 2 sec, the equipment automatically enters In-Flight Alignment.

29. Following a generator failure and subsequent reset, or an airborne relight when the aircraft generator comes back online, an In-Flight Alignment of the AHRS will take place. The aircraft should be flown in straight, level and unaccelerating flight. It is likely that the AHRS will initially enter SLAVE mode and should transfer automatically to AGPS mode when GPS data becomes usable.

Horizontal Situation Indicator

30. An HSI (Fig 10), on the centre panel in each cockpit, combines the compass system and radio navigational displays. The HSI displays the following information:

a. **Heading.** Heading is indicated by a rotating compass card read against a fixed `V' lubber mark above the card. The card is graduated at 5° intervals and is marked alpha-numerically at 30° intervals.

b. **Heading Index.** A yellow heading index registers against the outside edge of, and rotates with, the compass card. The index can be manually set relative to the compass card by a select heading knob, marked with a symbol representing the heading index, at the lower left-hand corner of the HSI face.

c. **Compass Select Flag.** When the AHRS control unit mode selector is set to DG, a white flag with DG in black letters is displayed on the lower right side of the compass card.

d. **Track Index and Counter.** A track index, which is on a centre display assembly, registers against the inside edge of, and rotates with, the compass card. The index can be manually set relative to the compass card by a selector knob at the lower right hand corner of the front cockpit HSI only; the rear cockpit selector knob is inoperative. The reciprocal of the track set is indicated by a track index tail on the centre display assembly. A 3-digit display of the selection is given on a track (COURSE) counter at the top right of each HSI face. Operation of the front cockpit selector knob positions the index and the counter of both the front and rear HSI. The selector knob is marked with a symbol representing the track index.

e. **Deviation Bar.** A deviation bar and a fixed scale of two dots on either side of a centre index are on the centre display assembly. The bar moves left or right of the centre index to indicate deviation from the selected track when Tacan information is selected at the navigation mode selector or from an ILS localiser when ILS information is selected at the navigation mode selector. When operating in the ILS mode, the HSI track deviation display is more readily interpreted if the track index is set to the QDM of the localiser.

f. **Tacan Bearing.** The magnetic bearing to a Tacan ground beacon is indicated by a green pointer head when read against the compass card; the reciprocal is indicated by the tail of the pointer. The bearing is also displayed when ILS information is selected at the navigation mode selector.

g. **To/From Indication.** Two triangular indicator windows, `to' and `from', are on the centre display assembly; the `to' window is adjacent to the track index and the `from' window is adjacent to the tail of the track index. With the navigation mode selector (Chapter 13) set to TACAN, a Tacan radial set on the track index and the bearing pointer locked on to a Tacan beacon, a white flag is displayed in the `to' or the `from' window. The `to' flag is displayed whenever the bearing from the Tacan is less than 90° from the selected Tacan radial. Conversely, the `from' flag shows white whenever the bearing from the Tacan beacon is 90° or more from the selected Tacan radial.

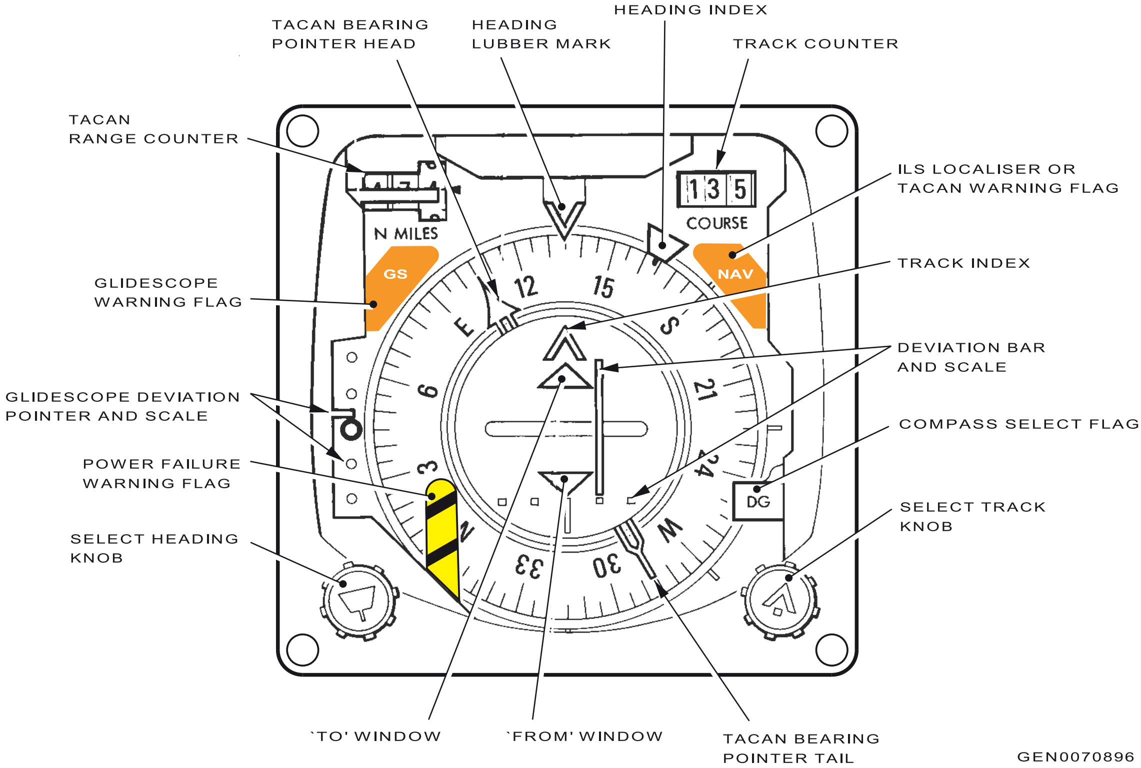
h. **Tacan Range.** Range to a Tacan ground beacon, in nautical miles, is shown on a 3-digit counter, marked N MILES, at the upper left corner of the HSI face. A yellow bar obscures the counter when range information is invalid. The range is also displayed when ILS information is selected at the navigation mode selector.

i. **Glidepath Deviation Pointer.** A pointer, to the left of the compass card, moves over a fixed vertical scale consisting of two dots above and two dots below a circle (representing the aircraft). The pointer is driven by the ILS equipment and indicates the vertical position of the ILS glidepath relative to the aircraft, eg, if the pointer is above the circle on the scale, the aircraft is below the glidepath. The pointer is only driven when ILS information is selected at the navigation mode selector.

j. **Glidepath Warning.** A red flag, with GS in white letters, appears above the glidepath deviation scale when the glidepath information is invalid.

k. **ILS Localiser or Tacan Bearing Warning.** A red flag, with NAV in white letters, appears below the course counter when the ILS localiser or the Tacan bearing information is invalid.

l. **Power Failure Warning.** An orange flag, with black diagonal stripes, appears at the lower left-hand side of the compass card when the power to the HSI has failed or when the AHRS generates an invalid signal.



1 - 11 Fig 10 Horizontal Situation Indicator

MISCELLANEOUS INSTRUMENTS

Accelerometer

31. An accelerometer calibrated from minus 5 to + 10g, is on the centre panel in each cockpit. Each accelerometer has three concentrically-mounted pointers; one pointer indicates instantaneous g and the other two indicate maximum positive and negative values experienced. On the front cockpit instrument the latter two pointers can be reset by pressing a PUSH TO SET knob on the instrument face.

Standby Compass

32. A standby compass is on the canopy centre line in each cockpit, one just aft of the front windscreen and the other just aft of the rear windscreen. The compass has integral lighting which is controlled by a COMPASS switch on the right panel.

NORMAL USE AND MANAGEMENT

Before Flight

33. **DGI.** With the battery switches on, or (T Mk 1A) with the battery switches off and an external DC supply connected, check that the warning flag clears. Set the compass heading on the DGI, checking that the heading index moves with the compass card. Set the heading index as required, by pulling out and rotating the control knob; check that the index moves independently and that the compass card does not rotate.

34. **Turn-and-Slip Indicator.** Check that three minutes after the batteries are switched on, or (T Mk 1A) the external DC supply is connected, the underspeed warning flag clears. Whilst taxying, check the instrument for correct indications.

35. **Accelerometer.** In the front cockpit, reset the accelerometer; in the rear cockpit check that the accelerometer has been reset.

36. **Altimeters.**

a. **Main Altimeter.** Do not attempt to adjust the millibar scale until AC is on line. Check that the warning bar clears from the altitude counter when power is applied to the instrument. Set QFE on the millibar scale and check that the altimeter pointer indicates zero±35 feet at the QFE datum.

b. **Standby Altimeter.** Set QFE on the millibar scale and check that the altimeter indicates zero ±35 feet at the QFE datum.

37. **Attitude Indicators.**

a. **Main Attitude Indicator.** With DC and AC on line check that the warning flag clears.

b. **Standby Attitude Indicator.** With the battery switches on, check that the warning flag clears. If fast erection is required press the caging knob; check that the red warning flag is displayed whilst the knob is pressed (see para 21).

38. **HSI.** With AC on line check that the power failure flag clears. Using the select heading knob check that the select heading index moves freely relative to the compass card; set as required. Using the select track knob on the front cockpit HSI, check that the track index moves freely relative to the compass card on both the front and the rear cockpit HSI (if appropriate) and that the track (COURSE) counter indicates correctly; set as required.

In Flight

39. **AHRS Performance.** The AHRS is designed to operate within the following maximum operational flight envelope:

a. **Angles.**

(1) Pitch up to ±90°.

(2) Bank up to ±180°.

(3) Azimuth 0° to 360°.

Note: In the pitch range ± 85° to 90°, heading and roll data are frozen to the last value calculated while pitch is still computed.

b. **Linear Acceleration.** ±10.0g in all axes.

c. **Angular Acceleration.** ±5 rad/sec² in roll, pitch and yaw.

d. **Angular Rate.** ±250°/sec, ±5 rad/sec² in roll, pitch and yaw.

e. **Altitude.** -1500 ft to +48,000 ft.

f. **Linear Velocity.** 800 kts.

40. The following observation was noted in flight trials for the AHRS:

a. **Aerobatics.** Whilst rolling in the vertical (up and down) in SLAVE and DG modes some hesitation of the main attitude indicators in roll may be observed. This behaviour is also to be expected in all modes when the absolute value of pitch angle is greater than 88°.

41. It is normal for the AHRS to cycle between AGPS and SLAVE with the loss of GPS signal and this may occur due to prolonged inverted flight or following a generator reset.

MALFUNCTIONS

Instrument Covers

42. Cloth covers for the main altimeter, attitude indicator and horizontal situation indicator are attached to the glare shields in both cockpits (and front cockpit right wall in some aircraft) by velcro fasteners. If any of these instruments fail, the covers may be used to remove false, distracting indications from view by attaching the covers to the velcro fastenings around the instruments.

Standby Instruments

43. If the power failure warning flag on either the standby attitude indicator or the DGI is displayed, set the STBY INST switch to BATT. If a warning flag then remains displayed, the associated instrument is unserviceable; return the switch to NORMAL. If the warning flag on both instruments appears a power supply failure is indicated; select the alternative power source by setting the switch to BATT.

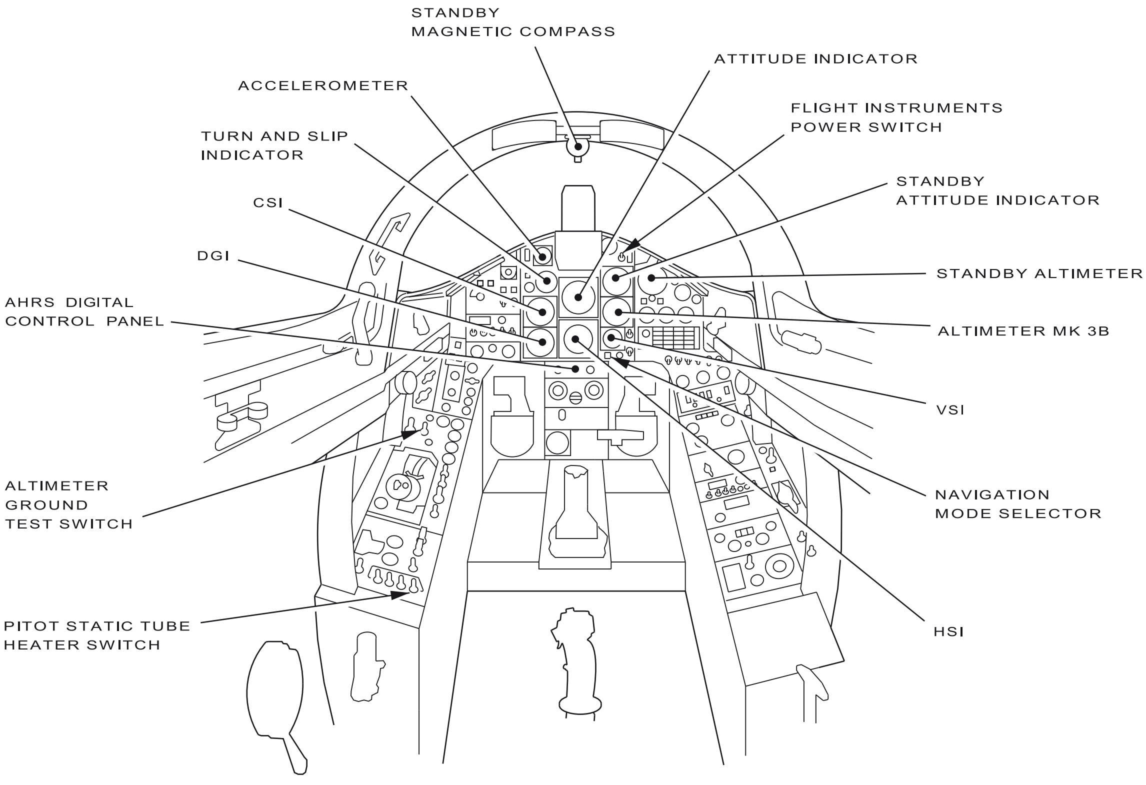
44. If the warning flag is displayed on the turn-and-slip indicator, the turn indications are unreliable and are not to be used; the slip ball indications are unaffected. If the warning flag is displayed in association with the warning flag on the standby attitude indicator and on the DGI, select the alternative power source by setting the STBY INST switch to BATT.

Main Altimeters

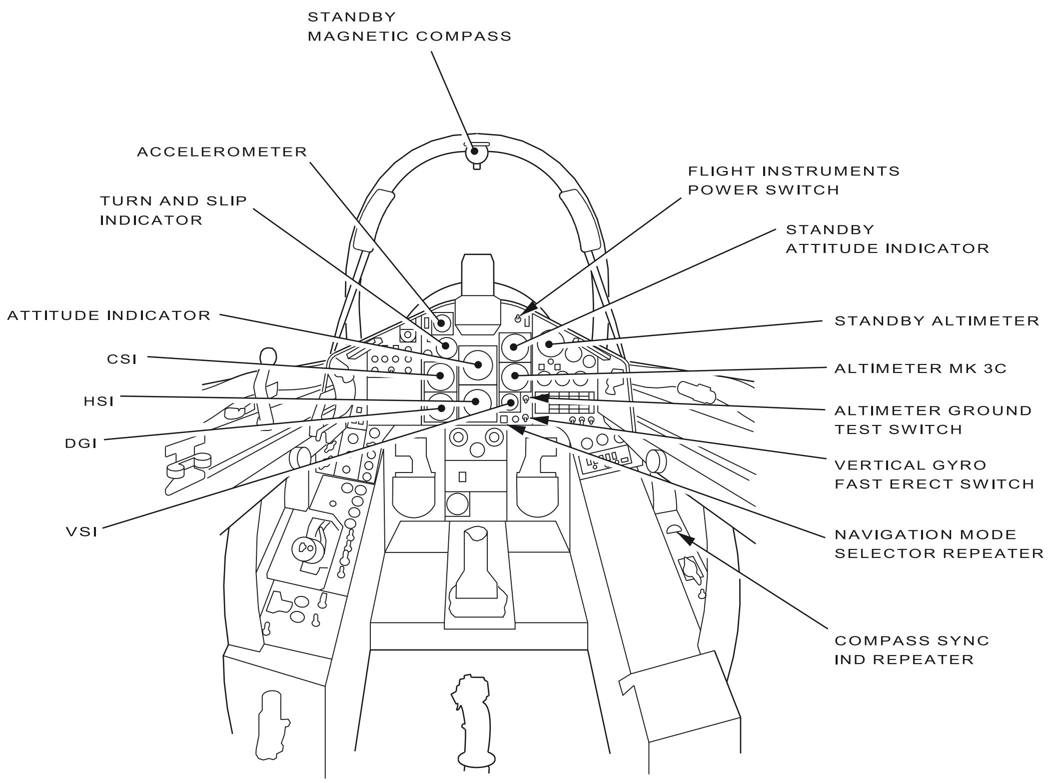
45. If the DC supply to the front cockpit main altimeter fails, the PE warning flag is displayed on the front cockpit altimeter and the altitude counter on the rear cockpit altimeter is obscured by the red and black striped bar. The front cockpit altimeter remains serviceable but in the rear cockpit the standby altimeter is to be used.

Attitude and Heading Reference System

46. If the main attitude indicator or the HSI power failure flag is displayed check the HSI or the attitude indicator respectively for a display of its power failure flag, and the DCP for a red FAIL caption. If the check shows that both the attitude indicator flag and the HSI power failure flag, and the AHRS FAIL indicator are displayed then consider the AHRS as unreliable and use the standby attitude indicator and standby compass/ DGI. If only the attitude indicator or the HSI power failure flag is displayed, then consider the indicator which displays the failure flag as having a power failure and do not use it; use the appropriate standby instrument(s).



FRONT COCKPIT



REAR COCKPIT

DAPS/HAW/GEN0070890/0740

1 - 11 Fig 11 Flight Information Instruments and Controls

(Incorporation of Mod 2516 at AL3)

PART 1

CHAPTER 12 - GENERAL EQUIPMENT

Contents

Illustrations

COCKPIT ACCESS AND CANOPY

Cockpit Entry and Exit

1. Entry to or exit from the front and the rear cockpit is by either:

   a. An extending footstep, a toe-in step and a retractable step which are integral with the left side of the fuselage, or

   b. An access ladder.

2. Except for an outlined area marked STEP HERE on the upper surface of the engine left air intake the engine air intake must not be used as a step. Vertical guide lines, from the cockpit rim to the toe-in step and the extending footstep, are provided as an alignment aid when vacating the cockpit.

3. **Extending Footstep.** The extending footstep is operated by:

   a. A handhold, marked FOOTSTEP PULL-OUT, on the face of the step.

   b. A lever on the front cockpit wall, forward of the LP fuel cock lever.

4. **Toe-in Step.** The toe-in step is covered by a spring-loaded flap, hinged along the upper edge.

5. **Retractable Step.** The retractable step is locked up by an integral anti-g latch. The step can be pulled down by a handhold, marked FOOTSTEP PULL DOWN, when a tongue below the handhold is raised. The anti-g latch is released when the tongue is held raised. The step is retracted under spring pressure when a plunger on the cockpit rim left side is depressed either manually, or automatically when the canopy closes. The step is to be retracted and locked up before the engine is started.

WARNING: Personnel are to be clear of the step before it is retracted.

Transparencies

6. The transparencies comprise a front windscreen and a one-piece canopy divided into front and rear sections by an integral windscreen.

7. The front one-piece, curved windscreen has good rain clearance characteristics; no rain clearance system is installed.

Canopy

WARNING: The canopy moves easily; therefore, take care to ensure that it does not close accidentally and trap the fingers of the occupants or the ground crew on the cockpit rim.

8. The sideways opening canopy rotates about four hinges on its right side. The canopy is manually operated and its weight is counterbalanced by a torque tube arrangement on its right edge.

9. A combined pneumatic damper and locking strut controls the rate at which the canopy can be opened or closed and enables the canopy to be locked in the open position. The damper/locking strut, which can secure the canopy in any desired position, is controlled by canopy operating levers via a teleflex cable. The strut is on the front cockpit right wall and is secured to the cockpit floor by a quick release pin. If a fault occurs in the strut or the controlling cable which prevents the canopy from being opened normally, remove the quick release pin to free the strut.

10. A cabin pressurizing seal strip is around the canopy base; the strip is not to be used as a handhold when entering or leaving the cockpit.

Canopy Controls

11. **Internal.** Two interconnected levers on the canopy frame, one at the left side of each cockpit, operate four interlocked canopy locking pins. The levers are spring-loaded to the forward position. The canopy is locked when the levers are fully forward and unlocked when the levers are moved aft. A thumb-operated spring-loaded safety catch in the front cockpit prevents inadvertent movement of the levers from the canopy locked position. The safety catch is linked to a thumb-operated catch in the rear cockpit and to a button integral with an external lock/unlock handle (para 12). When either the front or the rear cockpit catch is pressed outboard both levers are free to move. An UNLOCKED label in each cockpit is positioned such that when the canopy is locked each safety catch totally obscures the word UNLOCKED. If any part of the word is visible the canopy is not locked. When either safety catch is pressed the canopy seal is deflated. An arrowhead is marked on the left side of the front windscreen arch; a second arrowhead, on the canopy forward edge, is marked WITH CANOPY LOCKED ARROWS MUST BE IN LINE. When either lever is held fully aft the canopy swings partially open and the locking strut allows the canopy to be manually positioned; when the lever is released the locking strut holds the canopy in the selected position. In the front cockpit, a grab handle on the canopy frame forward of the lever may be used to position the canopy. In windspeeds in excess of 20 knots it may not be possible to open or to close the canopy without external assistance.

12. **External.** A lock/unlock handle, marked PRESS & TURN, is on the forward left side of the canopy. When a button incorporated in the handle is pressed, the safety catch in the cockpit moves outboard to free the canopy internal operating lever and to permit the handle to be turned clockwise from the horizontal to the vertical position, thus unlocking the canopy and allowing it to partially open. Using the handle, the canopy can be positioned manually and remains in the selected position when the handle is released.

Miniature Detonating Cord System - Canopy Shattering

WARNING: When raising the seat take care to avoid damaging the MDC pattern at the top of the canopy by contact with the helmet. Ensure that, when closing the canopy, the seat is at a height which avoids such contact.

13. A Miniature Detonating Cord (MDC) system is installed on the canopy. The MDC is a linear explosive charge which, when activated, shatters the canopy. It is activated via an MDC firing unit by:

a. The ejection seat/MDC interconnection, or

b. An internal firing handle in each cockpit, or

c. External firing handles (two) one on each side of the canopy frame.

14. The front and rear sections of the canopy each have a separate, patterned MDC circuit which is bonded to the transparency in a continuous run around the periphery and over the inner top surface. The ends of each MDC terminate in an MDC firing unit on the right side of the canopy in each cockpit. Each MDC circuit is individually detonated by initial movement of the appropriate ejection seat. Operation of the front or the rear cockpit MDC firing handle or either of the external MDC firing handles fires both circuits.

WARNING: For solo flight the MDC firing unit safety pins in both cockpits are to be removed; failure to remove the rear cockpit safety pin prevents operation of the front MDC firing handle. The pins are to be checked in the stowage.

15. Each MDC firing unit has two detonators. Each detonator, when fired, initiates both ends of the MDC circuit; this ensures that the complete circuit is fired even if there is a break in the MDC. Each MDC firing unit sear has a safety pin, marked MDC, which is to be removed before flight and placed in the stowage in the front cockpit, on the left side.

WARNING: Fouling of either striker by loose articles activates the MDC when the canopy is closed.

16. The MDC firing unit detonators are fired by:

a. **Seat/MDC Interconnection.** When an ejection is initiated, a striker platform on the ejection seat engages an operating lever on the associated MDC firing unit as the seat starts to rise. Actuation of the lever fires both detonators in the MDC firing unit, thus shattering the associated section of the canopy preparatory to ejection of the seat.

b. **Internal Firing Handles.** A black and yellow MDC firing T-handle on the right side of the canopy in each cockpit, is connected to both MDC firing units. When either handle is pulled both MDC are exploded. Each handle has a safety pin, marked CANOPY MDC, which is to be removed by the occupant and placed in a stowage after strapping in. In the front cockpit the stowage is on the left side of the glareshield (post-Mod 1046). In the rear cockpit the stowage is on the left glareshield (post-Mod 1195).

Note: To minimize the risk of injury from flying debris place the head against the headrest, close the eyes tightly and, if time permits, lower the visor prior to firing the MDC.

c. **External Firing Handles.** An external firing handle is on each side of the canopy frame near its forward end. Each flush fitting handle is striped black and yellow and bears the legend PUSH in white letters. A sharp push causes the internal fastener to disengage and the firing handle to stand proud of the canopy frame. The handle is connected to 1·5 metres (5 feet) of cable. The operator should grasp the handle and, facing away from the aircraft, take up the cable slack and then sharply tug the cable. When the taut cable is tugged both sections of MDC are exploded, irrespective of whether or not the internal firing handles are secured by their safety pins.

MDC Operation

17. To minimize injury from MDC debris it is prudent to fly with at least one visor down from just before closing the canopy until after opening the canopy. Maintain a clearance between helmet and canopy thus ensuring that the helmet never touches the MDC. Keep the fabric visor cover attached to the helmet just above the upper edge of the visor; this prevents MDC debris tracking down inside the visor. Always minimize the area of exposed skin in gaps between gloves and coverall and around the neck. Do not avert the head from the MDC as this exposes the back of the neck; keep the head against the head rest. Close the eyes tightly before pulling the MDC firing handle or ejecting.

Rear View Mirrors

18. Each cockpit has a pair of adjustable rear view mirrors, one pair on the front canopy arch and the other pair on the rear windscreen arch.

Grab Handles

19. A grab handle is in each cockpit. In the front cockpit, the handle is on the canopy frame forward of the canopy operating lever; in the rear cockpit, the handle is on the cockpit left wall forward of the canopy operating lever.

NORMAL USE

Before Flight

20. **MDC.** Before flight, in both cockpits, remove and stow the MDC firing unit safety pins. After strapping-in and closing the canopy, remove and stow the MDC firing handle safety pin(s).

21. **Canopy.** Before closing the canopy ensure that visors are lowered and oxygen mask(s) donned and check that ground personnel are facing away from the aircraft and clear of the retractable step. When the canopy is closed, check with the groundcrew that the step is locked up by the anti-g latch. After closing the canopy, check that it is correctly locked, that the arrowhead marks are in line and that the word UNLOCKED is totally obscured.

After Flight

22. After shutting down the engine, fit the safety pins to the MDC firing handle(s). Before opening the canopy ensure visors are lowered and oxygen masks donned and check that groundcrew are facing away from the aircraft. After unstrapping, fit the safety pins to the MDC firing units.

MALFUNCTIONS

Flight with the Canopy Damaged

23. If the canopy is damaged, besides loss of pressurization, airflow over the cockpit area has a suction effect and causes a greater cockpit altitude to be experienced than the actual aircraft altitude. The suction effect depends on speed and altitude and may typically give an increase of up to 5000 feet cockpit altitude. Altitudes flown following damage to the canopy should take account of this effect.

24. With MDC fired the rear windscreen should provide some protection against air blast for the rear seat occupant; even if the canopy and windscreen are totally lost the environment should remain tolerable up to 250 knots.

25. Canopy damage may degrade aircraft handling characteristics; therefore, carry out a low speed handling check, at a safe height, to assess the effect on handling prior to making an approach.

26. Following canopy damage communications both internally and with other aircraft and the ground may become difficult due to airflow noise.

Detached MDC

27. If the canopy is damaged (eg, by a severe birdstrike) some MDC may hang in the cockpit. Providing the occupant has a visor down subsequent MDC detonation should not cause severe injury or damage to equipment unless the MDC is in direct contact.

28. If possible, loose MDC should be cut away; this does not cause it to detonate. If the MDC cannot be cut or broken it must be kept clear of the body and aircrew equipment, particularly the eyes and visor.

29. If necessary an immediate ejection may be initiated. Injury caused by the MDC is likely to be less than if ejection is delayed. However, note that survival equipment may be damaged if MDC is in contact when fired.

30. If the rear occupant initiates ejection with the command ejection selected, the front occupant could be severely injured should he be handling loose MDC at the time. It is recommended that, if a command ejection is likely when inter-communication is not possible, any loose MDC in the front cockpit is left untouched apart from the very minimum and speedy removal of any cord in contact with the visor or face.

Table 1 - Internal Lighting Controls (Both Cockpits)

Control/Marking	*Function*

Main lights master switch - PANEL	Controls DC supply from Essential Services busbar to:
	- PORT and STBD dimmer controls
	- Map reading lights
	- Flap position indicator pillar lights
	- Indicator integral lights for:
	  - Landing gear, airbrake , air producer start, engine rotation and WCP busbars on
	  - Pylon selected
	  - WCP role indicator (TMk 1A)
	  - ADR status
	  - WMP busbar on
	  - Navigation mode selector repeater
	- Controls AC supply to CENTRE dimmer control

Rotary dimmer - PORT	Controls the intensity of left panel main strip lights. In front cockpit controls intensity of UHF transceiver integral lighting
Rotary dimmer - STBD	Controls the intensity of right console and right panel main strip lights and the intensity of integral lighting of the CCS station box. In front cockpit only, controls the intensity of the integral lighting in the VHF transceiver, IFF control unit, ILS control unit and the Tacan control unit
Rotary dimmer - CENTRE	Controls integral lighting on centre panel in: - CSI - HSI - Main altimeter - Main attitude indicator - VSI - DGI - ISIS control unit
Emergency lights switch - EMERGY	Controls commoned supply from No 1 and No 2 Battery busbars to centre light in cockpit lighting strips
Standby compass light switch - COMPASS	Controls commoned supply from No 1 and No 2 Battery busbars to standby compass integral light

INTERNAL LIGHTING

General

31. The aircraft internal lighting comprises general cockpit lighting and the lighting of control units and indicators by integral lights and pillar lights.

Cockpit Lighting

32. Cockpit lighting is provided by six white lighting strips in the front cockpit and by five white lighting strips in the rear cockpit. In the front cockpit each wall has two strips which illuminate the adjacent consoles, and the left and right glareshields each have one strip on the underside which illuminate the respective left and right panels. In the rear cockpit the strips are positioned similarly except that the right wall has only one strip. Each strip has a centre and two outer lights; the outer lights are for normal (main) lighting and the centre light is for emergency lighting. Two map reading lights are in each cockpit on the underside of the left and right glareshields respectively.

33. In each cockpit the main lights are powered from the Essential Services busbar via a main lights master switch, labelled PANEL, on the right panel; the emergency lights are powered from the commoned supplies from No 1 and No 2 Battery busbars via an emergency lights switch, labelled EMERGY, on the right panel. The toggle of each emergency lights switch has a self-powered light source for easy identification in the dark. The power supply to the map reading lights is via the main lights master switch, but it is controlled at each light by an integral push/pull off/on switch.

Main Lights Master Switch

34. Each main lights master switch, in addition to controlling the main strip lights and the map reading lights, also controls the integral lighting of indicators as shown in Table 1.

35. When the front cockpit master switch is on, the intensity of the CWP caption lights in both cockpits and of the navigation mode selector lighting is automatically reduced; in the T Mk 1A the intensity of the MCP caption lights is also automatically reduced.

Dimmer Controls

36. Three rotary dimmer controls, PORT,CENTRE, STBD and are on the right panel in each cockpit under the collective label PANEL LIGHTS. The PORT and STBD dimmer controls are supplied with DC via the main lights master switch. The CENTRE dimmer control is supplied from the AC busbar when the main lights master switch is on. The dimmers control the intensity of the cockpit lighting and of the control unit and indicator integral lighting as shown in Table 1.

EXTERNAL LIGHTING

General

37. The external lighting consists of a landing/taxy lamp, navigation lights, anti-collision lights and a landing gear indicator light. All external lights are powered from the Essential Services busbar and, with the exception of the landing gear indicator light, are controlled by a 2-position LAND-TAXI switch on the centre panel, a 2-position NAV switch and two 3-position ANTI-COLLISION switches on the right panel in the front cockpit.

Landing/Taxy Lamp

38. The landing/taxy lamp, which has a 500-watt filament, is in the nose cone. The lamp is controlled by the LAND-TAXI switch.

Navigation Lights

39. The navigation lights comprise a light in the leading edge of the left and right wingtips, and a light on the aft end of the tailcone. The lights are controlled by the NAV switch.

Anti-Collision Lights

40. Two anti-collision high intensity strobe light units, one on top of the fuselage aft of the rear cockpit and the other on the underside of the fuselage forward of the airbrake, can each be manually selected from off to show either a red or a white flashing light. The ANTI-COLLISION light switches are marked LOWER and UPPER. Each switch can be set from its centre (OFF) position to up (WHITE) or down (RED) to select its associated strobe light to white or red respectively. Each light is powered from its own power unit. The two power units are on each side of the jet pipe bay above the airbrake. When a single switch is set to WHITE or RED (other switch OFF) the associated light flashes about 60 times per minute. When both switches are set from OFF the upper light is out when the lower light flashes and flashes when the lower light is out; thus the combined flash rate is about 120 times per minute.

Landing Gear Indicator Light

41. When the aircraft is airborne a light on the nosewheel unit leg provides an external indication that the landing gear is locked down. The light cannot be seen from either of the cockpits. The light is powered from the Essential Services busbar via contacts of a de-energized weight-on-wheels relay when all three landing gear down microswitches are closed; it is automatically switched off on landing when the weight-on-wheels relay is energized via left and/or right mainwheel unit leg compression microswitches.

Note: The landing light and the upper anti-collision light, when on in cloud, may have a distracting influence.

ACCIDENT DATA RECORDER

General

42. An accident data recorder system has an Accident Data Recorder (ADR) in the upper fuselage below the RAT, a Data Acquisition Unit (DAU) in the main equipment bay and an ADR STATUS indicator on the right console in the front cockpit. Power from the Essential Services busbar is supplied to the ADR and the DAU via a power supply relay; power from No 1 Battery busbar is supplied to the ADR via a time delay unit which operates when the power supply relay is energized. The power supply relay is energized when START is selected at either engine start master switch.

43. The ADR accepts inputs from the DAU and records the data on a continuous tape loop, contained in a crash-protected case, which has a recording duration of 214±12 minutes. The ADR has Built-In Test Equipment (BITE) which monitors signals from the DAU and from the in-use track. When BITE monitoring is satisfactory a power supply from No 1 Battery busbar energizes the status indicator to show black. If the monitoring signals deviate from specified limits the indicator is de-energized and shows FAIL in black on a white background; the indicator then remains at FAIL even after satisfactory monitoring signals have been restored and are being recorded. When both battery switches are set to off, the time delay unit delays disconnection of the No 1 Battery busbar supply to the ADR for approximately one minute.

44. The ADR records signals representing the parameters listed in Table 2.

Table 2 - ADR Parameters

Normal acceleration	Aileron position	Landing gear position
Lateral acceleration	Rudder position	Pitch angle
Compass heading	Tailplane position	Roll angle
CWP events	Flap position	P6 engine pressure
Airspeed (Up to 600 kts)	Airbrake position	Throttle position
Altitude		

45. Post-Mod 1024 an underwater acoustic beacon (ARI 23438/1) with its own self-contained battery is attached to the ADR to assist in the location and recovery of the ADR from a sunken aircraft; the beacon transmits a 37·5 kHz signal for up to 30 days.

MISCELLANEOUS EQUIPMENT

Stopwatch Holder

46. A stopwatch holder forms an integral part of a radio frequency card holder (Chapter 13) on the left glareshield in each cockpit. The stopwatch holder is pivoted to lie flush with the frequency card holder when not required. When the frequency card holder is brought into use the stopwatch holder cannot be seen. Post-SEM 133 an additional stopwatch holder is fitted to the right glare shield in each cockpit.

Fatigue Meter

47. An accelerometer is positioned on the back upper portion of the rear seat frame and an indicator in the forward equipment bay. Power supply for the installation is from the Essential Services busbar via the landing gear up select relay; it is therefore inoperative when the landing gear is down.

EQUIPMENT STOWAGES

Maps

48. A stowage for maps is at the aft end of the right console in both cockpits. The maps are secured in the stowage by a velcro strip. Drain holes prevent condensation moisture from accumulating in the stowage. The stowage must not be used to hold small articles, eg, pencils, which could fall through the drain holes and

become loose item hazards. In-use maps can be secured by a clip on the top surface of each glareshield in both cockpits. Post SEM 157, a waterproof cover is provided to prevent the ingress of water into the avionics installations in the right console. In inclement weather, the cover should be removed and stowed after the canopy is closed and fitted prior to canopy opening.

Documents

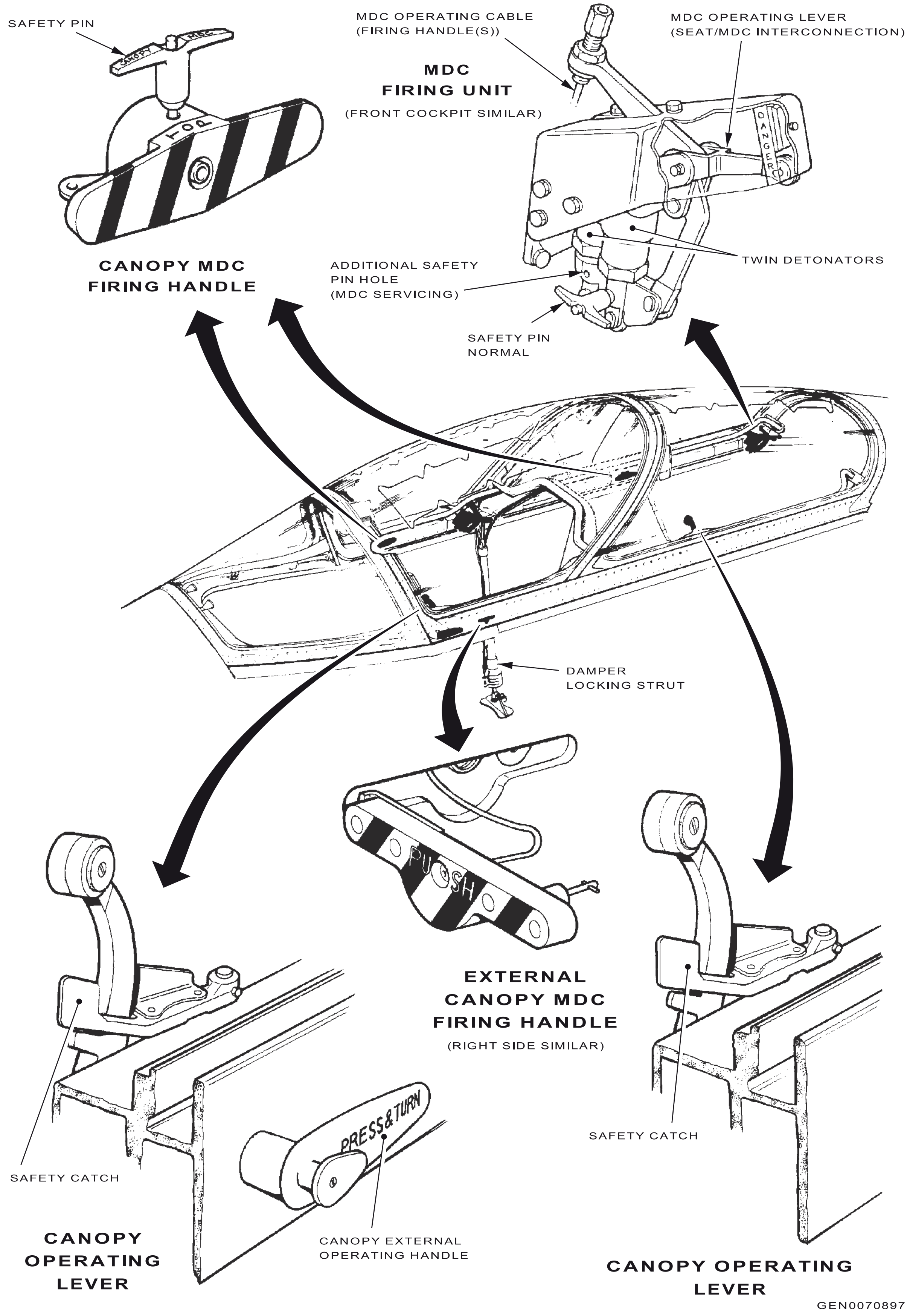
49. A stowage bag for the F 700B is in the rear cockpit at the top of the seat frame.

Personal Kit Containers

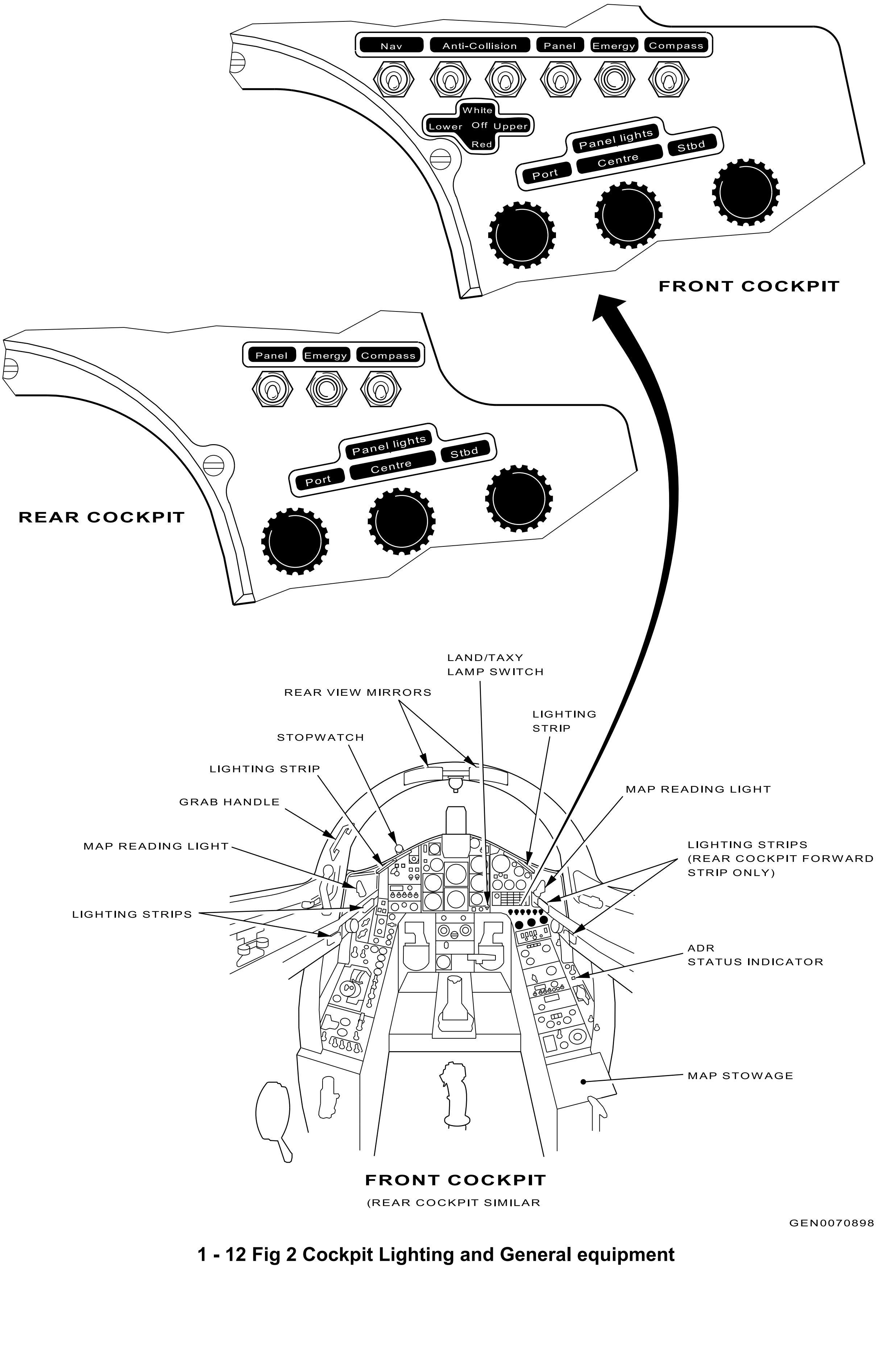
50. Personal kit containers can be secured in a bay beneath the rear cockpit. Access to the bay is via a door on the underside of the fuselage. Post Mod 2154, a replacement transponder is fitted in the bay thus preventing the carriage of the baggage container. Post Mod 2335 aircraft have the replacement transponder, but the personal kit container can still be used.

Gun Pod Rear Fairing

51. Up to 11 kg of soft baggage may be stowed in the rear fairing of the gun pod.



1 - 12 Fig 1 Canopy and Controls



1 - 12 Fig 2 Cockpit Lighting and General equipment

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PART 1

CHAPTER 13 - COMMUNICATIONS SYSTEMS

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Illustrations Fig

GENERAL

Introduction

1. The communications system provides multi-channel UHF, VHF and 2-channel standby UHF voice communications; associated with it are a Tacan installation, Instrument Landing System (ILS) equipment and an IFF/SSR installation. In the T Mk 1A the communications system also provides a telebrief facility.

2. A Communications Control System (CCS) provides overall control of the elements of the communications system. The CCS integrates the UHF (main and standby) and the VHF transmit facilities and the audio signals from these equipments and from the ILS and Tacan receivers; it also integrates the audio tone of the tone generator in the central warning system. The CCS provides intercom between the cockpits and between the cockpits and a groundcrew intercom point. In the T Mk 1A the CCS also integrates audio signals to and from the telebrief centre and audio signals from the Sidewinder missile launchers.

Power Supplies

3. Power for the communications system and associated equipment is provided as follows:

a. Essential Services Busbar
- CCS
- UHF (main and standby) / VHF
- IFF/SSR
- ILS marker light test
- Telebrief (T Mk 1A)
- VOR (Red Arrows aircraft)
- Tape recorder (post-SEM 115)

b. Generator Busbar
- ILS

c. AC Busbar
- Tacan
- VOR (Red Arrows aircraft via transformer)

4. When the communications power switch (Fig 12) marked UHF - NORMAL/BATT is at BATT, power for the CCS, the main UHF and (post-Mod 945) the telebrief facility is from the commoned supplies from No 1 and No 2 Battery busbars.

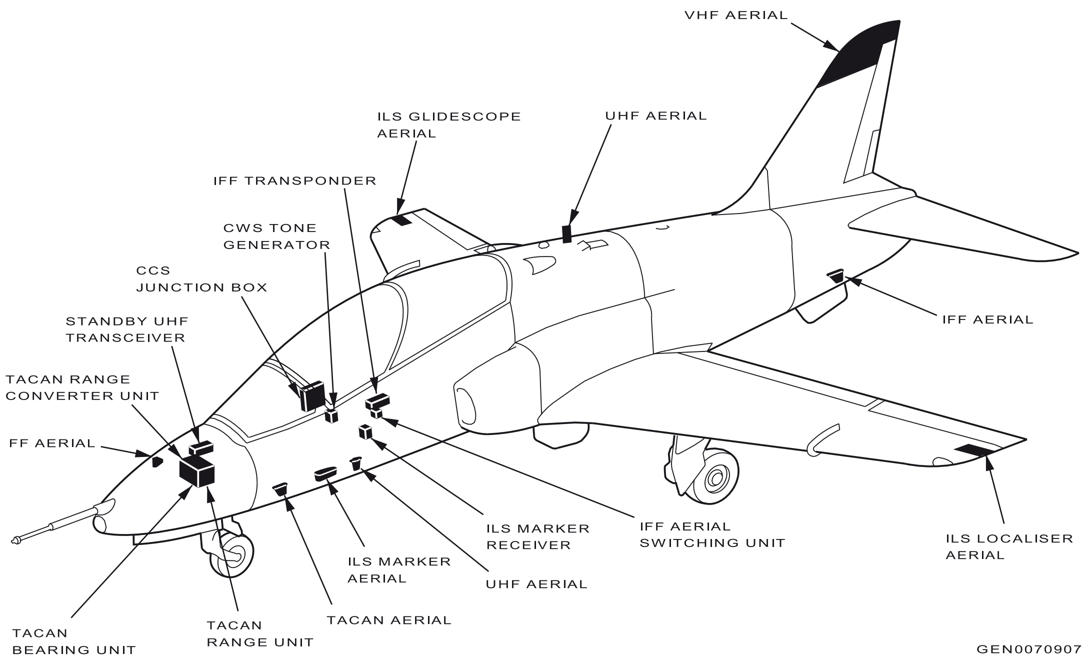
Navigation Mode Selector

5. With the ILS or Tacan switched on, a navigation mode selector on the centre panel in the front cockpit is used to select an HSI display of either ILS derived glidepath and localiser information or Tacan derived range, bearing and steering information. The selector is a spring-loaded oblong button which is marked with an upper and lower caption, ILS and TACAN respectively. At any one time either the upper or the lower caption is lit by integral lights to indicate the mode acquired and displayed. If the desired mode is not displayed, pressing the button (see Note) selects the alternative display and its associated caption is illuminated; the previously lit caption is extinguished. A flag-type mode selected indicator on the centre panel in the rear cockpit repeats the indication given on the mode selector. The mode selector is powered from the Generator busbar. When the Generator busbar is live an indication is given on the selector and the repeater irrespective of whether or not the ILS and/or Tacan is switched on.

Note: Operating the button other than by a straight press in the centre followed by a gentle release may cause the lenses and lighting assembly to become detached.

Aerials

6. A VHF aerial is on top of the aircraft fin (Fig 1). A UHF aerial is on the underside of the front fuselage, an additional UHF aerial is on top of the fuselage aft of the rear cockpit. Either the upper or the lower aerial can be manually connected to the UHF transceiver using an aerial selector switch in the front cockpit. UHF aerial selection may also be made from the rear cockpit; the rear cockpit selector overrides the front cockpit selector. The ILS localiser and glidepath aerials are in the left and right wingtips respectively and the marker aerial is on the underside of the fuselage beneath the front cockpit. The Tacan aerial is on the underside of the fuselage just aft of the nosewheel bay. The IFF/SSR equipment has two aerials: an upper aerial on the fuselage forward of the windscreen and a lower aerial on the underside of the fuselage forward of the tail bumper.



1 - 13 Fig 1 Location of Aerials and Equipment

Groundcrew Intercom Point

7. The groundcrew intercom point is in the nosewheel bay on the right-hand side.

Telebriefing Facility

8. In the T Mk 1A a telebrief facility enables the aircraft intercom to be connected to a telebrief centre. The connection is made by a telebrief ground connector which can be plugged into a socket on the left side of the nosewheel bay. A TELE/BRIEF light on the right console in both cockpits is on when the ground connector is plugged in, provided that the battery switches are on or an external DC supply is connected or (post-Mod 945) the communications power switch is set to BATT. When lit each TELE/BRIEF light can be dimmed by rotating its integral knurled collar. Normal operation in the telebriefing mode is with the UHF switched on and the CCS station box amplifier selector (sub-para 16f) set to NORM. When the TELE/BRIEF light is on:

a. Instructions from the telebrief centre can be received in both cockpits and by the groundcrew via the groundcrew intercom point. Two-way communication with the telebrief centre is obtained when the front cockpit main transmit switch is held pressed; with the switch pressed the groundcrew cannot hear signals from the cockpits or the telebriefing centre.

b. UHF and VHF transmissions from both cockpits are inhibited.

c. Intercom between the cockpits is available. The groundcrew can receive instructions from the cockpits but cannot reply.

d. The CCS station box RX control has no effect on the level of the audio signals from the telebrief centre.

e. The CWS audio warning facility remains operational.

9. The telebrief connector is to be manually disconnected before the aircraft is taxyed.

Frequency Card Holders

10. Two frequency card holders are on the glareshield in each cockpit, one on the left and one on the right. The holders are pivoted to lie flush with the glareshield when not required. A stopwatch holder (Chapter 12) forms an integral part of the left frequency card holder. Post-SEM 133 an additional stopwatch holder is fitted to the right glare shield in each cockpit.

COMMUNICATIONS CONTROL SYSTEM

General

11. The CCS (ARI 23245/7) comprises two similar station boxes, one in each cockpit, and a communications Junction Box (JB) in the front cockpit. Control of the communications system is effected by selector switches, the majority of which are on the station boxes.

Communications Junction Box

12. The JB interconnects circuits between the station boxes, the communications system and the associated facilities. The JB contains circuits incorporating:

a. Two main telephone amplifiers (one for each cockpit).

b. A standby telephone amplifier, which is common to both cockpits.

c. A groundcrew intercom microphone amplifier.

d. A groundcrew intercom telephone amplifier.

13. **Operation.**

a. The main telephone amplifiers amplify audio signals from the communications system and the associated facilities to the pilots' headphones in the respective cockpits. The standby telephone amplifier performs a similar function for the headphones in a cockpit when an amplifier selector on the station box in that cockpit is selected to FAIL.

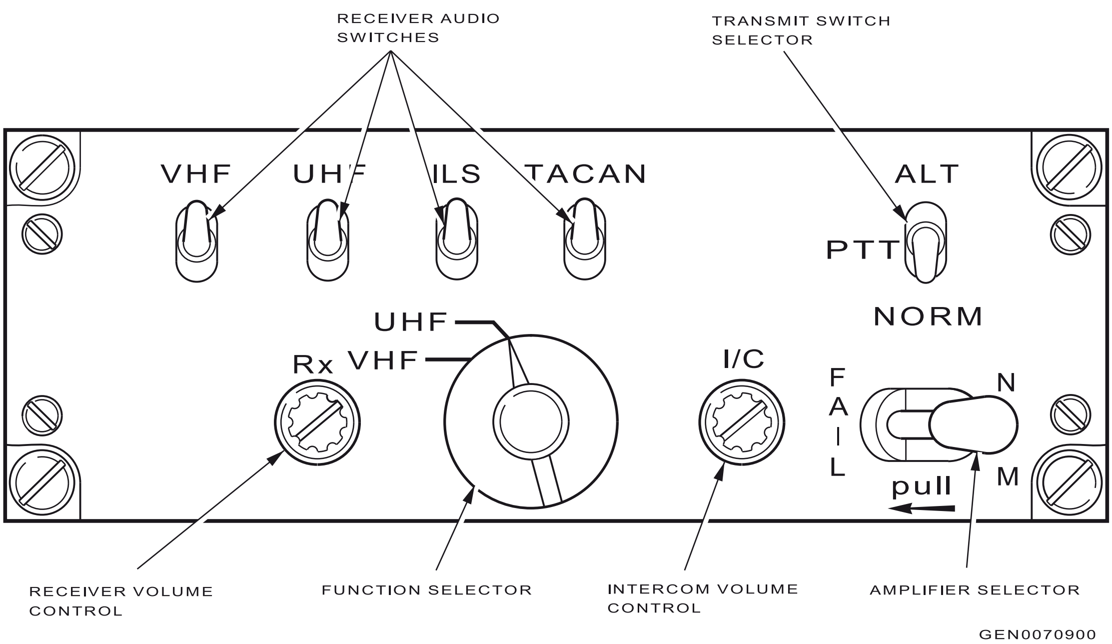
b. Groundcrew intercom signals pass from the intercom point in the nosewheel bay to the ground microphone amplifier and thence to both the main and the standby telephone amplifiers. Depending upon the setting of the amplifier selector, signals to the pilots' headphones are passed by either the main or the standby telephone amplifier. The ground intercom amplifiers are controlled by a 2-position NORM/GROUND CREW I/C switch on the right console in the front cockpit. When the telebrief is connected groundcrew microphone signals are disconnected from the ground microphone amplifier; signals from the cockpit and the telebrief centre are connected to the main and standby telephone amplifiers.

Station Boxes

14. A station box on the right panel in each cockpit provides for selection and control of the UHF (main and standby) and VHF receiver audio outputs, and the associated facilities comprising cockpit intercom, Tacan identification audio and ILS audio. When the telebrief is connected UHF and VHF audio reception is available but transmissions on UHF and VHF are inhibited.

15. Each station box contains switching circuits incorporating a normal and a standby microphone amplifier; amplifier selection is by a NORM/FAIL switch on the station box. Each amplifier contains two separate circuits: one amplifies microphone signals routed to the selected communications system, ie, UHF or VHF; the other amplifies cockpit or groundcrew intercom signals.

16. Each station box (Fig 2) has the following controls and switches:



1 - 13 Fig 2 CCS Station Box

a. **Function Selector.** A 2-position rotary selector, marked VHF/UHF, connects the cockpit microphone and a transmit switch to either the VHF or UHF communication system. Transmissions can be made from both cockpits simultaneously provided that one is on VHF and the other is on UHF. If the function selectors on both station boxes are set to similar positions and simultaneous transmissions are made from each cockpit, the transmission from the front cockpit is inhibited.

b. **Receiver Audio Switches.** Four 2-position switches (up for on), marked VHF, UHF, ILS and TACAN, each select the audio output from its associated receiver. The output of one or more receivers can be selected.

c. **Receiver Volume Control.** A rotary control, marked RX, controls the level of the receiver audio signals, which are routed via the communications JB to the pilot's headphones in that cockpit. The RX control is ineffective if the amplifier selector (sub-para 16f. below) is set to FAIL.

d. **Press-to-Transmit Selector.** A 2-position selector, marked PTT - ALT/NORM, selects either a normal or an alternative transmit switch for use with the selected transmitter. When the telebrief is connected only the front cockpit normal transmit switch is effective; the switch only allows transmissions to be made to the telebrief centre. If, however, the front cockpit normal transmit switch is held pressed then the rear cockpit can transmit to the telebrief centre when the rear cockpit normal transmit switch is pressed.

e. **Intercom Volume Control.** A rotary control, marked I/C, controls the level of the intercom audio signals in both the pilot's and the groundcrew's headphones when an amplifier selector (sub-para 16f. below) is set to NORM. When the telebrief is connected the I/C control also controls the level of the audio signals from the telebrief centre in both the pilot's and the groundcrew's headphones while the amplifier selector is set to NORM.

f. **Amplifier Selector.** A 2-position selector marked NORM/FAIL is gated at NORM. It selects either a normal (NORM) microphone amplifier in the station box and a main telephone amplifier in the communications JB, or a standby (FAIL) microphone amplifier in the station box and a standby telephone amplifier in the communications JB. The amplifiers are connected as follows

(1) At NORM the station box normal microphone amplifier intercom circuit is selected and connected to the associated main telephone amplifier in the communications JB; intercom is provided via the main amplifier. Pressing a transmit switch connects the normal microphone amplifier communications circuit with the selected transceiver. While the telebrief is connected the main amplifier communications circuit is connected with the telebrief centre when the front cockpit normal transmit switch is pressed and not with the selected transceiver.

(2) At FAIL, the station box standby microphone amplifier intercom circuit is selected and connected to the associated standby telephone amplifier in the JB; intercom is then provided by the standby telephone amplifier. Pressing a transmit switch connects the standby microphone amplifier communications circuit with the selected transceiver. With FAIL selected at a station box the pilot connected to that box hears the audio outputs from the selected receivers and intercom signals at a fixed level; the RX control is ineffective. The pilot also hears not only the audio output(s) selected at that box but any additional output selected at the station box in the other cockpit. While the telebrief is connected the standby microphone amplifier communications circuit is connected with the telebrief centre when the front cockpit normal transmit switch is pressed and not with the selected transceiver.

Note: Before flight, the selector is to be used to check the serviceability of the standby amplifiers.

Transmit Switches

17. Two press-to-transmit switches, for use with the UHF and VHF transmitters, are in each cockpit. One switch is on the throttle lever handle and the other switch, marked ALT PTT is on the left console inboard of the throttle quadrant. The required switch is selected at the station box in the associated cockpit. When the telebrief is connected only the front cockpit main (normal) transmit switch is effective; the switch only allows transmissions to be made to the telebrief centre. The rear cockpit normal transmit switch is effective while the front cockpit switch is pressed; transmissions can only be made to the telebrief centre.

Mute Switches

18. Two receiver mute switches are in each cockpit. The switches are a button type on the control column handle and a 2-position switch, marked MUTE/NORMAL, on the left console inboard of the throttle quadrant. The 2-position switch is spring-loaded to the NORMAL position. When a switch in either cockpit is operated,

audio signals from the UHF, VHF, Tacan and ILS receivers are muted. The mute switches are not effective when the amplifier selector switch on the station box in the cockpit is at FAIL. In the T Mk 1A the mute switches have no effect on audio signals from the telebrief centre.

UHF COMMUNICATIONS

Main UHF

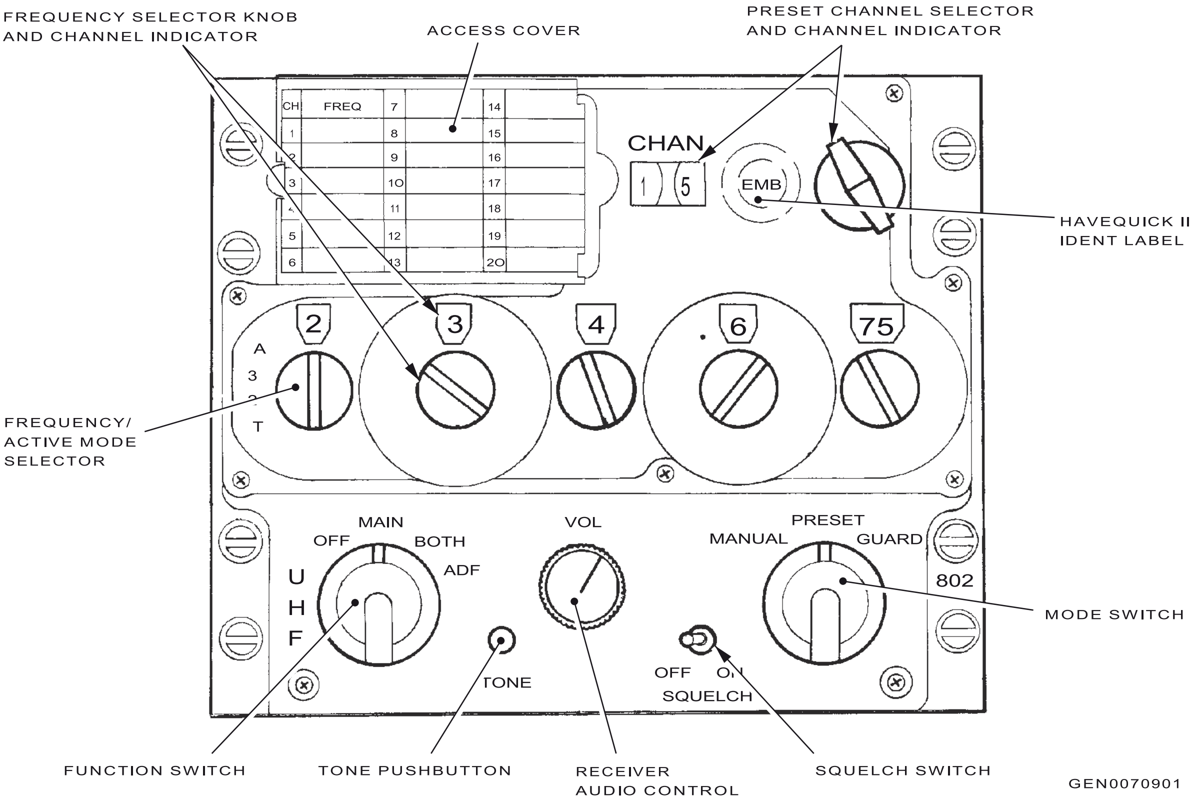
19. **General.** An AN/ARC 164 transceiver provides radio communication facilities in the UHF range 225 to 399·975 MHz. It is possible to select any one of 7000 channels, spaced at intervals of 0·025 MHz. Twenty of the channels can be preset for rapid selection. A separate guard receiver, preset to 243 MHz, is also provided.

20. **Havequick.** Post-Mod 1015 the transceiver has a Havequick anti-jamming (A/J) electronic counter-counter-measures (ECCM) facility. This provides a slow frequency-hopping capability in addition to the single-channel mode of operation.

Controls and Indicators

21. **General.** The controls and indicators comprise those on the control panel of the UHF transceiver, an aerial selector switch in each cockpit and a communications power switch, labelled UHF NORMAL/BATT, in the front cockpit. The UHF is powered from the Essential Services busbar when selected to normal and from the commoned battery supply when selected to BATT.

22. **Transceiver Control Panel.** Post-Mod 1015 the control panel (Fig 3) has the controls and indicators detailed in Table 1.



1 - 13 Fig 3 Main UHF Transceiver (Post-Mod 1015)

Table 1 - Main UHF Transceiver Controls (Post-Mod 1015)

Controls/Marking	*Function*
4-position rotary function switch: OFF MAIN BOTH ADF	 - Power off - Transmitter and main receiver operational - Transmitter and both main and guard receivers operational - Inoperative in this installation
3-position rotary mode switch: MANUAL PRESET GUARD	 - Gives tuning authority to manual frequency selectors - Gives tuning authority to preset channel selector - Selects transmitter and main receiver to guard frequency. Guard receiver disabled
20-position rotary preset channel selector and channel (CHAN) indicator	Selects in Normal (non A/J) mode any one of 19 preset communication channels. The channel number is shown in a window to the left of the selector. Preset channel frequencies are listed on a table at the top left corner of the control panel. Channel 20 selects MWOD elements (channels 20 to 15), data codes (channel 14) and operational date code (channel 1) when operating in Active (A/J) mode
5 rotary frequency selector knobs and digital indicators	From left to right the knobs are used to change frequency manually in steps of 100, 10, 1, 0·1 and 0·025 MHz when operating in Normal mode. The associated selected frequency step is shown on a digital indicator above each knob. In the Active mode the knobs sequentially select NET programme
Frequency/Active mode selector: A 3/2 T	 - Selects Active (A/J) mode - In Normal mode select required hundred digit - Set T and maintain. Request TOD on plain comms, release T and ensure 2 tone beep is heard within one minute, the presence of the tone indicates a serviceable transceiver
Rotary VOL control	Controls the audio output level of the receivers
EMB (Expanded Memory Board)	Identification label for Havequick II
SQUELCH switch - OFF/ON	Enables and disables the squelch circuit of the main receiver
TONE button switch	Enables transmission of 1020 Hz tone on the selected frequency

Standby UHF

23. A 2-channel standby UHF transceiver is in the forward equipment bay, a standby UHF switch is in each cockpit and a UHF aerial selector switch is in both cockpits.

24. The standby transceiver has two channels one of which is preset to 243·0 MHz; the other channel is preset to an alternative frequency. The required channel is selected at the standby UHF switch on the left console inboard of the throttle quadrant and forward of the alternative receiver mute switch. The transceiver is powered from the Essential Services busbar.

25. The standby UHF switch is a 3-position switch, marked STBY UHF - 243·0/MAIN/A. The switch is gated in its centre (MAIN) position and has to be lifted before it can be set to either its forward (243·0) or aft (A) position. When the switch is set to MAIN the main UHF transceiver can be used. When the switch is set to 243·0 the standby transceiver is brought into use on the 243·0 MHz channel. When the switch is set to A the standby transceiver is tuned to the alternative frequency. With the switch set to 243·0 or A the main UHF transceiver is isolated from the CCS. Rear cockpit standby UHF switch selections override front cockpit selections. If the function selector on both CCS station boxes is set to UHF and simultaneous transmissions are made from each cockpit the transmission from the front cockpit is inhibited.

26. Before solo flight the rear cockpit standby UHF switch is to be checked as set to MAIN and the aerial selector switch checked as set to FRONT.

Aerial Selector Switch

27. With the standby UHF switch in each cockpit set to MAIN, the main transceiver is connected to the aerial selected at the UHF AE - UPPER/LOWER selector in the front cockpit or at a UHF AE UPPER/FRONT/ LOWER selector in the rear cockpit. The front cockpit selector has control only when the rear cockpit selector is set to FRONT. If the standby UHF switch in either cockpit is set to 243·0 or A, the main transceiver remains connected to the selected aerial (but isolated from the communications system) and the standby transceiver is connected to the other aerial. Subsequent aerial selection for the standby transceiver is to be made in the opposite sense to the aerial selector switch markings.

WARNING: Aircraft UHF transmissions from the ARC 164 transceiver in the frequency band 225 to 399·975 MHz using the lower aerial may cause a reduction of maximum engine RPM by up to 2% and could lead to spurious T6NL warnings. Limit selection of lower aerial to essential use only.

Note: Aircraft VHF transmissions will break through on UHF tuned to the 2nd and 3rd harmonics of the VHF channel.

Note: The absence of sidetone when transmitting is an indication that the power output has fallen below a preset level, although the equipment may still be transmitting. Following generator failure a reducing battery voltage causes a progressive loss of sidetone.

VHF COMMUNICATIONS ARI 23259/1 RADIO

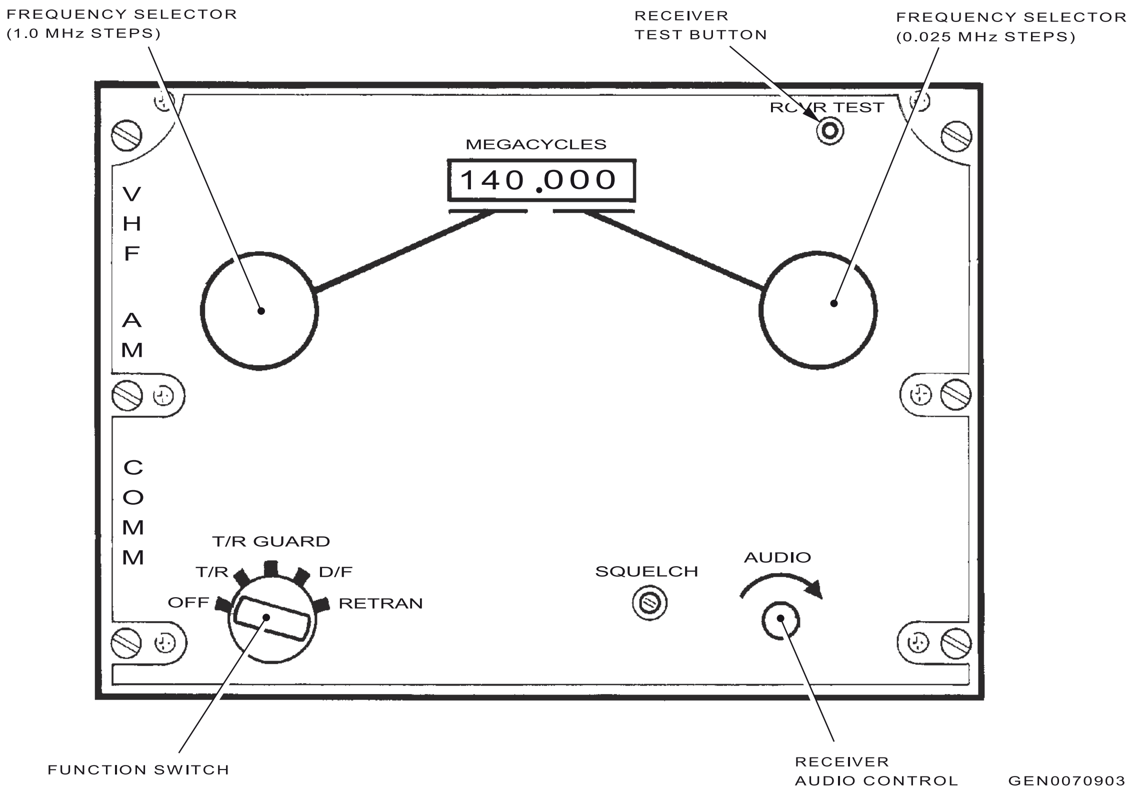
General

28. A VHF set (ARI 23259/1), on the right console in the front cockpit, provides radio communication facilities in the VHF range 116 to 149·975 MHz. It is possible to select any one of 1360 channels, spaced at 0·025 MHz intervals. A separate guard receiver, preset to 121·5 MHz, is also provided. Two-way air-to-ground communications may be obtained out to 100 NM at 30,000 feet but the range is reduced at the upper end of the frequency band and in the rearward aspects of the aircraft.

Controls and Indicators

29. The control panel for the VHF set is on the front face of the transceiver (Fig 4) and has the controls and indicators shown in Table 2.

Note: The absence of sidetone when transmitting is an indication that the power output has fallen below a preset level although the equipment may still be transmitting.



1 - 13 Fig 4 VHF Transceiver

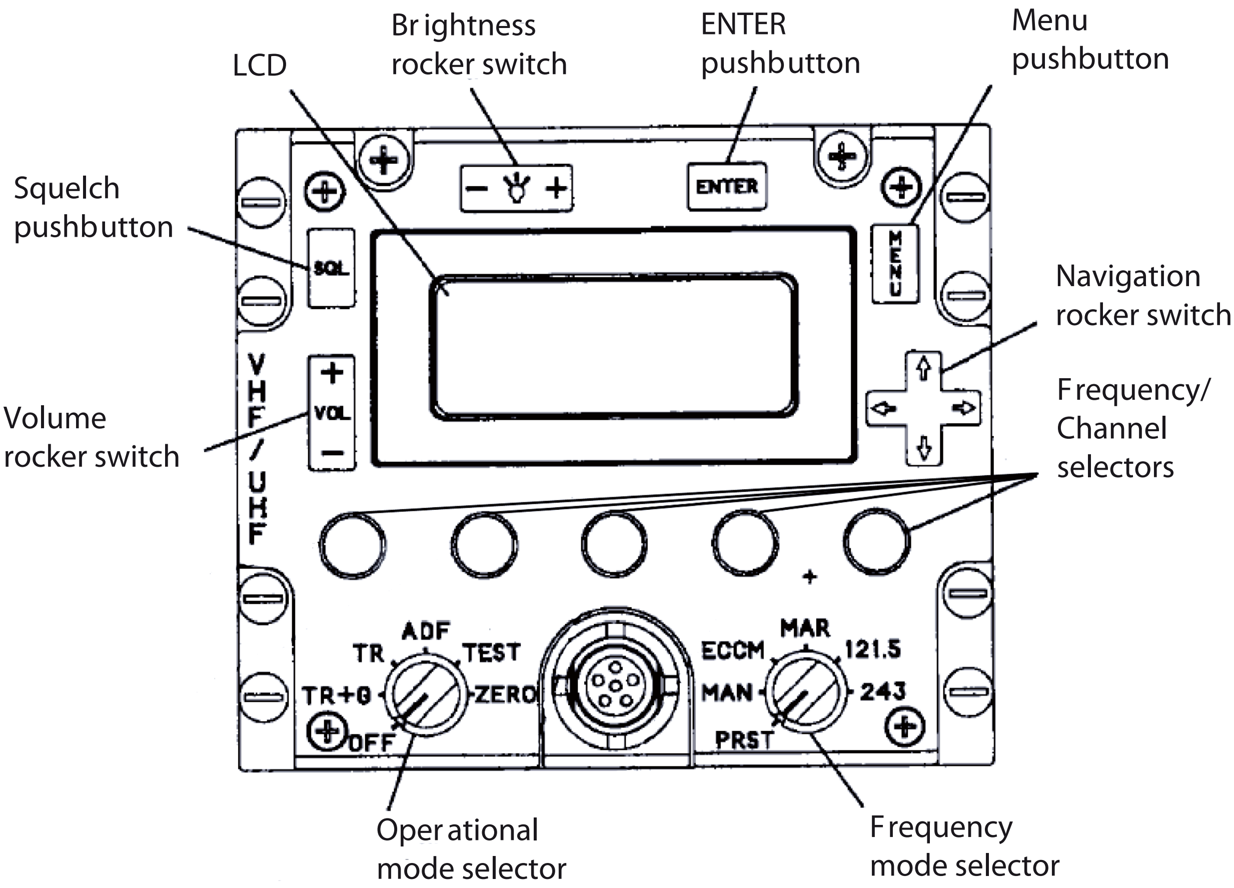
Table 2 - VHF Transceiver Controls

Controls/Marking	*Function*
5-position rotary function switch: OFF T/R T/R GUARD D/F and RETRAN	 - Power off - Selects transmitter and main receiver - Selects the guard receiver in addition to the transmitter and main receiver - Inoperative in this installation
Two rotary frequency selectors and a digital indicator: MEGACYCLES	Selectors are used to select the required frequency, the left-hand selector in steps of 1·0 MHz and the right-hand selector in steps of 0·025 MHz. The selected frequency is displayed on the digital indicator
Rotary AUDIO control	Controls audio output levels of the receivers
RCVR TEST button	With the set switched on, pressing the button initiates an 800 Hz audible tone signal in the pilot's headset; the tone is an indication of main receiver serviceability
SQUELCH	Preset

VHF COMMUNICATIONS RT8300 RADIO

30. **General** The RT8300 VHF receiver-transmitter, on the right console of the forward cockpit, provides radio communication facilities in the VHF range 118.000 to 136.975MHz in 8.33KHz steps. Only the VHF portion of the transceiver is functional.

31. **Controls and Indicators** The control panel for the VHF radio is on the front face of the transceiver (Fig 5) and has controls and indicators shown in Table 3. The LCD presentation for MAN and PRST operation is shown at Fig 6 and Fig 7.



1 - 13 Fig 5 RT8300 VHF Transceiver

Table 3 - Controls and Functions

Control/Marking	*Function*
LCD	Displays preset channel, frequency or built-in test (BIT) information
Brightness rocker switch	2-position rocker switch adjusts LCD brightness
ENTER pushbutton	Commands the transceiver to load the current configuration information displayed in the LCD (current selection is underlined)
Menu Pushbutton	Navigates up or down one menu level
Navigation rocker switch	4-position rocker switch to scroll through the LCD presentation
Frequency/Channel selectors	Rotary switches to select frequency or channel. The associated selected frequency step is shown on a digital indicator above each knob
Frequency mode selector	6-position rotary switch
PRST	Allows selection of preset channels. LCD indicates channel, frequency and modulation
MAN	Allows manual selection of operating frequencies and modulation type
ECCM	Not used
MAR	Not used
121.5	Transceiver is tuned to 121.5MHz. Only OFF, TEST, Vol, SQL and Brightness are operative
243	Not used

(Continued)

Table 3 - continued

Operational mode selector OFF TR+G TR ADF TEST ZERO	6-position rotary switch Power Off Main receiver, transmitter and guard receiver are powered On Main receiver and transmitter powered On Not used Used by groundcrew to select IBIT program Not used
Volume rocker switch	2-position rocker switch to adjust audio output level
Squelch pushbutton	Switches squelch on or off. Display of SQL in LCD indicates that squelch is off

Normal use

32. **Setting up Radio.**

a. Set Operational mode selector to TR or TR+G.

b. If SQL appears in the LCD window, press the squelch pushbutton to enable squelch and remove the SQL indication.

c. If EN OFST appears in the lower right hand corner of the LCD, press the MENU switch. Push the Navigation switch left or right to underline EN OFST, then push the Navigation switch up or down to disable offset (DIS OFSET) on the LCD. Press ENTER to initiate.

d. Continue for manual frequency or preset operation as required.

Note: T Mk 1A. When the telebrief is connected VHF transmissions are inhibited.

33. **Manual Frequency Operation.**

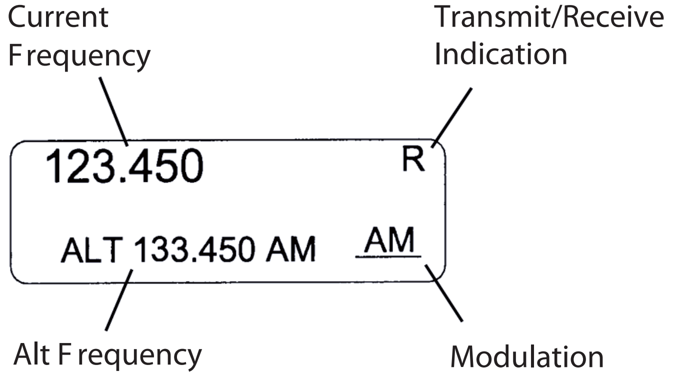
a. Set Frequency mode selector to MAN.

b. Rotate Frequency/Channel selectors to set desired frequency in ALT frequency. From left to right the rotary switches change frequency in steps of 100, 10, 1, 0·1 and 0·05 MHz.

c. Press ENTER to transfer ALT frequency to current frequency; the previous operating frequency will appear as the ALT frequency and can be transferred back to the current frequency by pressing ENTER.

Note: Selection of a frequency outside the radio operating range will result in the momentary display of INVALID in the LCD. The current operating frequency will remain in use.

d. Key the radio to establish two-way communication.



1 - 13 Fig 6 LCD Manual Frequency Display

34. **Preset Operation.**

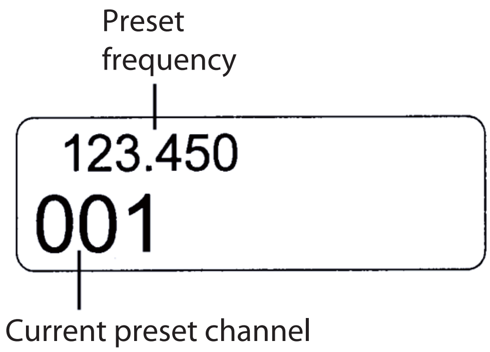
a. Set Frequency mode selector to PRST.

b. Rotate the Frequency/Channel selectors to set the desired preset channel. From left to right the rotary switches change the channel in steps of 100, 10 and 1. The fourth selector does not function in this mode. The right hand rotary selector scrolls through channels one at a time.

Note: Do not use channels 26 to 30.

c. Key the radio to establish two-way communication.

Note: T Mk 1A. When the telebrief is connected VHF transmissions are inhibited.



1 - 13 Fig 7 LCD Preset Change Display

35. **Loading a Preset Frequency.**

Note: Do not use channels 26 to 30.

a. Set Frequency mode selector to PRST.

b. Rotate the Frequency/Channel selectors to select the required channel.

c. Push MENU.

d. Push the Navigation switch left or right to underline CHG PRST, if necessary.

e. Press ENTER to initiate change preset mode.

f. Rotate the Frequency Channel selectors to select the required frequency.

g. Press ENTER to change the current preset frequency to the required frequency.

Note: When ENTER is pressed, if the required frequency is outside the radio operating range, the current frequency remains preset.

h. Set the Operational mode selector to OFF, then back to TR or TR+G.

TACAN

General

36. A Tacan installation (ARI 23256/1) gives information on the range and bearing of a complementary ground beacon at ranges up to 150 NM at 30,000 feet. The information is displayed on the HSI by selection. When used with the HSI, the system enables a specific Tacan radial, as selected at the front cockpit HSI, to be tracked. The system has 252 channels available and has a built-in test facility. The system comprises the following units:

a. Control unit.

b. Range unit.

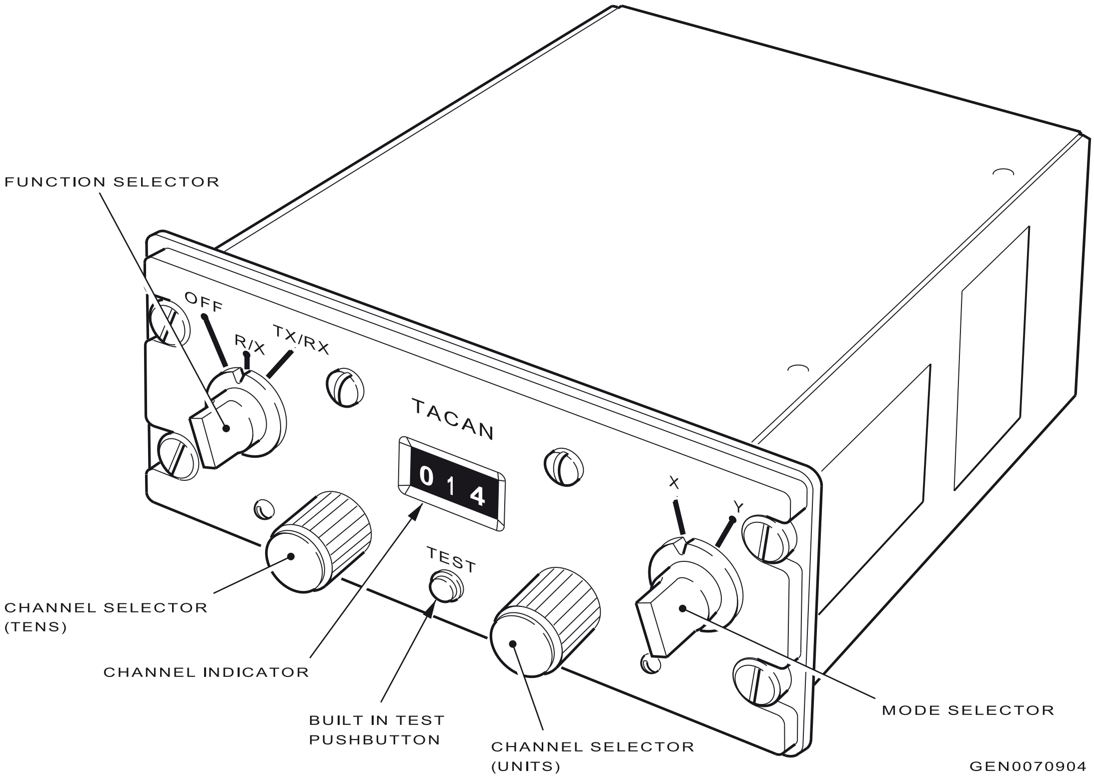
c. Bearing unit.

d. Range converter unit.

Unit Location

37. The control unit is on the right console in the front cockpit; the range, bearing and range converter units are in the forward equipment bay.

Controls and Units



1 - 13 Fig 8 Tacan Control Unit

38. **Control Unit.** The control unit (Fig 8) has the following controls:

a. **Function Selector.** The function selector is a 3-position rotary switch which provides the following facilities:

(1) **OFF.** The AC supply is disconnected. With TACAN selected at the navigation mode selector, the NAV flag alarm is displayed on the HSI and the range counter is obscured.

(2) **R/X.** The system receiver is operative but its transmitter is inoperative. Ground beacon identification signals are fed into the CCS to permit positive identification of the beacon. The HSI NAV flag alarm is removed and the magnetic bearing of the beacon is displayed on the HSI; however, the range counter remains obscured.

(3) **TX/RX.** The system receiver and transmitter are operative, interrogating pulses are transmitted and response pulses from the interrogated ground beacon are received. Range and magnetic bearing of the beacon are displayed on the HSI and the beacon's identification signals are fed into the CCS. The HSI course deviation bar shows deviation from the selected Tacan radial and either the to- or the from- flag is displayed.

b. **Channel Selector.** Two rotary controls and a digital readout are used to select the required channel. The left-hand control selects the tens position of the digital readout and the right-hand control selects the units position; the controls select the frequency of both transmitter and receiver.

c. **Built-In Test Switch.** A button, marked TEST, when held pressed, makes a built-in test.

d. **Mode Selector.** The 2-position switch, marked X/Y, selects the mode of operation, X or Y, as required.

39. **Range Unit.** The range unit contains the transmitter-receiver. Range information is processed within the unit and passed to the range converter unit. Beacon identification signals are fed into the CCS.

40. **Range Converter Unit.** The range converter unit converts information from the range unit to a form suitable for the HSI.

41. **Bearing Unit.** The bearing unit processes the bearing information and provides the following information on the HSI:

a. A heading referenced indication of bearing of the selected beacon.

b. A flag alarm indication which is fed to the HSI NAV flag.

c. A left/right deviation indication from the selected radial.

d. A to/from indication to indicate whether the aircraft is approaching or leaving a selected Tacan beacon on the Tacan radial selected.

Built-In Test

42. The serviceability of the system can be checked as follows:

a. Check that AC and DC power are on line.

b. Tacan control unit function selector to TX/RX.

c. Set HSI track index to 000 degrees.

d. Set navigation mode selector to TACAN.

e. Allow 45 seconds, then press and hold pressed the TEST button; an audio tone should then be heard in the headphones.

f. NAV flag alarm should be displayed on the HSI for 3 seconds; as the flag appears the HSI range counter shows 000 and is obscured by the yellow bar. As the NAV flag alarm disappears from view, the range counter is no longer obscured; the HSI bearing pointer rotates to between 178 and 182 degrees. Check that the from-flag is displayed and the deviation bar is central.

g. Set the track index to 180 degrees. Check that the to-flag is displayed and the deviation bar is central.

h. Set the track index to 170 and 190 degrees and check that the deviation bar indicates the appropriate deflection.

i. Move the track index through 090 and 270 degrees and check that the to/from flag display is reversed.

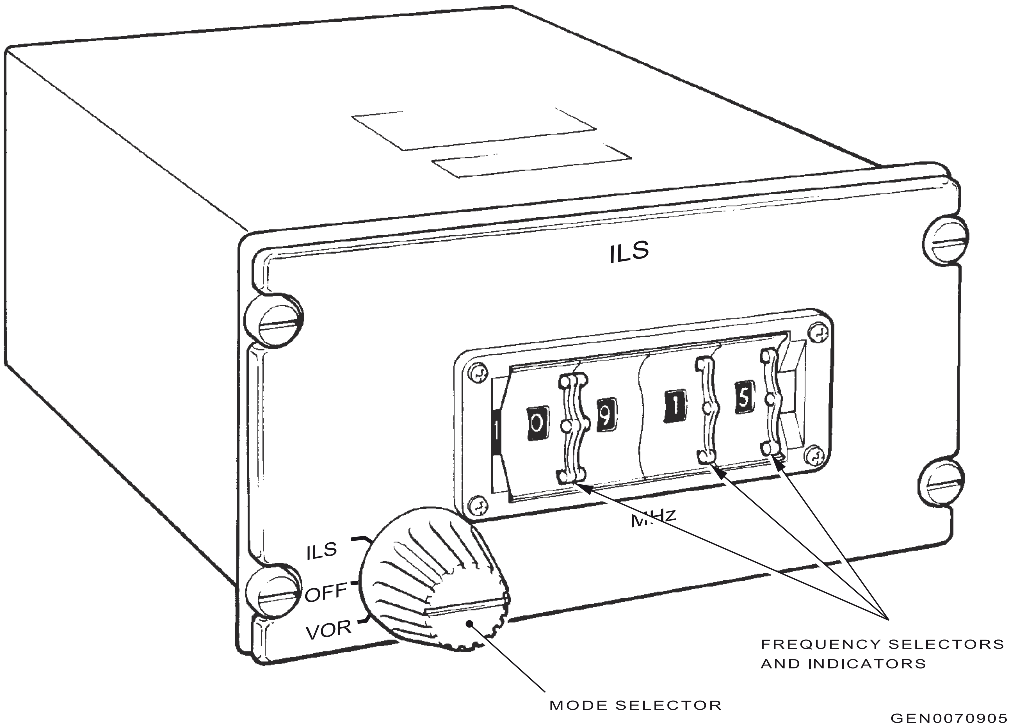
j. Release the TEST button. Check that the range counter is obscured by the yellow bar and the bearing pointer rotates smoothly counterclockwise.

INSTRUMENT LANDING SYSTEM

General

43. The ILS installation (ARI 18227/2) comprises a localiser and glidepath receiver and a marker receiver. Post SEM 155 the localiser and glidepath receiver, which has the system's control on its front panel, is on the right console in the front cockpit. Localiser frequencies in the range 108·00 to 111·95 MHz can be selected in 0·05 MHz steps; glidepath frequencies are selected by automatic pairing with localiser frequencies. The marker receiver is in the front cockpit on the left side of the seat frame. When the navigation mode selector is set to ILS, deviation from the localiser centre line and from the glidepath of the selected ILS ground installation is shown on the HSI; marker audio signals are fed to the CCS. If the glidepath signal is weak or inaccurate the GS warning flag is displayed on the HSI. If the localiser signal is weak or inaccurate the NAV flag is displayed on the HSI. Sensible localiser and glidepath indications may be obtained out to 25 NM and 10 NM respectively at 2000 feet AGL.

Controls and Indicators



1 - 13 Fig 9 ILS Control Unit

44. The ILS control unit (which houses the localiser and glidepath receiver) (Fig 9) has the controls and indicators shown in Table 4.

Table 4 - ILS Control Unit - Controls and Indicators

Controls/Marking	*Function*
3-position rotary mode: OFF ILS VOR	 - Power off - Connects the power supply to the system - Inoperative in this installation
Three, rotary frequency selector thumbwheels and digital indicators:- MHz	From left to right, the knobs are used to manually change localiser receiver frequency in steps of 1, 0·1 and 0·05 MHz. The selected frequency is shown on four digital indicators; a fixed digital 1 to the left of the tens digit indicates one hundred

45. **Marker Indicator Light.** A marker indicator light, marked ILS MARKER, is on the centre panel in each cockpit. When the marker receiver generates a marker signal the light comes on momentarily; the period of operation of the marker light is a function of signal strength to the marker receiver. The filament of each light can be tested for serviceability by depressing its holder; power for the test is from the Essential Services busbar.

IFF/SSR

General

46. The IFF/SSR installation (ARI 5970/1) provides a means of identification for military purposes (IFF) and for ATC secondary surveillance radar (SSR). The system allows the aircraft to be interrogated by IFF and SSR stations and makes rapid automatic identifying transmissions in reply. In addition to its normal identification role, the system can, by selection, transmit the following information:

a. Aircraft altitude, derived from the Mk 3B altimeter

b. Identification of position, to enable the aircraft to be readily identified, distinct from other aircraft using the same code, by the controlling station.

Units

47. The system comprises the following units:

a. **Transponder.** The transponder, in the rear cockpit to the left of the left rudder pedal, receives interrogations on a frequency of 1030 MHz and transmits coded replies on a frequency of 1090 MHz.

b. **Aerials and Aerial Switching Unit.** The system uses upper and lower aerials which are alternately switched to the transponder at 40 Hz by an aerial switching unit to give all-round reception and transmission cover. A 3-position aerial test switch, marked UPPER/FLT/LOWER, is adjacent to the transponder. The switch is used for ground test purposes and is normally locked at FLT.

c. **Control Unit.** The control unit, on the right console in the front cockpit, applies power to the transponder, determines the modes and provides manual code selection for modes 1 and 3/A/B.

Suppression

48. When the installation is replying to an interrogation, the Tacan equipment, which operates in the same frequency band, is suppressed. IFF/SSR is similarly suppressed when Tacan is transmitting.

Controls and Indicators

49. The IFF/SSR control unit (Fig 10) has the following controls and indicators:

a. **Function Selector.** The function selector is a 3-position rotary switch selecting:

(1) **OFF.** Power off.

(2) **SBY.** Power is supplied to the installation; the transponder is placed in a warm-up condition which enables it to become fully operational when XMT is selected.

(3) **XMT.** The transponder is fully operational. If, however, XMT is selected directly from OFF, there is a warm-up delay of approximately 5 minutes before the transponder becomes operational.

b. **Mode Switch.** The mode selector, a 2-position switch marked 1 and 3/A/B, is used to select the mode of operation. When 1 is selected, the transponder replies to interrogations on military mode 1. When 3/A/B is selected, the transponder replies to interrogations on military mode 3 and ATC modes A and B.

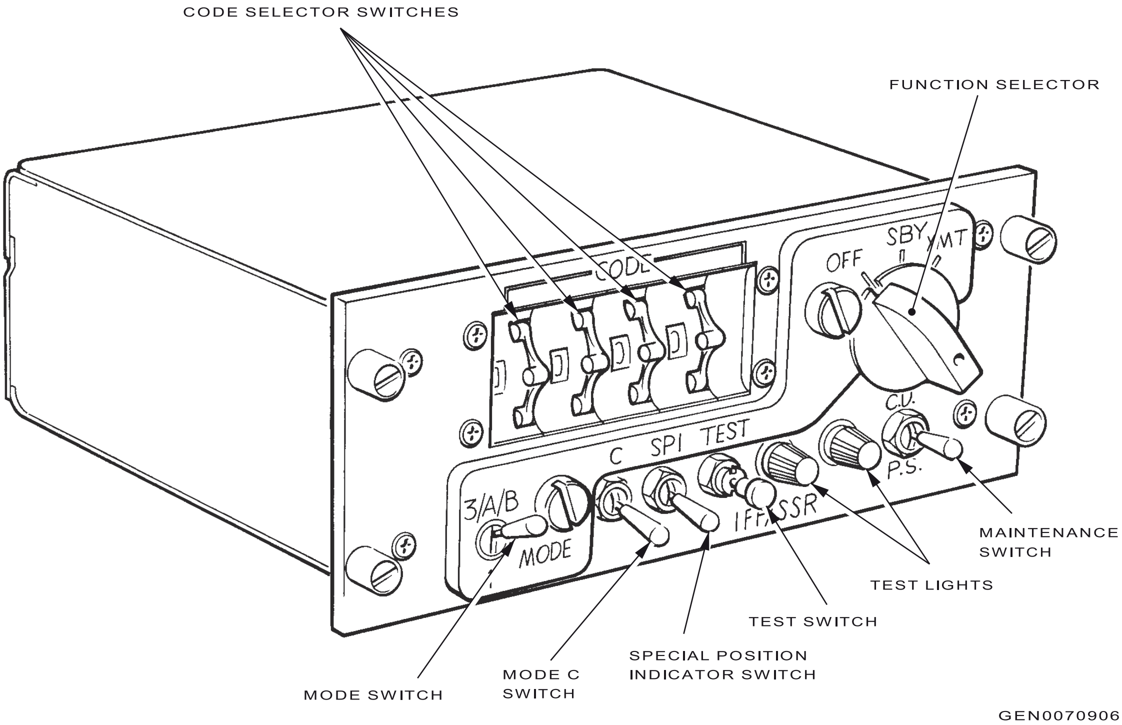
c. **Mode C Switch.** The mode C switch is a 2-position switch, marked C in the up position, which is used to transmit automatically-coded altitude information. Mode C can be selected at the same time as either modes 1 or 3/A/B. A mode C reply is made if a mode C interrogation is received and the mode is selected.

d. **Code Selector Switches.** The code selector switches are four rotary thumbwheel type switches arranged in a bank, marked CODE, and used to select the coded replies to mode 1 and 3/A/B interrogations. Each switch has eight positions numbered from 0 to 7; a total of 4096 codes can be selected.

e. **Special Pulse Identification (SPI) Switch.** The SPI switch is a 2-position switch, spring-loaded to the down position and marked SPI in the up position. Setting the switch momentarily to SPI initiates the transmission of a pulse after a normal train of reply pulses. When the switch is released, an SPI pulse is displayed on the ground interrogation equipment for a period of 15 to 30 seconds after the switch is released.

f. **Test Switch.** The button TEST switch is used, in association with two parallel-wired green lights, to test the control unit and transponder. When the switch is pressed, with the transponder warmed up and the function selector at XMT, the lights come on if the receiver sensitivity is satisfactory, if the transmitter output is above a certain level and if operation of video processing, decoding and encoding circuits is correct. If only one light comes on, failure of one bulb is indicated.

g. **Maintenance Switch.** A 3-position switch, marked CU/off/PS, is spring-loaded to off. The switch is used during maintenance to isolate faults between the control unit (CU) and the transponder (PS); do not use it in flight.



1 - 13 Fig 10 IFF/SSR Control Unit

SUCCESSOR IDENTIFICATION FRIEND OR FOE(SIFF)

General

50. Successor IFF is being introduced to all aircraft under Mods 2154 and 2335 as a replacement for the ARI 5970/1 IFF/SSR. SIFF is an IFF Mk XII transponder which is capable of Mode 1, 2 and 3A transactions for identification and ATC. The transponder can supply Mode C altitude information and is capable of Mode

S transactions for TCAS and, when a crypto unit is fitted, is capable of Mode 4 transactions (no Mode 4 with Mod 2335).

IFF Systems

51. SIFF is capable of responding to both clear interrogations and to encrypted interrogations when a crypto unit is fitted to the transponder. The following modes are employed:

a. **Mode 1:** Mode 1 is a military mode transmitted in clear to indicate a platform's mission.

b. **Mode 2:** Mode 2 is a military mode transmitted in clear to indicate a NATO allocated individual identification code.

c. **Mode 3/A:** Mode 3/A is a joint civil and military mode transmitted in clear. Mode 3 is the military designation and mode A is the civil designation.

d. **Mode C:** Mode C is a joint civil and military mode that indicates the aircraft barometric height.

e. **Mode 4:** Mode 4 is an encrypted military mode that requires a crypto unit to be fitted and loaded with a valid set of crypto. A valid reply to a Mode 4 interrogation indicates that the responding platform is a friend.

f. **Mode S:** Mode S replaces mode A in civil use. Each aircraft is allocated a unique 24-bit address. The transponder maintains a scan all around the aircraft to obtain the 24-bit address of all aircraft within the sphere of interest. It then uses the addresses obtained from the scan to interrogate individual aircraft for information such as speed, heading, height, rate of climb or descent and can then feed this information to TCAS (when fitted). The SIFF transponder fitted to the Hawk only responds to interrogations from other aircraft by transmitting the 24-bit address. This address includes Modes A, C and the bespoke identification hardwired into each aircraft.

g. **Mode 5:** Mode 5 is for future use.

Units

52. The system comprises the following units:

a. **Transponder Control Display Unit (TCDU).** The control unit is on the right console in the front cockpit. The TCDU (Fig 11) provides mode selection, code selection and BIT, tell-backs (two second display confirmations of switch selections) and system status. The TCDU controls are described in Table 5. The display is in two sections. The two top lines are annunciator states; six are green and are status indicators and four are amber and act as caution annunciators. The bottom line provides an alphanumeric decode of function menu selection, tell-backs or BIT checks. Tellbacks appear for two seconds following switch selection. The annunciator is described in Table 6, the Alphanumeric display is described in Table 7

b. **SIFF Transponder.** The transponder is a self-contained unit located in the main equipment bay. Mod 2154 in this location prevents the carriage of luggage panniers, panniers may still be carried with Mod 2335 embodied.

c. **Cryptographic Unit.** When a Mode 4 capability is required, a Cryptographic Computer Unit will be fitted to the transponder unit. The Cryptographic Unit holds two sets of data key variables (KV) - 4A and 4B. A Termination unit is fitted when the Cryptographic unit is not fitted. Mod 2335 has no Mode 4 capability.

d. **Inertia Switch.** When the inertia switches operate following a longitudinal deceleration of 3g or more, the Mode 4 KV are erased.

e. **Antennas.** The original IFF aerials located on the forward upper and rear lower fuselage are used.

f. **Power Supplies.** Main power is supplied from the 28VDC Essential Services Busbar. Secondary battery power from both the No.1 & No.2 Battery Busbars is used to maintain the memory for the KV codes.

g. **IFF Warning Annunciator.** The IFF Warning Annunciator forms the lower half of the IFF/ILS marker annunciator:

(1) The IFF warning annunciator illuminates to indicate failure of the IFF under the following circumstances.

(a) When one of the 3 amber annunciators is illuminated: MS, Mode 4 or ACC.

(b) When any of the alphanumeric fail messages are displayed: TPDR, CDU, ANT FAIL or I/F FAIL.

(2) The annunciator operates as follows:

(a) Any failure described above will illuminate the annunciator to a bright setting.

(b) Removing the failure condition from the TCDU will extinguish the annunciator.

(c) If it is not possible to remove the failure, pressing the annunciator will dim the light to an acceptable level. Any further failure will cause the annunciator to resume the bright setting.

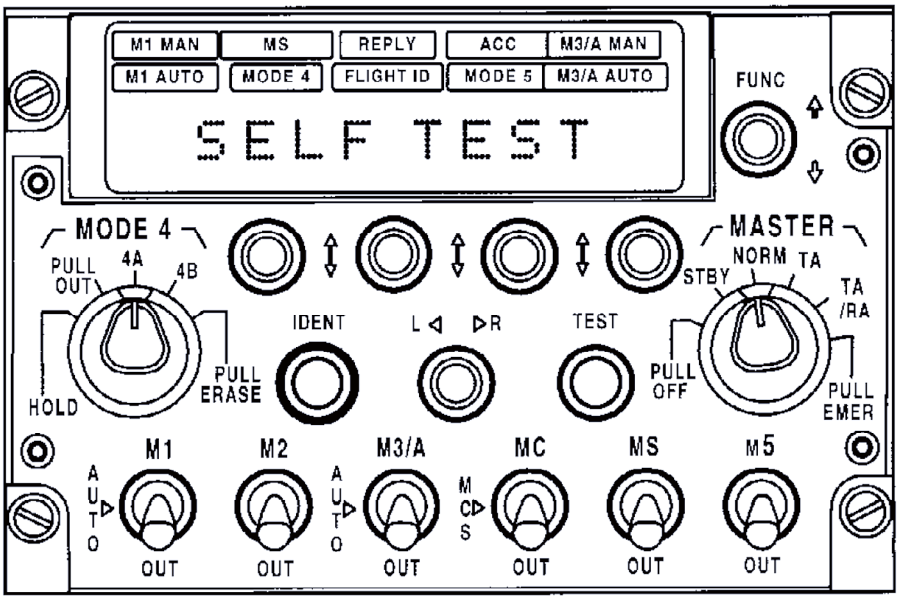
(d) When the annunciator is not illuminated, it has a press-to-test function for the IFF portion. The ILS MKR portion always has the press-to-test facility available.

h. **Lighting Control.** The TCDU panel lighting is controlled through the Master Lights Switch and dimmed by the Starboard Panel Dimmer. The TCDU annunciator and alphanumeric display lighting can be further controlled by selecting the right hand code select switch up or down as required (`Dimmer than Dim' mode). The TCDU display lighting level is slow to operate and can take up to 30 seconds to go from either extreme level.

Note: When using the `Dimmer than Dim' mode it is possible to fully extinguish the TCDU annunciator and alphanumeric display.

i. **Tone Generator.** A tone generator is fitted to the intercom system to warn of a Mode 4 caution (not fitted to Mod 2335 aircraft). The caution is disabled with M4 NONE selected. Details of the causes of a Mode 4 caution are included in Table 6

Controls and Indicators



1 - 13 Fig 11 SIFF TCDU

53. The TCDU has the following controls and indicators:

Table 5 - TCDU Controls

Control	*Marking*	*Function*
MASTER	PULL OFF	Removes power from transponder functions
	STBY	Energises the transponder and performs a PBIT; SELF TEST is displayed during the test. On completion (15 - 30 secs), either TEST PASS is displayed for five seconds or FAIL is displayed to the right side of the display with the faulty element nominated to the left. Following a successful test, the system is set to standby, transmission disabled
	NORM	Sets the Transponder to normal operation
	PULL EMERG	Enables all IFF modes regardless of Mode switch settings. The transponder responds with all appropriate emergency codes and formats
MODE 1	M1	Transponder is enabled to reply to Mode 1 interrogations using the manually set Mode 1 code
	AUTO	Do not use
	OUT	Transponder is disabled from replying to Mode 1 interrogations
MODE 2	M2	Transponder is enabled to reply to Mode 2 interrogations using the manually set Mode 2 code
	OUT	Transponder is disabled from Mode 2 interrogations
MODE 3/A	M3/A	Transponder is enabled to reply to Mode 3/A interrogations using the manually set Mode 3/A code
	AUTO	Do not use
	OUT	Transponder is disabled from replying to Mode 3/A interrogations (but see Mode S)
MODE C	MC	Transponder is enabled to reply to Mode C interrogations using the transponder altitude data
	MCS	When selected the Transponder replies to Mode C interrogations but without any height data. Selection will also suppress height data in Mode S replies. Do not use
	OUT	Transponder is disabled from replying to Mode C interrogations (but see Mode S)

(Continued)

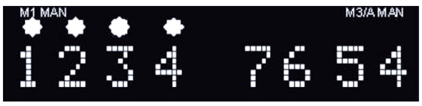
Table 5 - continued

Control	*Marking*	*Function*
MODE S	MS	Transponder is enabled to reply to Mode S interrogations. If the Mode 3/A or MC controls are Out, then they will be automatically enabled while Mode S is selected
	OUT	Transponder is disabled from replying to Mode S interrogations
MODE 5	M5	Mode 5 not currently in use
	OUT	Transponder is disabled from replying to Mode 5 interrogations
MODE 4	HOLD	When selected it will allow the Mode 4 codes to be held when the power is removed and weight-on-wheels micro-switches are made
	PULL OUT	When selected the transponder is disabled from replying to Mode 4 interrogations
	4A	When selected the transponder replies to Mode 4 code A interrogations
	4B	When selected the transponder replies to Mode 4 code B interrogations
	PULL ERASE	When selected Mode 4 codes are erased
TEST		When pressed with the MASTER set to STBY or NORM, the transponder initiates (IBIT)
IDENT		When pressed, the transponder initiates an identification response
LEFT/ RIGHT	L<>R	Selecting the left /right switch to left or right allows the four characters on the display to be edited by use of the four code select switches. Selecting left or right again enters the code into the transponder
CODE SELECT		When down is pressed, the display character corresponding to the switch pressed is decremented. When up is pressed, the display character corresponding to the switch pressed is incremented. When the selected character is incremented or decremented beyond the 0 or 7 range, it will roll over ie, 0 to 7 or 7 to 0. If any switch is held Up or Down for more than one second the corresponding character will automatically cycle through the digits
Function Select	FUNC	The up-down switch activates the function menu. When selected down the next function display page is displayed. When selected up the previous function display is displayed. The function select control switch also returns the system to normal operation following a BIT failure indication, provided that the nature of the fault allows this

Table 6 - Annunciator Display

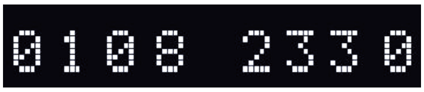
Annunciator display	*Conditions for Illumination*
M1 MAN (Green)	Both M1 selected and the function display set to display modes 1 & 3/A codes
M1 AUTO (Green)	ACC Mode 1 functionality is not implemented. Illuminates on lamp test only
MS (Amber)	Mode S fail when MS selected and the transponder is not operating on Mode S
MODE 4 (Amber) Accompanied by audio alert	Mode 4 failure to reply to a mode 4 interogation caused by: Master switch set to STBY MODE 4 switch set to PULL OUT Mode 4 KV not loaded or erased BIT detected failure during Mode 4 operation ModeA/Mode B mismatch Mode 4 reply fail (switches correct but system fails to reply to interogation)
REPLY (Green)	Transponder replying to Mode 4 interogations while Mode 4 indication control set to M4 LIGHT or M4 ALL only
FLIGHT ID (Green)	Illuminates if function switch is set to display FLIGHT ID
ACC (Amber)	ACC functionality is not implemented. Illuminates on lamp test only
MODE 5 (Amber)	Mode 5 functionality is not implemented
M3/A MAN (Green)	Both M3/A selected and the function display set to display modes 1 & 3/A codes
M3/A AUTO (Green)	ACC functionality is not implemented. Illuminates on lamp test only

Table 7 - Alphanumeric Display Function Menu

MENU ITEM	*Meaning and Operation*
Normal Operation  	This is the initial power on state (standby) with no warning indications and with both Mode 1 and 3/A manually enabled. If either mode switch is selected OUT the corresponding code display is blanked (except while editing the manual code); if both mode switches are selected OUT the display reads NORM.
Mode 1 code edit  	To enter a new Mode1 code, press L< to enter code edit. The display characters 1-4 all blink at 2 Hz. Change the code by cycling code select switches. Press L< again to enter the new code. The display then returns to normal operation.
Mode 3A code edit  	To enter a new Mode 3A code, press >R to enter code edit. The display characters 1-4 all blink at 2 Hz. Change the code by cycling code select switches. Press >R again to enter the new code. The display then returns to normal operation.

(Continued)

Table 7 - continued

MENU ITEM	*Meaning and Operation*
Date/Time Display 	The TCDU displays the current ACC date (day, month) and time (hours, minutes) in UTC. The function is display only.
ACC Time Remaining Display	Displayed but ACC not implemented.
Mode S Flight ID Display 	The TCDU displays the current flight ID stored in Non Volatile Memory (NVM). The flight ID can be edited using the standard method described in Normal Operation.
Mode S Address Display 	Displays current Mode S Address as stored in the transponder NVM and allows editing. Only displayed on the ground.
Ident Type Display 	Displays IDENT type. Type set by configuration pins.
Mode 5 Displays	Not Used
Mode 2 Code Display 	Displays current Mode 2 code and allows editing.
Mode 4 Indication 	The TCDU displays the current Mode 4 indication. Pressing >R enters the Mode 4 edit display, blinking at 2 Hz. The display steps to the next selection when any code select switch is switched down in the following sequence: 1. **M4 NONE** - Caution indicator, Reply indicator and Audio OFF. No Mode 4 cautions. 2. **M4 CAUT** - Caution indicator ON, Reply indicator and Audio OFF. 3. **M4 LGHT** - Caution and Reply indicator ON, and Audio OFF. 4. **M4 ALL** - Caution indicator, Reply indicator and Audio ON. Press >R again to enter the changed Mode 4 indication.
TCAS Display	Not used

Menu Operation

54. Code entry routines and functions are available from the function menu. The function menu uses the FUNC switch to navigate between the next or previous menu item.

SIFF Self Test

55. **Built-In Test Modes.** The transponder unit provides 3 BIT modes:

a. **Power-up BIT (PBIT)** A PBIT is initiated automatically whenever the TCDU Master Switch is selected from PULL OFF to STBY. During a PBIT, which lasts 30 secs, the SIFF is unable to perform any other function other than the PBIT.

b. **Continuous BIT (CBIT).** The Transponder continuously monitors itself for correct operation when the TCDU Master Switch is at STBY or OPERATE except during IBIT.

c. **Interruptive BIT (IBIT).** An IBIT is commanded by the operator. Normal operation is interrupted and functions are stimulated by the transponder unit and checked against prestored values. Depending on the selection of Mode 4, IBIT or VBIT is initiated by pressing the TEST button.

56. **PBIT.** To perform a PBIT switch the TCDU on by setting the MODE 4 switch to PULL OUT and the MASTER switch to STBY from PULL OFF.

57. Ensure that SELF TEST is displayed continuously on the alphanumeric display for the duration of the PBIT (approximately 15 seconds) and the Mode 4 audio warning is heard. This can be difficult on the Hawk T1 but the audio can be heard during IBIT and normal operation.

CAUTION: The Mode 4 audio test signal may not generate correctly during PBIT. If the Mode 4 audio test is not confirmed during PBIT, the operator should select IBIT to obtain confirmation of Mode 4 Audio alert. Other than PBIT, all normal Mode 4 audio functionality is available.

58. On completion of PBIT, confirm the following:

a. TEST PASS is displayed for 5 seconds, then STBY is displayed for 2 sec, and the MODE 4 annunciator is only illuminated if Mode 4 KVs are not loaded.

b. The IFF annunciator is illuminated.

59. In the event of PBIT failure, one of the fail messages detailed in Table 8 is displayed on the alphanumeric display.

Table 8 - Test Failure Messages

TPDR FAIL	Transponder failure.
CDU FAIL	Control and display unit failure.
ANT FAIL	Antenna failure.
I/F FAIL	Transponder/CDU interface failure.

60. If the Mode 4 audio test signal has not been confirmed during PBIT, the operator should select IBIT to confirm if there is a problem with the Mode 4 audio generator.

61. To increase confidence that all functional aspects of SIFF are operating correctly, aircrew are advised to perform an IBIT once the PBIT is complete.

62. **IBIT.** To perform an IBIT, with the MODE 4 switch in the OUT position and the MASTER switch at STBY or NORM, press and release the TEST button.

63. Ensure that SELF TEST is displayed continuously on the alphanumeric display for the duration of the IBIT (approximately 15 seconds) and the Mode 4 audio warning is heard.

64. On completion of PBIT, confirm the following:

a. TEST PASS is displayed for 5 seconds and the MODE 4 annunciator is only illuminated if Mode 4 KVs are not loaded.

b. The IFF annunciator is illuminated.

65. In the event of IBIT failure, one of the fail messages detailed in Table 8 is displayed on the alphanumeric display

CAUTION: Operation of IBIT in flight should be avoided as it can result in the loss of Mode S. If an IBIT in flight is necessary, the transponder power should be cycled OFF then ON within 7 seconds to avoid the loss of Mode 4 KVs and to restore Mode S operation.

66. **Verification BIT 1 (VBIT).** When the MODE 4 rotary switch is selected to 4A or 4B position, valid KV are loaded and the MASTER switch is in the NORM position, the verification BIT 1 Radiation Test (Rad Test) is set on pressing TEST. The Rad Test is used to transfer a subset of Mode 4 data between the host aircraft and the recipient to check system function. Tell-back RAD TEST is shown for the duration of the button press.

Note: Selection of TEST when in NORM and Mode 4 selected results in Mode 4 RAD TEST and not Transponder IBIT. Either deselect Mode 4 or select STBY if Transponder IBIT is required.

VINTEN TAPE RECORDER

General

67. Post-SEM 115 a Vinten tape recorder is provided to record radio communications and intercom. The recorder is at the aft of the right console in the front cockpit.

68. **Controls and Indications.**

a. **Rotary Switch.** A 4-position rotary switch is labelled CONT RECORD/RECORD VO/1 REPLAY/ REPLAY 1+2; its functions are

(1) CONTinuous RECORDing.

(2) RECORDing actuated by VOice.

(3) Track 1 REPLAY.

(4) REPLAY tracks 1 + 2. If required track 2 can be replayed independently.

b. **Central 4-Way Switch.** A 4-way toggle switch is up for ON, down for OFF, left for REWIND and right for FAST WIND.

c. **Recording Light.** A green recording light confirms RECORD selected and the recorder running.

d. **LED Display.** A LED display indicates digitally the tape used and position.

69. **Power Supplies.** Power is from the Essential Services busbar.

LOCATOR BEACONS

Sonar Locator Beacon

70. A Sonar Locator Beacon (SLB) is in the ram air turbine bay (post-Mod 1029) or the forward equipment bay (pre-Mod 1029). The battery-operated SLB is self-contained and requires no aircraft electrical power supply. Following submersion in water the beacon is automatically switched on at a depth of between 15 and 30 feet; the SLB then transmits a 13 millisecond pulse every 1·7 seconds on a frequency of 9·5 kHz. The transmission can be detected by airborne or shipborne sonar equipment and so enables the SLB to be located. The life of the SLB battery enables continuous transmissions to be made for 240 hours. The SLB

can withstand pressures equivalent to a water depth of 3600 feet. Correct functioning of the SLB can be checked on the ground by pressing an integral button; when the button is pressed the sonic pulses are heard.

Underwater Acoustic Beacon

71. Post-Mod 1024 an Underwater Acoustic Beacon (UAB) (ARI 23438/3) is attached to the Accident Data Recorder (ADR) to assist in the location and recovery of the ADR from a sunken aircraft. The self-contained, battery-powered beacon produces, for up to 30 days after immersion, a 37·5±1 kHz omni-directional signal which can be received by a sonar receiver up to a distance of about 3 km from a depth of 20,000 feet.

NORMAL USE

General

CAUTION: If a frequency or UHF aerial change is made while a transmit button is pressed, damage to the radio equipment results.

72. When using the communications system note that:

a. The quality of the speech signal may be progressively degraded in low level flight as IAS is increased above 420 knots.

b. To avoid distortion of the VHF and main UHF receiver signals, the volume controls of these equipments should not be set beyond 5/8 of their maximum travel; volume should then be controlled with the CCS RX volume control.

c. Distortion may be experienced on the VHF equipment and communications may be further degraded by interference from the IFF transmitter in the form of a high level background noise which may occur on frequencies from 116 MHz upwards at 2 MHz spacing.

d. The ILS localiser and marker audio signal levels may be excessive and that the localiser audio signal may interfere with marker audio signals.

e. CCS crosstalk is present between all receiver selections. The crosstalk is approximately strength 1 but varies with CCS volume control setting.

Ground Intercom

73. With either an external DC supply connected or both battery switches on, make the following selections:

a. Set the communications power switch to NORMAL.

b. On the station box, set the amplifier selector to NORM and adjust the I/C volume control as required.

c. Set the ground intercom switch to GROUND CREW I/C.

Before Flight

Note: In the T Mk 1A the UHF and VHF transceivers should be checked (para 78 to para 82) before the telebrief is connected.

74. **Engine Start.** Before solo flight check the rear cockpit standby UHF switch is set to MAIN and the UHF aerial selector switch is set to FRONT. Check (T Mk 1A) telebrief is connected if required. Ensure headset and PEC are properly connected, then continue as follows:

a. External DC power supply disconnected.

b. No 1 and No 2 battery switches on.

c. Communications power switch set to NORMAL.

75. **CCS Station Box.**

a. Set amplifier selector to NORM.

b. Set PTT selector to NORM.

c. Adjust I/C volume control as required.

d. Set amplifier selector to FAIL. Check serviceability of standby amplifier. Return selector to NORM.

e. Set function selector to UHF or VHF.

f. Switch on required receiver audio switches.

g. Adjust RX volume control as required.

76. **UHF Aerial Selector Switch.** Set the UHF AE switch as required.

77. **Main UHF Transceiver (Pre-Mod 1015).**

a. Set function switch to MAIN or BOTH.

b. Adjust VOL control.

c. Set MANUAL or PRESET and frequency as required.

d. Press TONE button; check tone present.

78. **Main UHF Transceiver (Post-Mod 1015).**

a. Set function switch to MAIN.

b. Adjust VOL control fully anticlockwise.

c. Set mode switch to MANUAL.

d. Set frequency/active mode selector to 3.

e. Set frequency selector knobs to display 220·000.

f. Set preset channel selector to display 20 in CHAN readout.

g. Set mode switch to PRESET.

h. Check that a single beep is heard in headset.

i. Open access cover (top left corner of panel).

j. Press and release PRESET button.

k. Check that a single beep is heard in headset.

l. Close access cover.

m. Set SQUELCH switch to OFF.

n. Adjust VOL control.

o. Set SQUELCH switch to ON.

79. **Time-of-Day Acquisition (Post-Mod 1015).**

a. Complete switch-on procedure (para 78).

b. Select appropriate frequency (MANUAL or PRESET) to receive Time-of-Day (TOD) transmission.

c. Ensure that a TOD acquisition tone (1667 Hz) is momentarily heard in headset.

d. Select alternative channel (MANUAL or PRESET).

e. Press TONE button. Ensure TOD acquisition tone is momentarily heard.

Note: When no automatic TOD transmission is available request, by normal RT, the transmission of a TOD timing signal.

Note: The TOD acquisition tone (1667 Hz) may be followed by a lower tone (1020 Hz).

80. **Standby UHF Transceiver.**

a. Set STBY UHF switch to A; check transmission and reception.

b. Set STBY UHF switch to MAIN.

Note: T Mk 1A. When the telebrief is connected UHF transmissions are inhibited; the standby UHF should therefore be checked before the telebrief is connected.

81. **VHF Transceiver.**

a. Set function switch to T/R or T/R GUARD.

b. Adjust AUDIO control.

c. Set frequency as required.

d. Press RCVR TEST button; check tone.

82. **IFF/SSR.**

CAUTION: Special care is necessary when making selections on the IFF/SSR control unit as the miniaturized switches are particularly susceptible to damage.

a. Set function selector to SBY.

b. Select mode and code as briefed.

c. Allow 2·5 minutes for warm-up, then set function selector to XMT.

d. Press TEST button and check two green lights come on.

e. Set function selector as required.

83. **SIFF.**

Note: Power up must not be attempted within one minute of power being applied to the aircraft.

a. Power Up. On the TCDU set the following switch positions:

(1) Set the MODE 4 switch to PULL OUT (Mode 4 off).

(2) M1 switch to OUT.

(3) M2 switch to OUT.

(4) M3/A switch to M3/A.

(5) MC switch to MC.

(6) MS switch to MS.

(7) MASTER switch to STBY.

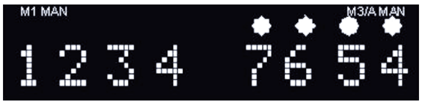
(8) When Mode 4 audio test and PBIT (TEST PASS displayed) are complete, select MASTER switch to NORM to operate transponder.

b. Editing Code. The two groups of code can be edited using the following method.

(1) Press L< or >R to enter code edit for either the left or right code group. The display characters 1-4 or 5-8 all blink at 2 Hz

(2) Change the code by cycling code select switches up or down to obtain the required digit or letter.

(3) Press the previously selected L< or >R again to enter the new code. The display then returns to normal operation.



c. Shutdown. To shutdown the SIFF carry out the following procedure. Step a is only required if KVs are loaded and need to be saved.

(1) After landing (weight-on-wheels switch made) set MODE 4 switch to HOLD. Confirm HOLD tellback and release.

(2) Set Mode 4 switch to PULL OUT.

(3) Confirm all mode select switches (M1, M2, M3/A, MC, MS and M5) are set to OUT.

(4) Set the MASTER switch to STBY for 2 seconds, ensuring display shows STAND-BY, before selecting PULL OFF.

84. **ILS.**

a. Set mode selector to ILS.

b. Test ILS MARKER indicator light.

85. **Tacan.**

a. Set function selector OFF.

b. Set mode selector to X.

86. **Telebrief - T Mk 1A.** With the telebrief connector plugged in check that the TELE/BRIEF light is on.

Systems Operation

87. **UHF (Pre-Mod 1015).**

Note 1: VHF transmissions may break through on UHF tuned to the 2nd or 3rd harmonic of the VHF channel.

Note 2: T Mk 1A. When the telebrief is connected, UHF transmissions are inhibited.

a. Set the station box function selector to UHF and set the UHF receiver audio switch to on.

b. With the UHF transceiver mode switch at PRESET, select the required channel; with the mode switch at MANUAL, set the required frequency manually. Set the function switch to MAIN or BOTH and adjust the VOL control as required.

c. To transmit on the guard channel select GUARD, or select MANUAL and set 243·000 MHz manually.

d. Set the UHF AE switch as required.

88. **UHF (Post-Mod 1015).** The RT can be operated in either normal (non A/J) or active (A/J) mode. In A/J mode the transceiver is to be programmed with single word-of-day (WOD) or multiple word-of-day (MWOD) data and is to receive the same TOD synchronization as other A/J users in the net. Programming procedures are detailed in AP 116D-0157-1B. In normal mode WOD and TOD are not required although active net users may request TOD transfer on normal communication channels. TOD acquisition procedure is therefore considered to be applicable to both modes. To counteract jamming when operating in normal mode:

a. Set function selector to MAIN.

b. Set frequency/active mode selector to A.

c. Enter appropriate net number.

89. **VHF.**

a. Set the station box function selector to VHF and set the VHF receiver audio switch to on.

b. On the VHF transceiver set the required frequency, select T/R or T/R GUARD and adjust the AUDIO control as required.

c. To transmit on the guard channel (121·500 MHz), set 121·500 MHz manually.

Note: T Mk 1A. When the telebrief is connected VHF transmissions are inhibited.

90. **IFF/SSR.** In flight, with the function selector set to XMT and correct mode and code selected, the transponder replies automatically to interrogation.

91. **ILS.**

Note: Aircraft UHF and VHF transmissions may cause erroneous ILS glidepath and localiser indications respectively; in both cases a fail flag may show.

a. Select ILS on the control unit and set the required localiser frequency.

b. Select ILS on the navigation mode selector.

Note: Tacan range and bearing are displayed when the Tacan system is operating.

92. **Tacan.**

a. On the Tacan control unit select the required channel, set the mode selector to X or Y and the function selector to R/X or TX/RX.

b. Select TACAN on the navigation mode selector.

Note: Beacon signal bearings may be subject to oscillations of 3° and bearing lock may be difficult to achieve. Bearing errors of up to 30° can be expected when type STURN 3 beacons are interrogated.

93. **Vinten Voice Recorder.** The Vinten voice recorder can only be operated in the CONT RECORD mode. When using the facility ensure that the volume controls on the VHF and UHF radios are not adjusted beyond their one o'clock positions.

MALFUNCTIONING

Electrical Failure

94. **AC Inverters.** If both No 1 and No 2 inverters come off line (AC1 and AC2 captions illuminated) and cannot be reset, the HSI is inoperative; neither Tacan derived information nor ILS information can be displayed.

95. **Generator.** If the generator comes off line (GEN caption illuminated) and cannot be reset, ILS and Tacan are inoperative. To ensure continued communication facilities, set the communications power switch to BATT.

Communications Failure

96. **CCS or UHF Systems.** If either or both the CCS or the UHF system fails, set the communications power switch to BATT to provide an alternative power source (No 1 and No 2 Battery busbars). If the main UHF system fails to operate when the communications power switch is set to BATT set the standby UHF switch to 243·0 or A as required; it may be necessary to reset the aerial selector switch to obtain optimum performance.

97. **Transmit Button.** If the throttle lever handle transmit button fails, set the CCS station box PTT selector to ALT and use the ALT PTT button inboard of the throttle quadrant.

Note: When connected to the telebrief centre the ALT PTT button is inoperative.

98. **CCS Normal Microphone Amplifier.** If the CCS normal microphone amplifier fails, set the CCS station box amplifier selector to FAIL. When flying dual, advise the occupant of the other cockpit of the action taken.

99. **Main UHF Transceiver.**

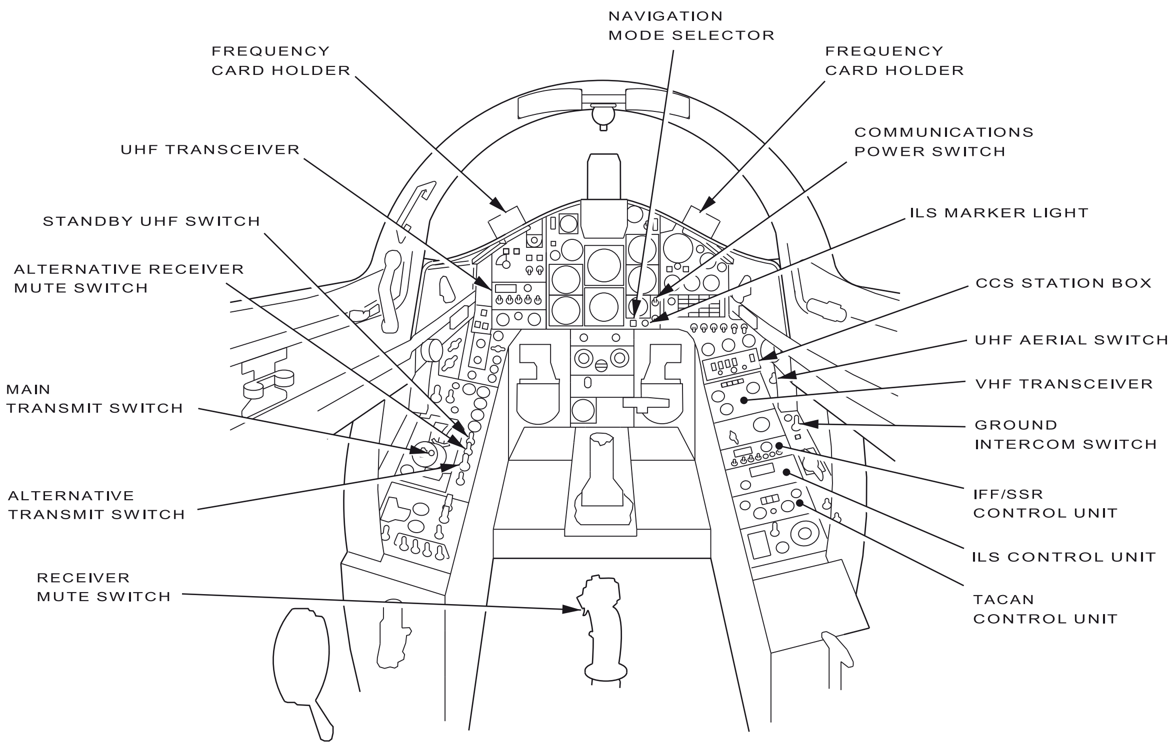
a. If the preset channel selector is suspect, use alternative manual tuning facility.

b. If receiver serviceability is suspect press the TONE button; serviceability is confirmed if the 1020 Hz tone signal is obtained.

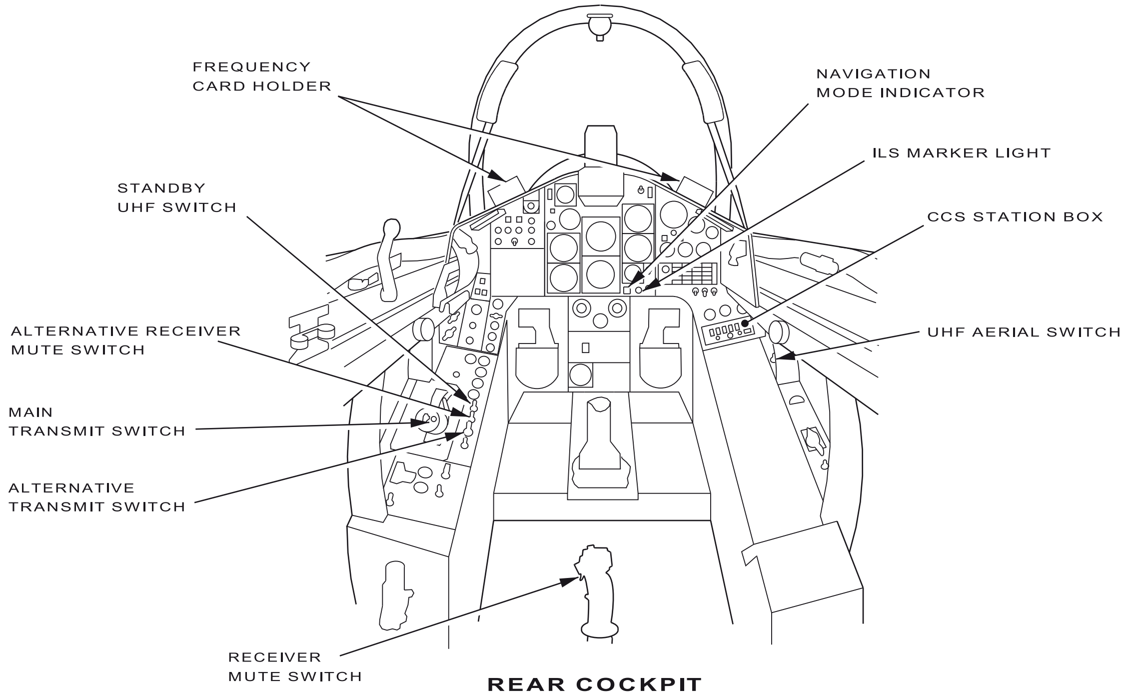
Note: The 1020 Hz tone is transmitted on the selected frequency while the TONE button is pressed.

c. At any time that the serviceability of the main UHF transceiver is suspect select the required standby frequency at the standby UHF switch.

100. **VHF Transceiver.** If receiver serviceability is suspect, press the RCVR button. Serviceability is confirmed if the 800 Hz tone signal is obtained.



FRONT COCKPIT



REAR COCKPIT

GEN0070899

1 - 13 Fig 12 Units and Controls - Cockpit Location - T Mk 1

PART 1

CHAPTER 14 - ARMAMENT

Contents

DESCRIPTION

Introduction

1. The armament installation enables the aircraft to carry Sidewinder missiles and a gun. Two underwing pylons can be fitted, one left and one right; the pylons are interchangeable but non-jettisonable. Each pylon is equipped to carry a or a carrier bomb light stores (CBLS) No I00 Mk 1, Mk 3 or Mk 4 for carrying practice bombs. Each pylon of the T Mk 1A is additionally equipped to carry a Sidewinder missile launcher (LAU-7A); an adaptor is fitted to the launcher to enable it to interface with the pylon. With the exception of the Sidewinder launcher the pylon carried stores are jettisonable. A 30 mm Aden gun, contained in a non-jettisonable gun pod, can be carried under the wing on the fuselage centre line. Aiming facilities for the available attack modes are provided by a D195R Integrated Strike and Interception System (ISIS). In the T Mk 1, only one weapon can be used at any one time, ie, either practice bomb or gun. In the T Mk 1A the gun can be selected for firing at the same time as any of the pylon-carried stores are selected for release or firing. When AAM are selected the firing or release of any other pylon-carried store is inhibited. On some aircraft, a ground launched banner target can be towed and released.

2. The main armament controls are on a weapon control panel (WCP) in the front cockpit and a weapon monitor panel (WMP) in the rear cockpit. The T Mk 1A additionally has a missile control panel (MCP) and a bomb spacing intervalometer in the front cockpit and a Sidewinder junction box (JB) with electrical circuit breakers in the rear cockpit. Electrical supplies for the armament circuits are controlled by a lockable master armament safety switch (MASS) in the front cockpit. The WCP, WMP, sight heads and MASS are not necessarily fitted to aircraft in the flying training role. Fig 1shows the position of all the related armament switches and control panels.

Pylons

3. **General.** Each pylon (Fig 2) has a forward compartment which houses a twin-suspension ejector release unit (ERU) and an aft compartment which houses an armament relay junction box. Additionally, each pylon fitted to the T Mk 1A has a Sidewinder launcher connector and nose and tail fuzing units. Each pylon is electrically connected to the aircraft services by two cable connectors, one forward and one aft, which are stowed in the wing when a pylon is not attached.

4. **Snatch Connector.** The pylon is fitted with a rocket launcher/CBLS snatch connector. The connector provides an instantaneous electrical `break' when a store is jettisoned. When not in use the snatch connector is stowed on a dummy receptacle in the pylon structure.

Ejector Release Unit

5. The ERU (Fig 3) in the forward compartment of the pylon has two hooks for the suspension of stores when the hooks are closed and for release when the hooks are opened. Whenever action is taken to jettison the pylon store, twin cartridges in the ERU are electrically fired causing an actuator piston to move the release hooks to the open position to release the store; expanding gases from the twin cartridge combustion chambers pass to ejection ram pistons which forcibly eject the store. A safety pin is to be fitted into each ERU while the aircraft is on the ground. The pin, which can be inserted from either side of the pylon at a hole marked GROUND SAFETY PIN, is to be removed before flight. With the safety pin fitted a store cannot be jettisoned, although the ERU can nevertheless be fired.

Gun Installation

6. The gun installation consists of the pod (Fig 4) which contains the single 30 mm Aden gun and its ammunition. The gun has to be pneumatically cocked before flight; firing is initiated electrically. Inadvertent

firing of the gun on the ground is prevented by the open contacts of the nosewheel leg uplock microswitch. To provide a more positive safety measure on the ground, the gun electrical circuits can be disconnected at a gun electrical connection on the pod (Fig 5). The gun has a rate of fire of 1200 to 1400 rounds per minute with a muzzle velocity of 800 metres per second (2600 feet per second). 120 rounds of ammunition can be carried.

7. A blast suppressor tube protrudes forward of the pod nose fairing. Expended ammunition cases are ejected downwards into the airstream through an ejection tube in the pod; empty ammunition belt links are retained in a receptacle in the pod. Whenever a gun firing safety catch, on the control column handgrip in each cockpit is raised, an electrically-operated ventilation door in the pod front fairing is opened; the door takes approximately seven seconds to open fully. If the safety catch is lowered before the seven seconds have elapsed, the door continues to the fully open position before closing.

Power Supplies

8. **T Mk 1.** On T Mk 1 aircraft two armament busbars, No 1 and No 2, are supplied from the No 1 Battery busbar and the Essential Services busbar respectively, whenever the MASS is at UNLOCK LIVE. (A simplified schematic diagram of the armament electrical system is at Fig 17) The No 1 Armament busbar provides a DC supply for store jettisoning only. The No 2 Armament busbar supplies DC for store jettisoning, weapon selection and release and for gun firing control; the supply to the gun firing circuits is broken whenever the nosewheel leg uplock microswitch is open (ie, nosewheel leg not locked up). A 2-position ground test switch in the left wheelbay allows the nosewheel leg microswitch to be bypassed and the gun firing circuits to be powered when the aircraft is on the ground with the nosewheel leg locked down. The gun installation also requires a 115 volt 400 Hz single-phase AC supply from the AC busbar; this supply is available whenever the No 2 Armament busbar is live, the gun pod ventilation door relay is energized and a gun firing trigger is pressed. The routing of the jettison supplies (ie, from both No 1 and No 2 Armament busbars) is independent of landing gear position and only requires the MASS to be set to UNLOCK LIVE.

Note: The two armament busbars do not physically exist in the aircraft but are so designated in this chapter to define the supplies from the No 1 Battery busbar and the Essential Services busbar after No 1 and No 2 safety relays are closed.

9. **T Mk 1A.** On T Mk 1A aircraft two armament busbars, No 1 and No 2, are supplied from the No 1 Battery busbar and the Essential Services busbar respectively whenever the MASS is at UNLOCK LIVE. Both armament busbars provide a DC supply for store jettisoning (except Sidewinder AAM); if one busbar supply fails store jettisoning can still be carried out. When the nosewheel leg uplock microswitch is closed, a combined supply from No 1 and No 2 Armament busbars is extended to No 3 Armament busbar which provides a DC supply for weapon selection, release and firing, and for Sidewinder jettisoning. The Sidewinder installation also requires a 115-volt 400 Hz single-phase AC supply in addition to DC supplies from the Essential Services busbar and No 3 Armament busbar. The AC supply is made available from No 3 inverter whenever the Generator and the Essential Services busbars are live. No 2 and 3 circuit breakers on the Sidewinder JB control the missile selection/firing DC supply and the jettison DC supply respectively; No 7 and 8 circuit breakers control the AC supply to the left and the right launcher respectively. The routing of the jettison supply (ie, from both No 1 and No 2 Armament busbars) for stores other than Sidewinders is independent of the landing gear position and only requires that the MASS is set to UNLOCK LIVE. A 2-position test switch on a weapon control JB allows the nosewheel leg microswitch to be bypassed and the pylon-carried weapon selection, release and firing circuits to be powered on the ground with the nosewheel leg locked down; the weapon control JB is in the main equipment bay. The combined supply from No 1 and No 2 Armament busbars also provides a DC supply via a second set of contacts on the nosewheel leg uplock microswitch for gun firing selection and control. A 2-position ground test switch in the left wheelbay allows the second set of microswitch contacts to be bypassed and the gun firing circuits to be powered on the ground with the nosewheel leg locked down. The gun installation also requires a 115-volt 400 Hz single-phase supply from the AC busbar; this supply is available when, with No 3 Armament busbar live, the gun pod ventilation door open relay is energized and a gun firing trigger is pressed.

Note 1: No 1 and No 2 Armament busbars do not physically exist in the aircraft but are so designated in this chapter to define the supplies from No 1 Battery busbar and the Essential Services busbar after No 1 and No 2 safety relays are closed. Similarly, No 3 Armament busbar is so designated to define the supply from No 1 Battery busbar and the Essential Services busbar after No 1 and No 2 safety relays are closed and the nosewheel leg uplock microswitch is closed.

Note 2: Sidewinder JB No 9 circuit breaker has no effect. The circuit breaker is intended to control a supply from the AC Armament busbar to a Sidewinder Expanded Acquisition Mode (SEAM) box. Although provision is made for the SEAM box it is not fitted.

ARMAMENT CONTROLS AND INDICATORS

Master Armament Safety Switch

10. DC to the armament installation is controlled by the MASS in the front cockpit. The MASS (Fig 6) is on the centre instrument panel and is a 2 pole break before make switch which is centrally-positioned. The knob has two positions, marked LOCK SAFE and UNLOCK LIVE. When the knob is in the LOCK SAFE or UNLOCK LIVE position the word LIVE or SAFE respectively is obscured by the knob. When the MASS is set to LOCK SAFE a green flag is automatically raised to the right of the sight head. When the aircraft is on the ground the flag can be seen from outside the cockpit, thus indicating to the groundcrew that the MASS is set to SAFE. The MASS is set to UNLOCK LIVE by inserting the key, with the directional arrow pointing to LOCK SAFE, then turning the key to the right through 90° to align the arrow with UNLOCK; the knob can then be turned clockwise to the LIVE position, lowering the flag as it turns. With the MASS set to UNLOCK LIVE the key cannot be removed from the switch assembly. When the knob is reset to LOCK SAFE the key is not to be allowed to turn with the knob; should it do so it may not be possible to reset the switch correctly.

Note: The key is only to be used to unlock or lock the MASS; it is not to be used to turn the control knob (which is to be turned separately). When not in use the key is to be stowed in the rubber grommet adjacent to the sighthead.

Bomb Release Button

11. A bomb release button is used for the release of pylon-carried weapons. The button, on the aft face of the control column handgrip in each cockpit, is protected by a safety flap which operates a safety switch in the bomb circuit. Raising the safety flap also energizes the GVRS.

Gun Firing Trigger

12. A gun firing trigger is on the forward face of the control column handgrip in each cockpit. To prevent accidental operation the trigger is guarded by a 2-position safety catch which protrudes on the right side of the handgrip. The safety catch also controls the AC supply to the gun firing circuit, the DC supply to the gun pod ventilation door and a DC supply for energizing the GVRS. Moving the catch up frees the firing trigger; a red section of the catch is then displayed above the top of the control column indicating that the gun firing circuit is live. Moving the catch down renders the firing trigger inoperable and the circuit safe.

Weapon Control Panel - T Mk 1

13. **General.** The WCP allows the selection of any pylon-loaded store for release or the gun for firing. The WCP also allows all pylon-loaded stores to be jettisoned.

14. **Controls and Indicators.** The WCP (Fig 7) has the following controls and indicators:

a. **Power Indicators.** Two magnetic indicators (MI), marked BUSBAR 1 and 2, individually show black when the associated No 1 or No 2 Armament busbar is live. With No 2 Armament busbar live, the WCP controls and indicators are effective. The MI show OFF in black on a white background when the power supply to the respective busbar is off.

b. **Jettison Button.** A guarded JETTISON button, on a yellow and black diagonally striped panel, is used to jettison all pylon-loaded stores. With the MASS set to UNLOCK LIVE and either No 1 Battery busbar or the Essential Services busbar live, pressing the JETTISON button connects DC supplies to jettison relays in the pylons; all other weapon control circuits are bypassed. To prevent damage to the jettison relays the button should not be held pressed for longer than three seconds.

c. **Weapon Type Selector.** A 4-position WEAPON SELECT - OFF/RP/B/G switch is used to select rockets, bombs for release or the gun for firing.

d. **Pylon Select Switches** . Two switches, PORT PYLON SELECT - ON/OFF and STBD PYLON SELECT - ON/OFF, are used to select the required pylon for weapon release.

e. **Pylon Selected Indicators.** A MI is above each PYLON SELECT switch. Each MI shows OFF in white on a black background or green (on) depending on the setting of the associated PYLON SELECT switch.

15. **Panel Lighting.** When the front cockpit main lights master switch is on, the WCP is lit by the strip light below the glareshield, and the power indicators and the pylon selected indicators are integrally lit.

Weapon Control Panel - T Mk 1A

16. General. The WCP allows for the selection of any pylon-loaded store, except Sidewinder missiles, for release or the gun for firing. The WCP also allows pylon-loaded stores, except Sidewinders and their launchers, to be jettisoned.

17. **Controls and Indicators.** The WCP (Fig 8) has the following controls and indicators:

a. **Power Indicators** . Two MI, marked BUSBAR 1 and 2, individually show black when the associated No 1 and No 2 Armament busbar is live. The WCP controls and indicators are effective when either armament busbar is live. The MI show OFF in black on a white background when the power supply to the respective busbar is off.

b. **Jettison Button** . A guarded JETTISON button, on a yellow and black diagonally striped panel, is used to jettison all pylon-loaded stores except Sidewinder AAM and their launchers. With the MASS set to UNLOCK LIVE and either No 1 Battery busbar or the Essential Services busbar live, pressing the JETTISON button connects DC supplies to jettison relays in each of the pylons; all other weapon control circuits are bypassed. To prevent damage to the jettison relays, do not hold the button pressed for longer than three seconds.

c. **Role Indicator.** A MI, marked ROLE, shows either OPS or TRG in black on a white background when a 2-position role selector on the weapon control JB is set to OPS or TRG respectively. The selector is set before flight to OPS (which is now an unused setting) or to TRG when CBLS are carried. The setting of the selector is immaterial when Sidewinders are carried.

d. **Weapon Type Selector.** A 4-position WEAPON SELECT - OFF/RP/PB/B switch has settings for rockets, practice bombs or bombs. Only PB is to be used.

e. **Pylon Select Switches** . Two 2-position PYLON SELECT switches - PORT and STBD are collectively marked OFF/ON. The switches are used to select the required pylon(s) for weapon release.

Note: There is no requirement to make a pylon selection before selecting or firing a Sidewinder.

f. **Pylon Selected Indicators.** A MI is above each pylon select switch. Each MI shows OFF in white on a black background or green depending on the setting of the associated pylon select switch.

g. **Bomb Fuzing Switch.** An obselete 3-position bomb FUZING switch marked T/N+T/N enables either tail, nose and tail or nose fuzing to be selected when the weapon control JB role selector is set to OPS. The selected pylon arming unit(s) is (are) energized when the bomb safety flap is raised.

h. **Gun Select Switch.** A 2-position GUN select switch marked OFF/ON is used to select the gun for firing.

Note: The gun can be selected and fired at the same time as any of the pylon-loaded stores are selected or released.

18. **Panel Lighting** . When the front cockpit main lights master switch is on, the WCP is lit by the strip light below the glareshield; the power, role pylon selected MI are then integrally lit.

Weapon Monitor Panel - T Mk 1

19. **General.** The WMP for the T Mk 1 (Fig 9) has the following controls and indicators:

a. **Power Indicators.** MI, marked BUSBAR 1 and 2, individually show black when the associated No 1 or No 2 Armament busbar is live. With No 2 Armament busbar live, the WMP controls and indicators are effective. The MI show OFF in black on a white background when the power supply to the respective busbar is off.

b. **Jettison Button.** A guarded JETTISON button, on a yellow and black diagonally striped panel, can be used to jettison all pylon-loaded stores. With the MASS in the front cockpit set to UNLOCK LIVE and either No 1 Battery busbar or the Essential Services busbar live, pressing the JETTISON button connects DC supplies to jettison relays in the pylons; all other weapon control circuits are bypassed. To prevent damage to the jettison relays, do not hold the button pressed for longer than three seconds.

c. **Weapon Type Selected Indicators.** One of three green indicator lights, marked RP SEL, BOMB SEL and GUN SELECT, is lit by a double filament bulb to indicate the setting of the WCP weapon type selector. Failure of one bulb filament reduces illumination.

d. **Pylon Selected Indicators .** One of two green indicator lights, marked PYLON - PORT and STBD, is lit when the associated pylon is selected at the WCP.

e. **Bomb/Rocket Safety Flap Indicator.** A green indicator light, marked SAFETY FLAP, is lit when the bomb release button safety flap in either cockpit is raised.

f. **Gun Trigger Safety Catch Indicator.** A green SAFETY indicator light is lit when, with the WCP weapon type selector set to G, the gun trigger safety catch in either cockpit is moved up.

g. **Override Switch.** A 2-position NORMAL/OVERRIDE WEAPONS switch, when set to OVERRIDE WEAPONS, interrupts DC supplies to prevent the release and firing of all weapons from the front cockpit. Selection of override also prevents the gun firing once it has been initiated. Selection of override does not prevent release or firing from the rear cockpit or jettisoning from either cockpit.

20. **Panel Lighting.** When the rear cockpit main lights master switch is on, the WMP is lit by the strip light below the glareshield, and the power MI are integrally lit.

Weapon Monitor Panel - T Mk 1A

21. **General.** The WMP for the T Mk 1A (Fig 10) has the following controls and indicators:

a. **Power Indicators.** Two MI, marked BUSBAR 1 and 2, individually show black when the associated No 1 or No 2 Armament busbar is live. The WMP controls and indicators are effective when either armament busbar is live. The MI show OFF in black on a white background when the power supply to the respective busbar is off.

b. **Jettison Button.** A guarded JETTISON button, on a yellow and black diagonally striped panel, can be used to jettison all pylon-loaded stores except Sidewinder AAM and their launchers. With the MASS in the front cockpit set to UNLOCK LIVE and either No 1 Battery busbar or the Essential Services busbar live, pressing the JETTISON button connects DC to jettison relays in each pylon; all other weapon control circuits are bypassed. To prevent damage to the jettison relays, do not hold the button pressed for longer than three seconds.

c. **Weapon Type Selected Indicators.** One of three green indicator lights, marked RP SEL, PB SEL and BOMB SEL, is lit to indicate the setting of the WCP weapon type selector. A green indicator light, marked GUN SELECT, is lit when the WCP gun select switch is set to ON. Each indicator light is lit by a double filament bulb; failure of one filament reduces illumination.

d. **Pylon Selected Indicators.** One of two green indicator lights, marked PYLON - PORT and STBD, is lit when the associated pylon is selected at the WCP.

e. **Safety Flap Indicator.** A green indicator light, marked SAFETY FLAP, is lit when the bomb release button safety flap in either cockpit is raised.

f. **Gun Trigger Safety Catch Indicator.** A green SAFETY indicator light is lit when, with the WCP gun select switch set to ON, the gun trigger safety catch in either cockpit is moved up.

g. **Override Switch.** A 2-position NORMAL/OVERRIDE WEAPONS switch, when set to OVERRIDE WEAPONS, interrupts DC supplies to prevent the release and firing of all weapons, except Sidewinders, from the front cockpit. Selection of override also prevents the gun firing once it has been initiated. Selection of override does not prevent release or firing from the rear cockpit or jettisoning from either cockpit.

22. **Panel Lighting.** When the rear cockpit main lights master switch is on, the WMP is lit by the strip light below the glareshield; the power MI are then integrally lit.

Bomb Release Intervalometer

23. The bomb release intervalometer is on the leg panel in the front cockpit but it is no longer in use.

Missile Control Panel - T Mk 1A

24. **General.** A Sidewinder AAM can be carried on a launcher installed on each of the pylons. The MCP (Fig 11) enables either of the missiles to be selected for firing and both missiles to be jettisoned by launching as a pair in an inert state.

25. **Controls and Indicators.** The MCP has the following controls and indicators:

a. **AAM Switch.** The AAM switch is a spring-loaded oblong button which is marked with an upper and a lower caption, AAM (amber) and SELECT (green) respectively. When No 3 Armament busbar is live the AAM caption is illuminated by an integral light. When the button is pressed the SELECT caption is illuminated by an integral light to indicate that the Sidewinder control circuits are live; a coolant valve solenoid in each launcher is also energized. The release or firing of other pylon-loaded stores is inhibited while the SELECT caption is illuminated. The Sidewinder control circuits are deactivated when the AAM switch is pressed again; the SELECT caption is extinguished.

b. **Missile Selected Indicators.** The missile selected indicators are two square spring-loaded buttons which are marked PORT and STBD respectively. When the AAM switch is pressed either the PORT or the STBD button is illuminated by an integral light to indicate which missile is selected for firing; the missile selected depends on the setting of a rotary switch in the Sidewinder JB. Each indicator has a push-to-test facility which is active provided the Essential Services busbar is live.

c. **Coolant/Test Switch.** The coolant/test switch is a 3-position switch marked COOLANT ON/OFF/ TEST ON. The switch has to be lifted from the OFF position before TEST ON can be selected. When the switch is set to COOLANT ON the coolant valve solenoid in each launcher is energized from the Essential Services busbar independently of the AAM switch setting. When the switch is set to TEST ON a red spring-loaded test indicator is illuminated from the Essential Services busbar; this electrical supply enables testing of all the Sidewinder control circuits, except the firing control circuits, to be carried out independently of the No 3 Armament busbar supply. With the Essential Services busbar live the test indicator should be illuminated when pressed.

d. **Mode Switch** . The mode switch is a 2-position switch marked SCAN - B/S. The setting of the switch is immaterial.

Note: The target seeker head of both missiles is caged to the missile's boresight (aircraft longitudinal fuselage datum (LFD)).

e. **Aural Tone Volume Control.** A variable control enables the volume of the selected Sidewinder's target location tone to be adjusted. The control can be varied between a LO and a HI setting. The target location tone increases in intensity as the selected missile's boresight is aligned with the target.

f. **Reject Button.** A round spring-loaded REJECT button enables the selected missile to be rejected and the unselected missile to be selected.

Note: The button has an integral light which is inoperative. If a SEAM box is installed the reject button light comes on to show green when the selected missile locks on to a target.

g. **Jettison Button.** The jettison button, marked J, is guarded by a yellow and black diagonally striped spring-loaded cover to prevent accidental operation. When the button is pressed both missiles are simultaneously jettisoned by launching, provided the nosewheel leg is locked up and the MASS is set to UNLOCK LIVE.

Missile Telemetry Switch - T Mk 1A

26. Post-Mod 745, a 3-position MISSILE TELEMETRY - ON/OFF/TEST switch, spring-loaded to OFF, is on the front cockpit left glareshield aft of the MCP. When a training version of the Sidewinder AAM is carried and the switch is held at ON or TEST the missile transmits a location signal which enables a ground tracking station to locate and positively identify the missile's parent aircraft. Hold the switch at ON or TEST shortly before the missile is fired and until a successful launch is observed. The location signal is then transmitted automatically during the missile's free flight; the signal enables the ground station to track the missile's flight path.

External Controls

27. **Gun Electrical Connection** . The gun electrical connection (Fig 5), comprising a plug and socket, allows the gun AC supply to be disconnected. Access to the plug and socket is by a door (on the left of the gun pod) painted red and marked GUN ELECTRICAL CONNECTION.

WEAPON CONTROL AND RELEASE

General

28. **T Mk 1.** The MASS is to be set to UNLOCK LIVE to connect DC to the armament busbars before any weapon can be selected for release, firing or jettisoning. Check that the BUSBAR 1 and 2 MI show black. If the BUSBAR 2 MI shows OFF, only the store jettison facility is available; if both BUSBAR 1 and 2 MI show OFF with the MASS at UNLOCK LIVE, no armament facilities are available.

29. **T Mk 1A** . The MASS has to be set to UNLOCK LIVE to connect DC to No 1 and No 2 Armament busbars and the nosewheel leg uplock microswitch has to be closed to connect the busbar supplies to No 3 Armament busbar before any weapon can be selected for release or firing. Pylon-loaded stores, except Sidewinders, can be jettisoned when the MASS is set to UNLOCK LIVE. With the MASS at UNLOCK LIVE check that the BUSBAR 1 and 2 MI show black; if both MI show OFF no armament facilities are available.

30. For gun firing, the gun electrical connection has to be made and the landing gear retracted.

Practice Bomb Release

31. **T Mk 1** . With the MASS at UNLOCK LIVE, set the WCP weapon type selector to B; the WMP BOMB SEL light comes on. Select the PORT and/or STBD PYLON SELECT switch(es) to ON as required and check that the associated pylon MI show green; the equivalent pylon indicator(s) on the WMP are on. Raise the bomb safety flap to expose the release button; the SAFETY FLAP light on the WMP comes on. When the bomb button is pressed a signal is passed to the CBLS, on the pylon or pylons selected, to release a practice bomb. When the bomb button is released, the system is reset. Bombs are released from the CBLS in the order left then right when viewed from the rear.

32. **T Mk 1A.** With the MASS at UNLOCK LIVE and the nosewheel leg locked up, check that the WCP ROLE MI shows TRG and then set the weapon type selector to PB; the WMP PB SEL light comes on. Select the PORT and/or STBD PYLON SELECT switch(es) to ON as required and check that the associated pylon MI show green; the equivalent pylon indicator(s) on the WMP are on. Raise the bomb safety flap to expose the release button; the SAFETY FLAP light on the WMP comes on. When the bomb button is pressed a

signal is passed to the CBLS, on the pylon or pylons selected, to release a practice bomb. When the bomb button is released the system is reset. Bombs are released from the CBLS in the order left then right when viewed from the rear.

Gun Firing

33. **T Mk 1.** With the MASS at UNLOCK LIVE and the nosewheel leg locked up, set the WCP weapon type selector to G; the WMP GUN SELECT light comes on. Push up the gun firing safety catch; the WMP SAFETY light comes on and the gun pod ventilation door opens. Pressing the gun firing trigger connects AC power to the gun firing pin to fire the gun. After firing, when the gun safety catch on both control columns is pushed down, the gun pod ventilation door closes and the WMP SAFETY light goes out.

34. **T Mk 1A.** With the MASS at UNLOCK LIVE and the nosewheel leg locked up, set the WCP GUN switch to ON; the WMP GUN SELECT light comes on. Push up the gun firing safety catch; the WMP SAFETY light comes on and the gun pod ventilation door opens. Pressing the gun firing trigger connects AC power to the gun firing pin to fire the gun. After firing, when the gun firing safety catch on both control columns is pushed down, the gun pod ventilation door closes and the WMP SAFETY light goes out.

Sidewinder Firing - T Mk 1A

35. With the MASS at UNLOCK LIVE and the nosewheel leg locked up, check that the MCP AAM caption is illuminated and then press the AAM switch; the SELECT caption is then illuminated. Check that either the PORT or STBD missile selected indicator is illuminated. Set the aural tone volume control as required. Raise the bomb safety flap to expose the release button; the SAFETY FLAP light on the WMP comes on. When the bomb button is pressed a firing signal is passed to the missile launcher. When the bomb button is released the illuminated missile selected indicator is extinguished and the previously unlit indicator is illuminated. The second missile can then be fired.

Use of the Override Switch

36. **T Mk 1.** To terminate or prevent the release of weapons by use of the switches in the front cockpit, set the NORMAL/OVERRIDE WEAPONS switch on the WMP to OVERRIDE WEAPONS. Firing or release of weapons using the rear cockpit controls is not prevented with override selected. Jettison circuits are not affected.

37. **T Mk 1A** . To terminate or prevent the release of weapons by use of the switches in the front cockpit, set the NORMAL/OVERRIDE WEAPONS switch on the WMP to OVERRIDE WEAPONS. The firing of Sidewinders is not prevented with override selected nor is the release of weapons using the rear cockpit controls. Jettison circuits are not affected when override is selected.

Jettisoning

38. **T Mk 1.** With the MASS at UNLOCK LIVE, all pylon stores (CBLS) are simultaneously jettisoned when the JETTISON button is pressed.

39. **T Mk 1A.**

a. **Pylon-Loaded Stores except Sidewinders.** With the MASS at UNLOCK LIVE, all pylon loaded stores, except Sidewinders, (CBLS plus practice bombs) are simultaneously jettisoned when the WCP or WMP JETTISON button is pressed.

b. **Sidewinders.** With the MASS at UNLOCK LIVE and the nosewheel leg locked up, both Sidewinders are fired when the MCP jettison button is pressed; the guidance system of each missile is inoperative. Immediately after jettisoning action is taken, initiate a breakaway manoeuvre to avoid possible fragmentation damage if the missiles collide.

SIGHTING SYSTEM

General

40. The Integrated Strike and Interception System (ISIS) D195R sight is used for weapon aiming; the ISIS comprises a sight control unit, a sight head, a reference gyro interface (RGI) unit and a range switch incorporated in the twistgrip on each throttle lever. The sight operates as an optical lead computing system for A/A guns and missiles and as a depressed sight line system for ground attacks with rockets, guns and bombs.The sight uses a gyro-controlled reticule display (Fig 12) which consists of two collimated aiming marks, one moving and one fixed. The fixed aiming mark is the intersection point of the vertical and horizontal bars of an inverted T; a flightpath indicator is displayed 20 mils above the base of the inverted T. The moving aiming mark is the spot at the centre of the quartered circle; the circle, bars and dots shown in Fig 12 move in unison with the moving aiming mark. The position of the moving aiming mark depends on the mode selected. In the A/G bomb attack mode the moving aiming mark can be manually set to a required depression in elevation from LFD; the aiming mark can be similarly set in an `S' mode attack (para 41a(7)). In the A/G bomb attack mode the moving aiming mark is initially automatically depressed to a fixed value but it is reset to the manually-set value when the bomb/RP safety flap is raised. In A/G gun and rocket attack modes the moving aiming mark is automatically set to a fixed depression value appropriate to the mode; these values cannot be altered by the pilot. In A/G gun, rocket and bomb attack modes, and in the S mode, the moving aiming mark can also be manually set to allow for crosswind components. Gyro sensitivity is varied depending on the mode selected and, for air-to-air gun attacks, by the 3-position range switch integral with and set by the throttle twistgrip. Provided a roll stabilization cut-out switch (para 42b) is set to ROLL STAB, the reticule is roll stabilized by the RGI unit in response to signals received from the AHRS. In A/G attack modes the ISIS gives a fixed depression sightline; these attacks are therefore to be flown at a predetermined set of flight conditions and the weapons released at a predetermined range. The sight requires 28 volt DC from the Generator busbar and 115 volt 400 Hz from the AC busbar. The sighting system is switched on when a mode selector on the control unit is moved from OFF to any of the operating mode positions.

Note: If the aircraft is to be flown solo the sight control unit in the rear cockpit may be left selected OFF.

Sight Control Unit

41. The sight control unit (Fig 13) is below the centre instrument panel in both cockpits. Each unit has the following controls:

a. **Mode Selector.** The 7-position mode selector controls the mode of operation of the sight system. Switch positions are OFF/GA/M/G/R/B/S; functioning at these positions is as follows:

(1) **OFF.** DC supply to the control unit and AC supply to the sight head are disconnected.

(2) **GA.** The sight is selected to display lead angle computation for air-to-air gun firing. Lead angle is correct only if target range matches the throttle twistgrip range setting of 2000 feet (fully clockwise), 1500 feet (central position) or 1000 feet (fully counterclockwise) and tracking is accurate. The dimensions of the reticule display can be used as an aid to range estimation. If the required lead angle is such that the gyro reaches its limits, the aiming mark appears slightly blurred. In this mode an event mark is displayed in the reticule when the 1500 feet range is selected.

(3) **M.** This mode is for air-to-air missile attacks. In the T Mk 1A the moving aiming mark is set to LFD. In the T Mk 1 the M position is not used.

(4) **G.** This mode is for air-to-ground gun attacks. With G selected, the moving aiming mark is depressed in elevation to cater for the gravity drop of the shell at the preset firing range. the preset depression of the fixed aiming mark provides centre cross aiming.

(5) **R.** The R setting is similar to (4) above but with an initial elevation depression for RP gravity drop and a stiff gyro sensitivity when the bomb/RP safety flap is lowered or a loose gyro sensitivity when the safety flap is raised. While assessing crosswind the safety flap should remain lowered; once crosswind has been assessed and set on the sight control unit (sub-para 41b.) the safety flap should be raised for the remainder of the attack.

(6) **B.** When B is selected, the sight initially depresses to a preset value for use in establishing the required pass height over the target, and the gyro sensitivity is switched to the value for bombing attacks. Raising the bomb/RP safety flap with B selected depresses the sight in elevation to the value selected at the DEPRESSION control; the time taken for the aiming mark to move to the selected value depends on the amount of depression selected and gyro sensitivity.

(7) **S.** With S selected, a set gyro sensitivity is selected and the reticule elevation is depressed by the value set at the DEPRESSION control. Since this is effectively a fixed sight depressed sight line mode, the attack is to be flown at a predetermined set of flight conditions and the weapons released at a predetermined range.

b. **Drift Control.** The rotary DRIFT control is used to offset the reticule in azimuth to cater for crosswind components of up to 35 knots when operating in the G, R, B and S modes. The control is graduated at 5 knot intervals. The amount by which the reticule is offset varies, not only with the DRIFT control value set, but also by mode selection; eg, with B set at the mode selector a greater aiming mark offset is applied than for R or G, due to the greater wind allowance required for bombs. The control is to be pulled out before it is rotated; if this action is not taken the control may be damaged.

c. **Depression Control.** The rotary DEPRESSION control is used to manually set the required depression in elevation from LFD for depressed sightline attacks. The control is graduated at 5 mil intervals from 0 to 200 mils and is marked numerically at 20 mil intervals; the required depression is set against an arrowhead datum. The control has to be pulled out before it can be rotated; if this action is not taken the control may be damaged.

Sight Head

42. A sight head (Fig 14) is fitted in both cockpits. In addition to a combining glass on which the gyro-controlled reticule is displayed, the sight head carries the following controls:

a. **Roll Test Button.** A button on the underside of the sight head is used to test the roll stabilization facility. When the button is pressed, the reticule aiming mark should move up to the left. When the button is released the aiming mark should return to its original position.

b. **Roll Stabilization Cut-out Switch** . A 2-position REV/ROLL STAB switch is on the right side of the sight head. When the switch is set to REV (reversion) the roll stabilization signal is disconnected, allowing the reticule to be referenced to aircraft axes. REV should be selected if roll stabilization is suspect or if aircraft attitude information is incorrect.

c. **Lamp Dimmer Control** . A lamp dimmer control, on the left side of the sight head, gives control of the reticule light intensity. An arrow on the rim of the control points in the direction of DIM.

d. **Lamp Changeover Control.** The sighthead has two reticule illumination lamps, a main and a standby. Either lamp can be selected by a rod which projects from both sides of the sighthead. The rod projects more from one side than the other; when the part which projects most is pushed in, the alternative lamp is brought into use. The lamp dimmer control is to be set to the minimum reticule intensity position before the changeover control is operated to prevent damage to the standby lamp.

e. **Fixed Cross Occulting Switch.** A lever-operated switch, on the right side of the sight head, enables the fixed cross to be occulted from the display.

Gunsight Video Recording System

43. Post-MOD 5141 a Vinten gunsight video recording system (GVRS) is fitted to selected aircraft. When activated, the GVRS records the ISIS gunsight graticule, the pilots view of the outside world and cockpit intercom, radio and Sidewinder missile aquisition audio from the CCS. Event markers are also recorded onto the VHS video cassette by selection on the control column of weapons system switches. The GVRS comprises of a video recorder, a video control panel (VCP) installed in the starboard console in the front cockpit and a video cassette recorder (VCR) installed on a mounting tray on the starboard side of the rear cockpit

44. **Video camera.** The video camera is mounted on the ISIS sight head and records through the combining glass the combined outside scene and gunsight reticule onto a VHS video cassettte.

45. **GVRS Control Panel.** The GVRS control panel is installed in the starboard console in the front cockpit and is shown at Fig 15. The unit has the controls and indicators as detailed at Table 1.

46. **Video Cassette Recorder.** The VCR is installed on a mounting tray on the starboard side of the rear cockpit and is shown at Fig 16. A hinged, lockable door allows access to the VCR controls and for loading VHS video cassettes into the cassette housing. The unit is equipped with recorder heaters which activate when excessive moisture is detected in the recorder. When the heaters are activated recording will stop until the moisture has dissipated (this can take up to 20 minutes). The unit must be configured for format and record speed before use and has the following controls:

GVRS Operating Procedures

47. The GVRS is operated as follows:

a. Aircraft battery power must be on before a VHS video cassette can be loaded into the VCR.

b. During the **After Start Checks** set the OFF/STBY/REC switch to STBY, wait 20 seconds and check that the VIDEO BIT LED is lit; this will indicate that the system is serviceable..

c. When required set the OFF/STBY/REC switch to REC, wait 10 seconds and check that the REC LED is lit; this will indicate that the system is working normally. By selecting REC the VCR records the combined outside scene and gunsight reticule, records cockpit audio and places an event mark on the video cassette. Event marks are recorded as follows:

(1) **Event Mark 1.** Event mark 1 is a single white rectangle within a black border in the upper left hand corner of the video frame. It is initiated by operation of either: the camera run switch, the gun safety catch or the bomb safety flap

(2) **Event Mark 2.** Event mark 2 is two white rectangles within a black border in the upper left hand corner of the video frame. In addition to the two rectangles, event mark 2 also adds an audio event mark (at 1 kHz) to the recorded audio and video index search system (VISS) marks to enable rapid location of recorded events. It is initiated by operation of either: the controller test switch, the gun trigger or the bomb release switch.

d. When recording is no longer required, select the OFF/STBY/REC switch to OFF to stop the VCR recording.

e. After flight, with the VHS video cassette tape removed, the VCR cassette housing is to be left in its functioning position prior to turning the aircraft battery power off.

f. **VHS/S-VHS Format Switch.** A 2-position toggle switch is labelled V/S-V. V selects normal VHS and records at a resolution of 250 lines, S-V selects Superior VHS and records at a resolution of 400 lines.

g. **SP/LP Format Switch.** A 2-position toggle switch is labelled SP/LP. SP selects a superior quality recording at the standard time for the VHS video cassette loaded. LP doubles the recording time of the loaded VHS video cassette but at an inferior quality.

h. **Eject Button.** The eject button moves the cassette housing to its loading position and allows a VHS video cassette to be inserted.

CAUTION 1: When loading a VHS video cassette in the VCR push the cassette housing downwards with great care; it can be damaged by excessive force. Only load another video cassette if usage is imminent, i.e do not store video cassettes in the recorder as without power the recorder heaters cannot protect the video cassette from low temperature or moisture. When the VCR is empty the cassette housing is to be left in its functioning position to prevent damage to the deck sub-assembly.

CAUTION 2: Before inserting a VHS video cassette the tape must be tensioned by rotating the thumbwheel on the cassette, this prevents slack tape from failure/jamming in the VCR tape transport mechanism.

Note: After pressing the Eject button the cassette housing can take up to 15 seconds to reach its loading position.

NORMAL USE - T MK 1A

Readiness Procedures

48. Before Connecting External DC Power. In both cockpits check that the control column armament switches are safe. In the front cockpit check that the MASS is set to LOCK SAFE and the green flag is up, that the WCP WEAPON SELECT switch, the GUN switch and both PYLON SELECT switches are set to OFF and that the MCP coolant/test switch is set to OFF. In the rear cockpit check that the WMP override switch is set to NORMAL.

49. With Sidewinders. In the rear cockpit check that all circuit breakers (5) on the Sidewinder JB are made (in). When the external DC supply has been connected check that the CWP AC 3 caption is extinguished; press the AC 3 RESET button if necessary. Provided that the aircraft is in a `weapons safe' area, set the MCP coolant/test switch to TEST ON, press the test indicator and check that it is illuminated. With external assistance check that the target location tone is heard from each missile in turn; use the reject button to select the missiles as required. While tone is present set the MCP tone volume control as required. Set the coolant/test switch to OFF. Press the AAM switch and check that the SELECT caption is illuminated; the AAM caption is not illuminated until the nosewheel leg is locked up. Press the AAM switch to extinguish the SELECT caption. Set the ISIS control unit mode selector to GA and M in turn and check the sight head reticule display at each setting.

Note: In order to conserve the missile coolant in each launcher do not set the coolant/test switch to TEST ON for longer than necessary during the before flight check of the missiles.

MALFUNCTIONING

Sighting System

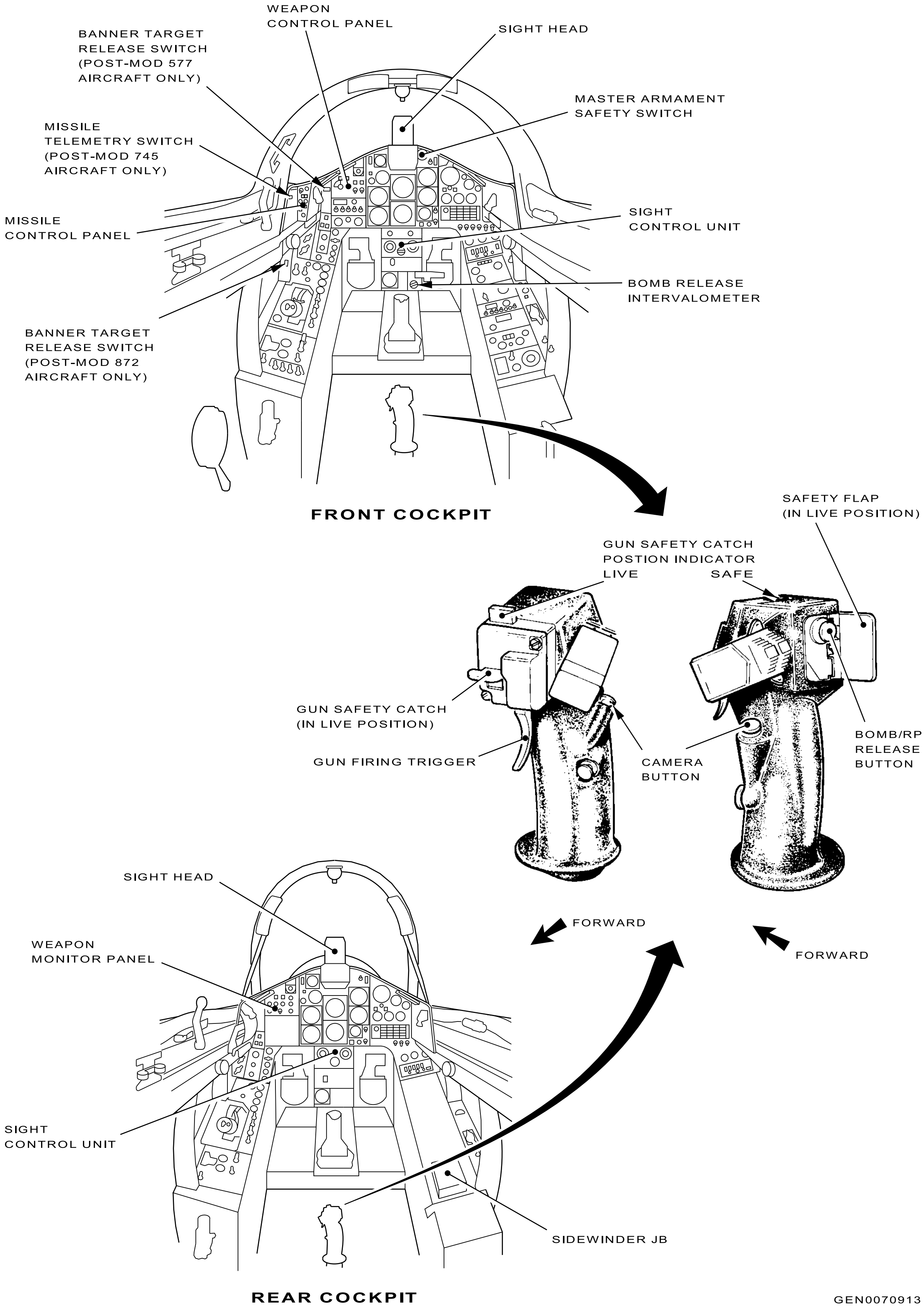
50. If the reticule is not displayed check the setting of the sight head dimmer control. If the control is correctly set, reset it to the minimum reticule intensity position and then operate the lamp changeover control; then adjust the dimmer as required. If the reticule is not displayed after these actions, or if the reticule is blurred, displaced, shaky or moving uncontrollably about the combining glass the system should be switched off.

51. If the reticule moves in a line which is tilted from the vertical when the depression control is operated in the S mode, set the roll stabilization cut-out switch to REV; the system may then be used without roll stabilization.

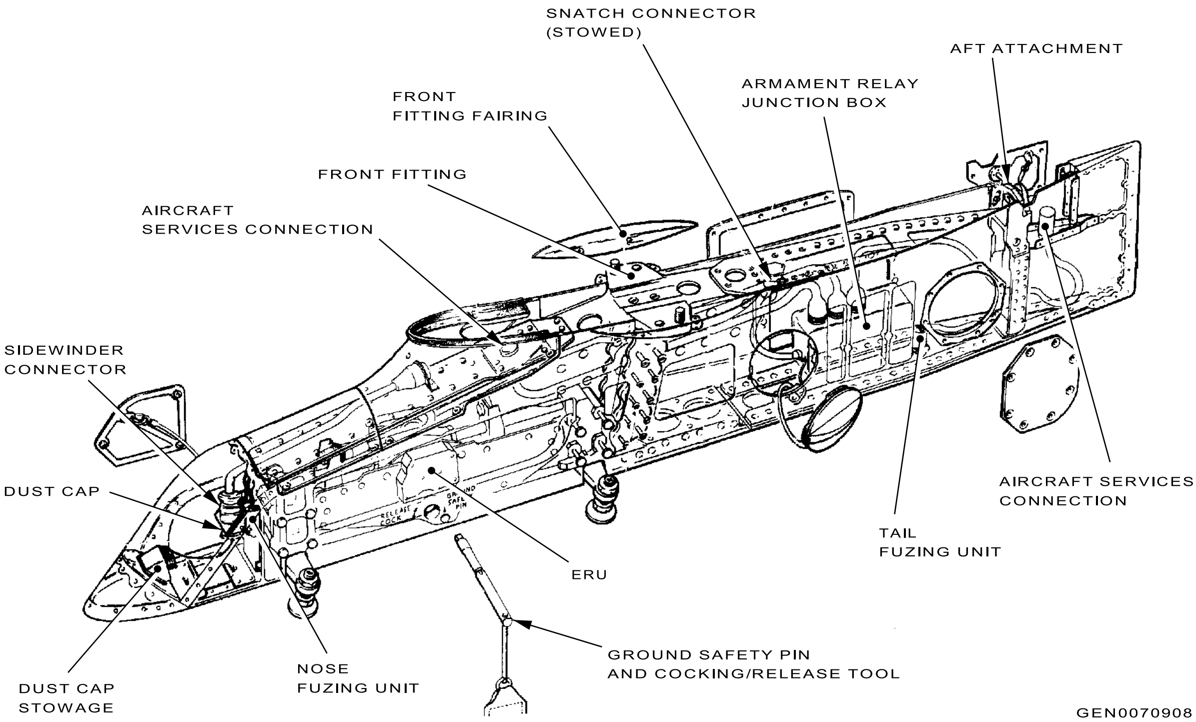
52. Do not use the system if the reticule is not depressed in the true vertical or if the reticule moves erratically when banking, is statically displaced or displays an incorrect lag angle.

Table 1 - GVRS Control Panel Controls and Indicators

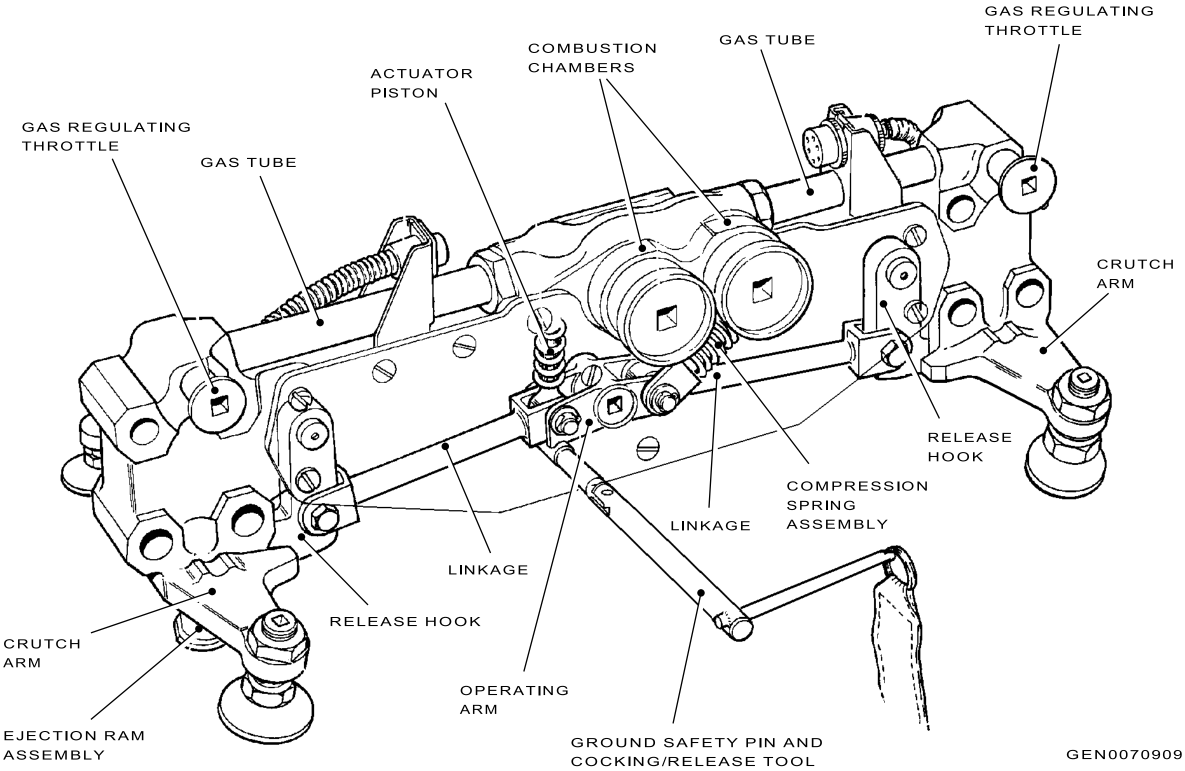
Control/Indicator	*Function*
3 position switch OFF/STBY/REC- OFF- STBY- REC	- Power Off- System is in standby mode and the camera is operating. The VCR is ready to begin recording.- When selected the REC LED illuminates and the VCR records the combined outside scene and gunsight reticule, records cockpit audio and puts an event marker (when required) onto the video cassette tape.
REC LED	Indicates the VCR is recording.
EOT LED	Indicates that end of tape has been reached and recording has stopped.
DEW LED	Indicates that there is excessive moisture detected in the recorder; recording will stop and the recorder heaters will activate until the moisture has dissipated. Recording will then recommence.
VCR BIT LED	The VCR BIT LED is normally on when the unit is powered. It will go out if the VCR does not enter record mode when selected.
VIDEO BIT LED	The VIDEO BIT LED is normally on when the unit is powered. It will go out if synchronization pulses, generated in the camera, are not received by the VCR.
Note: If the VIDEO or VCR BIT circuits detect a failure the REC LED will flash on and off at 2 Hz.	



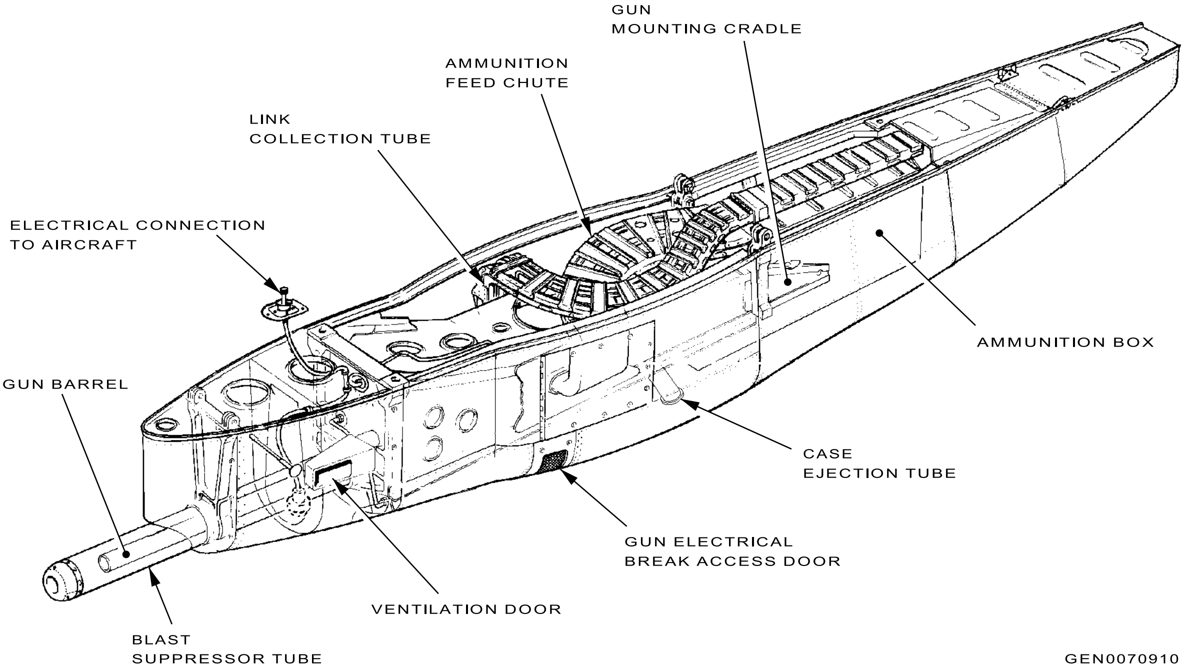
1 - 14 Fig 1 Armament Controls - Cockpit Location



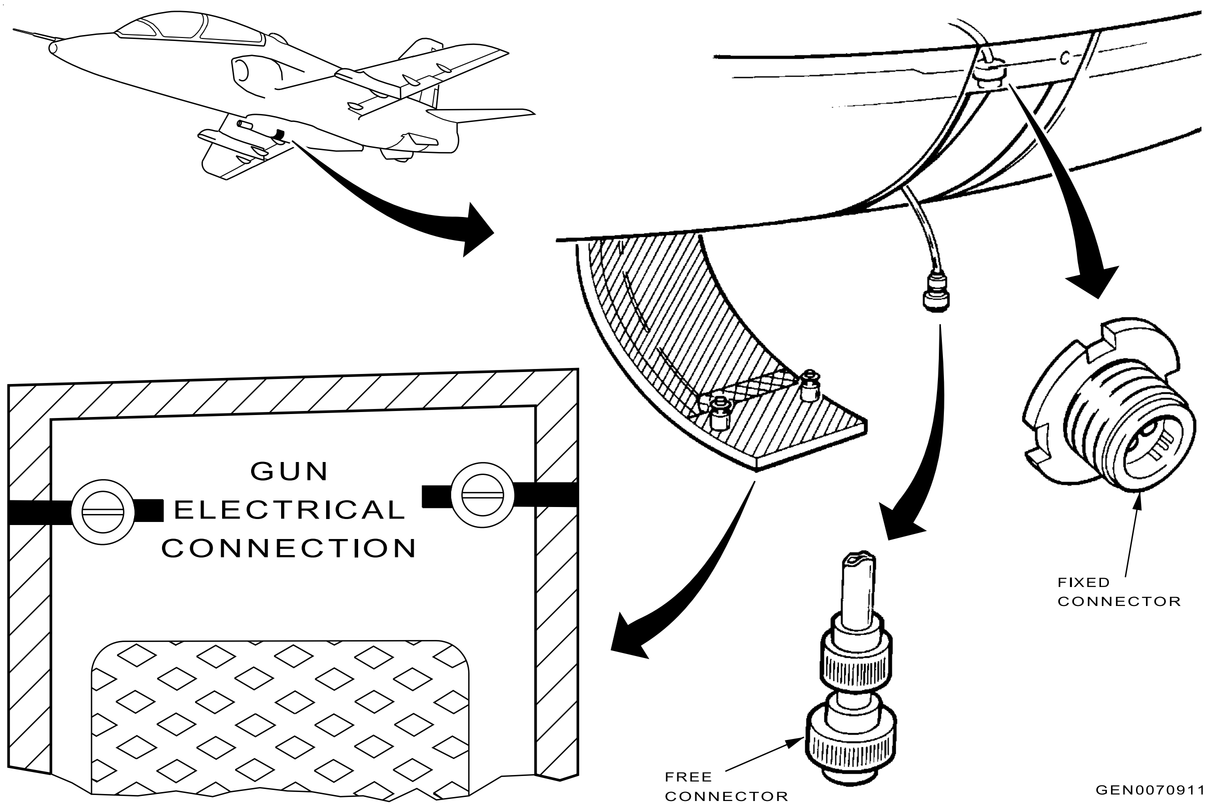
1 - 14 Fig 2 Pylon



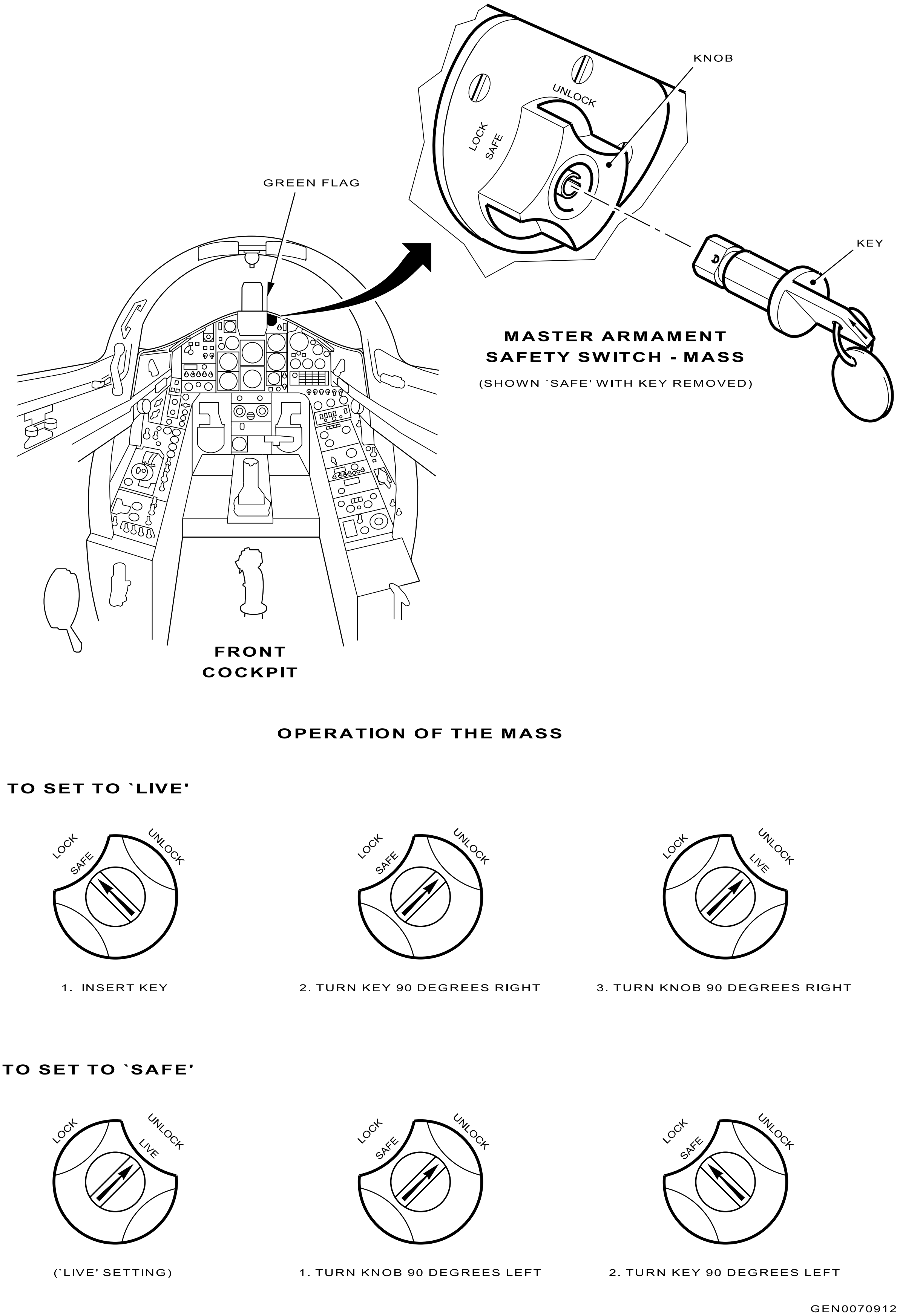
1 - 14 Fig 3 Ejector Release Unit



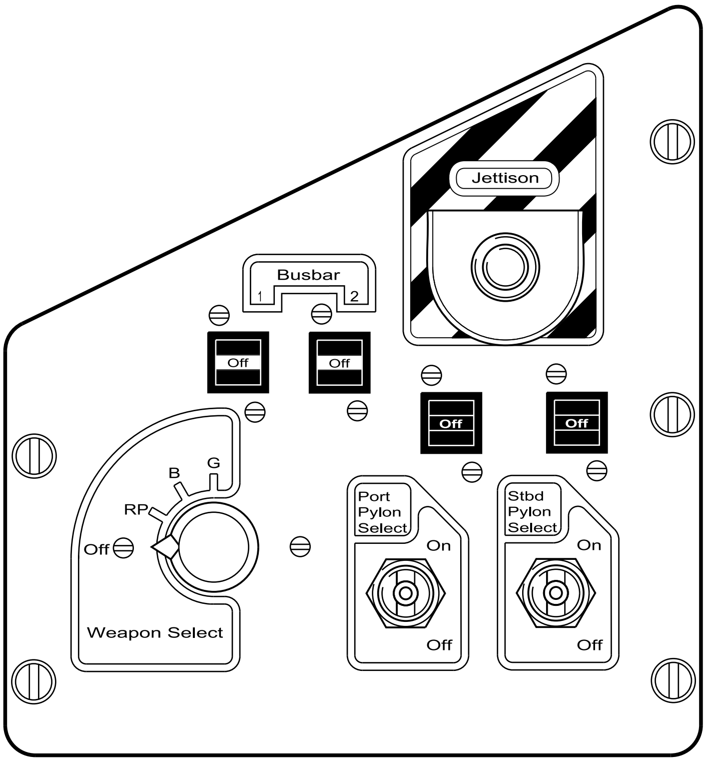
1 - 14 Fig 4 Gun Pod



1 - 14 Fig 5 Gun Electrical Connection



1 - 14 Fig 6 Master Armament Safety Switch



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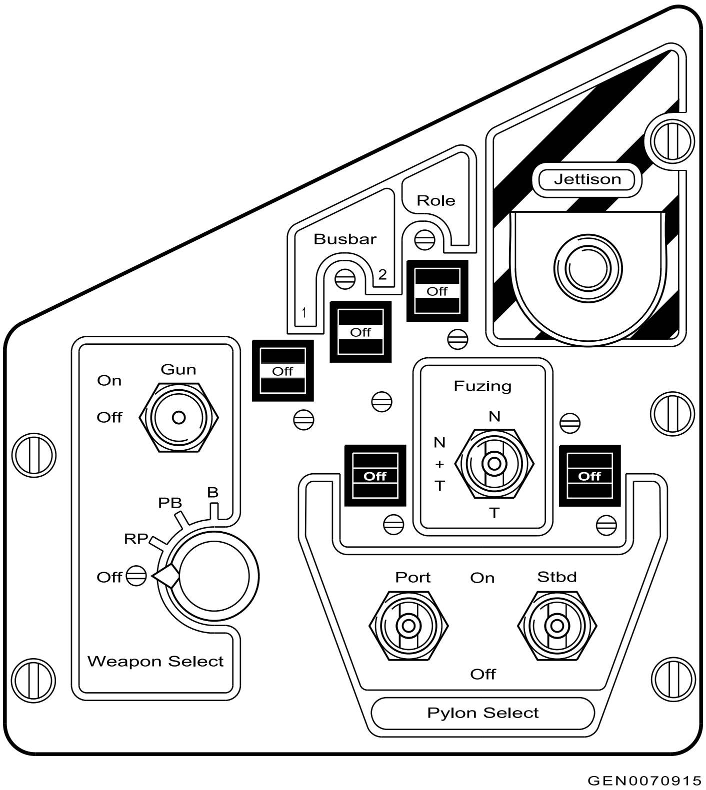
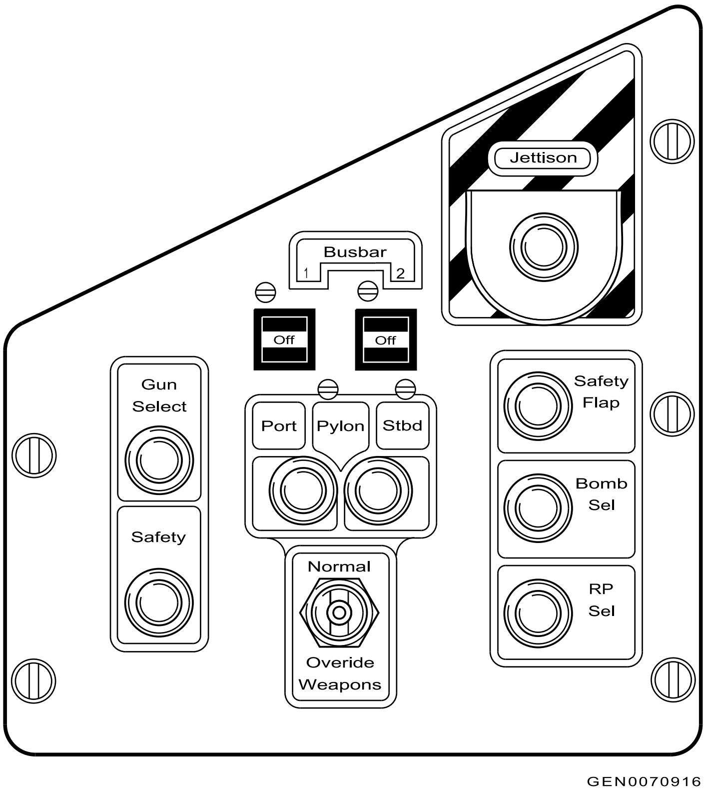
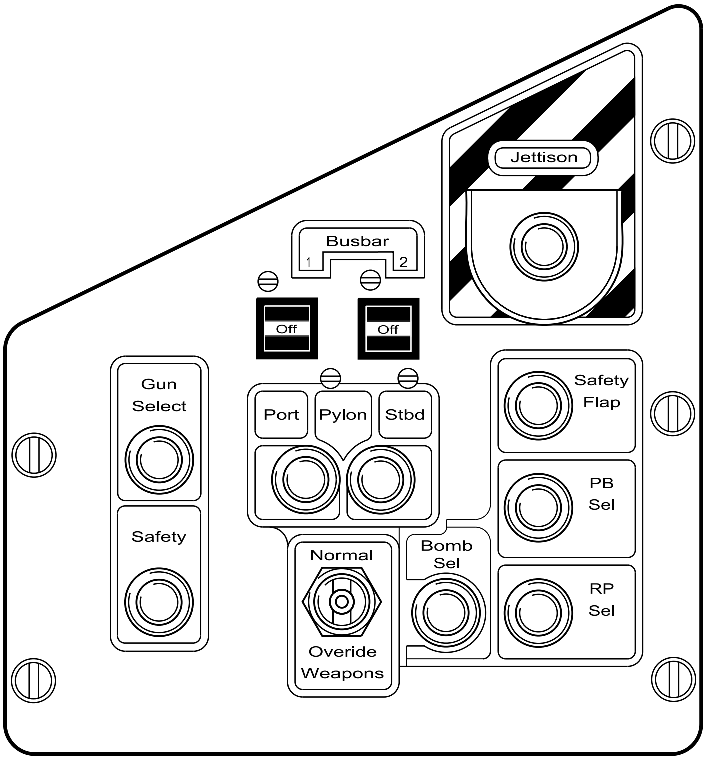
1 - 14 Fig 7 Weapon Control Panel - T Mk 1



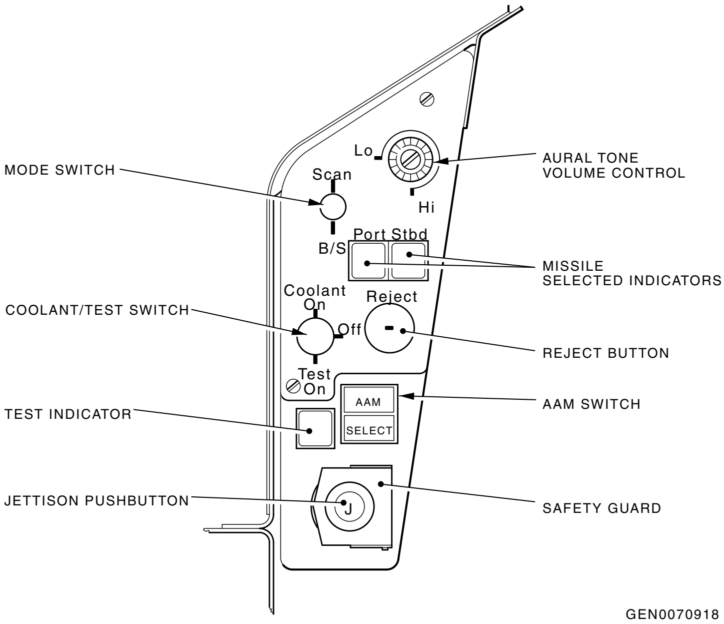
1 - 14 Fig 8 Weapon Control Panel - T Mk 1A



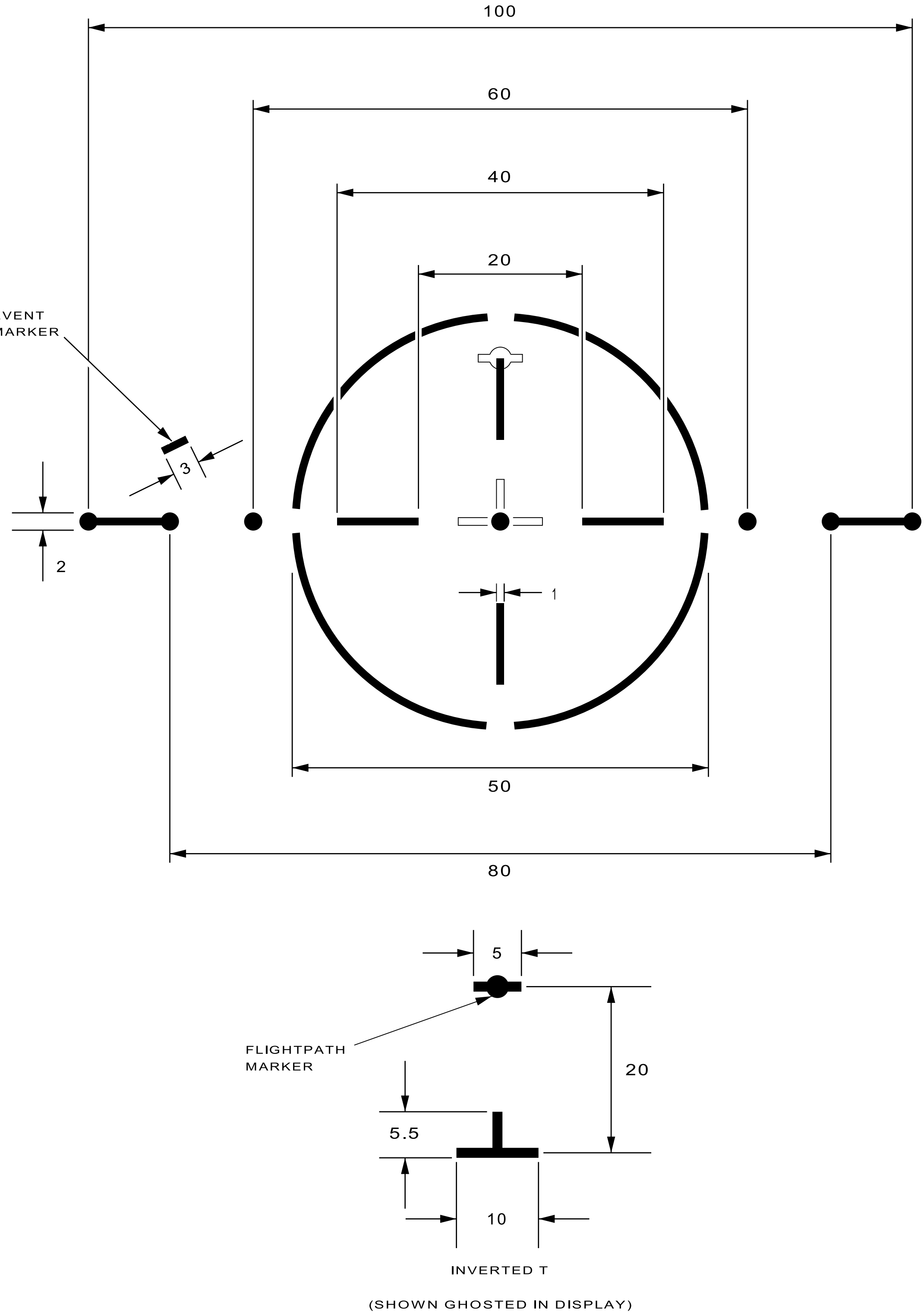
1 - 14 Fig 9 Weapon Monitor Panel - T Mk 1



1 - 14 Fig 10 Weapon Monitor Panel - T Mk 1A



1 - 14 Fig 11 Missile Control Panel - T Mk 1A



NOTE

DIMENSIONS ARE IN MILLIRADIANS

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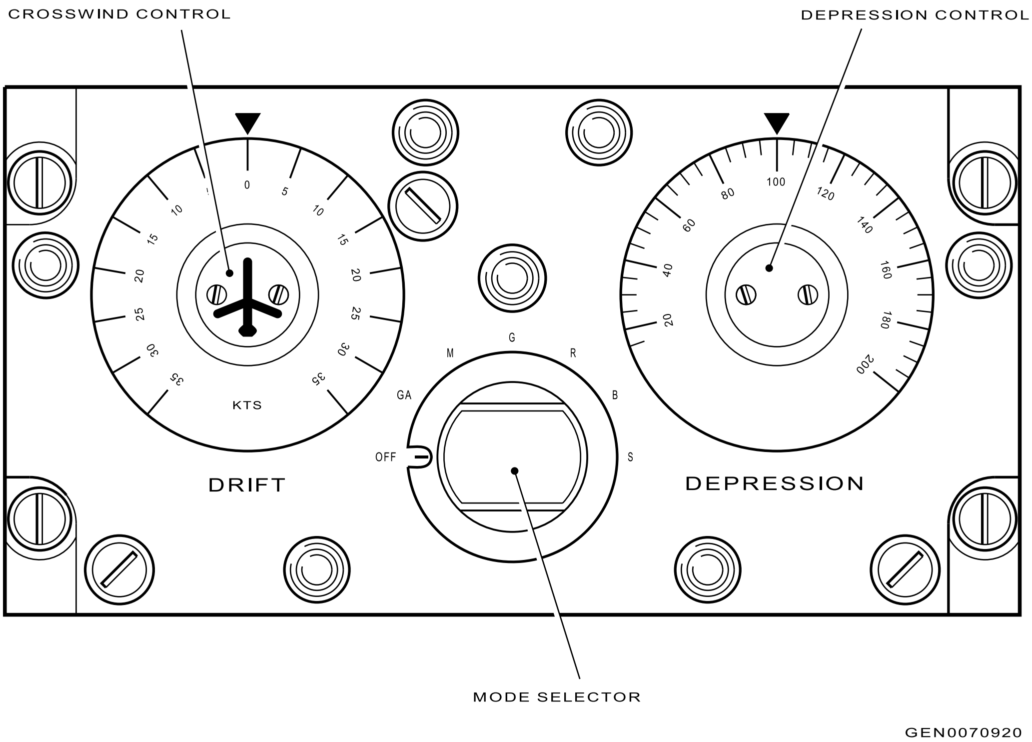
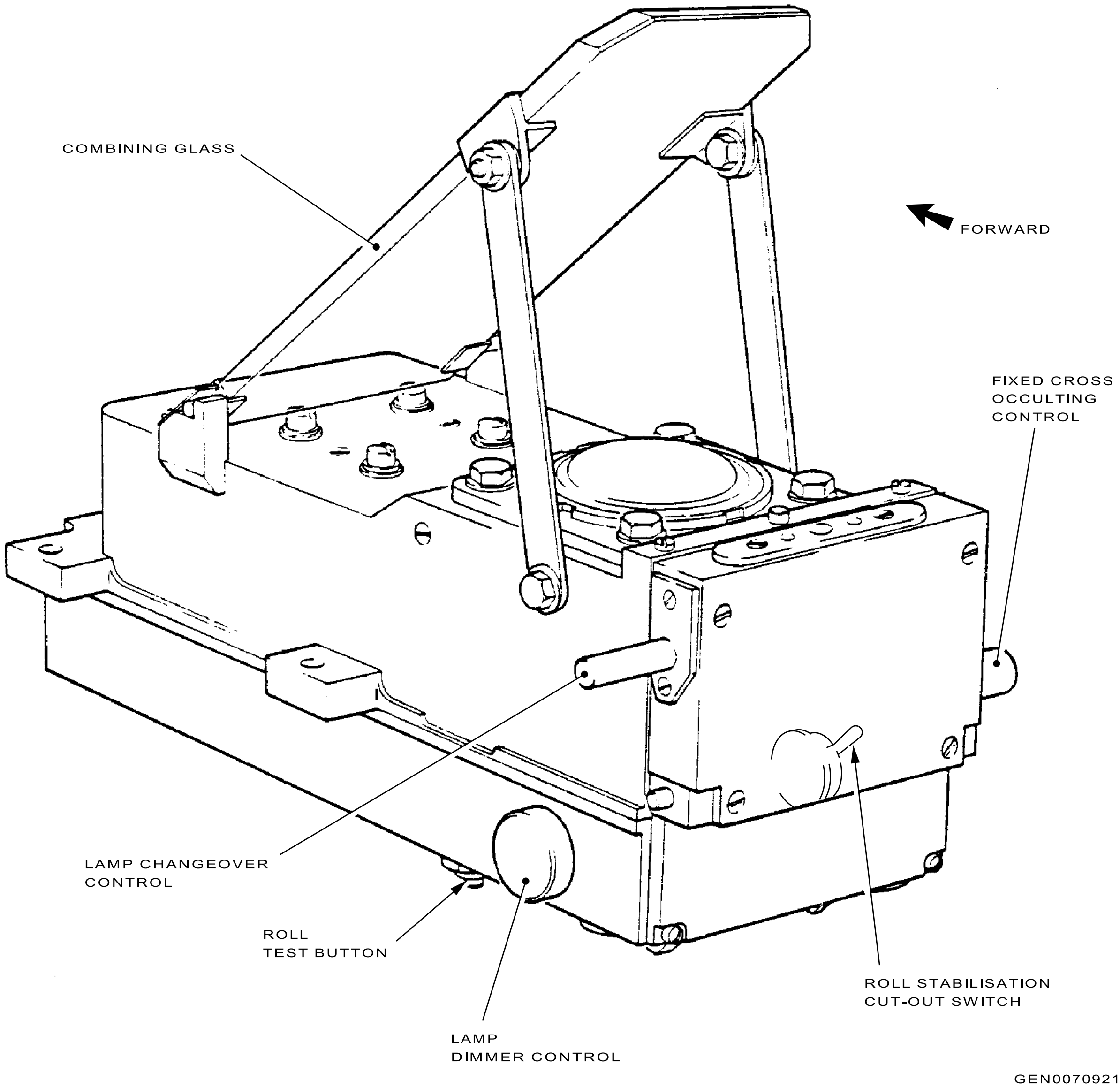
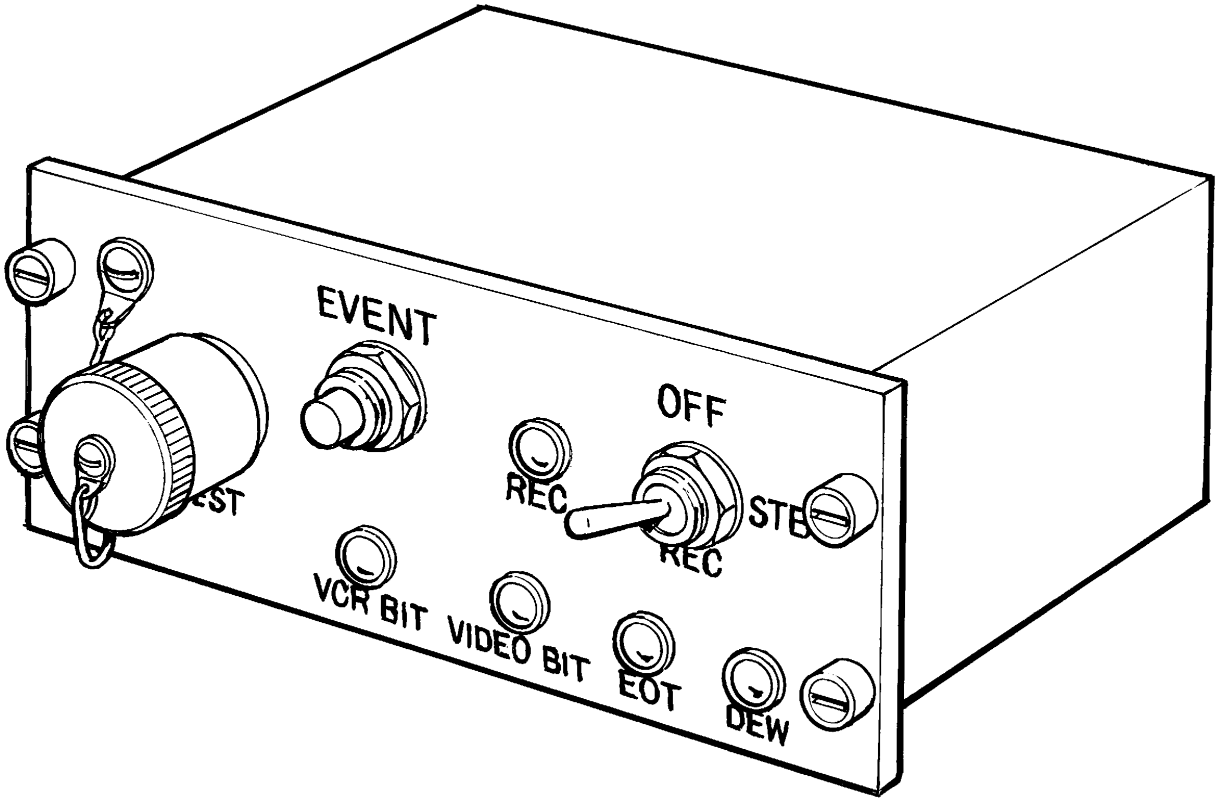
1 - 14 Fig 12 Reticule Display



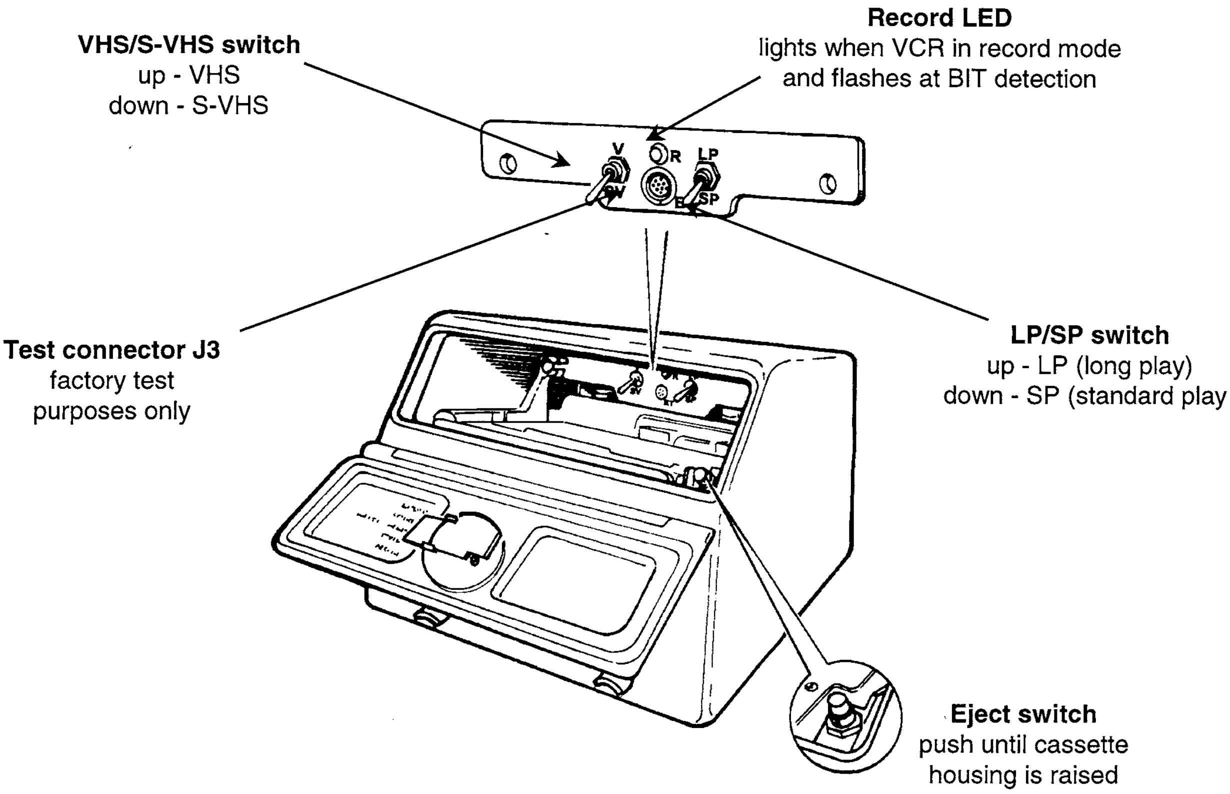
1 - 14 Fig 13 Sight Control Unit



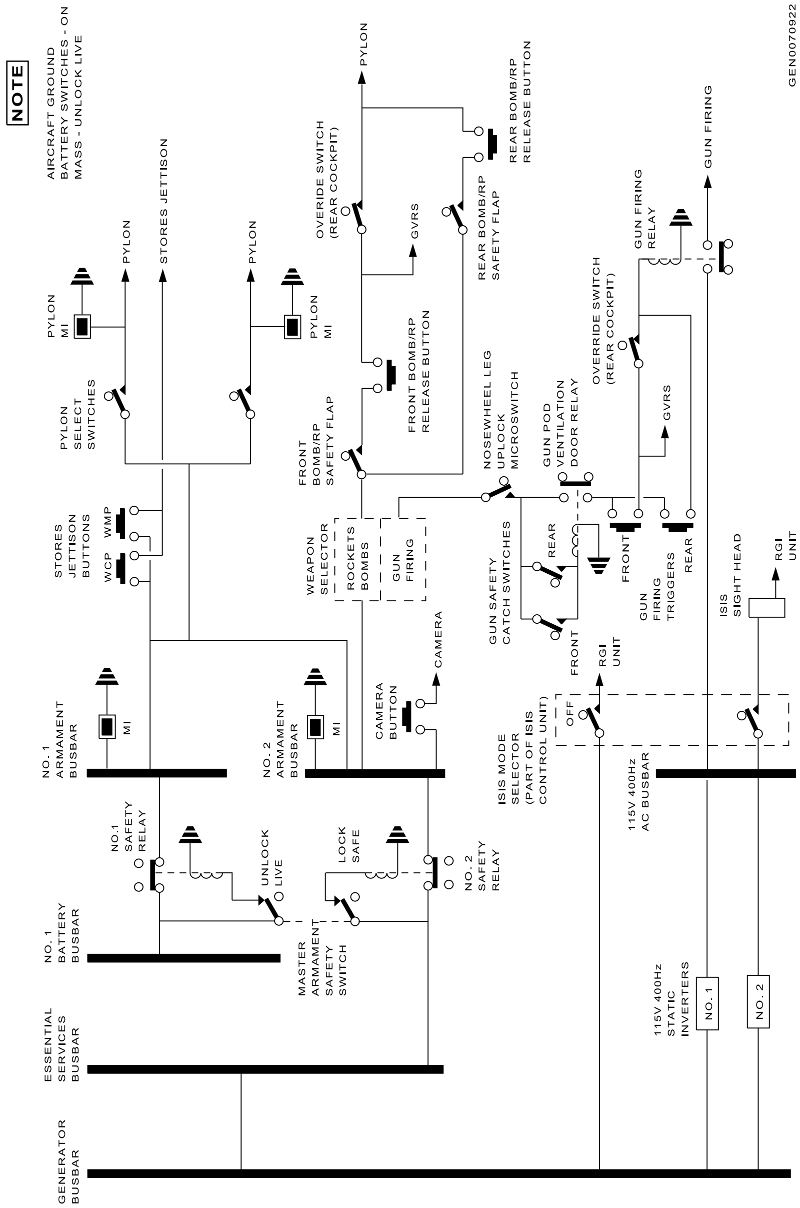
1 - 14 Fig 14 Sight Head



1 - 14 Fig 15 GVRS Control Panel



1 - 14 Fig 16 GVRS Video Cassette Recorder



1 - 14 Fig 17 Armament Electrical System - Simplified Schematic

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PART 1

CHAPTER 15 - SKYMAP II GPS

Contents

DESCRIPTION

Introduction

1. The Skymap II GPS is used for secondary navigation. It is mounted on either the ISIS gunsight, if fitted, or on a purpose built mounting bracket and can be used in portrait or landscape modes. Power is supplied from the essential services busbar or by internal rechargeable batteries. A database of aeronautical points, including airfields and navigation aids, is stored in a manufacturer programmable ROM chip. Separate GPS antennas are fitted next to a quick release combined antenna and power connector on the glare shield in each cockpit.

Hardware

2. **Power Switch.** A red push button is used to switch the unit on and off and to alter the screen backlight brightness. A single push turns the unit on. Subsequent presses cycle the backlight from full brilliance on the first push through decreasing levels of brightness to off on the eighth press. Whenever the backlight is activated a bulb symbol appears on the display. Holding the red button in initiates the shutdown procedure and once the cycle is complete, releasing the button turns the GPS off.

3. **Function Keys.** 5 black push button `soft keys' can be allocated different functions depending on the mode selected. A label drawn on the display, alongside the key, indicates the function of each soft key.

4. **Joystick.** A joystick allows movement of the pointer in MAP mode and in data entry modes is used to move the data entry cursor and also to select data characters. In general, selecting the joystick up increases the value, down decreases the value. Values cycle sequentially through the numbers 0 to 9 followed by the letters A to Z. Pressing right moves the cursor to the next right field, pressing left moves the cursor left. In MAP mode movement of the joystick activates a pointer which can be moved over the map. The position of the pointer is displayed relative to current position or a pre-defined bullseye and it can be used to define a destination or to interrogate a database point for additional information.

Software

5. **Waypoints and Flight Plans.** The Skymap II can store up to 500 waypoints and 99 flight plans (routes). A waypoint may be entered using latitude and longitude, UTM, British National Grid or as a range and bearing from another database point, including other waypoints. Waypoints 1 to 450 are user configurable. They may be assigned a name of up to 9 characters and a user configurable symbol. A waypoint may also be assigned as a MARKER and will depict a circle of the desired dimension around its location. Waypoints +01 to +50 are entered by entering current location and will be assigned the next available empty waypoint number.

6. **Special Waypoint Reservations.** Waypoints 446 to 450 have pre-set functionality:

a. Waypoints 446, and 448 - 450 were developed for a specific maritime exercise outside the scope of this manual.

b. Waypoint 447 is used for the `Direct to Home' function. The waypoint can only be named `HOME' but can be set to any location, usually home base. Since the soft key shortcut that provides the Direct to Home function actually provides steering direct to waypoint 447, care must be taken by the user to ensure that the correct location is in the 447 waypoint store

7. **Bullseye.** The Skymap II has the provision to report present position relative to a Bullseye. The Bullseye may only be a user waypoint.

8. **Timers.** The unit can display real time and hack time. Hack time can be referenced to a user definable `start' time or can be started from zero at any time. The unit will also display ETA as GPS ETA, based on satellite time or HACK ETA based on the hack start time. The hack start time may be set retrospectively. Arrival time at a destination is based on current groundspeed assuming the aircraft is tracking direct to the selected point. ETAs at waypoints along an active route are based on current groundspeed but assuming that the aircraft will fly via the route points.

9. **Database.** A commercial database can be loaded on a ROM chip inside the unit. Database points include airfields, navigational aids and airway intersections. More information may be obtained about database points via the joystick pointer. When the pointer is activated, positioning it over an airfield activates a soft key label to `More Info'. When the associated soft key is pressed, airfield information including a map and radio frequencies is displayed. Due to the infrequent update cycle of the database all information must be cross checked against current FLIP documents.

10. **Data Entry.** Data can be entered manually directly via the joystick and softkeys or via PC software including HAMPA. No provision is made for any other form of flash memory data input thus the device must be removed from the aircraft for software-based data entry

11. **Logging.** The unit stores 2000 entries of date, time, position, track, speed and height. A log of these fixes can be downloaded to HAMPA or a PC. The interval between fixes is user definable in seconds. A 3 second interval provides suitable fidelity for debriefing purposes and 100 minutes of recording time. If a longer recording time is required set the interval to a larger number.

12. **Map Setup.** The unit can be set by the user to display the map in North Up or Track Up modes. An extended track line shows the expected track of the aircraft based on its current track. When `Direct To' a point is selected, a solid line is drawn on the map to the destination. If the aircraft drifts away from the direct track, the solid line remains where it was but range and bearing are displayed dynamically to the point. The unit default power on range is set to 8nm scale. The map can be zoomed in and out using soft keys. The range at which icons and their associated names appear is user definable. Most icons can be deselected, or selected to only appear at a small scale, to declutter the display. Database points are always available for steering information even if not displayed on the screen. Names for most airspace depictions (airways, danger areas etc) are generic. For instance danger areas are annotated `DGR' and not by specific designator and are therefore best selected off.

NORMAL USE

13. Discharged batteries render the unit unusable without the use of a mains power unit. Make every effort to program the GPS using external power and minimize time spent using internal batteries alone.

14. Fit the GPS securely using the thumb screw and connect the aerial lead. In the rear cockpit move the aerial connector dust cover to the dummy socket to prevent it fouling the canopy on closing. Turn the unit on and check that it is powered from the internal supply. With the aircraft batteries ON check that the GPS is receiving aircraft power.

15. Due to the design of the GPS mounting bracket, when fitting and removing the GPS on non-gunsight aircraft, the unit may fall once the thumb screw is disengaged. The unit is easily damaged if it falls onto the control column.

16. In conditions of strong sunlight, remove the GPS from the bracket to prevent overheating and damage, particularly to the LCD screen.

17. After flight, remove the GPS from the aircraft and, if appropriate, re-fit the aerial lead connector dust cover.

MALFUNCTIONS

18. In the event of total aircraft power loss, the GPS, running on internal power, may be the only navigation aid available. The Ni-Cad batteries cleared for use suffer from `memory loss' and can become impossible to charge. Also the unit may be set not to recharge in use. If the GPS fails to operate on internal batteries have the cause investigated.

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PART 2

HANDLING

List of Chapters

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PART 2

CHAPTER 1 - STARTING, TAXYING AND TAKE OFF

Contents

General

1. The checks referred to in this chapter are listed in the Flight Reference Cards (FRC)

WARNING 1: Ensure the MASS in the front cockpit is set to LOCK SAFE at all times except from just before take-off to immediately after landing.

WARNING 2: The aircraft ejection seats and the MDC system are a potential source of danger since their inadvertent operation can cause fatal injuries. Safety precautions are therefore to be observed at all times, ie, the aircraft is to be left in the **Safe for Parking** or **Safe for Maintenance** condition, as applicable, as defined below:

a. **Safe for Parking.** Safety pins are to be fitted to the ejection seat firing handle, the MDC firing unit and the canopy MDC firing handle in each cockpit.

b. **Safe for Maintenance.** In addition to the safety pins fitted under sub-para a, safety pins are also to be fitted to the ejection seat main gun sear, rocket initiator sear and the manual separation firing unit sear in each cockpit.

Preparation for Flight

2. Approaching the aircraft carry out the **Approaching The Aircraft Checks**. Check that the aircraft is **Safe For Parking** as in **WARNING 2** above, then carry out the **Initial, External** and **Ejection Seat Checks**. If the aircraft is to be flown solo, carry out the **Solo/Rear Seat Flight Checks**. Then carry out the **Internal Checks**.

Starting the Engine

3. Before starting:

a. The aircraft should be heading into wind; with the tail facing into wind a hotter than normal start may result.

b. Access steps are to be removed and the canopy is to be closed and locked.

4. Start the engine in accordance with the **Engine Starting Checks**. Control of the starting system is automatic except for the initiation of the air producer start cycle and the engine start selection. Manual cancellation can be effected at any time during the cycle.

5. Engine light up normally occurs within 10 seconds of moving the throttle lever to Idle. During the start the TGT increases rapidly at first, but the rate of increase should reduce when the TGT rises above about 350°C; the highest TGT normally reached is about 400°C. If the starting TGT limit is rapidly approached and appears likely to be exceeded, set the throttle to HP Off. Monitor TGT and RPM during the start cycle.

WARNING: With the throttle at the Idle stop, when selecting HP Off the throttle lever has first to be eased forward fractionally (3 to 5 mm) from the stop to ensure that the throttle lever catch is fully disengaged before final aft movement of the throttle past the stop. This is particularly important when the rear cockpit throttle lever is used.

6. The air producer shuts down automatically if 82% air producer RPM is not attained within 30 seconds of pressing the start/relight button; automatic shutdown also occurs, following a start, when the engine reaches starter motor cut-out speed (approximately 45%). If 45% RPM are not attained within 45 seconds from selecting the engine start master switch to START, the air producer decelerates to, and remains running at, idle.

7. During engine starting, No 2 hydraulic pump remains off loaded, and the fuel pump is powered from the Essential Services busbar.

8. Note the engine idle RPM and TGT, open the throttle slowly to approximately 65% to close the bleed valve and, after observing a small drop in TGT, reselect Idle. Confirm bleed valve closure by noting an increase in idle RPM of approximately 3% and a decrease in TGT of approximately 50°C. To reduce the possibility of HP compressor blade damage, do not delay closure of the bleed valve.

9. Whilst operating on No 1 hydraulic system and before operating HYD 2 reset button, move the control column in a circle of approximately 2 inches diameter (measured at the top of the hand grip) about neutral at a rate of less than one cycle per second. A minimum of four complete circles is to be carried out to ensure that control surface response and control column feel are satisfactory.

Failure to Start

10. If the engine fails to start at the first attempt, refer to the **Starting Failures Checks**. Before making further attempts, check all relevant switches and indications. If the ROTATION indicator does not show green during the air producer start cycle, ignition is unlikely to occur.

11. Allow three minutes between air producer start cycles to avoid air producer starter motor overheat, and an interval of 20 minutes after three consecutive cycles. After three unsuccessful air producer start attempts have the cause investigated.

12. If it is necessary to stop the air producer or cancel the start cycle at any time, select the engine start master switch to OFF and the throttle to HP Off.

Checks After Starting

13. Carry out the **After Start Checks**.

Taxying

14. Carry out the **Taxying Checks**. Release the parking brake and increase the RPM up to approximately 70% to start the aircraft moving. As the aircraft moves forward, check the brakes. The brakes are very effective and should therefore be applied progressively. To prevent overheating, avoid excessive use of the brakes; the high idling thrust, however, may require the use of the brakes to maintain a slow taxying speed but avoid `riding' the brakes as this may lead to loss of servo pressure inducing an apparant brake failure.

15. Differential braking gives good directional control, and the fully castoring nosewheel allows the aircraft to be turned in a very small radius if necessary. The view from both cockpits is good to the front and sides, and both wingtips can easily be seen. Providing no hard turning movements are carried out, idle RPM is sufficient to maintain taxying speed on level ground. The fuel consumption at idle is approximately 3 kg per minute.

16. Carry out the **Before Take-Off Checks**. A tailplane indicator setting of zero is satisfactory for the clean aircraft. However, at high masses (ie, with fuselage and wing stores) or at forward centre of gravity (CG) (eg, two heavy pilots) a setting of 1° nose-up gives a more comfortable control column load during the post-take-off acceleration. Post-SEM 122, when carrying the sled, set 1° nose-up. If asymmetric stores are carried,

both aileron and rudder should be trimmed towards the light store: aileron half deflection, rudder one third deflection, as seen on the respective trim gauges.

WARNING: The aircraft is not to be flown if a surge, stall or overtemperature occurs. If the T6NL caption is illuminated during engine starting or at any other time on the ground, a take-off is not to be attempted, even if the warning has extinguished.

Take-Off Procedures

17. **Normal Take-Off.**

a. The normal configuration for take-off is with the flaps set to MID.

b. Align the aircraft on the runway with the nosewheel straight, and fully apply the wheelbrakes with the rudder bar central. Hold the aircraft on the wheelbrakes and open the throttle, checking that the brakes are holding and that the maximum values of RPM and TGT are not exceeded (refer to Hawk TMk1 & TMk1A MOD AFD Release to Service).

Note: With new brake pads fitted the brakes may not hold against full throttle until after they have been bedded in on the initial landing run. Therefore, this check may not be possible for the first take-off after fitting new brakes.

c. Release the brakes. Keep straight with rudder using differential braking if necessary until the rudder becomes effective, typically at about 50 knots. There are now two take-off technique options that can be applied.

(1) **Option 1.** At 90 knots move the control column aft in order to raise the nosewheel just off the runway. The minimum speed at which nosewheel lift off (NWLO) can be achieved varies with aircraft mass and CG position. At aft CG very little aft control column movement is required to raise the nosewheel at 90 knots, consequently stick forces are light. At forward CG the minimum NWLO speed is increased and at extreme forward CG the application of full aft control column displacement may not raise the nosewheel until about 110 knots. When Sidewinder missiles are carried increase the NWLO speed to 100 knots; the aircraft is particularly sensitive in pitch in this configuration especially at aft CG.

(2) Maintain the nosewheel off attitude until 120 knots is reached, then fly off by easing the control column further aft to rotate to the take-off attitude. If the rotation is delayed a slight hopping from one main wheel to the other results, especially if the nose attitude is unduly high. In the short period between rotation speed and unstick speed the forward view from the front cockpit is good but the view from the rear cockpit is restricted by the windscreen arch; however, there is ample view on either side of the nose to allow directional control to be maintained. With external stores fitted delay rotation until 130 knots.

(3) **Option 2.** At 120 knots, smoothly ease the control column aft to the take off attitude. With external stores fitted, delay rotation to 130 knots.

d. When safely airborne retract the landing gear and flaps, observing speed limitations; trim changes are negligible.

18. **Maximum Performance Take-Off.**

a. Proceed as for a normal take-off. At Vr (obtained from the ODM) firmly and smoothly rotate to a 10° nose-up attitude. At extreme forward CG the increased minimum NWLO speed may result in the nosewheel lift-off and the take-off rotation merging into one continuous attitude change. Maintain the 10° nose-up attitude and retract the landing gear. When clear of all obstacles, retract the flaps.

b. The maximum rate of rotation is limited by pre-stall buffet. Avoid rotation beyond the onset of buffet since it may increase the take-off distance to clear 50 feet.

c. When carrying Sidewinder missiles with a forward aircraft CG, take care to avoid rotation and unstick below the speeds given in the ODM as the margin between the stalling speed and the unstick speed is reduced.

19. **Flapless Take-Off.** If a take-off is made with the flaps up, raise the nosewheel off the runway at 100 knots (if required) or smoothly ease the stick aft at 130 knots to hold the take-off attitude. The aft control column displacement required to raise the nosewheel is very small and stick forces are therefore minimal; a positive check forward may be required to prevent over-rotation. The take-off is appreciably longer and, after unstick, the acceleration is more rapid than normal, consequently take care not to exceed the landing gear limiting speed.

20. **Crosswind Take-Off.** In crosswind conditions there is no tendency for the aircraft to lean out of wind during the ground roll. Raise the nosewheel at 90 knots. Some into-wind aileron may be necessary at unstick to maintain wings level. On becoming airborne, centralize the rudder and control column and allow the aircraft to adopt a crabbed attitude.

21. **Take-Off With Towed Banner Target.** With a towed banner target make a normal take-off but raise the nosewheel at 100 knots (if required) and unstick at 130 knots. It is recommended that the crosswind component should not exceed 15 knots for runways up to 150 feet wide nor exceed 20 knots for runways wider than 150 feet.

22. **Abandoned Take-Off.**

a. If a take-off is abandoned on the ground, the brakes may be applied at any speed. If mass is more than 5000 kg and braking is commenced at more than 110 knots the brakes are subsequently to be inspected for distortion and wear.

b. To abandon a take-off set the throttle to Idle, commence the emergency braking technique (Chapter 3) and then lower the flaps fully. If an overrun or barrier engagement appears likely, select HP Off to eliminate the high idling thrust of the engine. In an overrun situation consider emergency retraction of the landing gear or ejection. When the aircraft has stopped, set the LP cock to OFF (if appropriate), the battery switches to off and make the aircraft Safe for Parking.

Note 1: The use of emergency braking causes high temperatures at the brakes and the aircraft should not be taxyed subsequently.

Note 2: Maximum take-off abort speeds (ie, Vstop) are given in AP 101B-4401-16 (Hawk Operating Data Manual).

Engine Failure After Take-Off

23. An engine failure after take-off (EFATO) can be defined as an engine failure at any point from unstick up to 300 knots.

24. There are three possible situations in this context where engine failure can occur:

a. **Unstick Until Landing Gear Selected UP.** If the engine fails between unstick and the moment the landing gear is selected UP, the aircraft may be abandoned or, if the aircraft is only just airborne, an attempt to land ahead on the remaining runway may be made. Due to the large number of variables that affect the landing run the decision as to whether a safe landing ahead is possible can only be made by the pilot on the day. Take-off and landing data are available in AP 101B-4401-16 (Hawk Operating Data Manual).

b. **Landing Gear Selected UP to 250/270 Knots.** If the engine fails between the time the landing gear is selected UP and 250 knots (clean and/or gun and/or pylons) or 270 knots (aircraft with non-jettisonable wing stores), abandon the aircraft.

c. **Between 250/270 and 300 Knots.** If the speed is between 250/270 and 300 knots commence a turnback to the airfield. However, a turnback to the reciprocal of the runway in use is to be carried out with extreme caution because of the hard manoeuvring which would be required.

Note: Above 300 knots the failure should not be considered an EFATO; the pilot may position for any suitable runway.

25. The minimum speeds in para 24c and the Note above do not guarantee a successful turnback and safe landing; they merely ensure that the pilot is in a position to assess the situation and make a timely ejection decision if necessary.

26. The principal considerations that influence the decision are set out below, but the main factors determining the success of a turnback are twofold: firstly, the ability to make a prolonged turn whilst maintaining the minimum gliding speed and avoiding buffet, and secondly, the ability to land and stop the aircraft safely, even with the assistance of a barrier. The former is relatively easy to achieve but the latter is far more difficult.

27. A 20-knot tailwind, which could well be encountered, extends the landing ground run by about 45% beyond the zero wind situation. The ground run is extended again by an average 85% on a wet runway. Crosswinds above 10 knots extend the ground run by a further 15%, and landing above the correct threshold speed adds 10% per 5 knot increment.

28. Finally, the fact that the engine may not even be windmilling and therefore producing no extra HYD 1 system pressure may limit the amount of braking and steerage that can be maintained. The barrier arrests the aircraft but in the process extends up to 400 feet (T Mk 1 at 5000 kg) or 450 feet (T Mk 1A at 5550 kg) at, for example, an entry speed of 110 knots.

29. If in doubt whether a safe barrier engagement can be made, do not delay the ejection decision; there is a minimum safe distance from the barrier that ejection can be initiated. It is essential to bear in mind the ability to stop when carrying out the pre take-off emergencies brief.

30. **Considerations.** The chances of a successful turnback are affected by the following:

a. Factors Affecting the Manoeuvre

(1) Where two pilots are carried, which one is to fly the manoeuvre.

(2) Height, position and speed at which the failure occurs.

(3) Aircraft configuration and whether stores are jettisonable.

(4) Position of other aircraft which might conflict with the turnback.

(5) Cloudbase and visibility.

(6) Wind velocity.

b. Factors Affecting Ejection Decision

(1) Command ejection selector lever on or off.

(2) Position of buildings, ASPs, public roads, and personnel.

c. Factors Affecting Chances of a Safe Landing

(1) The length of the runway and the braking action.

(2) The touchdown point and speed.

(3) Availability of a barrier, and the length and nature of the safe overrun.

(4) Tail and crosswind components.

(5) The lack of full braking potential if the engine is not running to supply HYD 1 pressure.

31. **Turnback Manoeuvre - Initial Actions.** Following an EFATO, jettison stores if appropriate and set the throttle to HP Off. Climb and turn towards the selected runway.

32. **Turnback Manoeuvre - Subsequent Actions.** Make a brief radio call and concentrate on flying an accurate turn. Maintain 180 knots and aim to intercept the flightpath for an aiming point one third of the way along the runway. Once this is achieved, lower the landing gear on the normal and then the standby systems and maintain 170/175 knots. If time permits, switch off the fuel pump and close the LP cock. When certain of reaching the aiming point lower the flaps on the normal and then the standby systems to bring the touchdown point nearer the threshold and maintain a minimum speed of 150 knots until the landing flare.

33. **Intercepting PFL Pattern.** Anticipate a late intercept of the PFL pattern. The approach is likely to be flown with a tailwind component and with an aircraft that is relatively heavy. Maintain the correct speeds and make an early decision to eject if necessary.

WARNING: If speed falls below 170/175 knots when gliding flapless with landing gear down, the high rate of descent and limited margin above pre-stall buffet make it doubtful whether a successful roundout can be completed.

PART 2

CHAPTER 2 - HANDLING IN FLIGHT

Contents

ENGINE CONTROL AND HANDLING

Engine Control

1. Basic control of the engine is by the pilot's throttle lever which manually positions the throttle valve in the fuel control unit to vary the fuel flow and hence thrust. The fuel flow as scheduled by the throttle valve is compensated for variations in altitude and forward speed. To prevent the engine exceeding its maximum temperature, pressure and shaft speeds, automatic controls and governors reduce the scheduled fuel flow if maximum engine conditions are reached. Operation of the automatic controls and governors is effected by one of the four following parameters according to the flight conditions:

a. TGT.

b. LP shaft speed (NL).

c. HP shaft speed (RPM).

d. Fuel flow.

2. Fig 1 shows the approximate regions of engine limiters at maximum rating, ISA conditions. The limiting regions change with ambient temperature; the TGT limited region decreases at temperatures below ISA and increases at temperatures above ISA.

Note: On Fig 1, HP shaft speed (RPM) is referred to as NH.

3. During take-off at full throttle at ambient temperatures above approximately minus 5°C, the engine is TGT limited; at ambient temperatures below approximately minus 5°C, the engine is NL limited. During climb at full throttle, the engine is TGT, NL or fuel flow limited depending upon the altitude, ambient temperature and mach number. When the engine is NL limited or fuel flow limited the TGT and RPM are reduced from maximum, eg, at maximum power and minus 5°C, sea level static conditions, there is a reduction of approximately 20°C TGT and 0·9% RPM.

Engine Handling

4. Unless in emergency, the engine is not to be shut down from a high power setting.

5. Although slam and re-slam accelerations up to maximum thrust are permitted up to 0·90M/550 knots, pop surges may occur during slams above 40,000 feet at high incidence. An audible surge may also occur when the throttle is opened at high altitude/low IAS if high incidence or sideslip is present; under these conditions, however, warning of entry to the surge-prone area is given by the onset of pre-stall buffet. Immediate throttling back to Idle should clear the surge; TGT should then be closely monitored and the TGT/RPM relationship verified as normal to ensure that the surge has not `locked in'. In severe cases of surge the throttle is to be set to HP Off.

6. The minimum speed for engine relighting using the unassisted relight technique is determined by maximum permitted TGT. An attempt to carry out an unassisted relight below the recommended speed of 250 knots will probably cause the TGT to exceed the temperature limit.

7. Following an engine surge or a relight, and after recovering from a spin, prove the engine for surge-free operation by opening the throttle and checking that the increase in RPM leads the increase in TGT. If the engine is locked in surge the TGT increases rapidly at low RPM values.

8. During recoveries from the climbing vertical the engine is to be at idle RPM. After recovery the engine is to be monitored for surge-free operation.

WARNING: Aircraft UHF transmissions from the ARC 164 transceiver in the frequency band 225 to 399·975 MHz using the lower aerial may cause a reduction of maximum engine RPM by up to 2% and could lead to spurious T6NL warnings. When the transmission ceases, full fuel flow is restored rapidly and could cause engine surge.

Engine/Airframe Vibration

9. Certain combinations of engine RPM and altitude can cause engine vibration accompanied by noise level changes; both effects are perceptible in the cockpit. The amplitude of the vibration and the noise level can, at their worst, be considerable and the onset sudden. Although the vibration is not damaging in the short term and thus pilots may become accustomed to it with experience, the condition should he avoided since a vibration resulting from an engine malfunction may be incorrectly diagnosed as a `normal' vibration with potentially serious consequences. As vibration may also arise from airframe sources, the cause of vibration when experienced should be diagnosed if possible and the flight conditions adjusted or the sortie terminated, depending on the nature, severity and persistence of the vibration.

10. Possible causes of airframe vibration are the cold air unit, flap vanes, RAT (when extended) and the nosewheel doors. Vibration caused by the cold air unit is similar, both in noise and amplitude, to engine vibration and diagnosis should be effected, if height and other considerations permit, by switching the unit off. Flap vane vibration is recognized by a high frequency oscillation or buzzing which occurs at or near the mid-flap position. Nosewheel door vibration with the landing gear retracted, is proportional to IAS and is therefore easily recognized as airframe rather than engine in nature.

11. Engine vibration, at heights below about 30,000 feet, is apparent in the form of a mild rumbling and normally occurs between 85% and 95% RPM; it may be most marked at or close to 93% RPM. Avoid sustained operation in this RPM band when vibration is encountered.

12. As altitude is increased the level of engine vibration tends to increase and the band of engine speed in which it occurs widens; the peak amplitude however remains at or near 93% RPM. At 44,000 feet the band may extend from 80% to 98% RPM. Since when climbing at full throttle the RPM slowly decreases, the onset of vibration may be abrupt as the decreasing RPM enters the widening band; the onset may be sharp and accompanied by a small drop in RPM (about 0·3%). It is recommended that, if marked vibration is encountered in a full throttle climb, the climb be discontinued. If the throttle is left in its set position and speed increased the vibration ceases as the aircraft descends through the onset altitude.

13. If the RPM setting is reduced when operating at high altitude and outside the vibration RPM band the onset of vibration may be abrupt as the band is entered.

14. The amplitude of vibration and noise varies from aircraft to aircraft and day to day but the onset levels and RPM bands are repeatable during a single flight.

Thrust Pulsation

15. Pre-Mod 646, thrust pulsation may occur at any altitude when the engine is operating at full throttle. It is felt by the pilot as an oscillation in thrust. Between 10,000 and 35,000 feet the oscillation is quite fast but produces no readable changes in RPM or TGT; above 35,000 feet the oscillation is slow and changes of 0·2% RPM and 5°C TGT may be indicated. Flight in the thrust pulsation condition should be avoided; if encountered it can be eliminated by closing the throttle sufficiently to reduce engine RPM slightly.

Note: Occasionally the aircraft rocks fore-and-aft when held at full throttle on the brakes before take-off but this is acceptable.

Engine Icing

16. Engine icing may occur when the ambient temperature is plus 6°C or less, together with a relative humidity of 50% or more. Although the LP compressor nose fairing is continuously anti-iced, there is no anti-icing protection for the air intakes or for the airframe. It is therefore recommended that flight in icing conditions be avoided.

17. If icing conditions exist at take-off the ground running times are to be kept to a minimum. If icing is encountered in flight, climb or descend out of icing conditions as quickly as possible at the highest practicable RPM. Normal engine handling may be used, but it is recommended that, after an inadvertent icing encounter, engine response be checked before landing.

GENERAL HANDLING

WARNING: The IAS/Mach limits given in the Hawk TMk1 & TMk1A MOD AFD Release to Service are based purely on structural considerations. No adverse handling characteristics have been encountered up to the maximum permitted speeds. Without external stores the aircraft is virtually self-limiting, but with external stores, particularly at medium altitudes, the IAS/Mach limits can easily be exceeded in a shallow dive. Consequently, take care not to exceed the stated limits when carrying out aerobatics or air combat manoeuvres at medium altitudes.

General

18. The controls are light and precise, and the aircraft is very responsive throughout its speed range but particularly at high speeds. The forward view from both cockpits is good but the rearward view is restricted by the fuselage and ejection seat.

Climbing

19. The recommended climbing speed without wing stores is 350 knots converting to 0·73M, using maximum RPM within the engine limitations. When wing stores are carried, the recommended climbing speed is 300 knots converting to 0·65M.

Flying Controls

20. **Ailerons.** The gearing between (lateral) stick and aileron is approximately linear and independent of applied lateral trim. Artificial feel is provided by a simple spring, giving light stick forces that are independent of speed. In flight, if the stick is left free, the aileron circuit will respond slightly to both lateral and longitudinal accelerations, but the forces that are required to compensate for these effects are so light as to be unnoticable to the pilot. Aircraft roll acceleration and damping are high. Above 350 knots some light buffet may be felt during full aileron rolls. The maximum rate of roll is achieved at about 400 knots at low level, but above this speed roll rate is reduced by compressibility and aero-elastic effects. With wing stores fitted, the rate of roll is slightly reduced.

21. **Tailplane.** In the tailplane circuit there is a non-linear gearing between the stick and the control surface which gives small tailplane deflections per unit stick deflection around stick central, but significantly increased tailplane movements as the forward and aft stick limits are reached. The gearing is effectively independent of applied tailplane trim. Artificial feel is provided by a two-rate spring (increased stick force with stick displacement, assuming no re-trimming) and an inertia weight mounted in the forward fuselage (increasing stick force with G and pitch acceleration). Stick forces are generally light to moderate; manoeuvring to G envelope limits at high Mach numbers is characterised by increased pitch sensitivity if stores are carried.

22. **Rudder.** The gearing between pedals and rudder is approximately linear. Rudder pedal forces are primarily a function of rudder aerodynamic hinge moments (the circuit also includes a light spring) and hence are light at low speeds, becoming progressively heavier as speed increases. Rudder trim is applied through a simple trim tab. Application of rudder produces a useful roll response at moderate to high incidences; roll response is significantly lower at low incidence (unless flaps are deployed), and above 300kts, may be in an adverse sense. When carrying Sidewinder missiles the application of full rudder should be avoided at speeds above 300 knots as rudder buffet can occur and the sideslip limit may be exceeded.

Changes of Trim

23. **Flaps.** Lowering the flaps to MID at about 150 knots causes a small but easily controlled nose-up trim change; at 200 knots the effect is more marked. Lowering full flap produces an additional nose-up trim change; when the flaps are fully down there is slight airframe buffeting. Raising the flaps results in negligible trim changes but the inadvertent raising of the flaps on an approach would result in the loss of approximately 300 feet even with full RPM applied immediately.

24. **Landing Gear.** Lowering the landing gear causes a small nose-down movement, except when the flaps are down when the movement is nose-up; the trim changes are, however, negligible. Retraction produces no noticeable effects.

25. **Airbrake.** Trim changes following airbrake operation are insignificant below 350 knots/0·60M. As speed is increased the trim changes increase and, in general, are more marked on extension than on retraction. In all cases, a large nose-down transient change is followed by a small residual nose-down change.

26. **RPM.** Changes of RPM setting cause negligible trim changes.

27. **Acceleration and Deceleration.** As speed is increased up to approximately 350 knots, nose-down trimming is required to maintain level flight; some directional trimming may also be necessary. Between 350

and 450 knots however, trim changes are negligible. At higher speeds the nose drops slightly and trimming is again required. At the higher speeds longitudinal control becomes sensitive. During decelerations the required trim changes are reversed, becoming more pronounced in the low airspeed range.

Flying at High Mach Number

28. **General.** The speed limitations are to be observed. The handling and behaviour of the aircraft at high mach number varies with altitude, incidence and sideslip; the following description, for an aircraft without stores, is given to indicate the behaviour likely to be encountered.

29. **Transonic Flight.** At full throttle the maximum speed obtainable in level flight is approximately 0·87M. In level flight the transonic envelope starts at about 0·78M, and is characterized by the onset of light buffet followed by a slight nose-down trim change between about 0·80 and 0·82M. At higher speeds longitudinal control becomes more sensitive.

30. **Transonic Dives.** A dive angle of about 20° or more is required to give a supersonic mach number. Trim the aircraft at 0·75M before entering the dive and maintain this trim setting throughout.

a. As speed increases through 0·78M, slight buffeting may be felt, increasing noticeably at 0·85M. Above about 0·92M, buffeting is not present.

b. Following the nose-down trim change between 0·80 and 0·82M, the aircraft develops small, random pitch movements in the range 0·86 to 0·90M due to shock wave formation; above 0·90M the random pitch movements damp out. A further nose-down trim change occurs at about 0·95M.

c. Between 0·88 and 0·94M a wing heavy tendency develops, which can be easily controlled using about one-half aileron deflection; above 0·94M the tendency disappears. If the ailerons are used at the higher mach numbers, at low incidence values, some roll reversal may be apparent at very small aileron angles.

CAUTION: In the transonic region the aircraft exhibits increased longitudinal control sensitivity. When this is combined with the pitch changes associated with selecting the airbrake out, a pilot-induced oscillation, characterised by rapid development of a longitudinal divergent oscillation, may occur. If oscillation occurs, smoothly close the throttle to Idle and release the control column; the aircraft then recovers. Below 0·90M, replace the hand on the control column and re-establish control.

31. **Transonic Dive Recovery.** The accelerometer is to be monitored throughout the dive recovery. To prevent excessive g, the recovery from a transonic dive is to be initiated with a pull to not more than 2·5 g. During the recovery two significant nose-up trim changes occur: the first at 0·98M is followed by a sharper effect at 0·94M. The trim changes are to be countered by moving the control column forward to attempt to maintain 2·5 g; however, excursions beyond can be expected. If a pilot-induced oscillation occurs, smoothly close the throttle to Idle and release the control column; the aircraft then recovers. Below 0·90M replace the hand on the control column and re-establish control.

32. **Wing Stores.** With wing stores fitted, the flight characteristics up to 0·90M are broadly similar to those described in para 30 and para 31. However, the stores are destabilizing in pitch, and the random pitch motion which develops between 0·86 and 0·90M is likely to be more severe.

Unaccelerated Low Speed Handling

33. **General.** The unaccelerated low speed behaviour of the aircraft is docile; the aircraft is fully controllable down to the point of stall (CL max), beyond the stall it may be possible to control the attitude of the aircraft, but not the flightpath, using co-ordinated control. The stall itself is not obvious but recovery at all stages is immediate when the control column is eased forward. The low speed handling characteristics for the three basic configurations are given below. The speeds quoted are for an aircraft without stores and at a mass of 4600 kg; some scatter in these speeds occurs with stores and centre of gravity (CG) position as described in para 37.

34. **Clean Configuration, Flaps and Landing Gear Up.** The first indication of an approaching stall is the onset of buffet at about 130 knots. As speed is decreased (Angle of Attack (AOA) increased) buffet increases

and some slight lateral unsteadiness develops which is easily controlled with ailerons. At the stall a gentle wing drop may occur and a high sink rate develops if nose-up pitch is not markedly increased. The basic stalling speed is about 124 knots but this varies slightly depending on the rate of deceleration. If the aircraft is flown beyond the stall by moving the control column further aft some yaw may develop which causes a tendency to roll; check the yaw with rudder. The ailerons alone may not be adequate to control the roll if the yaw is not checked. At approximately 115 knots with the control column fully aft, the aircraft has an increased tendency to yaw and roll. If the control column is held fully back the aircraft descends at a high sink rate but with the airspeed increasing; pitch oscillations may occur.

35. **Flaps and Landing Gear Down.**

a. A nominal engine setting of 80% RPM simulates an intermediate approach and is suitable for practice with MID flap. With MID flap selected the onset of buffet is at about 113 knots. As speed is decreased (AOA increased) the aircraft behaviour is similar to that described above for the clean configuration down to the point of stall at about 109 knots. Beyond the stall there is less tendency for the aircraft to yaw. With the control column held fully aft the sink is more pronounced and the aircraft develops a moderate pitching oscillation.

b. An engine setting of 80% RPM can be used to simulate approach thrust and is suitable for practice with FULL flap. With FULL flap selected the low speed characteristics are similar to those with MID flap except that there is less warning of the stall and a greater tendency to oscillate in pitch. The onset of buffet is at about 105 knots and the stall at about 102 knots. At about 99 knots, with the control column fully aft, a pitch oscillation may develop into a combined pitch and roll oscillation which cannot be controlled; recovery from this stage is likely to result in a large height loss.

Note: In the event of flight with flap fully down but with the landing gear up, particularly at high altitude or with a forward CG position, an uncontrollable pitch nose down may occur. In this event control can immediately be restored by either selecting landing gear down or flap up.

36. **Airbrake.** Low speed handling characteristics with the airbrake extended are little different from those of a clean aircraft except that the buffet level is increased and tends to mask the buffet onset as speed is decreased (AOA increased) towards the stall.

37. **Effect of Stores.** With wing stores, the low speed handling characteristics are similar to those described above. However, there may be some slight variation in stalling speeds associated with variations in CG position and stores configuration. As speed is decreased (AOA increased) beyond the stall the wing stores, particularly with flap down, tend to amplify the pitch oscillation with FULL flap. The oscillation is more marked than with MID flap.

38. **Effect of Altitude.** As altitude is increased, lateral unsteadiness becomes more pronounced but remains controllable with aileron. At high altitudes (towards 40,000 feet) speeds may be one or two knots higher than described above.

39. **Recovery.** Recovery at any stage is immediate upon moving the control column forward. However, to minimise height loss, which is imperative if the stall occurs when the aircraft is slow speed and near to the ground (eg during the Final turn), the Standard Stall Recovery should be conducted. The Standard Stall Recovery is flown by simultaneously moving the control column forward and applying full power and rolling wings level. Once out of the stall, smoothly select a climbing attitude, taking care not to re-stall the wing. When a positive rate of climb is achieved, select gear and flap to UP.

40. **Stalling Speeds.** The stalling speed at any weight is shown at Fig 2. Table 1 summarizes the approximate buffet onset and stalling speed at mass of 4600 kg (1000 kg fuel, without external stores).

Table 1 - Buffet Onset and Stalling Speed

Configuration	*Nominal RPM (%)*	*Buffet Speed (IAS)*	*Stall Speed (CL max) (IAS)*
Flap and Landing gear Up	Flt idle	130	124
MID Flap and Landing Gear Down	80	113	109
FULL Flap and Landing Gear Down	80	105	102

Stalling In Manoeuvre

41. The amount of pre-stall buffet warning in manoeuvre increases with mach number. In the clean configuration the buffet boundary is very clear and provides a good natural warning of the stall at all altitudes. The stall characteristics are variable with mach number but may take the form of a wing drop, a pitching oscillation (sometimes preceded by a small movement in yaw), or by the control column reaching the fully aft position. Below about 0·40M, the buffet onset approximates to the maximum turning performance of the aircraft. Recovery is immediate on easing the control column forward.

42. The carriage of wing stores increases the severity of the pre-stall buffet and makes the aircraft more prone to pitching oscillations at the stall. The characteristics are otherwise similar to those of the unladen aircraft.

Stalling in the Final Turn or on Final Approach

43. During the final turn or on final approach, particularily with MID or FULL flap selected, there is limited natural warning of the onset of the stall. At the first onset of buffet carry out the standard stall recovery.

WARNING: Continuing beyond the initial onset of buffet may rapidly result in a stall, the consequences of which will result in significant, and possibly irrecoverable, height loss.

Spinning

44. **General.** The aircraft is very spin resistant and is therefore reluctant to enter a spin inadvertently; however, it can be made to spin by the use of recommended techniques. Provided these techniques are adhered to, the spin characteristics are consistent; if the controls are mishandled the characteristics vary and the spin may become very agitated. If the spin is allowed to become severely agitated or oscillatory, there is a risk of engine surge. The aircraft will recover when the recommended spin recovery action of centralizing the controls is taken.

45. **Normal Erect Spin.**

a. **Entry.** For the most consistent spin behaviour characteristics, the recommended entry to a normal erect spin is from a level turn with between 30° and 45° bank angle, at a speed of 160 to 170 knots and at an altitude between FL250 - FL300. A spin may also be entered from level flight at 150 knots in the same altitude band; however, if the speed is significantly less than 150 knots (eg, 130 knots) there is a risk of engine surge. To enter the spin, close the throttle, smoothly and progressively apply full rudder in the intended direction of the spin and simultaneously apply full aft stick ensuring that the ailerons remain neutral.

b. **Spin Characteristics.** The first turn of the spin is slow, but the rate of rotation increases as the spin develops, and stabilizes at about 4 seconds per turn. Height loss in the stabilized spin is 800 to 1500 feet per turn. The spin attitude is fairly steep with the nose about 55° below the horizon. Airspeed, which decreases to about 130 knots on entry, increases progressively by about 10 knots per turn. The airspeed and TGT should be monitored throughout the spin, and recovery is to be initiated before 180 knots is reached (fin loading consideration). During the developed spin there is considerable rudder buffet and increasing rudder forces may blow the rudder off the stop.

WARNING: If recovery (ie, rotation ceased, speed increasing and the aircraft responding normally to the controls) has not been achieved by 5000 feet AGL - Eject.

c. **Spin Recovery.** To recover from a spin, monitor the height, check the throttle is closed and smoothly centralize the controls. As the aircraft incidence reduces, the rate of rotation increases momentarily and some sideslip may be experienced as the rotation ceases. Recovery is effected within one or two turns. Height loss during recovery may be up to 2500 feet, with a further 4000 feet in the ensuing dive, using 3·5 g. Note that the aircraft recovers from an erect spin if the controls are abandoned but this technique is not recommended since aircraft behaviour is less predictable and often physically unpleasant and may lead to disorientation. Following recovery check the engine for surge.

46. **Spinning with Stores.** Although the aircraft is not cleared for deliberate spinning with external stores fitted, other than a gun pod, flight tests have shown that the carriage of stores does not change the general spin characteristics and recovery. However, the attitude in the spin is slightly steeper, the rate of rotation higher, and the height loss per turn greater. Jettisoning of stores in the spin is not recommended.

47. **Engine Behaviour.** TGT is to be monitored during spinning, and a precautionary check is always to be made after spin recovery to ensure that the engine is surge free. An engine surge may be experienced if an agitated spin develops, particularly if the entry altitude is above the recommended band or the RPM setting is above idle at entry. The surge is unlikely to be audible unless the engine is at a high RPM setting. The TGT may rise rapidly or remain only a little above normal until the throttle is opened on recovery. Therefore, following recovery, a positive check is to be made that TGT and RPM rise normally as the throttle is opened. If an engine surge occurs during the spin, spin recovery action is to be taken immediately and the throttle set to HP Off.

48. **Inverted Spin.** Deliberate inverted spinning is prohibited. Tests indicate that recovery is immediate on centralizing the controls. During an inverted spin aerodynamic forces move the rudder in the pro-spin direction. A positive effort is therefore required to centralize the rudder for recovery; the rudder forces may be high.

49. **Mishandling the Controls.** If an oscillatory spin develops through mishandling, normal spin recovery action is always effective. If a spin develops through mishandling, recovery action is to be taken immediately and the TGT checked for engine surge indications. Engine surge is more likely if the spin motion causes the airspeed to fall below 100 knots.

a. **Effect of Mishandling at Spin Entry.**

(1) **Application of Full Rudder Before Aft Stick.** If the roll rate is allowed to develop before the stick is moved aft, the application of aft stick causes the roll rate to slow down; the spin then becomes hesitant with fluctuations in sideslip, roll rate and airspeed.

(2) **Application of Full Aft Stick Before Rudder.** With full aft stick applied the aircraft may oscillate in roll. If the rudder is applied as the aircraft is rolling in the opposite direction, a very oscillatory manoeuvre develops which is more in the nature of a divergent Dutch Roll than a spin.

b. **Effect of Mishandling During the Spin.**

(1) **Relaxation of Full Aft Stick** . If the stick is relaxed from the fully aft position, the spin becomes more rapid and is generally smoother.

(2) **Relaxation of Rudder.** If the rudder angle is reduced the rotation slows down. If the rudder is centralized the spin stops, regardless of the position of the stick.

(3) **Application of Outspin Aileron.** Small amounts of outspin aileron have little effect. Although careful application of full outspin aileron can cause aircraft descent rate in the spin to stabilize (at a speed around 160kts), rapid application of outspin aileron may destabilize the spin and give large sideslip angles. In this condition the spin may become inverted. Hence, deliberate application of outspin aileron is prohibited.

(4) **Application of Inspin Aileron.** Inspin aileron has a destabilizing effect on the spin; the greater the aileron angle the greater the effect. Destabilization develops progressively and may lead to a very oscillatory spin; the indications to the pilot are a hesitation in roll and yaw, high rudder forces and increased side forces acting on the aircraft. Because of the large sideslip angles generated in these circumstances, inspin aileron is not to be applied intentionally. Using the rear view mirror, the aileron neutral position is easily seen.

c. **Effect of Landing Gear, Flaps, Airbrake and RPM.** The aircraft is only cleared for spinning with landing gear and flaps up, airbrake in and with the throttle at Idle. Spinning with any of these in an incorrect position may lead to an oscillatory spin with an increased risk of engine surge. If spinning occurs with the airbrake, flaps or undercarriage deployed, recover the aircraft before deselection. If the spin entry occurs at a high throttle setting, the throttle should be set to Idle immediately and then the spin recovery carried out.

Rapid Rolling

50. Rapid rolling is permitted within the limitations given in the Hawk TMk1 & TMk1A MOD AFD Release to Service. To prevent high structural loads on the rear fuselage, the control column must not be deliberately moved from the longitudinal position at manoeuvre entry during rapid rolling, even to counteract a change in normal acceleration. Avoid full aileron rapid rolling when buffet is encountered. The rudder bar is to be kept as close to neutral as possible during rapid rolling, this may require forceful restraint of the pedals. The foot forces required to keep the bar central are generally low although a high force may be required to prevent rudder trail when rolling close to manoeuvre limits for rapid rolling, particularly if some inadvertent adverse longitudinal control movement has occurred. The presence of high foot forces always indicates high structural loads.

Aerobatics

51. **General.** Flick manoeuvres and stall turns are not permitted. If loss of control is experienced recover by centralizing the controls; if very low airspeeds are also experienced, monitor the engine for surge. Make recovery from the climbing vertical in the looping plane; if the true vertical is obtained move the control column aft a small amount, to induce a residual nose-up pitch rate for recovery, before IAS reduces below 70 knots. Aerobatics are not to be carried out with the FUEL caption illuminated.

Note: Use of flaps in manoeuvres is prohibited.

52. Until experience is gained, the following speeds are recommended:
- Roll..................... 300 knots
- Loop....................300 knots
- Roll off the top.......350 knots
- Vertical roll...........400 knots

53. **Looping Manoeuvres.** A loop is entered at 300 knots which gives a speed of about 160 knots over the top and requires about 4000 feet to execute. Normal acceleration on entry should be about 4g and the buffet, when encountered, is well defined and causes no handling difficulties. In the second half of a loop, the aircraft accelerates rapidly especially if full throttle is being used; the throttle setting may have to be reduced slightly when recovering to the starting altitude and speed.

54. **Inverted Flying.** Illumination of the FUEL and OIL captions is delayed for a nominal 10 seconds to eliminate transient warnings. Periods of flight under zero or negative-g conditions are not to exceed 30 seconds.

Low Speed Recovery Drill

55. If, during vertical manoeuvres, it becomes obvious that the manoeuvre cannot be completed without loss of control or that airspeed is likely to fall uncontrollably below 100KIAS the aircraft commander is to ensure that the Low Speed Recovery Drill is completed.

56. The Low Speed Recovery Drill is:

a. Throttle - Gently to Idle.

b. Flying controls (including rudder) - Held central (TPI 0°) roll wings level when airspeed is in excess of 100KIAS.

c. Recover to level flight above 150KIAS with throttle at Idle.

d. When recovery is complete and the aircraft is not in buffet open throttle to check the engine is surge free.

Practice Low-Speed Nose-High Recoveries

57. The minimum altitude for practice Low-Speed Nose-High recoveries is 15000ft AGL.

58. The final steady pitch attitude is to be a maximum of 70° above the horizon.

59. Recovery is to be initiated before airspeed falls below 100KIAS.

Formation Flying

60. Control in formation is precise, and little control column activity is required to hold station. Engine response to small throttle movements is adequate at low altitude but increasing anticipation is required at higher altitudes. Any trim changes are easily controlled. Take care in the echelon position not to get closer than the specified minimum separation distance between aircraft; especially at high angles of attack, the leading aircraft's wing tip vortices can overcome the formating aircraft's aileron power. This can be a particular problem on formation take-offs.

61. The view from both cockpits is good except in line astern when the upward view from the front cockpit may be obstructed by the windscreen arch.

62. To prevent the possibility of engine surge, avoid deliberate prolonged flight with the air intake immersed in the jet efflux of another aircraft.

Flying with Asymmetric Stores

63. The aircraft can be trimmed at all normal operating speeds even with the most adverse asymmetric store. However, on the approach, full aileron trim away from the heavy wing and slight rudder trim towards the heavy wing may be required when asymmetric underwing stores are carried. In manoeuvre, the presence of an asymmetric store is felt as a wing heavy tendency, which requires the application of aileron to maintain a constant bank angle. Turns in the direction of the asymmetric store should therefore be flown with caution.

Instrument Flying

64. The instrument layout is good and the instruments are easily read, allowing accurate flight path changes to be made.

65. Setting 83 to 85% RPM, with flaps fully down, gives a rate of descent of about 600 feet per minute on the glidepath. On the approach, small and accurate heading changes are easily made.

Night Flying

66. Internal lighting of both cockpits is good, and the main instrument panel lighting balances well with other light settings. Glare effects are negligible, but canopy reflections are apparent, especially in the rear cockpit.

Descending

67. The descent configurations and settings are:

a. **Rapid/Tactical Descent.** For a rapid or tactical descent set the throttle to Idle, select the airbrake OUT, and descend at 0·85M/400 knots (clean aircraft) or 0·80M/400 knots (aircraft with stores).

b. **Range Descent.** For range descent set the throttle to Idle and, with the airbrake IN, descend at 0·70M/300knots.

c. **Instrument Descent.** For an instrument descent set 80% RPM, select the airbrake OUT, and descend at 0·70M/300 knots.

Gliding

170/175

ANA 10 68. The recommended gliding speed for best range is 180 knots, reducing to 165/170 knots with the landing gear down. Above 20,000 feet glide at 0·65M; this avoids the risk of an undamaged engine ceasing to windmill and places the aircraft at the correct IAS for an unassisted relight attempt at or below 25,000 feet, reduces canopy misting to a minimum and preserves battery life. The difference in rate of descent between an aircraft with a windmilling engine and one with a seized engine is small enough to ignore.

Note: A flamed-out engine may cease to windmill during a prolonged glide at speeds below those recommended.

Forced Landings - Gliding Performance

69. **Wings Level Flight.** The aircraft covers just over 2 NM for every 1000 feet height lost when gliding with engine windmilling, landing gear and flaps up and airbrake in at 180 knots. With engine windmilling, landing gear down, flaps up and airbrake in at 170 knots the figure is approximately 1·25 NM per 1000 feet. The difference between a windmilling and a seized engine is small enough to ignore.

70. **Turning Flight.** With engine windmilling, landing gear and flaps up, airbrake in at 180 knots a 360° turn using 30° angle of bank produces a height loss of about 3500 feet. With 45° angle of bank the figure is about 2500 feet. With landing gear down at 170 knots about 4800 feet is lost using 30° angle of bank and 3000 feet with 45° angle of bank.

71. **Configuration.** The difference in gliding performance between an aircraft with no external stores and one with a gunpod or smokepod and bare pylons is insignificant. The figures in para 69 and para 70 can therefore be applied to aircraft in either configuration.

Flying in Turbulence

72. The recommended speed band for flight in turbulence is 300 to 325 knots.

Operating in Icing Conditions

73. Icing degrades the aircraft's performance, behaviour and handling qualities. Engine icing information is given at para 16. Even small amounts of ice accretion on the wings and tailplane leading edges degrade behaviour at the stall. Stall and pre-stall buffet speeds are increased and with full flap down natural pre-stall warning buffet is masked by airframe buffet. Tailplane effectiveness may be reduced with landing gear and full flap down and an uncontrollable pitch down can occur if the landing gear is raised with full flap remaining down. This condition does not occur with mid flap. Whenever icing conditions are encountered attempt to de-ice before landing if time and weather conditions permit. If airframe icing is visible during the approach to land, land using mid flap only.

Note: If appreciable icing has been accumulated with the landing gear or flaps extended, damage may be caused if the landing gear is retracted or the flaps are selected up from the mid position.

TARGET TOWING

General

74. A banner target towing cable can be attached to aircraft equipped for towing at an Electrically Operated Release Unit (EORU) on the underside of the fuselage aft of the airbrake. The EORU is energized to release the cable when the gangbar of two button-type switches is pressed down. The switches are in the front cockpit outboard of the left console on the aft face of frame 4 and are marked TARGET BANNER RELEASE; the gangbar is white. Each switch controls a supply, one from the Essential Services busbar the other from the No 1 Battery busbar, to one of two EORU solenoids. The EORU operates when either solenoid is energized. Each electrical supply is independent of the MASS.

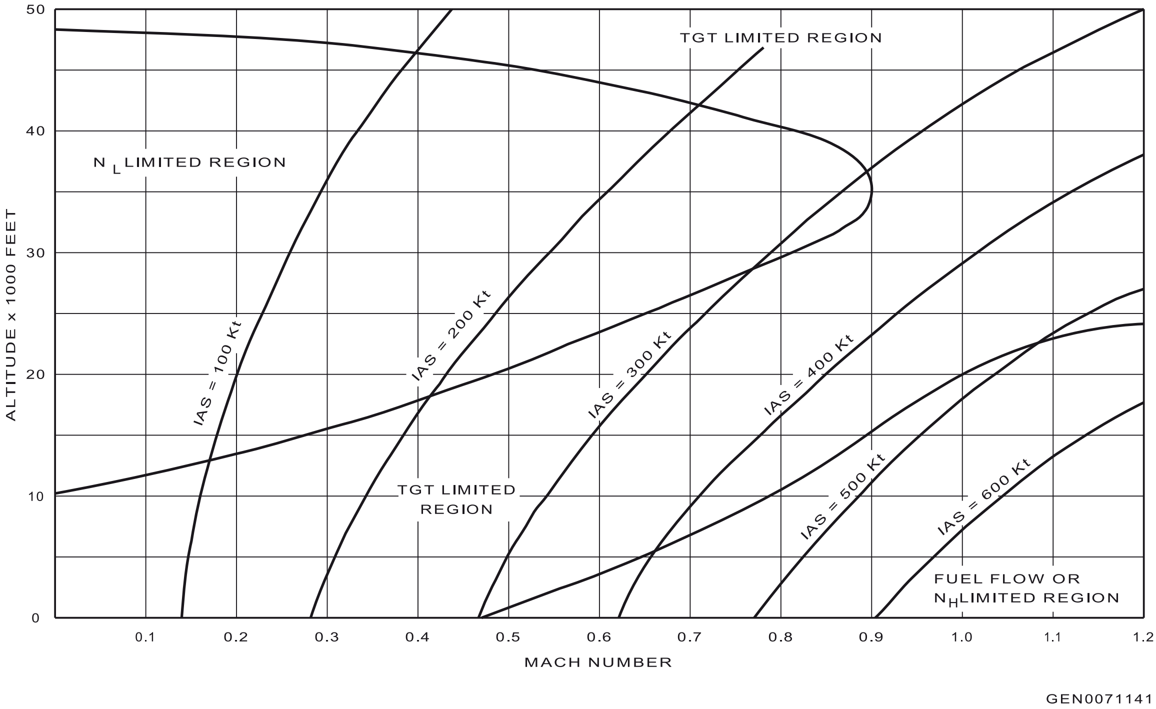
Towed Banner Target Release

75. To release a banner target fly at 150 knots with mid flap in level flight at 350 feet AGL and operate the ganged release switch.

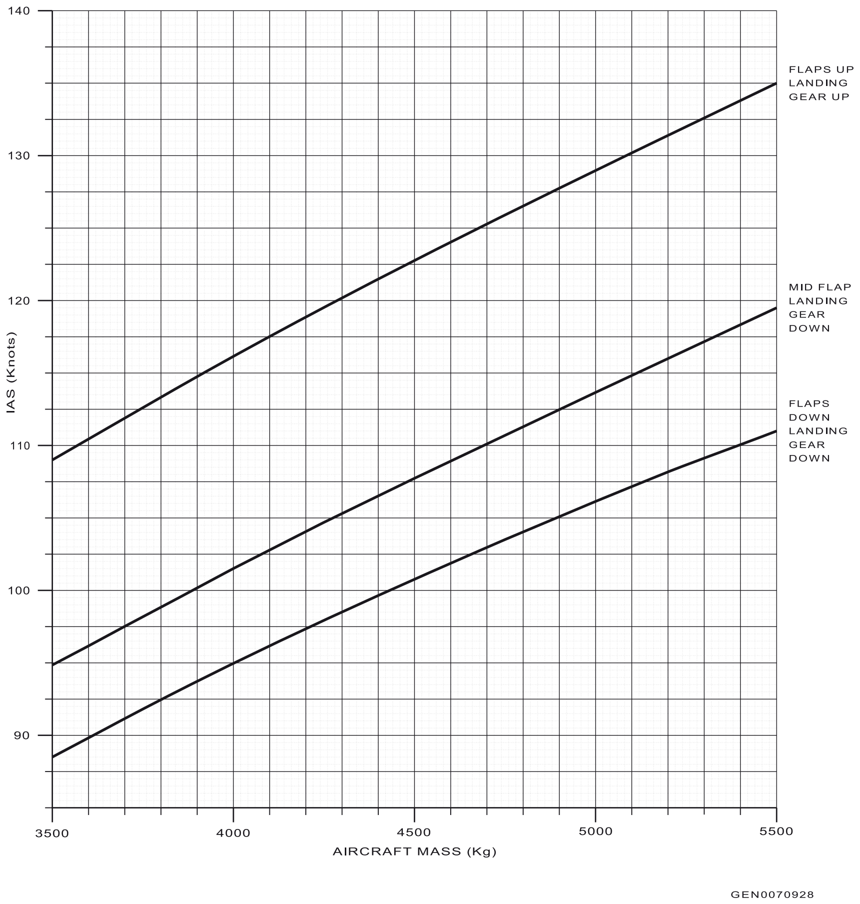
Malfunctions - Banner Target Towing

76. **Failure to Release.** If a target fails to release normally, increase speed in a safe area to about 360 knots when the weak link should break. A shallow dive may be necessary to reach this speed. If this is unsuccessful or impracticable, a landing may be attempted with the target on tow but displace the threshold upwind by 2000 feet if possible.

77. **Other Aircraft Malfunctions.** In event of a confirmed engine bay or air producer bay fire or engine mechanical failure or a flame out requiring a cold relight release the target as soon as practicable.



2 - 2 Fig 1 Approximate Regions of Engine Limiters (Maximum Rating - ISA Conditions)



2 - 2 Fig 2 Stalling Speeds

PART 2

CHAPTER 3 - CIRCUIT PROCEDURE AND LANDING

Contents

General

1. The checks referred to in this chapter are listed in the Flight Reference Cards.

2. In the circuit, the view from the front cockpit is good. From the rear cockpit the forward view may be restricted by the front windscreen arch on roundout, especially during flapless approaches; however, there is ample view on either side of the nose to complete the landing.

Circuit Procedure

WARNING: Whilst in the final turn or on final approach, if at any time the onset of buffet is felt, carry out the standard stall recovery immediately; failure to do so will result in significant, and possibly irrecoverable, height loss.

3. Start the downwind leg at 190 knots with 78% RPM set. Carry out the **Before Landing Checks**. If residual brake pressure in excess of 10 bars is indicated after the **Before Landing Checks** have been completed, switch off the anti-skid, unless Post MOD 1863 (Touchdown Protection) fitted - leave anti-skid On. With MID flap selected and landing gear down allow the airspeed to decay to 160/150 knots at the end
ANA 10 of the downwind leg (use the higher speed when more than 1000 kg of fuel remains (500 kg with external stores)). the aircraft AUM is greater than 5000 kg).

4. Commence the final turn and select full flap when required. When Sidewinder missiles are carried the aircraft is very sluggish in its response to pitch control at aft CG with full flap and landing gear down, especially at about 160 kts. Progressively reduce the airspeed to 140/130 knots by the end of the turn, use
ANA 10 the higher speed when* more than 1000 kg of fuel remains (500 kg with external stores). When lined up on the final approach, gradually reduce the airspeed in order to arrive at the runway threshold at the correct speed. When asymmetric underwing stores are carried full aileron trim away from the heavy wing and slight rudder trim towards the heavy wing may be required on the approach.

* the aircraft AUM is greater than 5000 kg.

5. For a normal powered approach the threshold speed is calculated by adding 1 knot per 100 kg of fuel remaining to the basic threshold speeds of 110 knots (without external stores) or 115 knots for symmetric underwing stores or asymmetric Sidewinder.

6. Approximately 25 kg of fuel are required for a circuit. The time taken to accelerate the engine from idling RPM to maximum thrust is approximately 7 seconds; therefore, to ensure adequate engine response during the approach, do not reduce RPM below 70%.

Landing Procedure

CAUTION: A landing made with pressure applied at the brake toe pads could result in a burst tyre. To prevent inadvertent brake application at touchdown, check on short finals that the feet are clear of the toe pads.

Note 1: Because brake pressure at the wheels is relieved for up to a maximum of two seconds under skid conditions with anti-skid on, the aircraft could deviate significantly from the intended path if a tyre burst on landing. Aircraft are therefore to be operated on the nominal centre line of the runway except when landing in pairs.

Note 2: In the normal landing configuration at maximum normal landing weight and at normal approach speed on a 3° glidepath the pilot's eye height is 8.4ft (front cockpit) and 8.8ft (rear cockpit) above the main wheels. The effect of a 1° change in attitude is 0.2ft (front cockpit) and 0.1ft (rear cockpit).

7. As the touchdown point is approached, gradually close the throttle, check the rate of descent and fly the aircraft smoothly on to the runway. Lower the nosewheel onto the runway after touchdown and apply gentle braking. If any difficulty occurs in keeping straight, momentarily release the brakes. An attempt to hold off prior to touchdown is likely to cause the aircraft to skip several times before settling on the runway, particularly at low mass or when higher than recommended threshold speeds are used. If a tyre bursts at touchdown or during the landing run, or if a rapid and unexpected change of direction occurs, cease braking and immediately select anti-skid off. Differential braking can then be recommenced to maintain directional control. With anti-skid selected off there is a possibility of a tyre bursting under heavy braking.

Landing at High AUM

8. When landing at a mass above 5000 kg take care to avoid high vertical velocities at touchdown; the approach should therefore be shallower than normal.

Braking

9. **Dry and Wet Surfaces.** Initially use gentle, continuous brake application, gradually increasing the pressure as speed reduces. Keep the control column central. The anti-skid system prevents the wheels locking if high brake pressures are applied at high groundspeeds. In normal circumstances, to retain good directional control during the landing run and to minimize tyre wear, gentle braking is recommended. During heavy braking care must be taken to ensure that good directional control is maintained. On wet runways retardation may be considerably reduced, depending on the degree of wetness of the surface.

10. **Flooded or Icy Surfaces** . Due to the considerable loss in braking effectiveness, avoid flooded or ice covered surfaces when possible. If a landing has to be made on such surfaces, use extreme caution; touchdown firmly at the correct speed, lower the nosewheel and apply the brakes carefully.

11. **Emergency Braking.** If emergency braking is necessary lower the nosewheel on to the runway immediately after touchdown and apply maximum foot pressure at the toe pads. Below 100 knots pull the control column hard back and hold it back until taxying speed is reached.

12. **Aerodynamic Braking.** Wheelbraking is far more effective than aerodynamic braking; therefore the use of this technique with an exaggerated nose high attitude is not recommended. Aerodynamic braking extends the landing distance and, if a nose high attitude is maintained to very low speeds, tailplane effectiveness may be insufficient to lower the nosewheel on to the runway, and the aircraft may come to rest on the tailskid. Therefore lower the nosewheel on to the runway by 70 knots.

CAUTION: Following prolonged or heavy braking brake efficiency is considerably reduced; similarly, successive applications of brakes, even at light weight and slow speed, can have the same effect. Under these circumstances it is essential that sufficient time is allowed for the brakes to cool in order to restore brake efficiency.

Rolling

13. Carry out normal approach and touchdown. After touchdown keep the nosewheel clear of the runway and smoothly select full throttle, checking that the engine responds correctly to throttle movement. After unstick, at a safe height, raise the landing gear and flaps simultaneously.

Overshooting

14. Open the throttle smoothly to the RPM required and, at a safe height, raise the landing gear and flaps simultaneously.

Instrument Approach

15. The settings shown in Table 1 are recommended for an instrument approach; the RPM settings apply to an aircraft without external stores.

Table 1 - Instrument Approach Settings

Approach Stage	*RPM (%)*	*Flaps*	*Landing Gear*	*Airspeed (kts)*
Downwind	80	UP	UP	230
Base Leg	83 to 85	MID	DOWN	160/150
Glidepath	83 to 85	DOWN	DOWN	160/150 (Reducing steadily to 140/130 at 2/300 ft AGL)

Flapless Landing

16. The recommended maximum landing mass with zero flap is 4500 kg. If landing above this mass is unavoidable, the application of brakes above 140 knots may result in brake failure during the landing run. Fly a wider than normal downwind leg; adjust the circuit to achieve a long, shallow approach and cross the threshold at 135 knots (140 knots for external stores) plus 1 knot for every 100 kg of fuel remaining. Make the final turn at 160 to 170 knots, depending on the mass, and line up on the final approach at 150 to 160 knots. On the approach, speed is slow to decrease; take care to avoid an excessive nose-up attitude. Below 200 feet above ground level (AGL) the forward view from the rear cockpit is obscured by the front windscreen arch, but ample view is available on either side of the nose to allow execution of the landing. The landing run is increased considerably.

MID Flap Landing

17. When landing in conditions of airframe icing (see Chapter 2, para 73.) only use MID flap. The threshold speed for MID flap approaches is calculated by adding 1 knot per 100 kg of fuel remaining to a basic speed of 120 knots (without external stores) or 125 knots (with external stores). If airframe icing is present a further margin of speed must be allowed to compensate for the effect of icing on stalling speed. Speed control on the approach is affected by the reduced drag at MID flap; fly a wider and shallower approach than normal. The forward view from the rear cockpit is obscured by the higher nose position on the final approach, but ample view is available on either side of the nose to allow for the completion of the landing. The landing run is increased.

Crosswind Landing

18. Landing in crosswinds using the crab technique presents no difficulty. In strong crosswind conditions, select flap DOWN; in the MID or UP flap configurations the aircraft is more sensitive to gusts, turbulence and sink and touchdown position is difficult to predict due to the tendency to float. Positive rudder is required, just before touchdown, to remove drift; take extra care, during the application of rudder, to avoid inadvertent brake application on touchdown. The use of rudder produces noticeable roll, which is easily corrected with aileron. When the drift has been corrected, fly the aircraft on to the runway, and lower the nosewheel without delay. When carrying asymmetric underwing stores it is particularly important not to hold off and an additional allowance of 5 knots for adverse (loaded wing downwind) crosswind components and gusts is necessary. During the landing ground roll, directional control is best maintained by coarse use of rudder. At low speeds the aircraft leans downwind and the ride becomes bumpy, giving the impression of a burst tyre. Ground roll distances have not been established for strong crosswind conditions, but due to the requirement for

asymmetric wheel braking they are likely to be significantly greater than those published in the Operating Data Manual.

Airbrake-Out Landing

19. If it is necessary to land with the airbrake out, nose high attitudes must be avoided to lessen the possibility of the airbrake striking the ground during the landing. Use higher RPM to maintain the required circuit and approach airspeed. Carry out a shallower than normal approach and do not round out for landing. Lower the nosewheel immediately after touchdown.

Forced Landing Procedures

20. For a forced landing or PFL, glide at 180 knots with the throttle at Idle, flaps UP, landing gear UP and airbrake IN, aiming for a high key at 4500 feet AGL above a position about 6000 feet upwind from the runway See AIL 1/20 threshold. At high key, lower the landing gear carrying out the normal landing vital actions but leaving the flap UP. Glide at 165 knots (170 knots when more than 1000 kg of fuel remains (500 kg with external stores)). Aim to achieve the low key position abeam the intended touch-down point at 3000 feet AGL. Sight line angle is to be used to assess the finals turn. Should a tighter than normal turn be required, speed must be increased above 165/170 knots. When certain of reaching the desired touchdown point select flap DOWN. To lose excess height begin to dive as the flap passes the mid position; speed increase is slight. In order to prevent dangerously steep and steepening approaches, the maximum speed on the final approach with full flap down is 170 knots. Owing to the high rate of descent with flap DOWN, a two stage roundout is to be initiated by visual references only; no attempt is to be made to cross-refer to altimeter indications (do not allow speed to fall below 150 knots prior to starting the landing flare). At extreme forward CG, tailplane control may be insufficient for a normal flare to be achieved from a steep power-off approach; a slightly early flare ensures that adequate control is available. If an overshoot is intended, overshoot action is to be initiated at not less than 300 feet AGL; abrupt attitude changes are to be avoided.

Checks After Landing

21. Carry out the **After Landing Checks**.

22. Following a braked landing at a mass in excess of 5000 kg, during which braking is commenced at a speed in excess of 110 knots, have the brakes inspected for distortion and wear.

Shutdown Procedure

23. Normally allow 30 seconds at Idle for the RPM and TGT to stabilize and check that HYD 1 and HYD 2 pressures are normal. Then carry out the **Shutdown Checks** selecting the fuel pump off only just before selecting throttle to HP Off. Not less than 18 seconds after shutdown move the control column in circles of approximately two inches in diameter (measured at the top of the handgrip) about neutral monitoring HYD 1 and HYD 2 gauges. During this period HYD 1 and HYD 2 pressures decay and the RAT should extend at an indicated HYD 2 pressure of approximately 103 bars. After HYD 1 pressure falls to 60 bars it drops rapidly to zero and HYD 1 caption illuminates. HYD 2 pressure should be approximately 75 bars. Move the control column through a further four cycles as described above. No tendency should exist for the control column to lock in any position or to move away in any direction contrary to pilot input, nor should control surfaces fail to move as required.

Note: Due to design characteristics of the hydraulic systems, the HYD 1 and/or HYD 2 captions may illuminate at indicated system pressures much higher than the nominal settings of the low pressure caption switches of 41 and 113 bars respectively. As long as no other indications of hydraulic malfunctions are observed, no inference of hydraulic system unserviceability should be drawn from these high system pressure indications on shutdown.

March 2020

HAWK T MK 1 & T MK 1A
AIRCREW MANUAL

ADVANCE INFORMATION LEAFLET 1/20

Insert this leaflet in AP101B-4401-15 Third Edition (AL3) after Part 2, Chapter 3, Page 4. By manuscript amendment, strike through Part 2, Chapter 3, paragraph 20 and insert 'See AIL 1/20' adjacent to the **Forced Landing Procedures** title. On completion, record the insertion of AIL 1/20 into the AIL record.

This AIL amends the flap up, gear down glide speeds, introduces a suggested maximum angle of bank for Practice Forced Landings, and incorporates the Forced Landing Contract into the Aircrew Manual.

FORCED LANDING PROCEDURES

Forced Landing Procedures

20. For a forced landing or PFL, glide at 180 knots with the throttle at Idle, flaps UP, landing gear UP and airbrake IN, aiming for a high key at 4500 feet AGL above a position about 6000 feet upwind from the runway threshold. At high key, lower the landing gear carrying out the normal landing vital actions but leaving the flap UP. Glide at 170 knots (175 knots when AUM is greater than 5000 kg). Aim to achieve the low key position abeam the intended touchdown point at 3000 feet AGL. Sight line angle is to be used to assess the finals turn, ideally not exceeding a 45° angle of bank for a PFL. Should more than 45° angle of bank be required during a forced landing, speed must be increased above 170/175 knots; this may necessitate increasing the rate of descent. A speed of 170/175 knots with a maximum angle of bank of 45° should provide a buffer from the stall of approximately 10 knots in an aircraft with an AUM of less than 5000 kg/between 5000 and 5500 kg, respectively. Currently there is no data on a stall margin for an aircraft with an AUM of greater than 5500 kg. When certain of reaching the desired touchdown point, select flap DOWN. To lose excess height, begin to dive as the flap passes the mid position; speed increase is slight. In order to prevent dangerously steep and steepening approaches, the maximum speed on the final approach with flap DOWN is 170 knots. Owing to the high rate of descent with flap DOWN, a two stage roundout is to be initiated by visual references only; no attempt is to be made to cross-refer to altimeter indications (do not allow speed to fall below 150 knots prior to starting the landing flare). At extreme forward CG, tailplane control may be insufficient for a normal flare to be achieved from a steep power-off approach; a slightly early flare ensures that adequate control is available. If an overshoot is intended, overshoot action is to be initiated at not less than 300 feet AGL; abrupt attitude changes are to be avoided.

Forced Landing Contract

21. It is recommended that a forced landing or PFL should only be continued below 300 feet AGL if all the following criteria have been met:

a. Landing gear is locked down.

b. Clearance to touch and go (PFL) has been received from ATC.

c. Down flap is indicated, or has been selected and is travelling.

d. Heading is within 30° of runway heading.

e. Angle of bank is less than 45°.

f. Speed is between 150 and 170 knots.

22. The above criteria are referred to as the 'Forced Landing Contract'. If it is evident that all the criteria for the contract will not be achieved by 300 ft AGL, a decision to eject for a forced landing, or go-around for a PFL should be conducted at the earliest opportunity.

Note 1: The information in this leaflet will be incorporated in the Aircrew Manual in due course.

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

PART 3

EMERGENCIES AND MALFUNCTIONS

List of Chapters

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PART 3

CHAPTER 1 - INDEX OF MALFUNCTIONS AND EMERGENCY PROCEDURES

Contents

General

1. Details of system malfunctions, malfunctioning drills and emergency handling procedures are in the appropriate chapters of this Manual and in the Flight Reference Cards as shown in the following index.

Table 1 - Index of Malfunctions and Emergency Procedures

Malfunction/Emergency	*Aircrew Manual*	*Flight Reference Cards Tab Ident*
ABORT		
Abort	Part 2, Chapter 1, para 22	E-2
Barrier Engagement	Part 2, Chapter 1, para 22	E-2
Overrun / Runway Departure	Part 2, Chapter 1, para 22	E-2
ENGINE		
Engine Surge	Part 1, Chapter 4, para 61	E-3
Immediate Relight	Part 1, Chapter 4, para 39	E-3
Post Relight	Part 1, Chapter 4, para 43	E-3
Assisted Relight	Part 1, Chapter 4, para 41	E-4
Unassisted Relight	Part 1, Chapter 4, para 42	E-4
Engine Bay Fire in Flight	Part 1, Chapter 4, para 44	E-5
Engine Bay Fire on the Ground	Part 1, Chapter 4, para 44 - Part 1, Chapter 4, para 53	E-5
Air Producer Bay Fire in Flight	Part 1, Chapter 4, para 59	E-6
Air Producer Bay Fire on the Ground		E-6
Engine Seizure / Mechanical Failure		E-7
Engine LP Cooling Air Overheat	Part 1, Chapter 4, Table 1	E-7
T6NL	Part 1, Chapter 4, para 71	E-7
Jet Pipe Bay Overheat	Part 1, Chapter 4, para 48	E-13
Oil Pressure Low	Part 1, Chapter 4, para 75	E-13

(Continued)

Table 1 - continued

Malfunction/Emergency	*Aircrew Manual*	*Flight Reference Cards Tab Ident*
ECA	Part 1, Chapter 4, para 72	E-7
Bleed Valve	Part 1, Chapter 4, para 74	
GTS Fuel Supply	Part 1, Chapter 4, para 76	
Engine RPM Indication	Part 1, Chapter 4, para 77	
Failure after Take-Off	Part 2, Chapter 1, para 23	
Failure to Start	Part 2, Chapter 1, para 10	N-10
SMOKE OR FUMES / OXYGEN		
Smoke or Fumes	Part 1, Chapter 8, para 30	E-8
Suspected Hypoxia	Part 1, Chapter 10, para 36	E-8
Contaminated Oxygen Supply		E-8
CPR or Cabin Altitude Above 25,000ft	Part 1, Chapter 8, para 27	E-8
OXY or MI Continuous White or Black or Difficulty Breathing In	Part 1, Chapter 10, para 28	E-9
Difficulty Breathing Out	Part 1, Chapter 10, para 28	E-9
High Consumption	Part 1, Chapter 10, para 35	
ELECTRICAL		
Generator	Part 1, Chapter 1, para 25	E-10
Inverter(s)	Part 1, Chapter 1, para 32	E-15
Load Shedding	Part 1, Chapter 1, para 28	E-10
Undervoltage and Time Delay Unit	Part 1, Chapter 1, para 30	
Battery	Part 1, Chapter 1, para 31	
FUEL		
Low Fuel Pressure	Part 1, Chapter 3, para 35	E-14
Low Fuel Contents	Part 1, Chapter 3, para 32	E-14
Low Fuel Transfer Pressure	Part 1, Chapter 3, para 33	E-14
High Fuel Consumption	Part 1, Chapter 3, para 37	E-14

(Continued)

Table 1 - continued

Malfunction/Emergency	*Aircrew Manual*	*Flight Reference Cards Tab Ident*
Vapour Release Valve	Part 1, Chapter 3, para 37	E-14
HYDRAULICS		
Total Hydraulic	Part 1, Chapter 5, para 35	E-11
Hyd 1	Part 1, Chapter 5, para 28	E-11
Hyd 1 When Landing Gear Selected Up	Part 1, Chapter 5, para 30	E-12
Hyd 2	Part 1, Chapter 5, para 31	E-11
Hyd 1 and 2	Part 1, Chapter 5, para 34	E-12
Accumulator Nitrogen Loss	Part 1, Chapter 5, para 36	
LANDING EMERGENCIES		
Anti-Skid	Part 1, Chapter 7, para 51	E-16
Landing Gear Emergency Retraction	Part 1, Chapter 7, para 14	E-2
Residual Brake Pressure	Part 1, Chapter 7, para 50	E-16
Forced Landing	Part 2, Chapter 2, para 69 Part 2, Chapter 3, para 20	E-17
Airbrake Out	Part 2, Chapter 3, para 19	
LANDING GEAR		
Gear Selected Up But Fails to Retract		E-20
Gear Up Selector Cannot Be Depressed		E-20
Gear Selected Down But Only Partially Extends	Part 1, Chapter 7, para 39	E-20
Gear Selected Down But Fails to Move	Part 1, Chapter 7, para 37	E-21
Standby Lowering System	Part 1, Chapter 7, para 11	E-21
Landing With Gear Unsafe	Part 1, Chapter 7, para 42	E-22
Landing Gear Doors	Part 1, Chapter 7, para 41	
Undemanded Lowering	Part 1, Chapter 7, para 40	
Landing Gear Selector Valve Malfunction	Part 1, Chapter 7, para 44	

(Continued)

Table 1 - continued

Malfunction/Emergency	*Aircrew Manual*	*Flight Reference Cards Tab Ident*
ABANDON		
Premeditated Ejection	Part 1, Chapter 9, para 98	E-18
Emergency Ground Egress	Part 1, Chapter 9, para 111	E-2
Failure to Eject	Part 1, Chapter 9, para 106	E-18
Auto Seat Separation fails After Ejection	Part 1, Chapter 9, para 108	E-19
Ejection at Low Level	Part 1, Chapter 9, para 102	
Escape on / in Water	Part 1, Chapter 9, para 114	
AIR CONDITIONING/PRESSURIZATION		
Cabin Temperature Control Malfunction	Part 1, Chapter 8, para 31	
CANOPY		
MDC Operation	Part 1, Chapter 12, para 13	E-19
Flight With Canopy Damaged	Part 1, Chapter 12, para 23	
Flight With Detached MDC	Part 1, Chapter 12, para 27	
Canopy Seal	Part 1, Chapter 8, para 29	
CENTRAL WARNING SYSTEM		
Audio Warning	Part 1, Chapter 2, para 14	
FLIGHT CONTROLS		
Flaps Fail to Operate	Part 1, Chapter 6, para 42	E-23
Flaps Standby Lowering	Part 1, Chapter 6, para 42	E-23
Airbrake Fails to Operate	Part 1, Chapter 6, para 46	E-23
Airbrake/Landing Gear Interconnect Failure	Part 1, Chapter 6, para 26	E-23
Main Tailplane Trim Failure	Part 1, Chapter 6, para 37	E-24
Rudder or Aileron Trim Failure	Part 1, Chapter 6, para 40	E-24
Flap Selector Valve Malfunction	Part 1, Chapter 6, para 45	

(Continued)

Table 1 - continued

Malfunction/Emergency	*Aircrew Manual*	*Flight Reference Cards Tab Ident*
Undemanded Flap Lowering	Part 1, Chapter 6, para 43	E12
Flap Undemanded Retraction	Part 1, Chapter 6, para 44	
GTS		
Fuel Supply Failure	Part 1, Chapter 4, para 76	
JETTISON		
Jettisoning External Stores	Part 1, Chapter 14, para 14b	E-19
RADIO AND COMMUNICATIONS		
Loss of Intercom or Radio Reception	Part 1, Chapter 13, para 96	E-25
Microphone Failure		E-25
Failure to Transmit	Part 1, Chapter 13, para 97	E-25
SPINNING		
Recovery procedure	Part 2, Chapter 2, para 45c	
VIBRATION		
Engine/airframe	Part 2, Chapter 2, para 9	

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PART 4

ILLUSTRATIONS

List of Chapters

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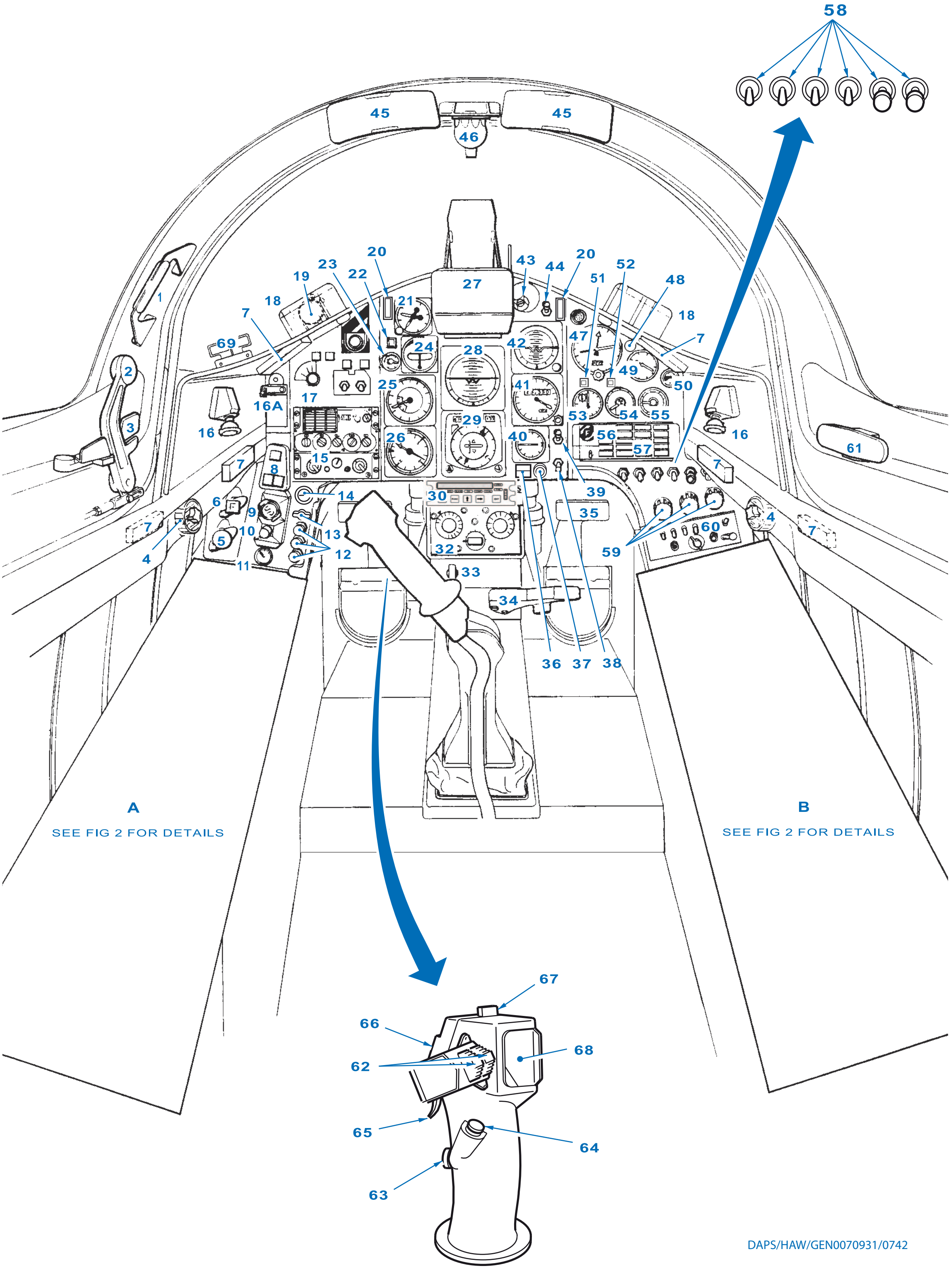
PART 4

CHAPTER 1 - COCKPIT ILLUSTRATIONS

Illustrations Fig



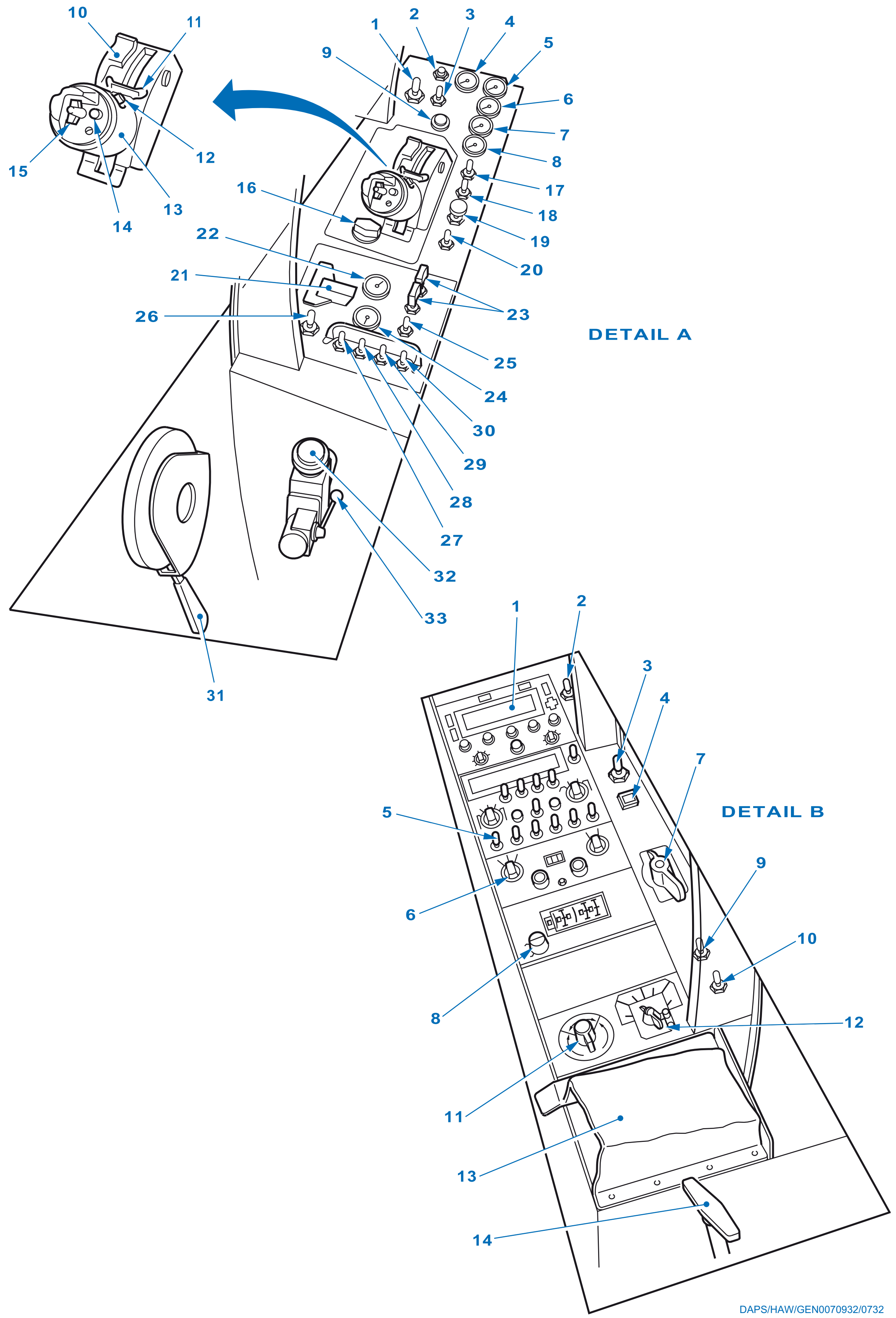
4 - 1 Fig 1 Front Cockpit - T Mk 1

(Incorporation of Mod 2516 at AL3)

Table 1 - Key to 4-1 Fig 1 Front Cockpit - T Mk 1

No	Item	Ref
1	Grab handle	1 - 12
2	Canopy operating lever	1 - 12
3	Canopy operating lever safety catch	1 - 12
4	Body spray adjustable louvre (2)	1 - 8
5	Landing gear standby lowering system selector	1 - 7
6	Flap standby lowering system selector	1 - 6
7	Strip light (6)	1-12
8	Landing gear unit position indicator	1-7
9	Landing gear retraction selector button and ground emergency retraction facility	1-7
10	Landing gear lowering selector button	1-7
11	DC voltmeter	1-1
12	Reset buttons - bottom to top:	
	Generator reset	1-1
	No 2 inverter reset	1-1
	No 1 inverter reset	1-1
13	Flap position selector	1-6
14	Flap position indicator	1-6
15	UHF transceiver control panel	1-13
16	Map reading light (2)	1-12
17	Weapon control panel	1-14
18	Frequency card holder (2)	1-13
19	Stopwatch holder	1-12
20	CWS attention light (2)	1-2
21	Accelerometer	1-11
22	Airbrake indicator	1-6
23	Tailplane position indicator	1-6
24	Turn-and-slip indicator	1-11
25	Combined speed indicator (CSI)	1-11
26	Directional gyro indicator (DGI)	1-11
27	ISIS sight head	1-14
28	Attitude indicator	1-11
29	Horizontal situation indicator (HSI)	1-11
30	AHRS digital control panel	1-11
31	Not used	
32	ISIS control unit	1-14
33	Rudder pedals adjustment control	1-6
34	Rudder bar locking handle	1-6
35	Wheelbrakes toe pad - also on left side	1-7
36	Navigation mode selector	1-13
37	ILS marker indicator light	1-13

No	Item	Ref
38	Landing/taxy lamp switch	1-12
39	Communications power switch	1-13
40	Vertical speed indicator (VSI)	1-11
41	Main altimeter	1-11
42	Standby attitude indicator	1-11
43	Master armament safety switch (MASS)	1-14
44	Flight instruments power switch	1-11
45	Rear view mirror (2)	1-12
46	Standby magnetic compass	1-11
47	Standby altimeter	1-11
48	Oxygen flow indicator	1-10
49	Cabin altimeter	1-8
50	Oxygen main supply contents gauge	1-10
51	Engine LP shaft rotation indicator	1-4
52	Air producer start indicator	1-4
53	RPM indicator	1-4
54	TGT indicator	1-4
55	Fuel contents gauge	1-3
56	Fire extinguisher button	1-2
57	Central warning panel	1-2
58	Lighting switches left to right:	
	Navigation light switch	1-12
	Lower anti-collision light switch	1-12
	Upper anti-collision light switch	1-12
	Internal main lights master switch	1-12
	Internal emergency lights switch	1-12
	Standby compass light switch	1-12
59	Internal lighting rotary dimmer (3)	1-12
60	CCS station box	1-13
61	MDC firing handle	1-12
62	Tailplane trim switches	1-6
63	Receiver mute switch	1-13
64	Camera button	1-14
65	Gun firing trigger	1-14
66	Gun safety catch	1-14
67	Gun safety catch indicator (Set to live)	1-14
68	Bomb/RP release button safety flap	1-14
69	Canopy/seat pin stowage	1-9
	Detail A- See Fig 2	
	Detail B- See Fig 2	

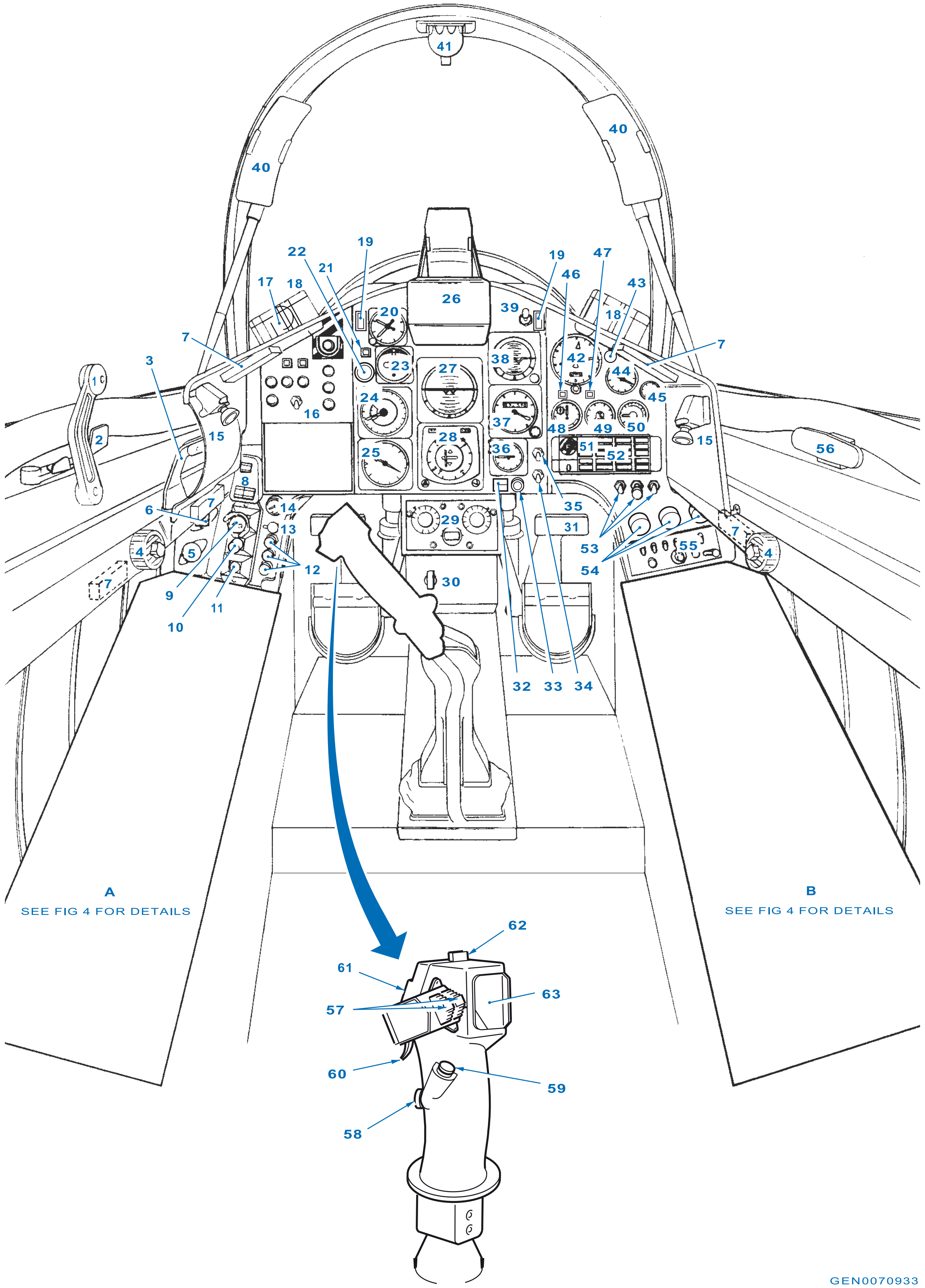


4 - 1 Fig 2 Front Cockpit Consoles - T Mk 1

Table 2 - Key to 4 - 1 Fig 2 Front Cockpit Consoles - T Mk 1

No	*Item*	*Ref*
	Detail A	
1	Engine ignition switch	1-4
2	Altimeter ground test switch	1-11
3	Left brake pressure gauge	1-7
4	Right brake pressure gauge	1-7
5	Brakes supply pressure gauge	1-7
6	No 1 hydraulic system pressure gauge	1-5
7	No 2 hydraulic system pressure gauge	1-5
8	No 2 hydraulic pump/ram air turbine (RAT) reset button	1-5
9	Full throttle stop	1-4
10	Throttle idle stop lever	1-4
11	Start/relight button	1-4
12	Throttle twist grip	1-4
13	Transmit switch	1-13
14	Airbrake switch	1-6
15	Throttle damper friction control	1-4
16	Standby UHF switch	1-13
17	Alternative receiver mute switch	1-13
18	Alternative transmit switch	1-13
19	Anti-skid switch	1-7
20	Cover for tailplane trim standby switches	1-6
21	Aileron trim indicator	1-6
22	Aileron trim switches	1-6
23	Rudder trim indicator	1-6
24	Rudder trim switch	1-6
25	Engine start master switch	1-4
26	No 1 battery switch	1-1
27	No 2 battery switch	1-1
28	Fuel booster pump switch	1-3
29	Pitot-static tube heater switch	1-11
30	LP fuel cock control lever	1-3
31	Anti-g system test button	1-8
32	Anti-g system control lever	1-8

No	*Item*	*Ref*
	Detail B	
1	VHF transceiver control panel	1-13
2	UHF aerial selector switch	1-13
3	External intercom switch	1-13
4	Accident data recorder (ADR)status indicator	1-12
5	SIFF TCDU	1-13
6	Tacan control unit	1-13
7	Oxygen main supply selector	1-10
8	ILS control unit	1-13
9	Seat pan height adjustment switch	1-9
10	Airbrake test switch	1-6
11	Temperature control switch	1-8
12	Cabin conditioning control switch	1-8
13	Map stowage	1-12
14	Parking brake T-handle	1-7

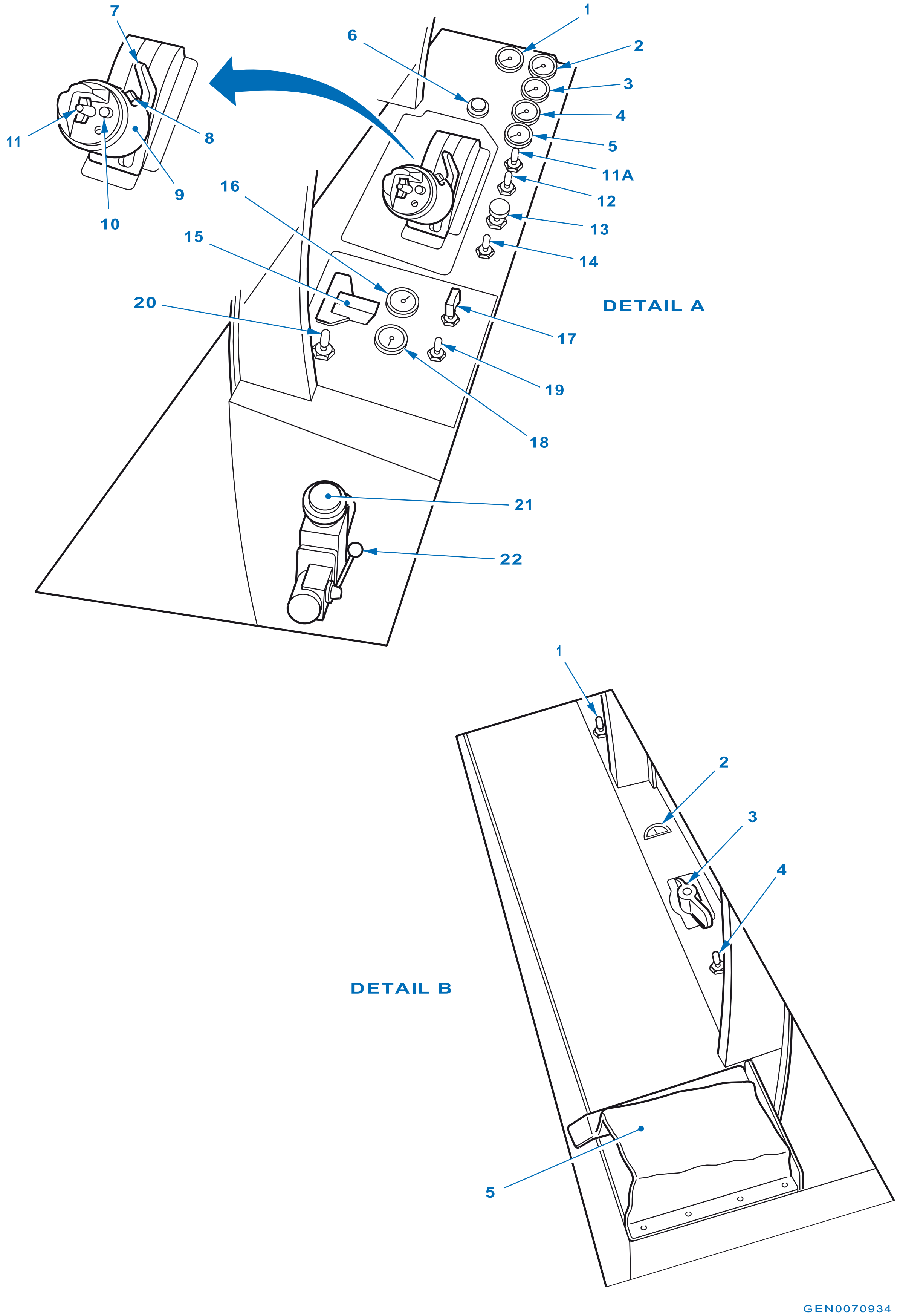


4 - 1 Fig 3 Rear Cockpit - T Mk 1

Table 3 - Key to 4 - 1 Fig 3 Rear Cockpit - T Mk 1

No	*Item*	*Ref*
1	Canopy operating lever	1-12
2	Canopy operating lever safety catch	1-12
3	Grab handle	1-12
4	Body spray adjustment louvre (2)	1-8
5	Landing gear standby lowering system selector	1-7
6	Flap standby lowering system selector	1-6
7	Strip light (5)	1-12
8	Landing gear unit position indicator	1-7
9	Landing gear retraction selection button and ground emergency retraction facility	1-7
10	Landing gear lowering selector button	1-7
11	Landing gear selection control transfer button	1-7
12	Reset buttons - from bottom to top:	
	Generator reset	1-1
	No 2 inverter reset	1-1
	No 1 inverter reset	1-1
13	Flap position selector	1-6
14	Flap position indicator	1-6
15	Map reading light	1-12
16	Weapon monitor panel	1-14
17	Stopwatch holder	1-12
18	Frequency card holder (2)	1-13
19	CWS attention light (2)	1-2
20	Accelerometer	1-11
21	Airbrake indicator	1-6
22	Tailplane position indicator	1-6
23	Turn-and-slip indicator	1-11
24	Combined speed indicator (CSI)	1-11
25	Directional gyro indicator (DGI)	1-11
26	ISIS sight head	1-14
27	Attitude indicator	1-11
28	Horizontal situation indicator (HSI)	1-11
29	ISIS control unit	1-14
30	Rudder pedals adjustment control	1-6
31	Wheelbrakes toe pad - also on left side	1-7
32	Navigation mode selected indicator	1-13
33	ILS marker indicator light	1-13

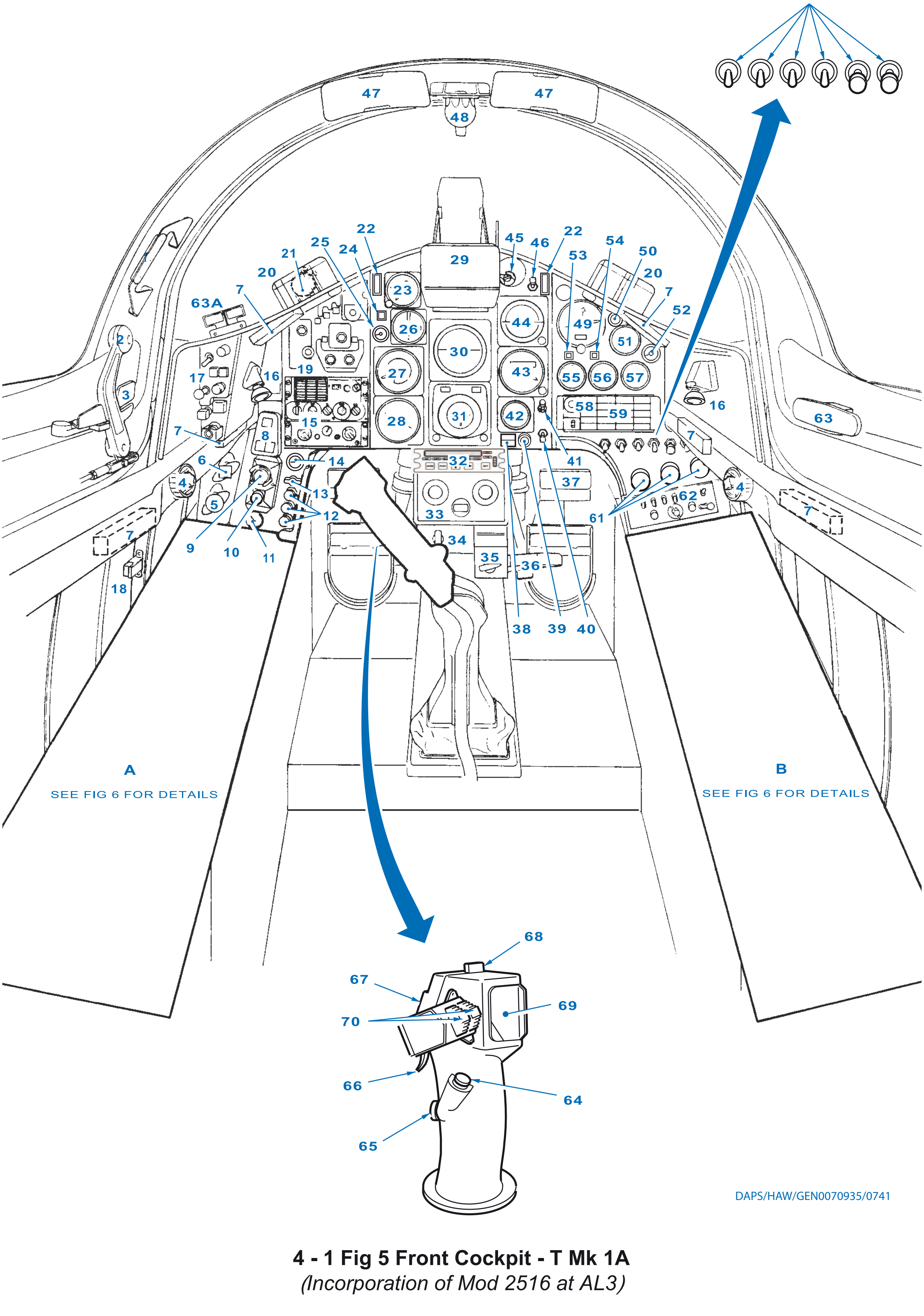
No	*Item*	*Ref*
34	AHRS fast erect switch	1-11
35	Altimeter ground test switch	1-11
36	Vertical speed indicator (VSI)	1-11
37	Main altimeter	1-11
38	Standby attitude indicator	1-11
39	Flight instruments power switch	1-11
40	Rear view mirror (2)	1-12
41	Standby magnetic compass	1-11
42	Standby altimeter	1-11
43	Oxygen flow indicator	1-10
44	Cabin altimeter	1-8
45	Oxygen main supply contents gauge	1-10
46	Engine LP shaft rotation indicator	1-4
47	Air producer start indicator	1-4
48	RPM indicator	1-4
49	TGT indicator	1-4
50	Fuel contents gauge	1-3
51	Fire extinguisher button	1-2
52	Central warning panel (CW)	1-2
53	Lighting switches - left to right:	
	Internal main lights master switch	1-12
	Internal emergency lights switch	1-12
	Standby compass light switch	1-12
54	Internal lighting rotary dimmer (3)	1-12
55	CCS station box	1-13
56	MDC firing handle	1-12
57	Tailplane trim switches	1-6
58	Receiver mute switch	1-6
59	Camera button	1-13
60	Gun firing trigger	1-14
61	Gun safety catch	1-14
62	Gun safety catch indicator (Set to live)	1-14
63	Bomb/RP release button safety flap	1-14
	Detail A- See Fig 4	
	Detail B- See Fig 4	



4 - 1 Fig 4 Rear Cockpit Consoles - T Mk 1

Table 4 - Key to 4 - 1 Fig 4 Rear Cockpit Consoles - T Mk 1

No	*Item*	*Ref*
	Detail A	
1	Left brake pressure gauge	1-7
2	Right brake pressure gauge	1-7
3	Brakes supply pressure gauge	1-7
4	No 1 hydraulic system pressure gauge	1-5
5	No 2 hydraulic system pressure gauge	1-5
6	No 2 hydraulic pump/ram air turbine(RAT) reset button	1-5
7	Throttle idle stop lever	1-4
8	Start/relight button	1-4
9	Throttle twist grip	1-4
10	Transmit switch	1-13
11	Airbrake switch	1-6
11A	Standby UHF Switch	1-13
12	Alternative receiver mute switch	1-13
13	Alternative transmit switch	1-13
14	Anti-skid switch	1-7
15	Cover for tailplane trim standby switches	1-6
16	Aileron trim indicator	1-6
17	Aileron trim switches	1-6
18	Rudder trim indicator	1-6
19	Rudder trim switch	1-6
20	Engine start master switch	1-4
21	Anti-g system test button	1-8
22	Anti-g system control lever	1-8
	Detail B	
1	UHF aerial selector switch	1-13
2	Compass synchronization indicator repeater	1-11
3	Oxygen main supply selector	1-10
4	Seat pan height adjustment switch	1-9
5	Map stowage	1-12

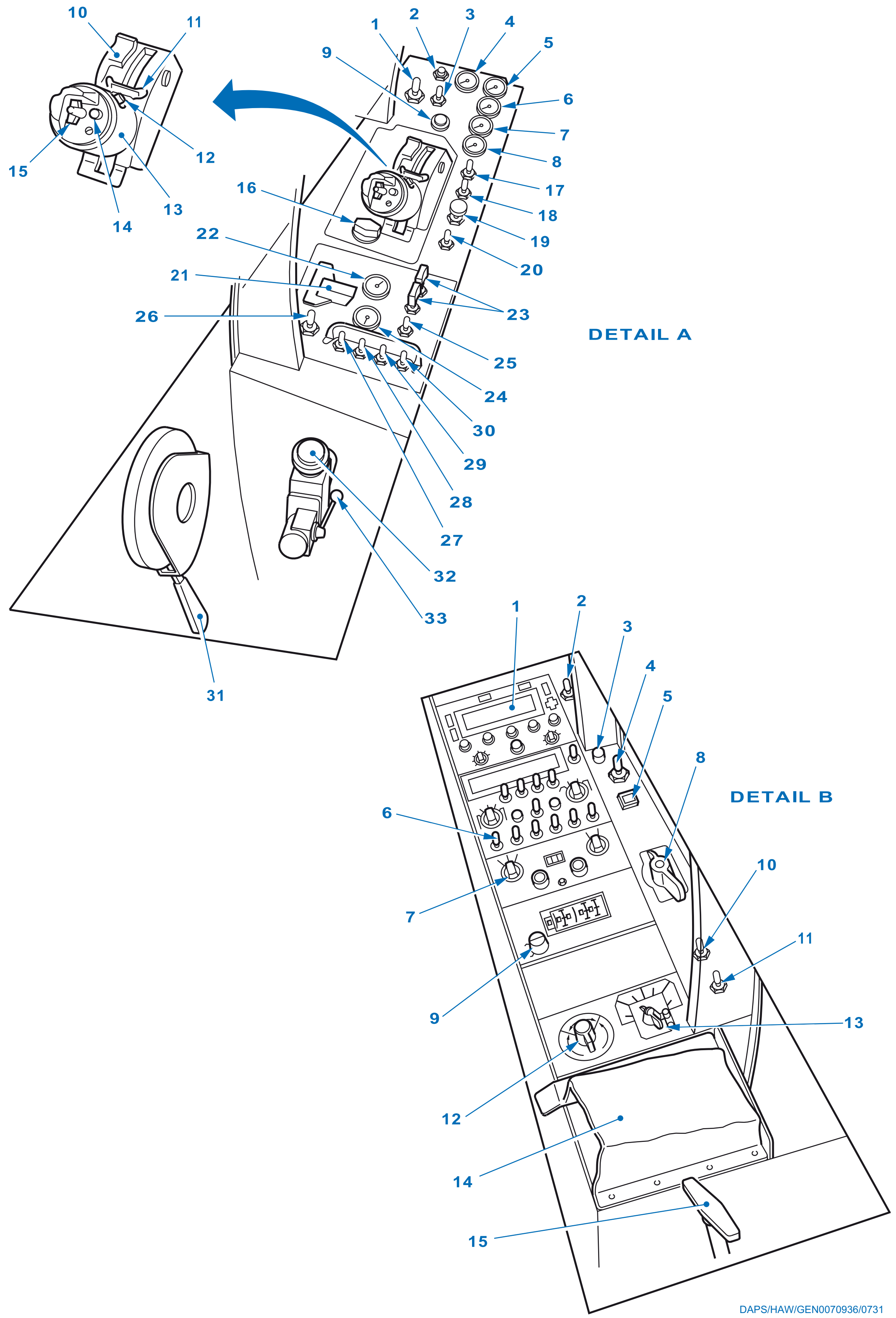


4 - 1 Fig 5 Front Cockpit - T Mk 1A

(Incorporation of Mod 2516 at AL3)

Table 5 - Key to 4 - 1 Fig 5 Front Cockpit T Mk 1A

No	*Item*	*Ref*
1	Grab handle	1 - 12
2	Canopy operating lever	1 - 12
3	Canopy operating lever safety catch	1 - 12
4	Body spray adjustable louvre (2)	1 - 8
5	Landing gear standby lowering system selector	1 - 7
6	Flap standby lowering system selector	1 -6
7	Strip light (6)	1-12
8	Landing gear unit position indicator	1-7
9	Landing gear retraction selector button and ground emergency retraction facility	1-7
10	Landing gear lowering selector button	1-7
11	DC voltmeter	1-1
12	Reset buttons - bottom to top:	
	Generator reset	1-1
	No 2 inverter reset	1-1
	No 1 inverter reset	1-1
13	Flap position selector	1-6
14	Flap position indicator	1-6
15	UHF transceiver control panel	1-13
16	Map reading light (2)	1-12
17	Missile control panel	1-14
18	Banner target release switches	1-14
19	Weapon control panel	1-14
20	Frequency card holder (2)	1-13
21	Stopwatch holder	1-12
22	CWS attention light (2)	1-2
23	Accelerometer	1-11
24	Airbrake indicator	1-6
25	Tailplane position indicator	1-6
26	Turn-and-slip indicator	1-11
27	Combined speed indicator (CSI)	1-11
28	Directional gyro indicator (DGI)	1-11
29	ISIS sight head	1-14
30	Attitude indicator	1-11
31	Horizontal situation indicator (HSI)	1-11
32	AHRS digital control panel	1-11
33	ISIS control unit	1-14
34	Rudder pedals adjustment control	1-6
35	Bomb release intervalometer	1-14
36	Rudder bar locking handle	1-6
37	Wheelbrakes toe pad - also on left side	1-7
38	Navigation mode selector	1-13
39	ILS marker indicator light	1-13
40	Landing/taxy lamp switch	1-11
41	Communications power switch	1-13
42	Vertical speed indicator (VSI)	1-11
43	Main altimeter	1-11
44	Standby attitude indicator	1-11
45	Master armament safety switch (MASS)	1-14
46	Flight instruments power switch	1-11
47	Rear view mirror (2)	1-11
48	Standby magnetic compass	1-11
49	Standby altimeter	1-11
50	Oxygen flow indicator	1-10
51	Cabin altimeter	1-8
52	Oxygen main supply contents gauge	1-10
53	Engine LP shaft rotation indicator	1-4
54	Air producer start indicator	1-4
55	RPM indicator	1-4
56	TGT indicator	1-4
57	Fuel contents gauge	1-3
58	Fire extinguisher button	1-2
59	Central warning panel	1-2
60	Lighting switches left to right:	
	Navigation light switch	1-12
	Lower anti-collision light switch	1-12
	Upper anti-collision light switch	1-12
	Internal main lights master switch	1-12
	Internal emergency lights switch	1-12
	Standby compass light switch	1-12
61	Internal lighting rotary dimmer (3)	1-12
62	CCS station box	1-13
63	MDC firing handle	1-12
63A	Canopy/seat pin stowage	1-9
64	Camera button	1-14
65	Receiver mute button	1-13
66	Gun firing trigger	1-14
67	Gun safety catch	1-14
68	Gun safety catch indicator (Set to live)	1-14
69	Bomb/RP release button safety flap	1-14
70	Tailplane trim switches	1-6
	Detail A - See Fig 6	
	Detail B - See Fig 6	

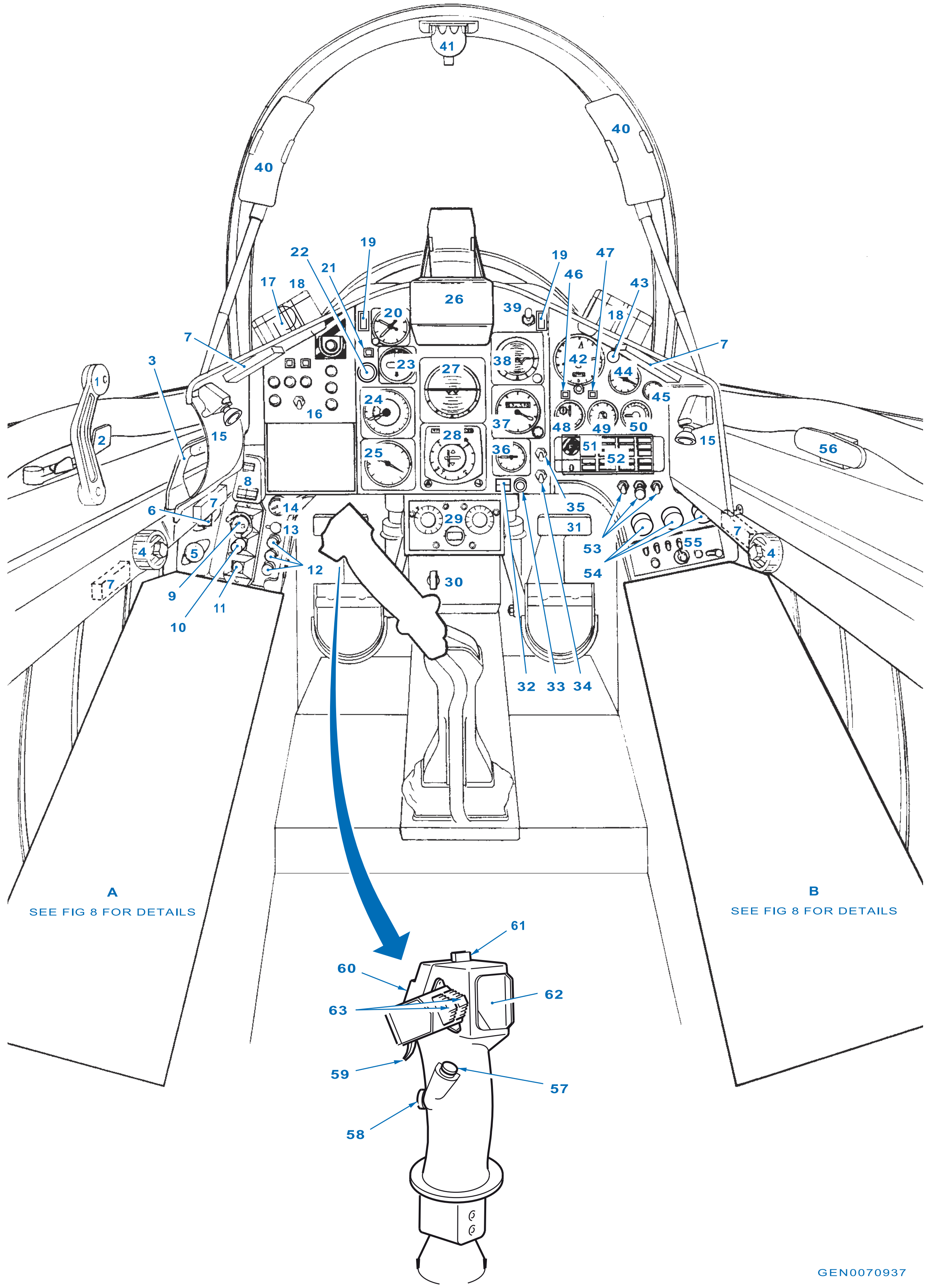


4 - 1 Fig 6 Front Cockpit Consoles - T Mk 1A

Table 6 - Key to 4 - 1 Fig 6 Front Cockpit Consoles - T Mk 1A

No	*Item*	*Ref*
	Detail A	
1	Engine ignition switch	1-4
2	No 3 inverter reset switch	1-1
3	Altimeter ground test switch	1-11
4	Left brake pressure gauge	1-7
5	Right brake pressure gauge	1-7
6	Brakes supply pressure gauge	1-7
7	No 1 hydraulic system pressure gauge	1-5
8	No 2 hydraulic system pressure gauge	1-5
9	No 2 hydraulic pump/ram air turbine (RAT) reset button	1-5
10	Full throttle stop	1-4
11	Throttle idle stop lever	1-4
12	Start/relight button	1-4
13	Throttle twist grip	1-4
14	Transmit switch	1-13
15	Airbrake switch	1-6
16	Throttle damper friction control	1-4
17	Standby UHF switch	1-13
18	Alternative receiver mute switch	1-13
19	Alternative transmit switch	1-13
20	Anti-skid switch	1-7
21	Cover for tailplane trim standby switches	1-6
22	Aileron trim indicator	1-6
23	Aileron trim switches	1-6
24	Rudder trim indicator	1-6
25	Rudder trim switch	1-6
26	Engine start master switch	1-4
27	No 1 battery switch	1-1
28	No 2 battery switch	1-1
29	Fuel booster pump switch	1-3
30	Pitot-static tube heater switch	1-11
31	LP fuel cock control lever	1-3
32	Anti-g system test button	1-8
33	Anti-g system control lever	1-8

No	*Item*	*Ref*
	Detail B	
1	VHF transceiver control panel	1-13
2	UHF aerial selector switch	1-13
3	Telebrief light	1-13
4	External intercom switch	1-13
5	Accident data recorder (ADR)status indicator	1-12
6	SIFF TCDU	1-13
7	Tacan control unit	1-13
8	Oxygen main supply selector	1-10
	Detail B	
9	ILS control unit	1-13
10	Seat pan height adjustment switch	1-9
11	Airbrake test switch	1-6
12	Temperature control switch	1-8
13	Cabin conditioning control switch	1-8
14	Map stowage	1-12
15	Parking brake T-handle	1-7

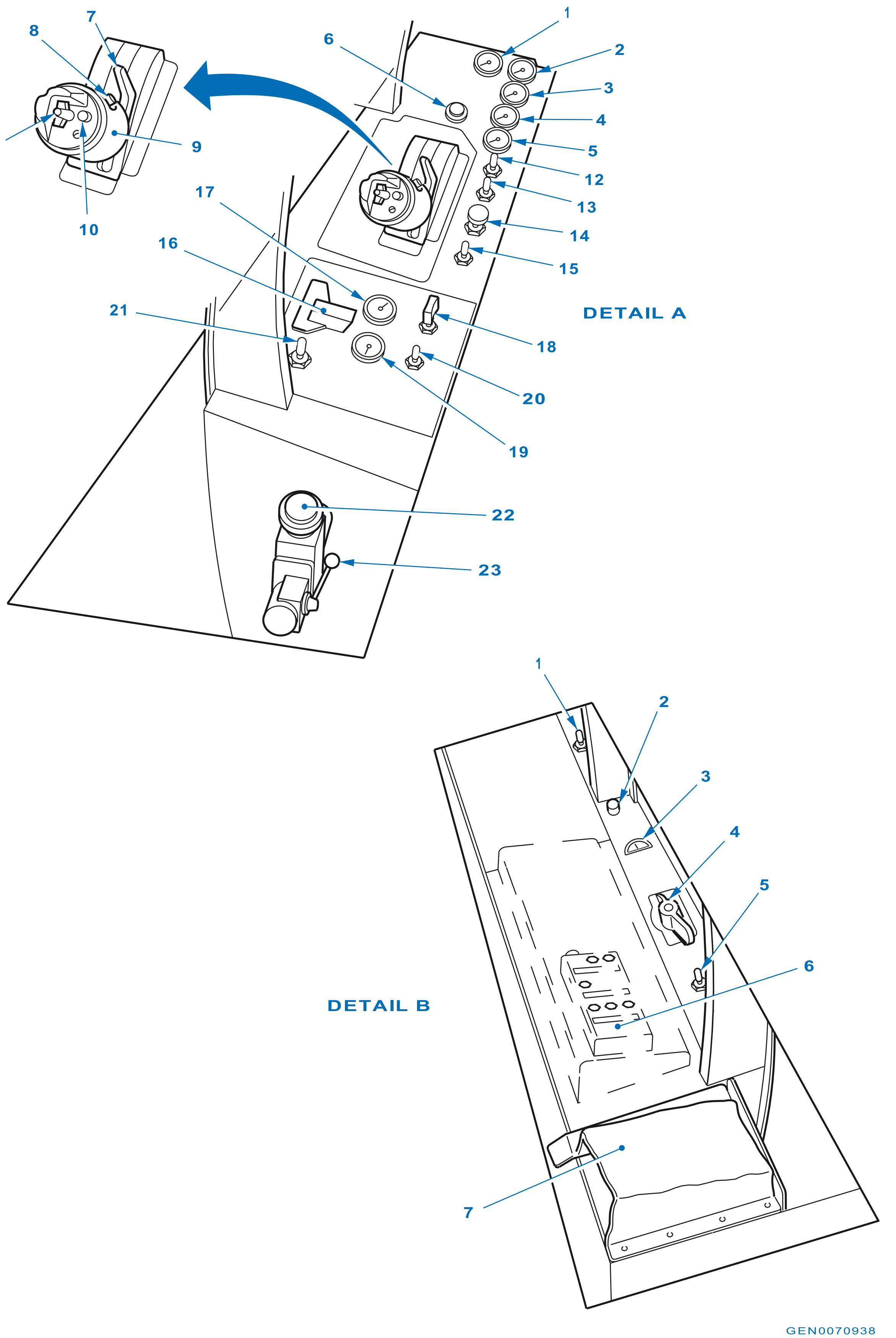


4 - 1 Fig 7 Rear Cockpit - T Mk 1A

Table 7 - Key to 4 - 1 Fig 7 Rear Cockpit - T Mk 1A

No	*Item*	*Ref*
1	Canopy operating lever	1-12
2	Canopy operating lever safety catch	1-12
3	Grab handle	1-12
4	Body spray adjustment louvre (2)	1-8
5	Landing gear standby lowering system selector	1-7
6	Flap standby lowering system selector	1-6
7	Strip light (5)	1-12
8	Landing gear unit position indicator	1-7
9	Landing gear retraction selection button and ground emergency retraction facility	1-7
10	Landing gear lowering selector button	1-7
11	Landing gear selection control transfer button	1-7
12	Reset buttons - from bottom to top:	
	Generator reset	1-1
	No 2 inverter reset	1-1
	No 1 inverter reset	1-1
13	Flap position selector	1-6
14	Flap position indicator	1-6
15	Map reading light	1-12
16	Weapon monitor panel	1-14
17	Stopwatch holder	1-12
18	Frequency card holder (2)	1-13
19	CWS attention light (2)	1-2
20	Accelerometer	1-11
21	Airbrake indicator	1-6
22	Tailplane position indicator	1-6
23	Turn-and-slip indicator	1-11
24	Combined speed indicator (CSI)	1-11
25	Directional gyro indicator (DGI)	1-11
26	ISIS sight head	1-14
27	Attitude indicator	1-11
28	Horizontal situation indicator (HSI)	1-11
29	ISIS control unit	1-14
30	Rudder pedals adjustment control	1-6
31	Wheelbrakes toe pad - also on left side	1-7
32	Navigation mode selected indicator	1-13
33	ILS marker indicator light	1-13

No	*Item*	*Ref*
34	AHRS fast erect switch	1-11
35	Altimeter ground test switch	1-11
36	Vertical speed indicator (VSI)	1-11
37	Main altimeter	1-11
38	Standby attitude indicator	1-11
39	Flight instruments power switch	1-11
40	Rear view mirror (2)	1-12
41	Standby magnetic compass	1-11
42	Standby altimeter	1-11
43	Oxygen flow indicator	1-10
44	Cabin altimeter	1-8
45	Oxygen main supply contents gauge	1-10
46	Engine LP shaft rotation indicator	1-4
47	Air producer start indicator	1-4
48	RPM indicator	1-4
49	TGT indicator	1-4
50	Fuel contents gauge	1-3
51	Fire extinguisher button	1-2
52	Central warning panel (CW)	1-2
53	Lighting switches - left to right:	
	Internal main lights master switch	1-12
	Internal emergency lights switch	1-12
	Standby compass light switch	1-12
54	Internal lighting rotary dimmer (3)	1-12
55	CCS station box	1-13
56	MDC firing handle	1-12
57	Camera button	1-13
58	Receiver mute switch	1-6
59	Gun firing trigger	1-14
60	Gun safety catch	1-14
61	Gun safety catch indicator (Set to live)	1-14
62	Bomb/RP release button safety flap	1-14
63	Tailplane trim switches	1-6
	Detail A - See Fig 8	
	Detail B - See Fig 8	



4 - 1 Fig 8 Rear Cockpit Consoles - T Mk 1A

Table 8 - Key to 4 - 1 Fig 8 Rear Cockpit Consoles - T Mk 1A

No	*Item*	*Ref*
	Detail A	
1	Left brake pressure gauge	1-7
2	Right brake pressure gauge	1-7
3	Brakes supply pressure gauge	1-7
4	No 1 hydraulic system pressure gauge	1-5
5	No 2 hydraulic system pressure gauge	1-5
6	No 2 hydraulic pump/ram air turbine (RAT) reset button	1-5
7	Throttle idle stop lever	1-4
8	Start/relight button	1-4
9	Throttle twist grip	1-14
10	Transmit switch	1-13
11	Airbrake switch	1-6
12	Standby UHF Switch	1-13
13	Alternative receiver mute switch	1-13
14	Alternative transmit switch	1-13
15	Anti-skid switch	1-7
16	Cover for tailplane trim standby switches	1-6
17	Aileron trim indicator	1-6
18	Aileron trim switches	1-6
19	Rudder trim indicator	1-6
20	Rudder trim switch	1-6
21	Engine start master switch	1-4
22	Anti-g system test button	1-8
23	Anti-g system control lever	1-8
	Detail B	
1	UHF aerial selector switch	1-13
2	Telebrief light	1-13
3	Compass synchronization indicator repeater	1-11
4	Oxygen main supply selector	1-10
5	Seat pan height adjustment switch	1-9
6	Sidewinder junction box	1-14
7	Map stowage	1-12

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SUPPLEMENT No. 1

DISPLAY AIRCRAFT

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SUPPLEMENT No. 1 Display Aircraft

Contents

General

1. Hawk aircraft used for display purposes are basically equipped for the flying training role but have provision for the emission of blue, white and red smoke. A modified Adour engine, Mk 15102, is installed which gives reduced acceleration and reslam times; the engine also has a modified fuel/oil heat exchanger.

SMOKE

Smoke Generation System

2. The smoke generation system generates and emits three separate coloured (red, white and blue) vapours by injecting liquid fuel (DERV with blue dye, DERV and DERV with red dye) into the jet pipe efflux under air pressure via three motorized on/off valves.

3. The fuel is contained in a non-jettisonable 3-tank pod which is fitted to the underside of the wing on the fuselage centre line. The tanks are pressurized from the aircraft fuel system HP air supply line via a pressure reducing valve (PRV) and three NRV. An inward relief valve provides protection if the PRV fails in the closed position. Three outward relief valves connected one to each pod fuel tank prevent overpressurization of the tanks if the PRV fails in the open position; fuel is vented to atmosphere through a vent on the left centre of the pod.

4. The blue and red fuel tanks each have a float-operated fuel/no-air stop valve which permits fuel flow when smoke is selected and prevents the flow of air into the delivery pipes when the fuel level falls below the level of the valve. The white fuel tank has four fuel/no-air stop valves which operate as those in the blue and red tanks but are positioned to allow for white smoke emissions during inverted flight.

5. The maximum duration of white smoke emission is approximately five minutes whilst that of each of the blue and red smoke emissions is approximately one minute.

6. The system is powered from the Essential Services busbar and controlled by a 2-position SMOKE CONTROL - ON/OFF switch on the left panel in the front cockpit; the switch is gated at the ON position. Individual smoke generation is controlled from the front cockpit control column handle receiver mute switch (blue smoke), the camera button (white smoke) and the bomb/RP button (red smoke). Each individual smoke control switch must be operated once to start smoke emission and once to stop smoke emission. The SMOKE CONTROL switch must be ON to allow a smoke control valve to be opened but a valve can be closed with the SMOKE CONTROL switch either ON or OFF. Once open a valve remains open, irrespective of the SMOKE CONTROL switch selection, until selected closed by its individual switch. The receiver mute switch does not mute the receiver audio signal when operated; receiver audio signals can be muted by the MUTE/ NORMAL switch on the left console.

7. Two panels on the left and right glareshields respectively each have three lights (from outboard to inboard - blue, white and red) which come on to show that the smoke valve is open and the colour of the smoke which is selected. When the SMOKE CONTROL switch is set to OFF with the Essential Services busbar live, operation of any of the individual smoke control switches causes the associated lights to come on thus permitting a check of filament serviceability.

Smoke - Normal Use

8. **Pre-Flight.** When carrying out the external inspection of the aircraft check the smoke fuel tank pod, panels and the smoke injector pipes for security and condition. During the Internal Checks, with the Essential Services busbar live and the SMOKE CONTROL switch OFF, test the blue, white and red smoke lights for serviceability using the receiver mute switch, the camera button and the bomb/RP button respectively. Confirm all lights are out (ie, all smoke valves are closed) before engine start; if any lights remain on, extinguish them by pressing the appropriate smoke button.

9. **Pre-Display** . Before a display set the SMOKE CONTROL switch to ON. To ensure instant smoke emission in response to a selection prime the system by giving a short burst of each colour during the pre-display period.

10. **Post-Display.** After a display, to prevent inadvertent smoke emission, confirm all smoke lights are out and set the SMOKE CONTROL switch to OFF.

WARNING: Flight in the smoke trail of a leading aircraft results in complete loss of outside visibility which remains degraded, due to smoke oil on the canopy, for several minutes after the aircraft has been flown clear of the smoke.

ENGINE

General

11. The engine is modified to Adour Mod A0629 standard. The modification includes the introduction of a hydro-mechanical acceleration switch into the fuel control unit; the switch reduces acceleration and reslam times. The switch modulates the action of the throttle valve dashpot by permitting an increased rate of throttle valve movement at a scheduled value of HP RPM during engine acceleration. The HP RPM are scheduled to increase with altitude, thus engine acceleration time increases with altitude.

12. The fuel-cooled oil cooler downstream of the HP fuel shut-off valve is removed. A two-pass fuel-cooled oil cooler is introduced between the LP pump and LP fuel filter. This change maintains adequate oil cooling and eliminates the possibility of icing in the fuel at the LP fuel filter.

COMMUNICATIONS

Station Boxes

13. The front cockpit station box VHF/UHF function selector is inoperative. The rear cockpit station box operation is unaltered.

UHF Communications

14. **Transceiver Control Panel.** The control panel of the UHF transceiver (pre-Mod 1015) (Fig 1) has the controls and indicators shown in Table 1.

Table 1 - Main UHF Transceiver Controls (Pre-Mod 1015)

Controls/Marking	*Function*
4 position rotary function switch:- OFF MAIN BOTH ADF	 - Power off - Transmitter and main receiver operational - Transmitter and both main and guard receivers operational - Inoperative in this installation
3 position rotary mode switch:- MANUAL PRESET GUARD	 - Gives tuning authority to manual frequency selectors - Gives tuning authority to preset channel selector - Selects transmitter and main receiver to guard frequency. Guard receiver disabled
20 position rotary preset channel selector and channel (CHAN) indicator	Selects any one of 20 preset communication channels. The channel number is shown in a window to the left of the selector. Preset channel frequencies are listed on a table at the top left-hand corner of the control panel
5 rotary frequency selector knobs and digital indicators	From left to right the knobs are used to manually change frequency in steps of 100, 10, 1, 0·1 and 0·025 MHz. The associated selected frequency step is shown on a digital indicator above each knob
Rotary VOL control	Controls the audio output level of the receivers
SQUELCH switch - OFF/ON	Enables and disables the squelch circuit of the main receiver
TONE button switch	Enables transmission of 1020 Hz tone on the selected frequency

Transmit Switches

15. In the front cockpit a PTT NORM/ALT selector switch is on the smoke control panel, a VHF press-to-transmit switch is at the base of the throttle and an alternative press-to-transmit switch labelled VHF ALT PTT is on the smoke control panel.

16. **Normal Operation.** For normal operation set the CCS station box PTT switch to NORM and the smoke control panel PTT switch to NORM. To transmit on UHF use the press-to-transmit switch on the top of the throttle. To transmit on VHF use the press-to-transmit switch at the base of the throttle.

17. **Alternative Transmit Facility Operation. If either** UHF or VHF normal press-to-transmit switches fail set the CCS station box PTT switch to ALT and the smoke control panel PTT switch to ALT. To transmit on UHF use the ALT PTT switch on the left console. To transmit on VHF use the VHF ALT PTT switch on the smoke control panel.

NAVIGATION EQUIPMENT

VOR

18. A VOR facility is provided as follows:

a. The ILS control unit (mode selector set to VOR and frequency selectors set to a VOR beacon frequency) controls a VOR receiver in the lower fuselage behind the rear seat.

b. The ILS localiser aerial in the left wingtip functions as a combined ILS localiser/VOR aerial.

c. The lower caption of the navigation mode selector in the front cockpit is marked VOR ILS and is illuminated to show that the ILS/VOR facility has been selected. The lower caption of the rear cockpit navigation mode indicator is marked ILS and is illuminated to show that the ILS/VOR facility has been selected in the front cockpit.

d. A 2-position VOR AUDIO switch aft of the Tacan control unit on the front cockpit right console is used to select the audio output of the VOR receiver.

19. The ILS control unit can select 200 VOR frequencies in the range 108·00 to 117·95 MHz.

20. With VOR ILS caption illuminated, VOR selected at the ILS control unit and a VOR beacon frequency selected, the bearing of the beacon is shown on the HSI bearing pointer in both cockpits; the HSI NAV flag is displayed if the VOR information is invalid. With a VOR radial set at the HSI track index and the bearing pointer locked to the VOR beacon, the HSI `to/from' flags operate as when in the Tacan mode. Tacan range is displayed on the HSI in the VOR mode provided the Tacan information is valid.

21. The VOR AUDIO switch is used in the same way as the CCS station box receiver audio switches; VOR audio is heard in both cockpits when selected.

22. When operating in the ILS/VOR mode, pressing the navigation mode selector extinguishes the VOR ILS caption and illuminates the TACAN caption. Tacan bearing is then shown on the HSI bearing pointer in place of VOR bearing, provided Tacan information is valid. The ILS/VOR facility is reselected when the mode selector is pressed again.

23. The VOR receiver is powered from the Essential Services busbar and No 2, 26-volt AC supplies JB. The VOR receiver imposes a maximum load of 1·0 ampere on the Essential Services busbar.

ESCAPE SYSTEMS

Safety Pins

24. A 2-place stowage for the seat firing handle safety pin and the MDC firing handle safety pin is in each cockpit. In the front cockpit, the stowage is on the left side canopy frame (pre-Mod 1046). In the rear cockpit, the stowage is on the left side canopy frame (pre-Mod 1195). An 8-place central stowage for the other pins from each cockpit is at the rear of the front cockpit on the upper left side. Stowages for the safety pins are shown at Fig 2

MANOEUVRES

Rapid Rolling

25. Rapid rolls executed at any speed within the limits given in the Hawk TMk1 & TMk1A MOD AFD Release to Service, under nominal 1 g conditions are unlikely to cause high fin load.

26. Avoid rapid rolls under any entry conditions which regularly give rise to high sideforce and/or significant rudder trail; such symptoms are most likely to occur when entry is made below 350 knots and above 3 g.

LIMITATIONS

Centre of Gravity

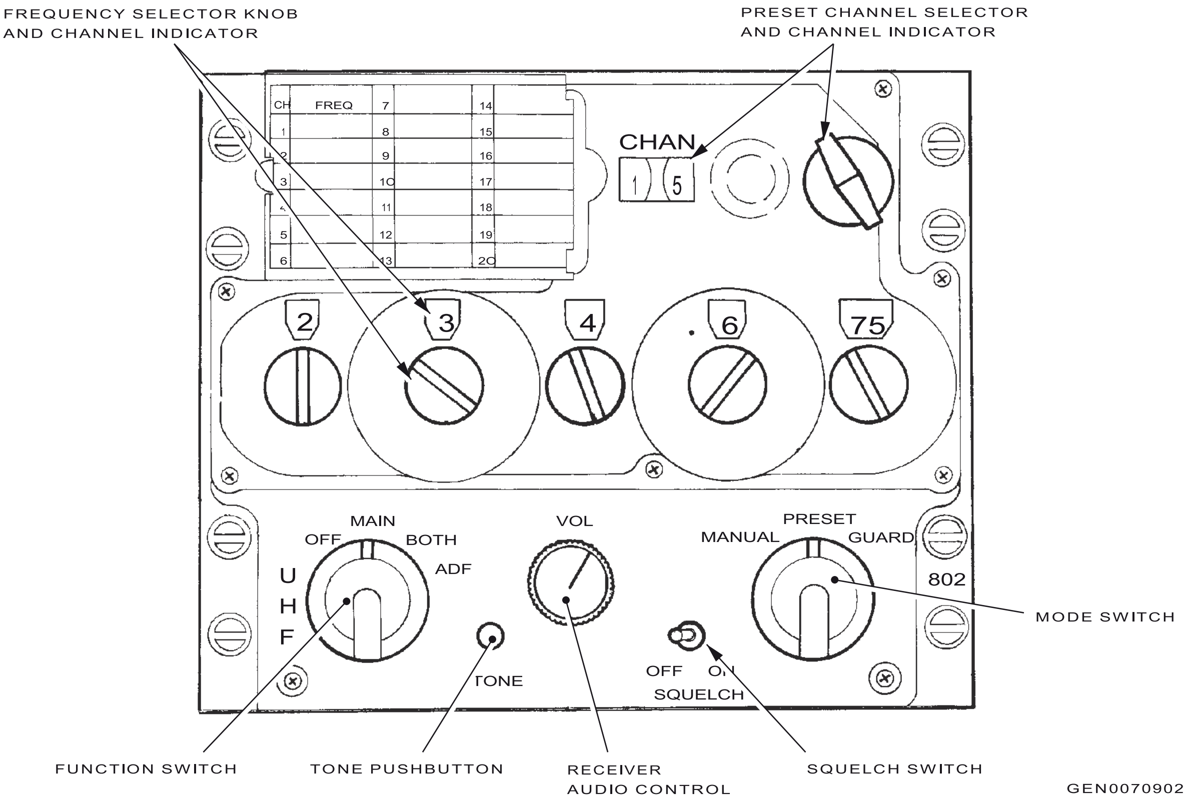
27. When carrying the smoke pod there are no changes to centre of gravity (CG) limits given in the Hawk TMk1 & TMk1A MOD AFD Release to Service, except that the condition for the CG to remain within these limits is that the CG of the aircraft at its basic mass falls within the range 6551 mm to 6574 mm aft of datum with the landing gear down. For this purpose the basic mass includes the empty smoke pod fitted to the aircraft.

ANA 9

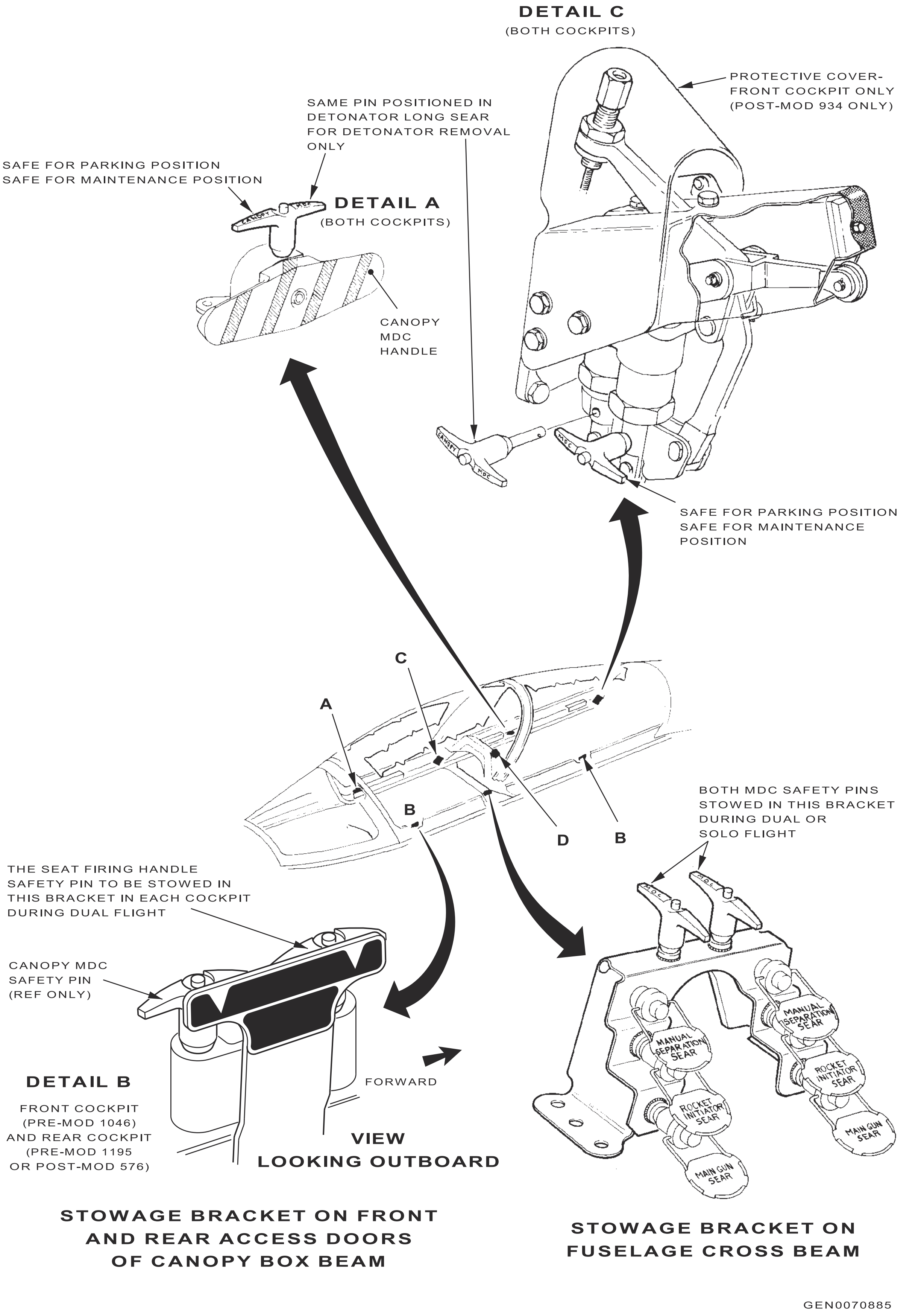
does not include

Spinning

28. Deliberate spinning is prohibited when the smoke pod is fitted. (Limited testing indicates that the spin and recovery are not affected by the smoke pod).



Supplement 1 Fig 1 Main UHF Transceiver (Pre-Mod 1015)



Supplement 1 Fig 2 Ejection Seat and MDC Safety Pin Stowages

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SUPPLEMENT No. 2

FLIGHT TEST SCHEDULE

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SUPPLEMENT No. 2 Flight Test Schedule

Contents

General

1. The Hawk Flight Test Schedule (FTS), AP101B-4400-5M, is designed to ensure that, as far as is practical, all aircraft perform, behave, and feel the same to the pilot. The reasons for the checks and the requirements for satisfactory compliance with the FTS should be understood by all pilots air testing the aircraft. This description of the tests aims to provide guidance on the items to be tested.

DESCRIPTION OF TESTS

Item 1a - Pre-Start - UHF Batt Switch

2. **Purpose of Test.** To ensure that the front cockpit and the rear cockpit have communications with the UHF Batt Switch set to Batt.

3. **Technique.** Set the UHF Batt Switch to Batt, ensure that there is communication between the two cockpits and reset the UHF Batt Switch to Normal.

Item 1b - Pre-Start - Relight

4. **Purpose of Test.** To ensure correct operation of the ignition system from both cockpits

5. **Technique.** Move throttle well `forward' of Idle, press and hold relight button. Move throttle towards Idle, ensure rotation MI green within 10mm of Idle. Audibly check that both igniters fire. Repeat from the rear cockpit.

6. **Comments.** Correct operation is indicated by sparking from both ignition units. Confirm correct operation with ground crew.

Item 1c - Pre-Start - HP Cock

7. **Purpose of Test.** To ensure that `HP Off' can be achieved from the rear cockpit.

8. **Technique.** Move the throttle forward of the idle stop. Lift the spring-loaded idle stop lever and move the throttle to HP OFF.

Item 2a - After Start - RAT

9. **Purpose of Test.** To check for correct operation of the hydraulic systems, particularly the RAT, which must be serviceable before flight.

10. **Technique.** After engine start, confirm that the CWP HYD 2 caption is on and the HYD 2 pressure is near to zero. If full HYD 2 pressure is present before the HYD 2 reset button is pressed, the automatic pump off-load facility may be inoperative.

a. To reset the HYD 2, press the reset button and confirm that the CWP HYD 2 caption goes out as the HYD 2 pressure increases through approx 110 bar.

b. Deploy the RAT by making vigorous control movements. RAT deployments can be identified as a flick on the HYD 2 pressure gauge at about 110 bar rather than the appearance of the HYD 2 warning. Continue to reduce HYD 2 pressure to about 80 bar.

c. Confirm correct RAT deployment with the ground crew. Reset the RAT with the HYD 2 reset button and confirm that the RAT has stowed correctly and hydraulic pump pressure is restored.

11. **Comments.** If the HYD 2 pressure is reduced very quickly by rapid control column movement, the RAT may not fully deploy. In this case reset the RAT and try again, with less control column activity.

a. With the RAT deployed and the engine at idle RPM, the HYD 2 pressure will normally stabilise at less than 100 bar.

Item 2b - After Start - Airbrake

12. **Purpose of Test.** To ensure correct selection/operation of airbrake from both cockpits.

13. **Technique.** Hold the Airbrake Test Switch in the forward position and select the airbrake OUT and IN from both cockpits. Ensure that front cockpit selections can be overridden by rear cockpit selections.

14. **Comments.** Physical check of position can be carried out by ground crew.

Item 2c - After Start - Flaps

15. **Purpose of Test.** To ensure correct selection/operation of flaps from both cockpits.

16. **Technique.** From the front cockpit, select the flaps to MID, UP, MID and DOWN positions. From the rear cockpit select the flaps from the PUPIL position to the UP and DOWN positions and then back to the PUPIL position.

17. Ensure that the front cockpit selection can be overridden by the rear selection by selecting the flaps UP from the front cockpit and then to the DOWN position from the rear cockpit. Attempt to select the flaps to the MID position using the front cockpit selector. Reset the logic by selecting the front selector to match the rear selector position and then selecting the rear selector to PUPIL.

18. **Comments.** Physical check of the flap position can be carried out by ground crew.

Item 3a - Runway - HSI

19. **Purpose of Test.** To check the indicated HSI heading against the known runway heading and to set the HSI for a check of DG drift over the period of the flight.

20. **Technique.** The HSI heading should be checked in `slaved' mode against the known runway QDM. Ensure the AHRS is correctly synchronised before carrying out this check.

Items 3d to f - Runway, Slam to MAX RPM

21. **Purpose of Test.** To ensure the engine has normal acceleration and performance.

22. **Technique.** Allow engine to stabilise at idle conditions.

a. Advance the throttle to the MAX position. Throttle is to be smoothly advanced from Idle to Max over 1 second.

b. Check the engine is stall and surge free.

c. Ensure TGT is 660± 5°C and no more than 104% RPM is achieved. Allow the engine to trim back (no more than 3.3%), record that figure and then set the throttle to Idle. The trimmed figure is the max RPM.

d. Slam the throttle from Idle to Max.

e. Record time from idle to max RPM less 4% , maximum time for the acceleration - 8 seconds .

f. Ensure that the engine trims back no more than 3.3% below placard RPM.

Item 3g - Runway - Brakes

23. **Purpose of Test.** To ensure that brakes hold at max RPM

24. **Technique.** Apply full brake pressure. Ensure aircraft remains stationary when throttle set to Max.

25. **Comments.** On the first take-off following a brake pack change, the brakes may not hold at max RPM. Bedding in of the brakes is normally required.

Item 4 - Climb - Cabin Conditioning

26. **Purpose of Test.** To check correct selection/operation of the cabin conditioning system.

27. **Technique.** Once established in the climb, set CABIN TEMP switch to AUTO COOL. Allow system to run fully cold. Repeat for auto hot, manual cool and manual hot. It is recommended that 100% oxygen is selected prior to selecting cabin to full hot.

a. Select the cabin control switch to DEMIST and ensure that the flow from the canopy sprays is increased and the flow from the ventilation sprays is decreased.

b. Select the cabin control switch to FLOOD and ensure that the flow from the canopy and ventilation sprays is increased and the cabin temperature increases.

c. Reset the cabin conditioning to the desired setting

Item 4a - Climb, FL 50 to FL 440

28. **Purpose of Test.** To record the overall engine/aircraft performance.

29. **Technique.** Record the parameters on the table during the climb.

Item 5a - Avionics - IFF/SSR

30. **Purpose of Test.** To check the correct operation of the IFF/SSR in all modes against a suitably equipped ground RADAR installation.

31. **Technique.** Establish via R/T that when the following modes are selected the information displayed on the ground RADAR display is as follows:

a. Mode 1&3A/B codes as selected on IFF/SSR control unit.

b. Mode C height as displayed on the Main Altimeter.

c. Confirm that when SPI (Ident) is selected, the displayed coding is highlighted.

Item 5b - Avionics - TACAN

32. **Purpose of Test.** To check the correct operation of the TACAN System and navigational instumentation.

33. **Technique.** Set TACAN control unit to the TX/RX position and select the channel of the ground beacon to be used for navigational purposes. In the front cockpit select TACAN on the Nav Mode Switch. In the front and rear cockpits select TACAN on the CCS station boxes.

a. Ensure TACAN ground beacon audio ident is heard in both headsets.

b. When the TACAN is tuned and identified and front and rear HSIs are indicating TACAN steering information, set course heading and steer towards the ground beacon. Ensure the TO/FROM windows on the HSIs indicate TO, distance counters decrease and the deviation bar moves smoothly across the display to the central position as correct heading is achieved. Turn the aircraft to port and starboard ensuring the deviation bar indicates in the correct sense with regards to the turn initiated. Fly the aircraft away from the ground beacon and ensure that the TO/FROM windows indicate FROM.

Item 6 - Handling at Altitude (FL 440)

34. **Purpose of Test.** To demonstrate that the aircraft flight characteristics in transonic flight are satisfactory and typical for the Mark.

35. **Technique.** Trim the aircraft in level flight at nominal 0·75M and FL 440 prior to dive entry. Do not retrim during dive. Approximately 40° nose down is required to achieve 0.98M. On reaching 0.98M leave full power selected and recover using 2.5g.

a. Aim to establish aircraft in dive before nominal 0·80M is attained.

b. Aircraft flying qualities should fall within the descriptive guidelines given in Part 2, Chapter 2, para 28 to Part 2, Chapter 2, para 32 of this manual. A nose-up trim change will occur at a nominal 0·94M during recovery from the dive. If a PIO results from an attempt to compensate for this trim change, the throttle should be smoothly closed to Idle and the control column released. Control should be re-established when the Mach Number has reduced to a nominal 0·90M.

c. A high frequency airframe vibration may be felt at about 0.95M. This is caused by shock waves on the into-wind leading edge steps on the engine access doors.

d. Recovery from the dive should be made with the throttle at max and at no more than 2.5g.

Item 7- Cabin Altitude Check

36. **Purpose of Test.** To confirm that the cabin pressurisation system is operating satisfactorily.

37. **Technique.** Establish the aircraft at FL 350, set 90% RPM

a. Record cabin altitude (18,000± 1000 feet)

38. **Comments.** None

Item 8 - Engine Response at Altitude

39. **Purpose of Test.** To verify that engine acceleration is surge free and that the time is within specification.

40. **Technique.** Establish the aircraft at FL 350 with the throttle at Idle.

a. Once the RPM has stabilised, record the idle RPM

b. Record max RPM from the climb table.

c. At 160 KIAS, with not less than 70% RPM, slam to max RPM.

d. Record the time from IDLE to max RPM minus 4% (Limit 18 seconds).

e. Confirm that the engine acceleration is smooth and surge free.

41. **Comments.** If airframe buffet is felt, check forward slightly to remove buffet. Ensure clear of buffet throughout the engine acceleration. A glide descent maintaining 160KIAS with the throttle at Idle may be required. During the throttle slam the aircraft will tend to roll to the left due to engine gyroscopic effects. This will be particularly evident if the slam is carried out stick free. An engine surge, stall or overtemperature is indicated by an excessive TGT for the RPM setting, it may be accompanied by a banging sound from the engine and, if a TGT of 685°C has been exceeded, the T6NL caption illuminating.

Item 9 - GTS Check

42. **Purpose of Test.** To ensure the GTS performance is adequate to provide an assisted relight within the cleared envelope.

43. **Technique.** Carry out a spiral descent in a 2·0g turn at 0·75M with the throttle at Idle.

a. At FL 240, press the relight button for two seconds. Light up should occur by FL 200 and recovery should be made at that height. If the GTS does not start, a total of three attempts may be made with a waiting period of three minutes between attempts.

b. Confirm that the generator off-loads when the relight button is pressed, followed by the AC1, AC2 and, if applicable, AC3 warning captions.

c. Select a straight, level, unaccelerating attitude, reset the generator and check the AC captions extinguish.

d. Select ENG START OFF (for a minimum of five seconds) and then ON, ensure that the GTS MI changes to black.

e. Note the number of attempted or actual GTS starts.

44. **Comments.** If the aircraft is not maintained in straight, level and unaccelerating flight when power is reapplied to the NSU it will not align correctly, making cockpit attitude and heading indications incorrect with no fail flags displayed.

Item 10 - Trim Check

45. **Purpose of Test.** To demonstrate that the aircraft retains acceptable directional trim characteristics throughout the level flight speed envelope with a set trim position.

46. **Technique.** Trim the aircraft in level flight at FL 150 and 0·70M with the slip ball central.

a. Accelerate to maximum level flight Mach Number and note:

(1) Initial slip ball excursion.

(2) Mach Number for onset of airframe buffet.

(3) Mach Number for onset of compressibility buffet.

(4) Maximum level flight Mach Number.

(5) Directional out-of-trim at maximum Mach Number (position of slip ball).

(6) Characteristics of any directional oscillations present during acceleration.

b. Decelerate in level flight to 0·60M and note:

(1) Slip ball movement resulting from power reduction at maximum Mach Number.

(2) Directional out-of-trim at 0·60M.

(3) Characteristics of any directional oscillations present during deceleration.

47. **Comments.** Onset of airframe buffet before nominally 0·74M is unsatisfactory. Compressibility buffet starts at nominally 0·78M. Maximum level flight Mach Number is nominally 0·84M at FL 150.

a. Directional out-of-trim of nominally half a slip ball is acceptable at Mach Numbers up to 0·80M. Between 0·80M and maximum level flight Mach Number, out-of-trim of nominally one slip ball is acceptable.

b. Up to nominally two balls of slip ball movement should be expected as a result of power reduction at the start of the deceleration. At 0·60M out-of-trim of nominally half a slip ball is acceptable.

c. Some directional oscillations may be experienced, particularly during the deceleration. Provided these are of small amplitude and not continuous they are acceptable.

Item 11 - Min Control Speed - Clean

48. **Purpose of Test.** To demonstrate that the aircraft wings level stall and post-stall characteristics, zero flap and gear retracted, are satisfactory and typical for the Mark.

49. **Technique.** Descend to 10,000ft MSD and record fuel mass and aircraft test mass.

a. Trim the aircraft in straight line un-accelerated flight, speed 1·4 x the projected minimum control speed (derived from Fig 2 of the FTS). The minimum control speed should be ±3 kts of the figure derived from Fig 2.

b. Set approximately 70%, decelerate the aircraft at a nominal 0·5 to 1 knot/sec to stick hard back and note:

(1) IAS for buffet onset.

(2) IAS when the stick reaches the fully aft position.

c. Recover the aircraft and repeat the test.

50. **Comments.** The stall occurs at an airspeed several knots higher than the minimum IAS defined by stick hard back. Post-stall, yaw may develop on the aircraft which in turn will generate a response in roll if

unchecked. The yaw should be controlled with rudder as application of ailerons alone may be insufficient to control the rolling motion.

a. If stick hard back is maintained the aircraft will develop a high sink rate, with airspeed increasing. Pitch oscillations may develop.

b. The standard stall recovery will recover the aircraft promptly at any stage of the stall although height loss will be greatest in recovery from a fully developed stall.

Item 12 - RAT Operation

51. **Purpose of Test.** To ensure the RAT performance is sufficient to provide hydraulic power for the flying controls at airspeeds down to a safe landing speed.

52. **Technique.** Carry out the test at approx 10,000ft MSD. Maintain speed between 150 and 200 KIAS, reduce engine RPM to idle and deploy the RAT by vigorous control column movements. When the RAT is deployed and operating, increase the RPM to 80%.

a. From the rear cockpit lower the landing gear and full flaps. Record the time taken for the gear to lower (max 10 secs).

b. Reduce speed slowly. The HYD 2 pressure should continue to cycle 160 to 210 bar as the speed reduces to 105 KIAS or the onset of stall buffet, whichever occurs first.

c. Increase IAS and/or RPM and reset the RAT.

d. From the rear cockpit raise the gear and record the time taken to retract (max 10 secs).

e. Reset the rear cockpit undercarriage override selector.

f. Set the rear cockpit Flap switch to Pupil.

53. **Comments.** The RAT performance is very dependent on engine RPM, therefore 80% RPM must be accurately set and maintained during the test.

a. The RAT off-load IAS of 105 KIAS is applicable, provided the aircraft is not in stall buffet. At high aircraft masses, stall buffet onset will occur above 105 KIAS. In this case the RAT should operate down to the IAS at which stall buffet occurs.

54. **Comments.** Failure of the main undercarriage indicator to show UP following an UP selection will most probably be due to the main landing gear door microswitch failing to operate because of a maladjusted door. In this case, and to enable the test flight to continue, the UP indication may be achieved by reducing the airspeed so that reduced airflow over the door allows it to close fully.

Item 13 - Min Control Speed Gear and Flaps Down and Airbrake Interconnect.

55. **Purpose of Test.** To demonstrate that the aircraft wings level stall and post-stall characteristics in the landing configuration are satisfactory and typical for the Mark.

56. **Technique.** Maintain 10,000ft MSD and record fuel mass and aircraft test mass.

a. At 190kts select airbrake out. From the front cockpit select gear down and full flap. Confirm that the airbrake retracts when the gear is selected down.

b. Trim the aircraft in straight line un-accelerated flight, speed 1·4 x the projected minimum control speed (derived from Fig 2 of the FTS). The minimum control speed should be ±3 kts of the figure derived from Fig 2.

c. Set approximately 85%, decelerate the aircraft at a nominal 0·5 to 1 knot/sec to stick hard back and note:

(1) IAS for buffet onset.

(2) IAS when the stick reaches the fully aft position.

d. Recover the aircraft and repeat the test.

57. **Comments.** The stall occurs at an airspeed a few knots higher than the minimum IAS defined by stick hard back. The margin between buffet onset IAS and the minimum IAS is typically 6 knots. A margin of less than 4 knots is unacceptable.

a. Post-stall, although there is less tendency for yaw to develop on the aircraft than in a flaps retracted stall, there is an increased tendency for a pitch oscillation to occur. This may develop into a combined pitching and rolling motion which is difficult to control.

b. If stick hard back is maintained the aircraft will develop a high sink rate, with airspeed increasing and the aircraft continuing to oscillate in pitch and roll.

c. Forward stick movement will recover the aircraft promptly at any stage of the stall although height loss will be greatest in recovery from a fully developed stall.

Item 14 - ASI Checks

58. **Purpose of Test.** To ensure that the ASI readings are within limits at slow speed.

59. **Technique.** At a speed between 110 to 130 KIAS record the front and rear cockpit ASI readings (±2 knots between cockpits). When complete, accelerate and raise the gear and flaps from the front cockpit.

Item 15 - Inverted Flight Test

CAUTION: Inverted flight must be kept to the minimum required to complete each element of the test, and in any case must be less than 30 seconds for either element.

60. **Purpose of Test.** To verify the correct operation of the negative-g hold-off time relay for the FUEL and OIL warnings. To demonstrate that the aircraft flight characteristics down to the aircraft negative-g limit are satisfactory and typical for the Mark.

61. **Technique.** It is recommended that the two test objectives are covered in separate elements of the test.

a. Trim the aircraft in level flight at maximum engine power setting.

b. Roll inverted and commence timing when g meter needle passes zero.

c. Record the following:

(1) Time to FUEL and OIL warnings ON (10 ± 2 seconds).

(2) Check no FPR caption.

(3) Check no loose articles.

d. Resume normal flight, check captions go out and retrim aircraft in level flight.

e. Roll inverted and push briefly to -3·5g.

f. Resume normal flight and check captions go out.

62. **Comments.** At maximum engine power at FL 100, the level flight Mach Number is typically 0·83M. The negative-g limit of -3·5g applies for Mach Numbers less or equal to 0·80M.

a. If the FPR caption comes on while the aircraft is inverted, immediately throttle back to Idle and recover to normal flight. After completion of the first test element a period under positive-g equal to or greater than the period under zero or negative-g in the first element must be flown before the second test element can start.

(1) Once inverted, ensure the aircraft g remains below zero g or the relay will reset.

(2) Towards the end of the inverted run mild engine vibration may be present. This is normal.

Item 16 - Spinning

CAUTION: For a Maintenance Test Flight (MTF) spin testing is only permitted following satisfactory completion of the zero flap stall testing and demonstration of the correct operation of the GTS and RAT. For a Partial Flight Test (PFT), operation of the GTS and RAT are not required prior to spinning, unless specifically required by the authorising engineer or the pilot carrying out the Flight Test.

63. **Purpose of Test.** To demonstrate that the aircraft spin characteristics, including spin recovery, are satisfactory, are similar in left and right spins and are typical for the Mark.

64. **Technique.** Climb to FL 300 and enter a 30°AoB turn, ensuring ailerons neutral, Idle selected and TGT below 300°. At 160 KIAS apply full pro-spin controls in the direction of the turn and enter a spin of up to four turns. Recovery should be within two turns.

a. Repeat this exercise in the opposite direction.

b. Confirm that the left and right spins have similar characteristics and that the engine is surge free.

65. **Comments.** Standard spin entry and recovery control actions and the limitations associated with spinning are detailed in this manual.

a. Rapid application of the pro-spin controls may generate a spin which is significantly oscillatory. Smooth simultaneous application of rudder and tailplane (ailerons neutral) in nominally 1 second to 2 seconds is recommended.

Item 17 - Max Speed Handling at 2000 ft AGL

66. **Purpose of Test.** To demonstrate that:

a. The aircraft flight characteristics at maximum permitted IAS and normal g are satisfactory and typical for the Mark.

b. The aircraft high speed, low level performance is satisfactory and typical for the Mark.

c. The rudder circuit is free from vibration in high speed, low level flight.

d. The aircraft response to deploying airbrake is satisfactory and typical for the Mark.

e. Aircraft trim requirements in high speed, low level flight are satisfactory and typical for the Mark.

67. **Technique.**

a. Dive the aircraft to attain 550 KIAS at no less than 2000 feet AGL and confirm satisfactory handling.

b. Pull 5·5g, decelerate to 500 KIAS and confirm satisfactory handling.

c. If gunpod and/or bare pylons are fitted pull to 7g or for a basic aircraft pull to 8g and confirm handling is normal in pitch.

d. Re-establish level flight at 2000 feet AGL with full power set. When stable, record:

(1) RPM

(2) TGT

(3) KIAS

(4) Mach Number

e. With full power still set at 500 KIAS, apply light rudder in each direction and confirm there is no vibration.

f. Adjust speed to 500 KIAS and re-trim in steady level flight at 2000 feet AGL. Extend the airbrake and check for:

(1) Normal extension characteristics.

(2) Directional change is less than ½ slip ball width.

(3) Stick free incremental g is − 1·5g maximum.

g. Adjust speed to 0·70M, when stable accurately record the aileron and rudder trim positions, the tailplane incidence and the rear tailplane indicator reading. At 0.7M, trimmed straight and level, ensure the front cockpit TPI gauge reads 1.5° to 2.0°. The rear cockpit TPI gauge should read within 0.5° of the front cockpit gauge.

68. **Comments.** For rudder vibration test, apply pedal force to give small pedal deflection.

a. Airbrake deployment, stick free may cause a small lateral stick deflection and hence a gentle roll to develop. Deployment should be made pedals fixed.

b. The rudder and aileron trim settings established in high speed, low level flight should be maintained to engine shut down if practical.

Item 18a - Approach and Landing - ILS

69. **Purpose of Test.** To ensure correct operation of the ILS and navigational instrumentation.

70. **Technique.**

a. On the HSI set the Track Index to the QDM to be used for ILS approach/landing.

b. With ILS selected on both CCS station boxes ensure audio ident is heard in both headsets.

c. Carry out a normal ILS approach ensuring that the Glideslope and Localiser drift indications on the HSI are consistent with the approach path of the aircraft. Small flight deviations left/right of the Localiser should be indicated by left/ right on the drift indicator; similarly, above/below flight deviations of the Glideslope should be indicated by the Glideslope needle indicating above/below centre.

d. Ensure as the aircraft approaches and passes over each of the Markers an audio tone is heard and the Marker light on the centre instrument panel momentarily illuminates.

e. Ensure indications of Localiser and Glideslope deviation indicated on the front and rear HSIs match throughout the approach/landing.

Item 18b - Approach and Landing - Wheelbrakes

71. **Purpose of Test.** To check the correct operation and performance of the anti-skid system.

72. **Technique.** Land the aircraft normally, apply maximum braking and pull the stick fully aft as soon as conditions permit.

a. Check (on the brake gauges) that anti-skid behaviour is normal and both brake gauge needles are flickering in unison (indicating cross-coupling).

73. **Comments.** The IAS at which the stick can be pulled fully aft will depend on the landing conditions. On wet surfaces the reaction from the brakes is not sufficient to stop the nose from rising if the stick is pulled fully aft at high speed.

a. On the first landing following the installation of new brakes the anti-skid system may remain active down to very low speeds (less than 50 KIAS) even on a dry runway. In this case the anti-skid system may provoke severe aircraft pitching. If this occurs, braking should be relaxed.

b. On the first few landings following the installation of new brakes, the brake performance may be lower (slightly longer landing run) than normal. This is because the brake pads are not yet bedded in. Normal performance is usually achieved after three or four braked landings.

Item 19 - Engine Shutdown

74. **Purpose of Test.** To confirm that the engine is within specification.

75. **Technique.** Allow 30 seconds at Idle for the RPM and TGT to stabilise, then record the RPM and TGT.

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